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EDITORIAL

A NEW alloy which will reduce the demand for tin is "P.M.G." This is made by Vickers-Armstrongs, Ltd., and it is intended as a substitute for Admiralty gun-metal. The latter alloy consists of 88% copper, 10% tin, and 2% zinc, whereas in P.M.G. a hardener consisting of silicon, manganese, and iron is used instead of tin.

THE retirement of Lord Harris from the chairmanship of the Consolidated Gold Fields of South Africa after a tenure of the office for over thirty years is an event which both shareholders and the public regret. His record in the City may be best described by the employment of a metaphor from his favourite pastime: "He played the game."

IN this issue three folding supplements illustrate the article by Mr. J. M. Callow on the mill and smelter at Mount Isa, which he designed, and by aid of these drawings a very complete idea can be obtained of the methods to be adopted for the treatment of the ore. The issue also contains a similarly informative article on the system of mining adopted, written by Mr. C. A. Mitke, consulting engineer to the operating company.

THE building of the new home of the Museum of Practical Geology, so long known as the Jermyn Street Museum, is to be commenced at an early date. It will form an extension easterly of the Natural History Museum, South Kensington, and will face Exhibition Road, being side by side with the Science Museum, with which it will be connected by a bridge. The cost is estimated at £200,000, but as the present site in Jermyn Street belongs to the Crown and is of great value the geologists may congratulate themselves on not adding to the financial burdens of the country.

MODERN art does not come within the scope of the MAGAZINE, but when it is announced that a picture called "The Fossil Hunters" received high commendation in America when hung upside down the mining man's attention is attracted and a smile at the expense of both painter and the public is inevitable. Seriously, however, even photographs leave some doubt of their true orientation when they portray a geological exposure either at surface or underground. On many an occasion an editor is at a loss to interpret such a photograph and cases have been known of a picture being presented in a position wrong by 90° or 180°. So the editor's smile at the blunder now recorded is tinged with a certain amount of sympathy.

RESEARCH at the old mining and metallurgical centre of Lydney, on the fringe of the Forest of Dean and near the banks of the Severn, has revealed the existence of an iron mine which is definitely ascribed to the era of the Roman occupation. The exploration has been conducted by the Society of Antiquaries and the owner of the land, Lord Bledisloe, is presenting the site to the nation. The shaft has been cleared for a distance of 30 ft.; it is found to be from 1 ft. 6 in. to 2 ft. wide and it dips at 20°. No doubt further work will be done in re-opening it, when its history and method of development will be better appreciated.

IN these days, when it is customary to exhibit apparatus which formed the beginnings of celebrated inventions, the exhibition at the Science Museum of instruments hitherto privately housed at the Royal Institution deserves special attention. For the first time the public are able to inspect Sir Humphry Davy's early apparatus for indicating electro-chemical effects and for preventing flames passing through wire gauze. Many inventions by Faraday are illustrated in their infancy, such as the discovery of benzene, the manufacture of the induction coil, and the demonstration of diamagnetism and of the magnetic ray. More recently the apparatus employed by Tyndall, Rayleigh, and Dewar have become famous and many of these are now on show. It is to be hoped that the authorities at the Museum and the Royal Institution will prepare printed descriptions of the various apparatus and thus greatly increase the value of the exhibition.

THE case relating to the damage done by the discharge of sulphurous gases into the atmosphere from the Manchester electric light station came before the House of Lords last month, when it was unanimously decided that the Corporation was committing a nuisance which must be mitigated. At about the same time the Committee appointed by the Minister of Transport to inquire into methods for preventing the escape of

these fumes at the Battersea power station, now about to be built, issued a report describing tests which indicate that these gases can be removed by scrubbing with water. Further, this report indicates that the water which has absorbed these gases will not be a nuisance in itself, as it and the condenser water drawn from the Thames or from the water mains contain sufficient carbonate of lime to neutralize the acid, the resulting material being nothing more harmful than sulphate of lime.

IN view of the secrecy attending the meeting of the Tin Producers' Association on November 27 and the bald character of the official announcement it is not easy to express an opinion as to what progress has been made in the direction of stabilization as the result of their action. It would appear that those present—not by any means representative of the industry as a whole—agreed that a percentage of their output should be held by the smelters, but whether the smelters would be agreeable to this and on what terms did not transpire, nor, so far as we can see, would there be any restriction in the output of any of the contracting parties, so that it would be possible for any of the companies to increase their production so as to counterbalance the quantity which it is suggested should be retained by the smelters. Since the meeting of the Association was held news has come to hand that the Malayan Government may relieve the position by instituting a six-day week for labourers.

IN South and Central Africa railway and other communications are continually to the fore in public discussions. No sooner had the announcement been made that the Government was postponing indefinitely the short cut via Kafue-Sinoia from Northern Rhodesia to Beira than the agitation for the construction of a line connecting the Rhodesian Railways with Walvis Bay, on the South Atlantic, was resuscitated. In writing of this project some time ago we stated that a railway from British Central Africa to the Atlantic would have the disadvantage of passing through country of little commercial value, some of it being swampy and some absolute desert. It appears, however, from information gained by the Aerial Survey, that a track might be chosen where natural conditions are more favourable. Mr. Moffat, the Premier of Southern Rhodesia, has expressed his interest in the project and no doubt steps will be taken to survey the country by some official body. The country from Walvis Bay to Bulawayo is already crossed for a third of the distance by the lines from the coast to Gobabis and Grootfontein and the question now to be settled is whether Bulawayo, Wankie to the north, or Plumtree to the south would provide the best route for the remainder of the line.

Nigeria during 1928

Though the appearance of the report of Mr. Langslow Cock, Chief Inspector of Mines for Nigeria, for the year 1928 is somewhat later than usual, it is full of interesting matter and helps to keep account of the progress of the colony. During the year under review there were 83 mining companies and 70 individual workers operating on tin in Nigeria, as compared with 82 and 78 respectively during the previous year. In addition one individual was winning gold and one was mining silver-lead, while one company was producing both silver-lead and zinc. The total output of tin concentrate was 13,045 tons, as compared with 11,509 tons in 1927 and 10,595 tons in 1926. The total working costs, including royalties, freights, returning charges, and London office expenses, averaged £130 per ton of concentrate produced. The average price of tin concentrate during the year, based on the London figures for the metal submitted quarterly, was about £165 per ton, so that the average profit worked out at, roughly, £35 per ton, as compared with £70 in 1927. It will be seen that with tin metal at the price ruling recently the average profit attending tin-mining operations in Nigeria will be virtually a non-existing quantity unless some reduction in working costs has been possible. In this connection the substitution of mechanical methods for human labour may bring down the cost. During 1928 labour-saving plant and machinery represented 12,200 h.p., as against 9,100 h.p. in 1927 and 6,100 in 1926. The European labour at the mines for 1928 was 363, against 331 in 1927, and the native labour employed was 39,757, against 37,115.

The output of gold was a negligible amount, being only 64 oz., but this was 42 oz. more than the production for 1927. As regards lead and zinc, 31 tons of silver-lead concentrate was won by the Nigerian Base

Metals Corporation, as compared with 316 tons in 1927, in addition to which 124 tons of zinc concentrate was obtained. Development of the silver-lead deposits at Zurak, in Adamwa Province, was continued by the British (Non-Ferrous) Mining Corporation. Here a three-compartment shaft was sunk during the year to a depth of 75 ft. and a second shaft was sunk from 45 ft. to 85 ft., a connection between the two being made for the purposes of ventilation. The lode has been proved over a considerable distance and at a depth of 90 ft. it consists of 18 in. of solid galena assaying over 100 oz. silver per ton. At present the company is only undertaking development work, while waiting for adequate transport facilities, which the new railway will give.

Mr. Langslow Cock refers to the work done on the hydro-electric installation to harness the power of the Kurra Falls as the most interesting development in the Nigerian mining region during the period covered by his report. As an account of this scheme was given in the issue of the MAGAZINE for October details need not be quoted here, but it is useful to know that he has formed a high opinion of the importance of the project.

Electrolytic Zinc

The commercial position of electrolytic zinc was the subject of a lecture at a recent meeting of the San Francisco Section of the American Institute of Mining and Metallurgical Engineers, delivered by Mr. Arthur Zentner, a metallurgist formerly connected with the Anaconda company and more recently known in London as an adviser to the National Mining Corporation. A few notes based on this lecture will prove of interest to readers of the MAGAZINE. Mr. Zentner estimates that the world's production of electrolytic zinc during 1929 will amount to about 369,000 tons, as compared with 3,500 tons in 1913, when the only producer was Brunner, Mond and Co. The rapid adoption of the method has for the past three years represented the total increase in the world's output of zinc, for the production by the distillation process is stationary, and it is probable that in many cases when the conditions governing the use of the present retort plants alter they will be closed down.

The largest producer of electrolytic zinc is the Anaconda company, in Montana, the capacity of its plant at Great Falls being 340 tons per day and of that at Anaconda 170 tons. The Bunker Hill and Sullivan and the Hecla companies have a joint plant at Kellogg, Idaho, the daily capacity of which is 70 tons. A plant with a daily capacity of 55 tons is in course of construction by the Evans-Wallower Zinc Co., at East St. Louis, Illinois, and it is expected to be in operation before the end of the current year. Over the border in Canada the Consolidated company, at Trail—of which details are given in an article in this issue—is producing 280 tons per day and the installation is being extended to a capacity of 380 tons per day, which will make it the largest individual plant in the world. A plant is being built by the Hudson Bay Mining and Smelting Co. to treat concentrates from the Flin Flon copper-zinc mine in Manitoba, the Noranda Mines at Rouyn have announced their intention of building a plant, and the Treadwell Yukon, near Sudbury, Ontario, and the Buchans Mine, in Newfoundland, are likely to make a similar decision. The Consolidated company announces its intention to build a plant in East Canada, but the source of the ore has not yet been made public.

In Africa the Rhodesia Broken Hill is producing 30 to 40 tons per day and in Tasmania the Electrolytic Zinc Co. of Australasia has a daily output of about 150 tons, with an early prospect of an increase when the Read-Rosebery concentrates are ready for treatment. In Europe there are a number of plants at work or in course of erection. Two of these are in Silesia, one of which is on the Polish side and the other on the German side of the boundary, both belonging to the Giesche firm, which is now financed by the Anaconda company. In Norway a plant is nearing completion for the treatment of concentrates from the Asturiana mine, in Spain. The Vieille Montagne company has a works at Viviez, in the south of France. In Italy the Montefione company operates near Genoa and the Pertusola company at Cotrone. As regards other countries, plants are being built by the Cerro de Pasco in Peru and by the Soviet Government in the Altai Mountains.

Originally the electrolytic method was adopted instead of the retort process where water power was plentiful and cheap and fuel scarce and expensive. Other factors in this connection have since arisen. In the first place it was found that the fine zinc concentrates obtained from complex ores

and the fume from slags and old residues could be treated with much better results electrolytically than by distillation, and, secondly, a demand for pure zinc has sprung up and there are modern uses for zinc which are only effective if pure electrolytic zinc is employed. The economic problem of coal *versus* water power has also changed to some extent during recent years, for it has been found that in many cases pulverized fuel and the steam turbine will generate current as cheaply as the water turbine. With regard to the purity of electrolytic zinc, it is notable that by the Tainton method, developed at Kellogg, Idaho, a zinc assaying 99·99% is obtained, as compared with 99·94% by the ordinary electrolytic process. It will be remembered that a description of the Tainton process was given in the MAGAZINE for January last, from which it was seen that much stronger acid and a higher current density are employed than is customary, conditions which are found to be favourable for the production of an absolutely pure zinc from what might be considered unfavourable material. The method has been adopted by the Bunker Hill and Hecla companies and by the Evans-Wallower. Whether any of the new plants we have mentioned are to use the process is not known, but the probability is that some of them will. On the other hand, the companies using the ordinary process have not found it an economic proposition to make a change.

Ventilation Problems

Although the paper before the November meeting of the Institution—"Studies in Ventilation at the Crown Mines, Witwatersrand"—is too full of exact information to lend itself to reproduction in part in the Mining Digest, it contains many points well worthy of consideration and brought a promise from Mr. R. E. Palmer that he would in the near future give a similar paper dealing with the problems at the Rio Tinto. In the unavoidable absence of the author, Mr. C. W. B. Jeppe, the paper, a somewhat lengthy one, was presented by Professor Truscott. It has long been recognized that for many reasons proper ventilation of the large mines on the Rand is a difficult problem. They are in many cases—the Crown Mines is an example—amalgamations of numerous properties, whose exploitation was previously carried on independently. While amalgamation may have improved matters to some extent, it has had the disadvantage that the boundaries of adjoining properties have been mined, permission having been given from time to time by the Government to work out many of the old boundary pillars. This, together with the caved ground in the shallower workings, means that there are many exits and entrances to the mine which cannot be watched or sealed. To some extent this difficulty has been eliminated by sealing the outcrop and closing many of the connections with adjoining mines, but there still remains a great deal of leakage into the ventilation system. On the Crown Mines Mr. Jeppe pointed out that, although only 550,000 cubic feet of air per minute is downcast in the summer months, the exhaust fans are removing 750,000 cubic feet, this representing an enormous waste of power.

Another important consideration is the prevention or mitigation of silicosis. Silica dust present in the air renders it necessary to use large quantities of water to lay the coarse dust, and in order to remove the fine dust every dead end has to be supplied with copious air draughts, resulting in damp air and splits in the airways. In addition, the altitude of the Rand necessitates an increased supply of air to secure a given measure of oxygen. One of the factors in the layout of the mine which added to ventilation difficulties was, perhaps, the fact that many of the central shafts, which are naturally upcast, had to be made downcast, as they are used for hoisting men and materials. The foregoing, with the additional one of keeping down expense incurred in the maintenance of permanent airways, probably constituted the main difficulties which had to be overcome in the Crown Mines, and the measure of success attained was such that air temperatures in the working places were never more than 81° F., though this result, it should be added, was partially due to the gradual geothermal gradient in the mine and the dry air condition at the surface.

In the discussion which followed Mr. A. J. Brett spoke highly of the ability of the manager, Mr. R. C. Warriner, and his staff in inaugurating the ventilation scheme when the system of mining was rearranged on the consolidation of the properties and he pointed out the difficulty of seeing far ahead for ventilation and other purposes in a metal mine when work must follow the payable ore.

REVIEW OF MINING

Introduction.—The past month has been very quiet in City mining circles, the depression being largely due to Stock Exchange troubles both in London and New York. The metal market has been dull in all sections and prices have ruled low. In consequence the time has been inopportune for new business.

Transvaal.—The output of gold on the Rand during November was 827,952 oz. and in outside districts 33,641, making a total of 861,593, as compared with 888,690 oz. in October. At the end of November the number of natives working at the gold mines was 186,941, as compared with 189,739 at the end of October.

The report of the Consolidated Gold Fields of South Africa for the year ended June 30 last shows an increased profit and the company is thus able to maintain its dividend of 15% on the ordinary shares, in spite of the increase in the capital last year from £2,000,000 to £2,500,000. The New Consolidated, which is the operating company and whose shares are all held by Consolidated Gold Fields, made a profit of £887,950, as compared with £694,787 the year before. After allowing £300,000 for depreciation and taxation, the company is paying £447,555 as dividend to the Consolidated Gold Fields and carries forward £173,339.

The annual report of the Van Ryn Gold Mines Estate records the estimated ore reserves at the end of the financial year as 961,944 tons, of an average value of 4·3 dwt., a decrease of 138,995 tons in quantity and 0·3 dwt. in value for the year. The decrease in value is largely accounted for by the fact that development has been almost entirely confined to the upper leaders, which have a lower value than the Main Reef. During the year 463,600 tons of ore was milled for a recovery of 110,718 oz. of gold, worth £470,552. In addition the slime plant recovered gold worth £7,160, the gross profit being £71,780. That a mine working values so low as 4·3 dwt. should yet make a substantial profit reflects well on the management.

Southern Rhodesia.—The output of gold during October was 46,923 oz., as compared with 45,025 oz. in September and 43,056 oz. in October last year. The number of producers reporting was 133. Other outputs in October were: Silver, 6,496 oz.; copper, 45 tons; coal, 111,793 tons; chrome ore, 28,862 tons; asbestos, 4,654 tons; mica, 26 tons; scheelite, 5 tons; diamonds, 5 carats.

An important move is being made in connection with the Rhodesian and General Asbestos Corporation, the company which is working the Shabanie group of mines so profitably. The firm of Turner and Newall, of Rochdale, the manufacturers of asbestos goods, has made an offer to buy the whole of the issued share capital of this corporation. The Rochdale company already controls several companies producing asbestos, of which Bell's United Asbestos is the most notable. The new deal involves a large amount of money, for the issued capital of the Rhodesian company is £1,050,000 and the £1 shares stand at around £5. The standing of Turner and Newall can be gauged by the fact that a net profit of £824,798 was made during the year ended September 30.

Northern Rhodesia.—At the meeting of the Johannesburg Consolidated Investment Co. held last month the chairman, Professor J. G. Lawn, stated that the company is interested in the Northern Rhodesian copper field through the Rhodesian Anglo American generally and in the Bwana M'Kubwa particularly. Incidentally, he protested against the publication of ill-informed articles which spoke of metallurgical difficulties, scarcity of native labour, and transport troubles, and casting doubts upon the reliability of estimates of tonnages and assay-values. He confirmed the general opinion that the world's consumption of copper will continue to increase and that the requirements in 1937 will have risen to 3,000,000 tons. Apart from Northern Rhodesia, no large new copper deposits are known or are indicated, and a number of present producers will be exhausted before that date. In fact, if it were not for the development of the Rhodesian deposits, there would be a risk of a scarcity of supply in a few years' time. Professor Lawn expected that by 1933 or 1934 the yearly output of Rhodesia would reach 250,000 tons, with a progressive increase thereafter.

A report of the meeting of the Roan Antelope Copper Mines, Ltd., which is controlled by the Rhodesian Selection Trust, appears elsewhere in this issue. From this it will be seen that the company now owns the adjoining Roan Antelope Extension and the Muliashi areas, which contain the continuation of the deposit in depth. It

is estimated that in the eastern or shallower section for a distance of 16,000 ft. to the 28th bore-hole the reserve amounts to 75,000,000 tons of ore averaging 3·33% of copper, of which 96·4% exists as sulphide. West of this bore-hole for a distance of 1,000 ft. six holes have intersected ore averaging 29 ft. in width and assaying 3·5% of copper, but further drilling is necessary before an estimate of the reserve can be made. It is of interest to learn that in depth larger proportions of bornite and chalcopyrite make their appearance, in place of chalcocite, and that a cobalt sulphide, probably linnæite, occurs in small amounts associated with the other sulphides. As regards metallurgical operations arrangements are being made to smelt the concentrates from Mufulira, which also belongs to the Rhodesian Selection Trust, at the Roan Antelope smelter and in consequence the smelter is to be extended. This will entail the postponement for a year or so of the production of copper from the Roan Antelope which had been originally intended to commence in June, 1931.

The report of the Rhodesian Selection Trust for the year to June 30 last deals with the extent of the exploration which has been done on the Mufulira mine. Sulphide ore has been proved by drilling over a length of 7,000 ft. and approximately 1,600 ft. on the dip, the width of ore being 85 ft. averaging 4·65% copper. It has been decided to develop this mine by means of four secondary inclined shafts, the initial plant being designed to deal with 5,000 tons of ore per day. Drilling on the Chambishi and Baluba areas is being continued, but work on the Mokambo location has been suspended for the present. Arrangements have been concluded with the American Metal Company, the Lehman Corporation, and Messrs. Cull and Co. to provide the funds required to develop and open up the properties.

Gold Coast.—The Consolidated African Selection Trust, of which Mr. A. Chester Beatty is chairman, reports a profit of £207,209 for the year ended June 30, which accrued from the operations of African Selection Trust, and dividends, at the rate of 70%, absorbed £174,844. The company also holds 160,000 £1 shares in Cape Coast Exploration, Ltd., which made a profit of £61,000 for the past year, the whole of which was carried forward.

Australia.—In reviewing the activities of the Mining Trust, Ltd., at a special meeting of shareholders held last month, Mr. Leslie Urquhart mentioned that the Lawn Hills silver-lead-zinc mines had been acquired. These deposits have been known for a number of years, but absence of railway communication has hitherto stood in the way of profitable operation. In the MAGAZINE for November and December, 1925, the views of Mr. E. C. Saint-Smith, Government Geologist for Queensland, were quoted. He reported that the mines are 110 miles from Burketown, the port on the Gulf of Carpentaria, and that they could be worked profitably if a railway was built. He also stated that failing a railway profits could be made by concentration on the spot and delivering the concentrates to Burketown by tractor.

In the issue of the MAGAZINE for November, 1928, it was recorded that the Mount Elliott company, of which Mr. J. A. Agnew is chairman and Mr. C. Q. Schlereth consulting engineer, intended to reopen and equip the Mount Oxide mine. In the report of the company for the year ended June 30 last it is announced that, owing to the difficult labour conditions prevailing in the Cloncurry district of Queensland, the programme at Mount Oxide is to be postponed. Meanwhile the company has secured an interest in the South American Copper Company.

Great Boulder has been forced to close down temporarily as the result of a fire which has damaged the power house running the mill.

The Mount Lyell Co. made a net profit of £324,128 during the year ended September 30 last, the dividend and bonus amounting to 4s. The smelter treated 4,587 tons of ore, 34,160 tons of concentrate, and 1,328 tons of pyritic flux and produced 7,869 tons of blister copper, containing 7,803 tons of copper, 127,687 oz. of silver, and 2,492 oz. of gold. The ore reserve at North Mount Lyell is estimated at 1,013,672 tons, averaging 5·25% copper and 1 oz. silver and 0·3 dwt. gold per ton, and at Lyell Comstock 600,000 tons, averaging 3·25% copper and 0·25 oz. silver and 0·6 dwt. gold per ton.

Canada.—Arrangements have been made for the amalgamation of the Huronian Belt Co. and the Pioneer Mining Corporation, the English and Canadian companies respectively which are under the chairmanship of Mr. F. H. Hamilton. The new company is to be called the Huronian Mining and Finance Co. and it will acquire certain interests from the Keeley and Vipond

companies, in addition to the whole of the assets of the Huronian Belt and Pioneer companies. The chairman of the new company will be Mr. R. Home Smith, who is president of the Toronto Land Corporation and of the Algoma Central and Hudson Bay Railway Co. This transfer of interests would seem to indicate that Canadian business can be more conveniently managed in Canada than in London.

Malaya.—In last month's issue it was recorded that the Chief Secretary of the Federated Malay States was considering a proposal for the Government to cease to grant new mining leases. It has since been officially announced that except in special cases no application for mining land or for conversion of agricultural to mining title outside of the existing mining areas will be considered and, further, that within such mining areas alienation or conversion will not in general be approved unless it is essential for the efficient development of existing undertakings. Undoubtedly such a step will give the Government some power in preventing over-production of tin, but such relief will not accrue for a year or two yet. Elsewhere in this issue mention is made of the proposals for more immediate relief of the position.

As recorded in the Company Reports, Pahang Consolidated has been able to maintain its dividend of 20%, though the price per ton received for the tin concentrates produced fell to £142 19s. 6d., as compared with £162 10s. 5d. the year before. The output rose from 2,464 tons to 2,526 tons, but a more important reason for the maintenance of profits was the reduction of working costs by 5s. 4d. per ton. The new pumping plant is expected to be in operation early next year, when it will be possible to undertake vigorous development at depth.

South Wales.—Owing to the depressed state of the zinc industry the distilling works of the English Crown Spelter Co. have been closed for a time.

Kent.—An Illingworth low-temperature carbonization plant has been erected at the Snowdown colliery, which is owned by Pearson and Dorman Long, Ltd. This process has been fully tested at Pontypridd and Treforest and the fuel produced is hard and smokeless, being suitable for burning in open grates as well as in stoves of all sorts. In addition it yields tar, oils, motor spirit, and sulphate of ammonia. The first unit at Snowdown is small, but it is to be increased to a capacity of 400 tons per day. This is the first case in this country where smokeless fuel is produced at the pithead.

Alaska.—It was announced recently that the Alaska Gold Dredging Co., which was floated to work alluvial gold and tin deposits in 1928, had suspended operations owing to the poor results obtained and that the directors recommended the liquidation of the company. It is now suggested that the liquidation should be postponed, as Mr. H. G. Scott, a director of the company and managing director for the East of the Siamese Tin Syndicate, has found an alluvial gold property in New Zealand which would suit the company. A meeting of shareholders will be held on December 18 to discuss the position.

Siberia.—The Tetiuhe Mining Corporation reports that the delay in the completion of the second mill unit and the obligation under the Concession agreement to erect a lead smelter within a limited period have put a considerable strain on the company's financial resources and have necessitated the obtaining of temporary advances from the Selection Trust. It has been decided, therefore, to issue debentures for £100,000 in order to put the finances on a more satisfactory basis. It is announced that the second mill unit is now in operation and that the smelter should be completed and earning revenue next year.

The Murex Company.—The Murex Company, which owns an ore-treatment process, expanded their business in January last when they completed the purchase of the Thermit processes from Imperial Chemical Industries, Ltd. That this policy of expansion is being continued is shown by the announcement that the company has acquired, also from Imperial Chemical Industries, 91·77% of the issued capital of the Premier Electric Welding Company. In each of these transactions the purchase has been made by the issue of fully-paid shares in the Murex Company.

A Lead Fusion.—Arrangements have been made for the acquisition of the remaining 60% interest in Walkers, Parker, and Co., Ltd., by the Associated Lead Manufacturers, Ltd., which company had previously held 40% of the share capital. Associated Lead will now control all the important lead manufacturing companies in England. In this connection it may be here recorded that the National Lead Company, of America, holds an interest in Associated Lead.

MINING METHODS AT MOUNT ISA

By CHARLES A. MITKE

The author describes the system of mining adopted at Mount Isa as initiated by himself.

INTRODUCTION.—Although a comparatively recent discovery, the Mount Isa mine in North-western Queensland already gives promise of becoming one of the world's largest lead-silver-zinc producers. Consistent diamond-drilling during the past eighteen months has resulted in the proving of 24,285,000 tons of ore. These figures are the more significant when it is understood that calculations have only been made to the 750 ft. level, vertically, whereas several diamond-drill holes have already indicated that there is no change in the nature of the ore at the 1,000 ft. level.

The ore occurs in sediments, principally shales, and appears to consist of a number of lenses, more or less parallel to each other. One large low-grade ore-body—the Black Star—and a number of smaller high-grade ore-bodies have been discovered to date. (See Fig. 1.) The low-grade ore-body parallels the mineral belt which contains the high-grade deposits at a distance of about 1,000 ft. to the west. Between these two belts, however, several drill holes have already disclosed the existence of new parallel ore lenses.

The Black Star ore-body has a proved length of 2,200 ft., with a maximum width of 230 ft. At the 500 ft. level it was found to continue at least 400 ft. further south than was indicated by surface prospecting. Six diamond-drills are now at work proving this ore-body in depth, and also exploring its north and south lateral extensions. Its proved ore reserves to date consist of 13,965,000 tons averaging 7·9% lead, 9·77% zinc, and 4·38 oz. silver per ton; and 9,400,000 tons averaging 4·3% lead, 6·2% zinc, and 2·2 oz. silver. The upper 150 ft. of ore is carbonate, mainly silver-lead, the zinc having been leached out, while the lower levels are sulphide.

FIG. 1.—OUTCROP OF BLACK STAR LODE TO BE MINED BY A SERIES OF GLORY-HOLES.

Of the known high-grade deposits, the more important are the Black Rock, Rio Grande, and Mount Isa. These three contain a total tonnage of carbonate ore above the 150 ft. level amounting to 420,000 tons, ranging from 12% to 22·4% lead, or an average of 16·9% lead, and from 4·4 to 10·6 oz. silver, or an average of 8·4 oz. silver. In the Rio Grande, the drills have blocked out a tonnage of 500,000 tons of

sulphide to the 500 ft. level, containing 15% lead, 4% zinc, and 15 oz. silver. No ore estimates in the Black Rock have been made below the 150 ft. level. Only the Black Rock and Rio Grande are being prepared for stoping at the present time.

The Black Rock high-grade ore-shoot is 350 ft. long by 20 ft. wide. A bore-hole on the 500 ft. level disclosed a vein hitherto undiscovered, 21 ft. wide, carrying 10·1% lead, 6·2% zinc, and 6·3 oz. silver.

The Rio Grande contains two lenses, separated by 5 ft. to 15 ft. of country rock. These lenses are as follows: No. 1, 620 ft. long, and 13 ft. wide; and No. 2, 600 ft. long, and an average of 14 ft. wide. The ore has been proved by diamond-drilling to a depth of 1,000 ft., where various veins were encountered, one carrying 20% lead, and 23 oz. silver over a width of 13 ft.

with a comparatively small production from each, would result in fairly high costs. A conclusion was therefore reached to unite the three larger ore-bodies (Black Star, Rio Grande, and Black Rock) underground, and operate them as subordinate divisions of one large mine.

Persistent search resulted in the finding of an ideal mill site, in a saddle between two hills, a short distance to the east of the high-grade belt. A site for a service shaft was located in the valley directly to the west of this belt, and about 1,700 ft. north-west of the mill. It was decided to sink an ore-hoisting shaft on the hillside at the head of the mill, and connect the two shafts underground. This connecting drift would pass through the high-grade mineral belt, which lies between the two shaft sites, and connections might readily be made from it

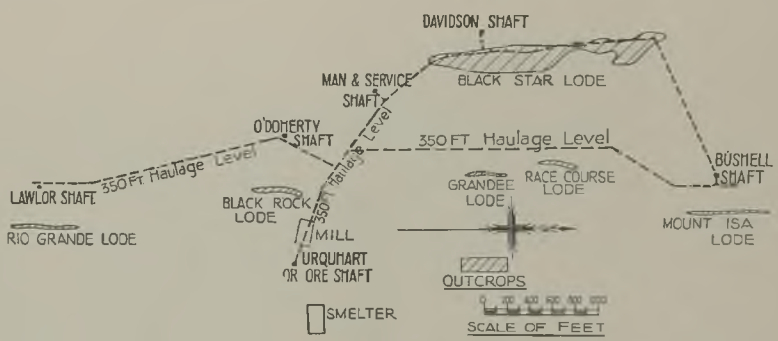


Fig. 2.—Plan showing Outcrops, Shafts, and Haulage Level.

Ore is known to exist at a number of other points in the high-grade mineral belt, and later prospecting will undoubtedly result in additional finds.

Development Plans.—As the larger proportion of the tonnage developed so far is contained in the low-grade Black Star deposit, profitable operation depends on large-scale, low-cost production. Such methods have been successfully applied in the large low-grade copper deposits of North and South America, but Mount Isa is the first deposit to require or justify the application of such methods in Australia.

As the deposits contain both high and low grade carbonates, as well as high and low grade sulphides, and as the mill called for both carbonates and sulphides, development plans had to provide for the economical production of both classes of ore from at least three more or less independent ore-bodies. To operate them as separate units, to the high-grade deposits, and also to the Black Star ore-body, which is about 600 ft. north of the service shaft site. A smelter site was also located on the eastern slope of the hill upon which the mill was to be erected, and about 1,000 ft. away.

The 350 ft. appeared to be the logical horizon for the first main haulage level, taking into consideration the depth of the carbonate zone and the economical stoping height of sulphides. This offered a very efficient and economical arrangement, as ore broken in the stopes might run by gravity to the 350 ft. haulage level, where it could be drawn off into 5-ton cars, and taken in trains of 20 cars, hauled by $7\frac{1}{2}$ ton locomotives, down a 0·5% grade to the large ore pockets at the bottom of the ore-hoisting shaft. The ore might then be hoisted to surface, dumped into the coarse ore bins, pass by gravity to the crushers and thence through the various treatment units to the

foot of the mill, where the finished concentrates would be pumped a distance of 975 ft. to the stock tanks at the smelter. Through the smelter, and in the loading of lead bullion and zinc concentrates into railroad cars, the progress would, in the main, be similarly down grade, and mechanical. (See Fig. 2.)

Such a plan required the sinking of the two shafts described above, and the driving of approximately 6,000 ft. of main haulage drift, in addition to the necessary preparation of the various ore-bodies before production could commence.

It was believed that the initial production should be on a basis of 2,000 tons daily, and that this should be increased to 5,000 tons or more as conditions warranted.

A very favourable condition in connection with the proposed main haulage level was that approximately one-third of the drift would be in, or under, known ore, while the balance would prospect very favourable ground under large outcrops, and might open up new lenses of high-grade ore.

Preliminary estimates indicated that approximately 7,500,000 tons of low-grade carbonates and sulphides, and about 800,000 tons of high-grade, existing above the 310 ft. level, might be extracted through this first 350 ft. main haulage level, before it would become necessary to utilize a second new haulage level, to be located 300 ft. below.

Progress of Development Work.—The first step prior to shaft sinking and driving was the providing of adequate compressed air, to take care not only of the necessary mine work, but of the large amount of excavating that had to be done for mill, smelter, and power plant, and for the riveting hammers during steel erection.

Owing to the delays necessarily involved in the manufacture and transport from England of the equipment for the permanent power plant, a temporary steam power plant was obtained in Queensland and set up at the mine in the early part of 1929. This is now furnishing 5,500 cu. ft. of compressed air per minute.

Work on the two large operating shafts is progressing satisfactorily, in spite of the fact that the large flow of water encountered in each of the shafts below the 200 ft. level has somewhat hindered sinking operations. The 200 ft. level appears to be the present water level of the district. In all shafts and water bores, underground flows have been encountered below this level. Nearly 500,000 gallons per day are now being pumped from the various mine shafts, while the two domestic 6 in. water bores are furnishing 30,000 gallons a day each.

Sinking is being prosecuted in four shafts, namely, the two main operating shafts mentioned above, and two development shafts, one in the Rio Grande, and the other in the Black Rock. At present, small sinking pumps are being used in each of these shafts, but later, once the mine is in operation, all water will drain to the ore-hoisting shaft, and be pumped to the surface

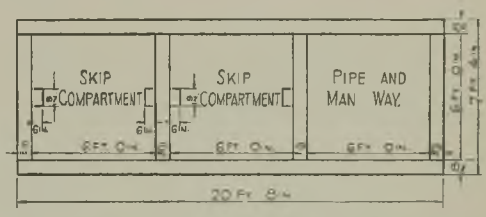


Fig. 3.—Cross-section of Urquhart or Ore Shaft.

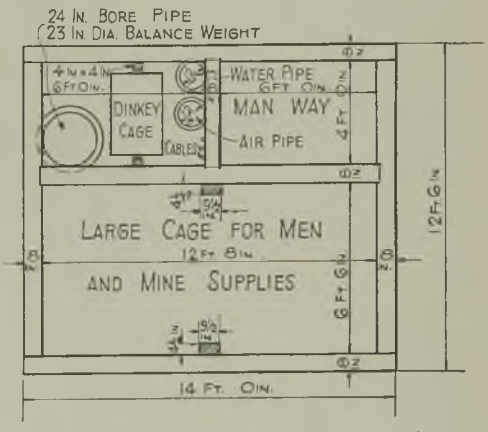


Fig. 4.—Cross-section of Man and Service Shaft.

tanks at the head of the mill, whence it can be drawn off to the various plants.

The ore-hoisting shaft, on top of the hill (at the head of the mill) has already reached a depth of 320 ft. and will be continued to a depth of 620 ft. to connect with the first main haulage level on the 350 ft., and to make provision for ore pockets, sump, and skip room. This will be a three compartment shaft, each 6 ft. by 6 ft. in the clear, two for skips, and one for manway, pipes, and electric cables. The hoist will be of the semi-automatic type, with push button control from pockets below the stations.

Two 8-ton skips, operating in balance, will be used. (See Fig. 3.) The head frame has been designed 115 ft. in height, which will permit the skips to raise the ore high enough to dump direct into the coarse ore bins.

The service shaft has reached a depth of 325 ft. and will be continued down a total depth of 380 ft. It is a three-compartment shaft, one for cage, one for pipes and cables, and the third for safety manway. Through this shaft, all men and supplies will enter the mine. The unique feature in connection with the equipment for this shaft will be the cage, 12 ft. 2 in. by 5 ft. 6 in., large enough to lower 50 men at a time. It will also be possible to transport large mine cars, or a $7\frac{1}{2}$ ton haulage locomotive, without the necessity of having them sectionalized. A great saving in time will also be effected by being able to run loaded timber trucks on the cage at the collar, and off again at the lower level without having to unload. (See Fig. 4.)

Both these shafts are capable of taking care of a much larger production than 2,000 tons a day, as at other properties 10,000 tons are being handled through shafts of equal dimensions.

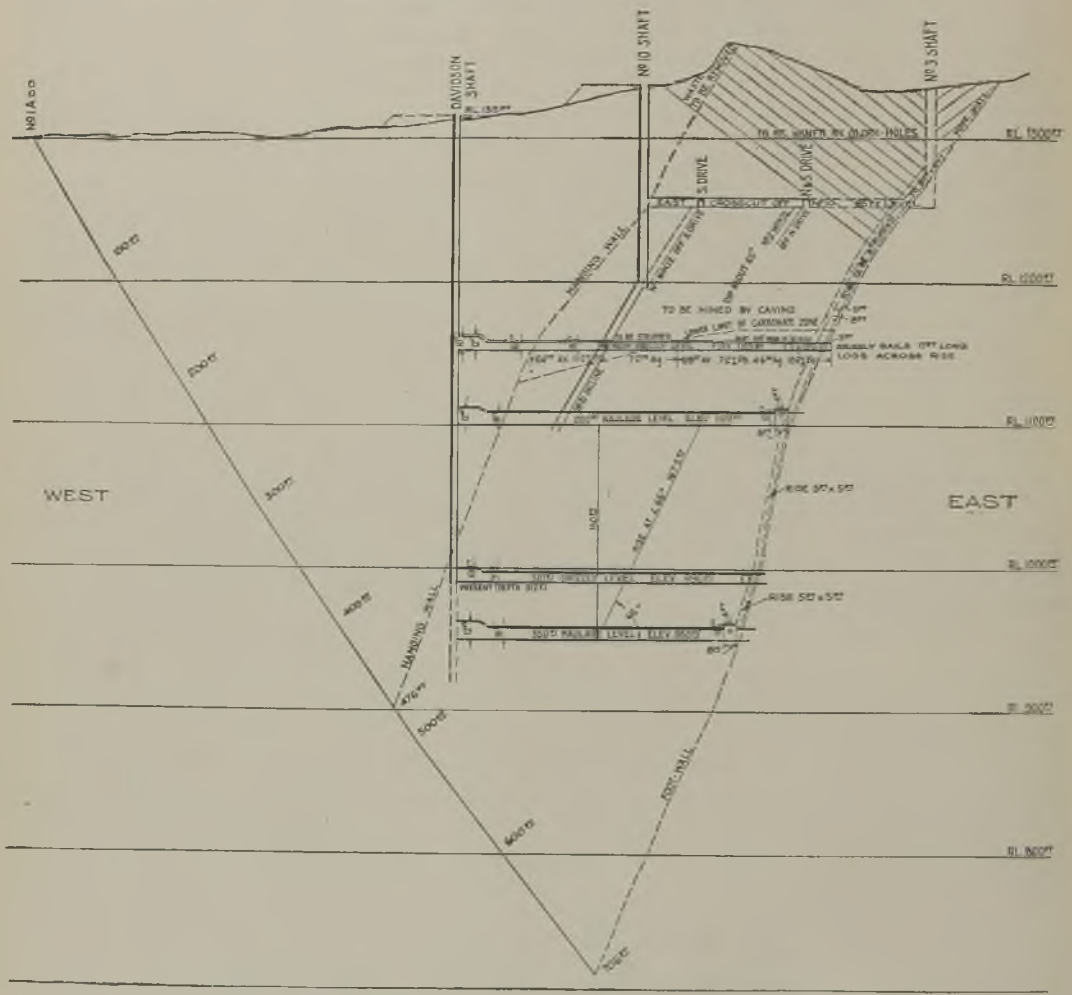


Fig. 5.—Cross-section of Black Star Lode, illustrating Methods of Mining.

While the two main operating shafts are being sunk, the three principal ore-bodies are being opened up and prepared for stoping, this work being carried on through small development shafts, sunk in the various ore-bodies at an earlier date.

The development shaft in the hanging wall of the Black Star ore-body, known as

the "Davidson," has reached the 350 ft. level, and cross-cutting to the foot-wall is being prosecuted on four levels. As soon as the cross-cuts reach the foot-wall, driving north and south will then commence on all four levels. The drift on the 350 ft. level will form part of the main haulage level scheme for the mine, while the other drifts will be utilized in mining this particular ore-body.

The two development shafts in the Black Rock and Rio Grande ore-bodies still have about 175 ft. and 150 ft. respectively to go to reach the 350 ft. level.

As soon as shaft sinking is completed, the work of driving the 350 ft. main haulage level will start from seven different points, in addition to the two headings on the 350 ft.

If a diagonal line is drawn from the hanging wall at surface, to the foot-wall on the 150 ft. level, as shown in Fig. 5, it will be apparent that the upper half can be mined with glory-holes. To mine the lower half by the same method would require the removal of a considerable tonnage of capping; therefore a caving system, somewhat similar to that in use at the large porphyry copper mines, will be used to extract this ore.

In preparation for glory-hole mining, inclined rises are being put up to surface, at 150 ft. intervals, for a distance of 1,200 ft. along the 200 ft. level, foot-wall drift, starting at the south end of the lode. There will be eight in all of these rises, 6 ft. by 8 ft. in area, the tops of which will later be glory-holes. (See Fig. 6.) Where these

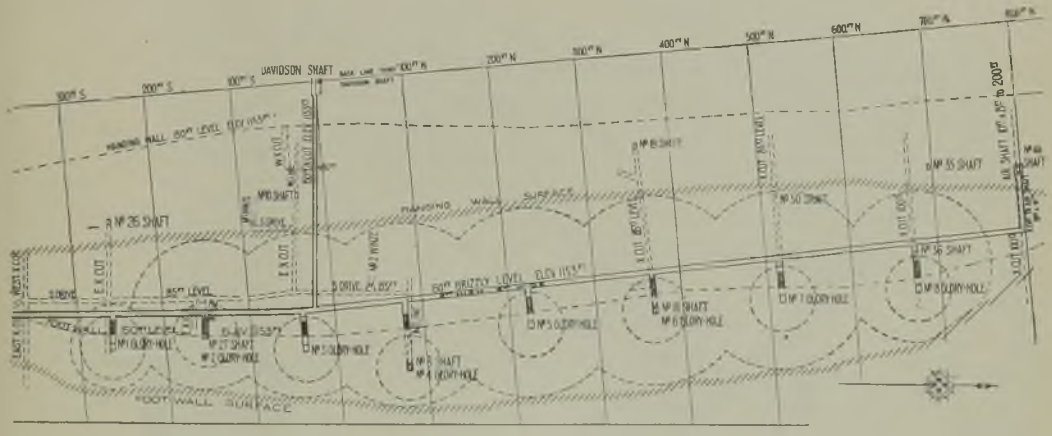


Fig. 6.—Plan of Glory-Holes for Mining Outcrop Ore at Black Star.

level in the Black Star lode. A number of Butler shovels will be used in driving the various headings. The drift will be 8 ft. by 8 ft. in the clear, with trolley wire in the centre. The rails will be 24 in. gauge, and weigh 42 lb. per yard. There will be a drainage ditch on the side.

Stoping Methods.—It is proposed to mine the low-grade carbonate ore in the Black Star lode partly by glory-hole and partly by caving. The maximum width of the lode is about 230 ft., and the depth of the carbonate zone around 150 ft. There are approximately 3,100,000 tons of carbonate ore, one-half of which will be mined by caving and the other half by glory-hole. (See Fig. 5.)

The ore outcrops at surface, and inclines towards the west at an angle of approximately 60°.

rises pass through the 150 ft. level drift, a series of iron bars, 9 in. apart, known as grizzlies, will be set across the opening in the floor of the drift. When the ore is broken on surface, it will run down the rises to these grizzlies where it will be broken small enough to pass through the openings between the bars. Practically all this ore will run down through long ore-passes to motor haulage cars on the 350 ft. level, while a smaller amount will be drawn off in motor cars on the 200 ft. level and be trammed to transfer rises.

When the first glory-hole is completed in the extreme south end of the ore-body, preparations will commence for mining the carbonate ore left by the removal of the upper glory-hole ore. This ore will be mined by a series of parallel shrinkage stopes and pillars carried across the lode.

The ore broken in these stopes will pass through short inclined rises, about 15 ft. long, known as " finger rises," to the main ore-passes. After all the ore in the shrinkage stopes has been broken, the pillars will be undercut, and the entire ore drawn through the rises and transfer chutes in the customary manner. As the ore subsides, the waste hanging wall will gradually follow, forming a waste mat above the ore. The fact that the hanging wall is very hard and tough facilitates the application of a caving system as it minimizes the dilution. As the caving area grows in extent beneath, the cap rock will be " force caved," and compelled to follow the ore. This is the general practice where hard cappings are encountered.

In order to test the breaking qualities of the ground, a trial shrinkage stope was carried up in the Black Star carbonate ore during 1928. (See Fig. 7.) This stope was started across the lode with a width of 15 ft. and then gradually widened to 30 ft. as it was found the ore would stand. The length of the stope was 80 ft. Very satisfactory results were obtained in tons per man in breaking the ore.

After a 200 ft. block along the lode has been completely mined down to the 150 ft. level, caving will commence on the 310 ft. level in the sulphide zone. Caving will be started in the extreme south end and retreat northward, the caving of the sulphides following the glory-holing and caving of the carbonates above. All stoping will be kept in step. In this manner there will be no interference of the lower caving with the upper workings.

When all the ore has been mined down to

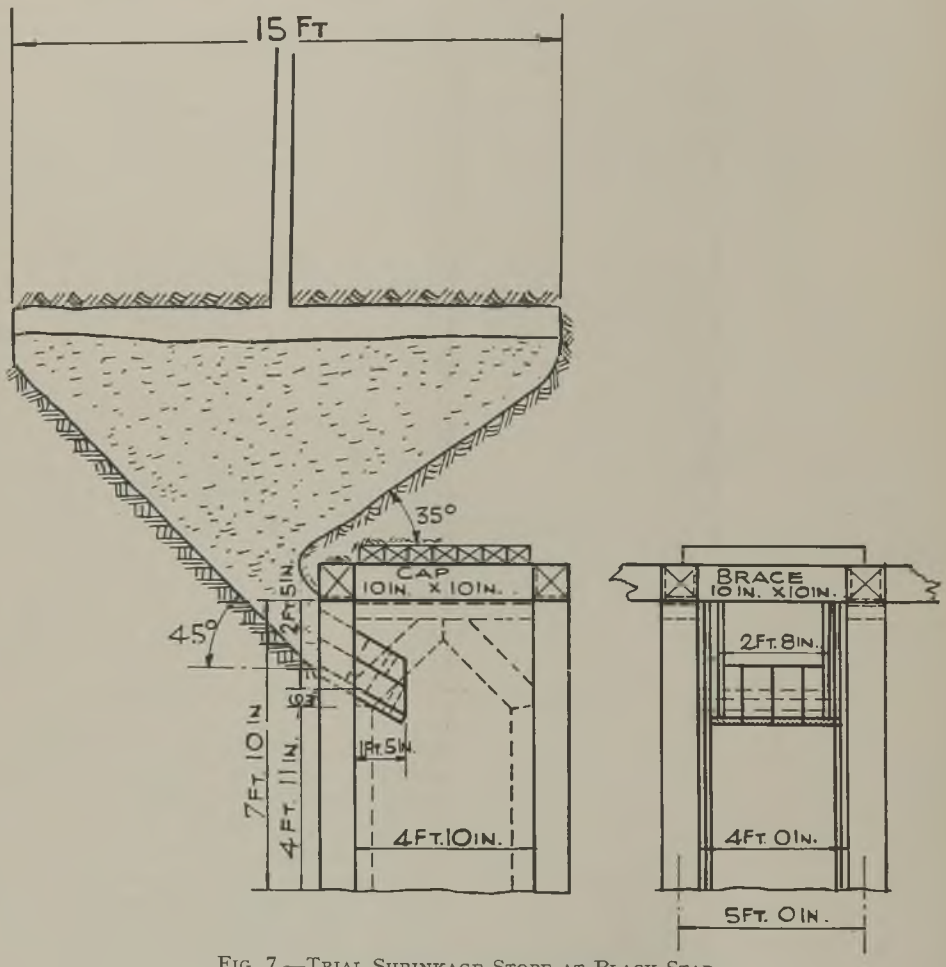


FIG. 7.—TRIAL SHRINKAGE STOPE AT BLACK STAR.

the 310 ft. sub-level, no further ore will be extracted through the 350 ft. main haulage level, but a new haulage level will be put in use, 300 ft. below, on the 650 ft. level. The block of ore remaining between the 310 ft. and 350 ft. levels will be extracted through the deeper haulage level.

The high-grade ore-bodies, being narrow lenses, in some instances fairly close together, shafts in the Black Rock and Rio Grande ore-bodies. This will permit the driving of the 350 ft. main haulage level from eight different points and when the ore-hoisting shaft (Urquhart shaft) is completed, driving will also begin at this point.

Approximately 1,200 men are employed at the mine, and three shifts are being worked in the shafts. All but about 150

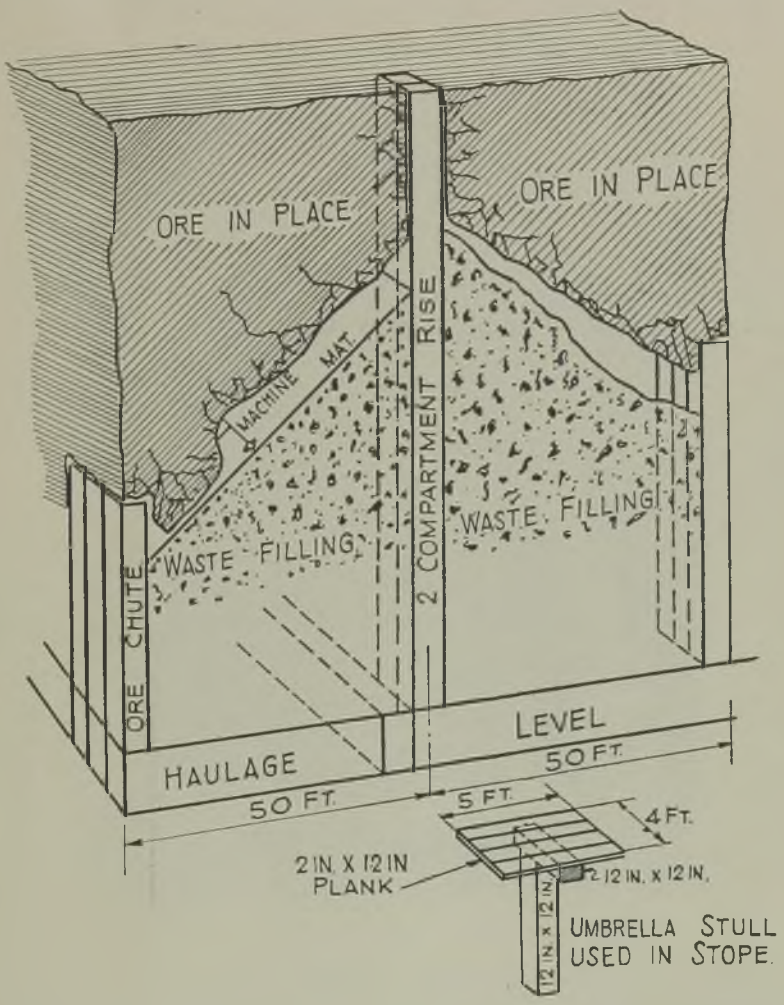


Fig. 8.—Cut and Fill Method at High-grade Ore-bodies where walls are weak.

and with weak walls, will have to be mined by different methods from those proposed for the Black Star. Shrinkage will be used when the walls are strong, and incline cut and fill where the walls are weaker. Fill will be run in from surface through rises, when the stopes need it. (See Fig. 8.)

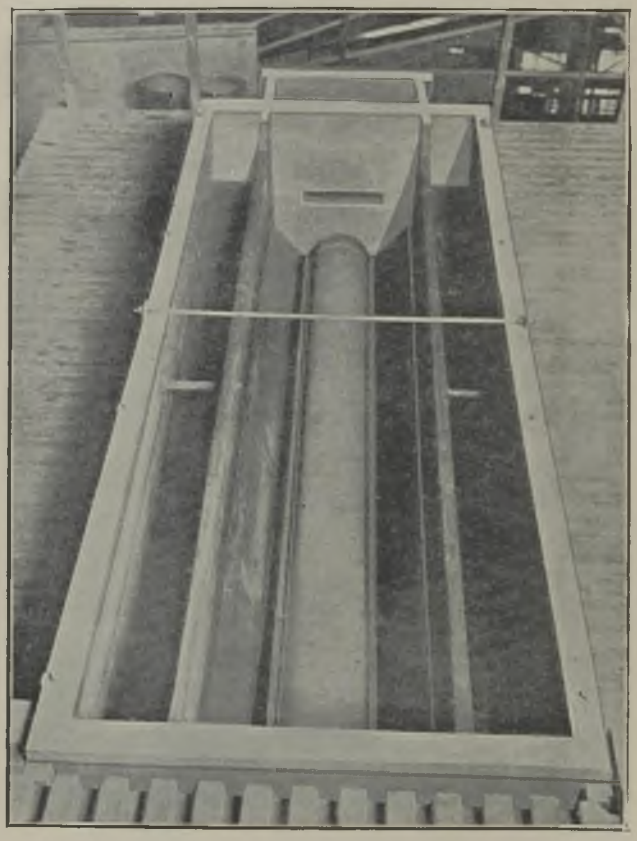
Conclusion.—By the first of the new year, the service shaft should be completed, and shortly afterwards the two development of the men employed are being housed on company ground, either in permanent dwellings, or in temporary quarters. The permanent buildings are comfortable and equipped with modern conveniences. The Government railroad into the mine was completed last April, and through trains are running regularly. It is expected that the mine, mill, and smelter will be operating by August, 1930.

THE MILL AND SMELTER AT MOUNT ISA

By J. M. CALLOW

The author, who is consulting metallurgist to the Mount Isa Mines, Ltd., here gives an account of the concentrator and metallurgical plant now in course of erection.

Following on the article published last month in which the Mount Isa lead-zinc mines were described, an outline is given in the following pages of the crushing, concentration, and smelting plant now under construction. It is hoped when the plant is fully at work to give operating results and other details of practice. The flow-sheets and plan in the folding supplements will help to illustrate the course of the ore through the treatment operations.



PHOTOGRAPH SHOWING INTERIOR OF MACINTOSH CELL.

THE MILL.—The mill consists of three units of nominally 500 tons each per day, but is capable of reaching a combined capacity of 2,000 tons per day. Two of the units are designed for the treatment of lead carbonate ore and one for the lead-zinc sulphide ore. The essential elements are the same in both cases, namely, a preliminary crushing in jaw breakers and Symons cone crushers to ½ in., followed by a primary grinding in ball-mills to 28-mesh, and a secondary grinding, also in ball-mills, to 60-mesh in the case of the carbonate ore and 100-mesh in the case of the sulphide ore. The carbonate ore is treated in 20 Deister tables between the primary and secondary grindings. After the final grinding both classes of ore are sent to the flotation plant which consists of 44 15 ft. MacIntosh pneumatic cells, 30 being devoted to carbonate ore and 14 to sulphide ore.

The details of the crushing and concentration plant are given in the flow-sheet forming Supplement No. 1, and a plan of the main plant is given in Supplement No. 2. Eighteen double cells, accounting for 36 cells out of the 44, are shown in the plan, the remaining

RETURN WATER

FRESH WATER

WATER STORAGE — FLOAT VALVE

— PRELIMINARY CRUSHING PLANT —

250 TONS PER HOUR

② 3' GRIZZLYS

② 48" × 60" HUMMER SCREEN 1" & ½" SCREENS.

36" CONVEYOR

36" SORTING BELTS — SORTED ORE — SORTED ORE TO SMELTER — CAR

MINUS ½" 36" CONVEYOR

② 3½ FT. SYMONS CONE CRUSHER TO ½"

8' GRIZZLYS

84" × 36" BLAKE CRUSHER

115'-0" PIT HEAD FRAME

2 SKIPS · EACH 7½ TONS CAPACITY.

ORE BIN 1300 Tons CAPACITY

ROCK CHUTE

5" COMPRESSED AIR

12" × 12" DORCO FILTER

— AT SMELTER SITE —

OVERFLOW

ELECTRODE

12' × 10' STOCK TANKS

NASH VACUUM PUMPS

FILTRATE

TO SMELTER BINS

— LEAD-IRON FILTER PLANT —

— ZINC STOCK BINS —

WATER SUPPLY

FINE ORE BIN -½"

HEIGHTOMETER

1000 TONS

30 MESH SCREENS ④

8'0" × 60"

HARDINGE BALL MILL

12'0" D.S. CLASS?

HARDINGS BALL MILL

DEISTER TABLES ⑳

② - 4"

② - 4"

1300 SQ. FT. CENTER

WET VACUUM PUMP

SHUTTLE CONVEYOR OVER BINS

— TWO 500 TON CARBONATE UNITS —

CONTACT TANK

1ST SERIES

④ PRIMY ④ PRIMY

SECT ④ Cº ④

④ - 3"

CONTACT TANK

2ND SERIES

② PRIMY ② PRIMY

SECT ② Cº ②

② - 3"

⑥ CLEANERS

WATER SUPPLY

FINE ORE BIN -½"

HEIGHTOMETER

500 TONS

30 MESH SCREENS ②

8'0" × 60"

HARDINGE BALL MILL

18'-0" DIA CLASS?

HARDINGE BALL MILL

① - 4"

1300 SQ. FT. CENTER

WET VACUUM PUMP

— ONE 500 TON SULPHIDE UNIT —

CONTACT TANK

LEAD CELLS

② PRIMY ② PRIMY

SECT ② Cº ②

① - 4"

CONTACT TANK

ZINC CELLS

① PRIMY ① PRIMY

SECT ① Cº ①

① - 4"

② CLEANERS

TAILS

FLOW SHEET OF THE MOUNT ISA MILL

ORE PULPS	SHOWN THUS	———
CONCENTRATED PRODUCTS EITHER LEAD OR ZINC	- -	——— ———
RETURN WATER	- -	- - - - - - - - - -
FRESH & FILTERED WATER & AIR	- -	———
SAMPLERS	- -	●
WILFLEY PUMPS	- -	⊠

LEAD · IRON

ZINC

LEAD · IRON PRODUCT

ZINC PRODUCT

RETURN WATER

1300 SQ. FT. CENTER

WET VACUUM PUMP

AKINS CLASS?

72% SOLIDS

3"

WILFLEY PUMPS

12' × 10' STOCK TANKS

61% SOLIDS

1300 SQ. FT. CENTER

WET VACUUM PUMP

CENTER FILTRATE

— LEAD · IRON & ZINC THICKENING PLANTS —

CENTRIFUGAL PUMP

TANK 1568

75% WATER RECOVERY

186 GALS. P.M. LOSS.

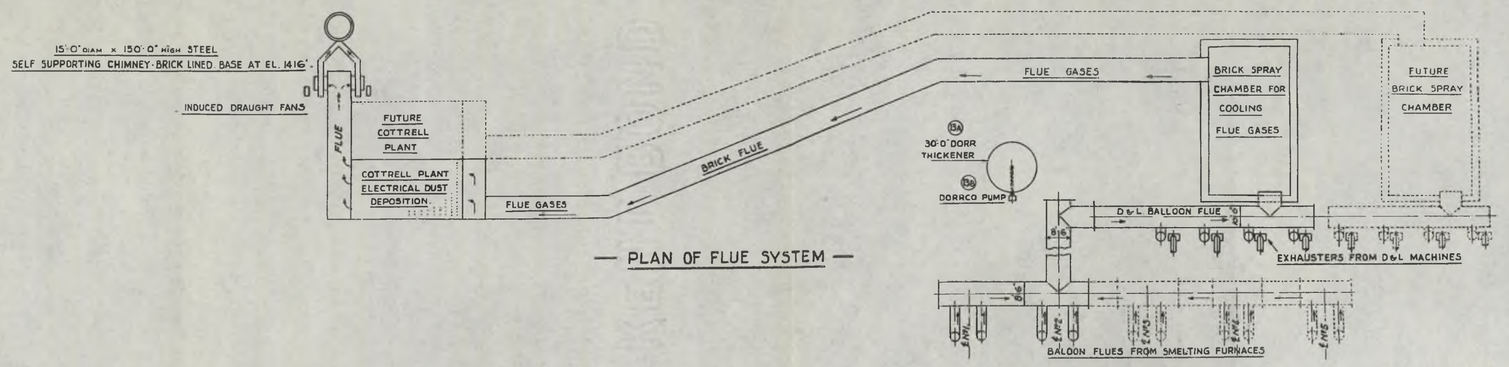
— TAILINGS DAM —

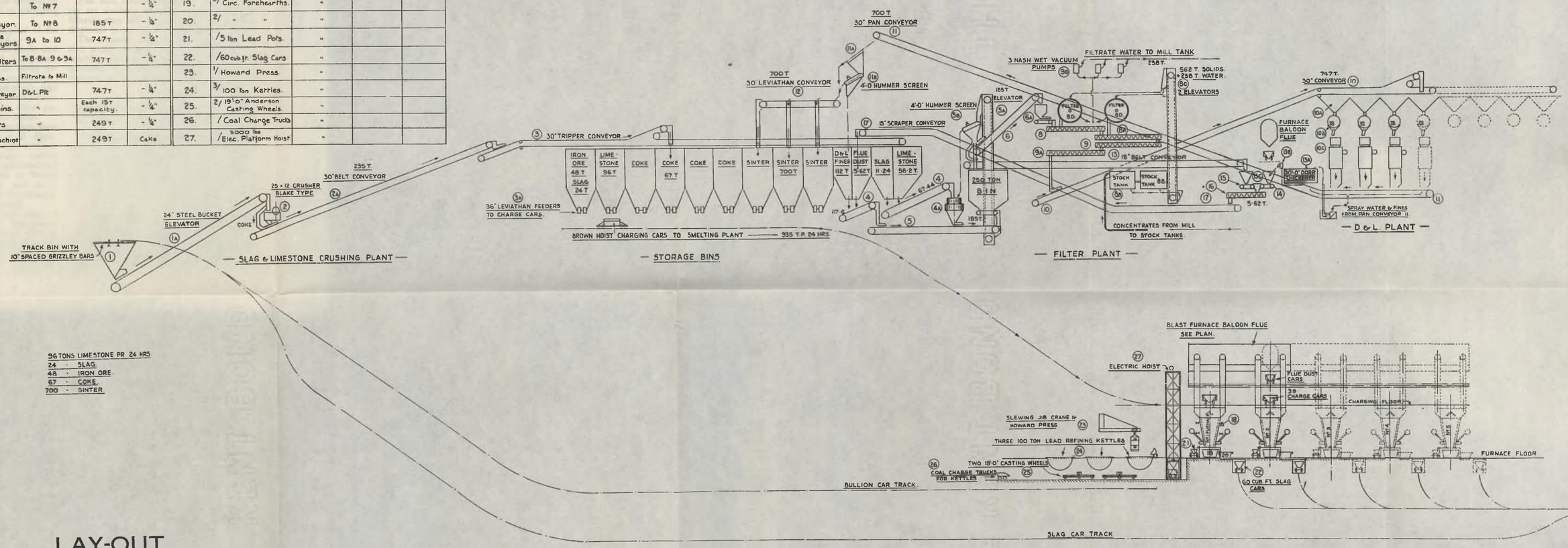
[To face p. 336.

PART PLAN OF THE MOUNT ISA MILL

REF. Nº	MACHINE.	PLANT.	CAPACITY TONS PER 24 HOURS EACH MACHINE.	REDUCTION IN SIZE OF MATERIAL.
1	Track Bin & Grizzley.	Primary Crushing Plant	235 T.	Minus 10"
1A	24" Bucket Elevator	"	"	"
2.	1/25" x 12" Crusher	"	168	10" to -2"
2A	30" Incline Conveyor	Storage Bins	235	-2"
3	30" Tripper Conveyor	"	235	-2"
3A.	36/ Leviathan Feeders	"	26 AV	-2"
3B.	/ Brown Hoist Charging Cars.	Bins to Blast Furnaces	935 Cars	-2"
4.	4/ Conveyors 18" wide.	Bins to 4A - 5	2 : 67·44 2 : 117·6	-2" -¼"
4A	1/ 30 Symons Cone Crusher	Filter Plant to Nº 5	67·44	2" to -¼"
5	1/ 18" Conveyor	To Elevator 5A.	185 T	-½"
5A.	1/8" Bucket Elevator	To Screen	185 T	-½"
5B.	¼-0" Hummer Screen	Minus ⅛" to Con. 6 or 13	5T + ⅛" 180T - ⅛	-⅛"
6.	1/18" Conveyar	To 10 ton Bin	185 T	-¼"
6A.	1/10 Ton Bin	To Nº 7		-¼"
7	1/ Feeder Conveyor.	To Nº 8	185 T	-¼"
8-8A-9-9A	4/ Mixing 16" dia Screw Conveyors	9A to 10	747 T	-¼"
8B - C - D.	Stock TanKs Elevators. & Filters	To 8-8A 9 & 9A	747 T	-¼"
9B.	3/ Nash Wet Vacuum Pumps.	Filtrate to Mill		
10	1/ Inclined 30" Tripper Conveyor	D&L Plt	747 T	-¼"
10A.	4/ Steel Feed Bins.	"	Each 15T capacity.	-¼"
10B.	3/ Rotary Mixers	"	249 T	-¼"
10C.	3/42"x396" D&L Machine	"	249 T	Coke

REF. Nº	MACHINE.	PLANT.	CAPACITY TONS PER 24 HOURS EACH MACHINE.	REDUCTION IN SIZE OF MATERIAL.
11.	1/30" Pan Conveyor	D&L. Plant to Bins.	700	-8"
11A.	1/ Splay Grizzley	+ to Nº 12 - to Nº 11B.	330T. 370T	+1" -1"
11B.	1/4'-0" Hummer Screen.	+ to Nº 12 - to Bin.	258T. 112T	+⅛" -⅛"
12.	1/30" Leviathan Conveyor	To Bins	588T	-8" to +⅛"
13.	1/18" Belt Conveyor	Filter Plant to 15.	2·81T.	-¼"
13A.	1/30'x 10' Dorr Thickener.	Brick Spray Chamber	2·81T.	Flue Dust Mud
13B.	1/ Dorrco Pump	To 13C	2·81T.	"
13C.	1/ Bin for Flue Mud.	To 14.	10 Ton capacity	"
14.	1/ 12" Feeder Belt	To 16.	2·81T.	"
15.	1/ 12" Feeder Belt	To 16	2·81T.	Dry Dust -⅛"
16.	⅛" Mixing Screw Conv.r	To 17	5·62T.	Mixed Mud & Dry Dust
17.	1/15" Scraper Conveyor	To Bins.	5·62T.	"
18.	2/48"x180" W.J. Furnaces.	Smelting Plant.	466 each	
19.	2/ Circ. Forehearths.	"		
20.	2/ - "	"		
21.	/5 ton Lead Pots.	"		
22.	/60 cub ft. Slag Cars	"		
23.	1/ Howard Press.	"		
24.	3/ 100 ton Kettles.	"		
25.	2/ 19'-0" Anderson Casting Wheels.	"		
26.	/ Coal Charge Trucks	"		
27.	/ 5000 lbs Elec. Platform Hoist.	"		





LAY-OUT OF THE SMELTER AT MOUNT ISA MINES

eight, which are cleaners, being arranged in the basement.

The MacIntosh cell is a recent modification of the Callow cell. Instead of the porous medium through which the compressed air used for creating the froth is introduced being constructed as a stationary flat bottom, it is in the form of a rotating cylinder. The chief advantage of the new design is that there is no blinding of the porous medium, and in addition a less quantity of air is employed and at a lower pressure.

The Genter thickener is a recently adopted machine which occupies comparatively little space. It was described in the MAGAZINE for August, 1925. The Dorr filter, used at Mount Isa for dewatering concentrates before going to the sintering plant, is also a machine of recent design. This was described in the MAGAZINE for October, 1927. It may also be mentioned here that the conditioning tanks are in the nature of mechanical agitators and are used for bringing the reagents into contact with the pulp before sending it to the cells.

The plant is so designed that it can be extended on symmetrical lines to accommodate any likely increase in tonnage, and also so that at any time a carbonate section can be converted into a sulphide section, or vice versa, without the removal or scrapping of the initial installation.

The following analyses are typical of the carbonate and sulphide mill-feed :—

Carbonate mixture, 4 tons low-grade and 1 ton high-grade :—13·5% lead, 3·4% zinc, 0·2% copper, 10% iron, 5·04 oz. silver per ton, trace of gold, and 51·6% insoluble.

Sulphide mixture, 2 tons low-grade and 1 ton high-grade :—9·5% lead, 10·5% zinc ; 0·14% copper, 19·4% iron, 8 oz. silver per ton, trace of gold, and 35% insoluble.

Complete preliminary laboratory tests were conducted in New York by Mr. J. H. Allen, and in Salt Lake City by the General Engineering Co. The preliminary results obtained have been more than substantiated by a continuation of the work at Mount Isa, both in the laboratory and in a continuous plant set up there for the purpose. Typical results are given herewith.

Carbonate ore from Black Star mine, 4 tons low-grade and 1 ton high-grade, averaging 13·2% lead, produced per 100 tons of crude ore 18·85 tons of combined table and flotation concentrates assaying 63·6% lead, 7·4% iron, 24·2 oz. silver, and 8·1% insoluble. This represented a recovery of 91% of the lead, of which 63·9% was obtained on the tables and 27·1% by flotation.

Sulphide ore, 3 parts from Black Star to 1 part Rio Grande, averaging 9·5% lead and 7·5% zinc, yielded per 100 tons of crude ore 17·85 tons of lead-iron concentrate and 9·9 tons of zinc concentrate. The lead-iron concentrate assayed 47% lead, 6·5% zinc, 12·5% iron, 36 oz. silver, and 6·5% insoluble, with a recovery of 87% of the lead in the crude ore. The zinc concentrate assayed 50% zinc and 2% lead, with a recovery of 66% of the zinc in the crude ore.

THE SMELTER.—The smelting plant consists of four Dwight-Lloyd sintering machines measuring 42 in. by 264 in., and two blast-furnaces measuring 48 in. by 180 in., with charge bins and all the usual contributary apparatus and auxiliaries. The lead-iron concentrate is pumped from the mill, after thickening, against a head of 50 ft. to stock tanks at the smelter, a distance of approximately 975 ft. Here it is filtered and automatically mixed with the flue-dust and other dry smelter materials to form a suitable charge for the sintering machines. Supplement No. 3 gives details of the arrangement of the plant.

The zinc concentrate from the sulphide ore are similarly handled, except that after filtering they will be stock-piled for periodic shipment to the coast for further treatment.

The amount of lead concentrates to be sent every 24 hours from the mill to the smelting plant is estimated at 253 tons of carbonate and 120 tons sulphide and their analyses are as follows :—

	Pb. %	Zn. %	Ag. Oz.	Fe. %	S. %	Insol. %
Carbonate Conc. .	63·6	0·5	24·2	7·4	—	8·1
Sulphide Conc. .	47·0	6·5	36·8	12.5	24·0	6·5
Average . .	58·3	2·4	28·2	9·0	7·7	7·6

The daily charge of the Dwight and Lloyd machines is estimated at 525 tons averaging 55% lead, 2·5% zinc, 10·5% iron, 6·5% sulphur, 25 oz. silver, and 9·5% insoluble, and the daily production of sinter at 415 tons averaging 57% lead, 2·5% zinc, 10·9% iron, 26 oz. silver, and 9·8% insoluble.

The daily charge to the two blast-furnaces is estimated at 415 tons sinter, 40 tons limestone, 12 tons ash from coke, 13 tons slag shell, making a total of 480 tons. The two furnaces are expected to produce 210 tons of lead bullion and 155 tons of slag per 24 hours.

THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA

By F. H. MASON

The author gives a historical account of the company which owns the Tadanac smelter and the Sullivan lead-zinc-silver mine and holds a dominating position in the lead and zinc industries of the world.

Operations at the Trail smelter, nowadays called the Tadanac smelter, were started in 1894 by F. A. Heinze, of Butte, Montana. Mr. Heinze made a contract with the Le Roi Mining Company to smelt 37,500 tons of gold-copper ore at $11 per ton, to include freight charges, and a further 37,500 tons at the lowest rate that the Le Roi Company could obtain in the open market. He obtained also a land grant from the Federal Government, in consideration for erecting a copper stack, and a bonus of $1 per ton of ore smelted. At the conclusion of the contract, the Le Roi Company, not satisfied with the rate it was receiving, decided to build a smelter of its own at Northport, Washington. The Trail concern was taken over by the British Columbia Smelting and Refining Company in 1896, which at the end of that year had five small copper furnaces in operation. Lead smelting was started in 1899. As was common with infant industries in those days, the company suffered sundry vicissitudes and underwent several reconstructions, lack of sufficient capital being one of the chief troubles. It did not get upon a really solid foundation until the Consolidated Mining and Smelting Company of Canada was formed in 1906, with an authorized capitalization of $15,000,000 to take over and operate the smelter and several mines. The Canadian Pacific Railway Company became a large shareholder, and was able to give the company moral as well as substantial backing and to help it markedly by railway expansion to open up mining areas that would bring ores to the plant.

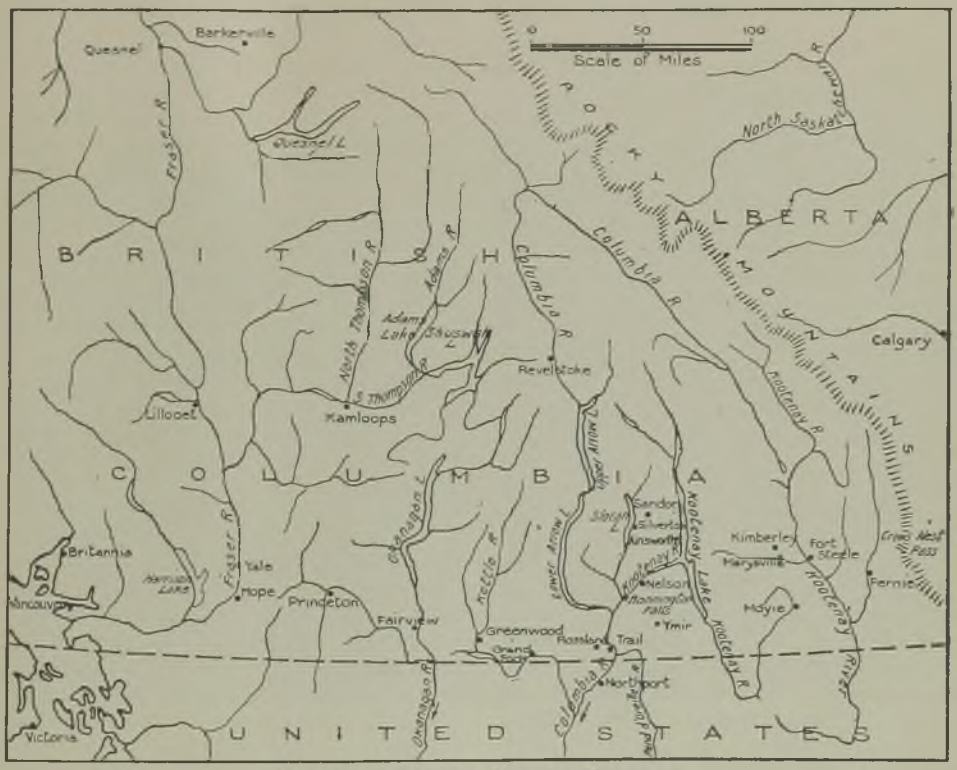
Gold-copper ores were drawn chiefly from the company's and independent operators' mines at Rossland; copper ore from the Iron Mask mine, at Kamloops, lead ores from the company's St. Eugene mine, at Moyie, the independently owned Slocan Star, at Sandon, the Standard, at Silverton, and several smaller operators, but the real foundation of the company's prosperity was laid in 1909, when it acquired an option on the Sullivan mine, at Kimberley.

In 1896 the Sullivan group was bonded to A. Hanson, of Leadville, but the bond was not taken up. It was then bonded to Colonel Redpath and associates, who formed the Sullivan Group Mining Company. The year 1900 marked the beginning of systematic development and the first shipments of ore were made to the Hall Mines smelter at Nelson and to the Canadian smelting-works at Trail. In 1903 construction was started and a smelter (of sorts) rose into being at Marysville. The following year this smelter was entirely remodelled and, after smelting some 75,000 tons, the smelter closed down for good late in 1907. However, at the end of its smelting career, the Sullivan Group Mining Company became financially embarrassed with mining creditors, the principal one being the Crow's Nest Pass Coal Company which obtained judgment under which a seizure was made subject to the interest of the bondholders. In 1909 the bondholders and the creditors, including the Crow's Nest Pass Coal Company, reorganized the company under the name of the Fort Steele Mining and Smelting Company, the control of this company being vested in the Federal Mining and Smelting Company. In December, 1909, the Consolidated Mining and Smelting Company of Canada, Ltd., took a lease and bond on the Federal Mining and Smelting Company's holdings in the Fort Steele Mining and Smelting Company, and subsequently, towards the close of 1910, the option on the stock of the Federal Company and on that of some of the other shareholders was exercised, and the control passed into the hands of the Consolidated Mining and Smelting Company of Canada, Ltd.

The Sullivan is a curious deposit. Besides the immense body of complex intimately mixed sulphides of iron, lead, and zinc with some 6% of earthy matter, concentrations of almost clean galena, sphalerite, pyrite, and pyrrhotite occur here and there. It was these lenses of galena chiefly that were smelted in the early days, and when the Federal sold the mine, there appeared to be little prospect that the full width of the deposit would ever be treated economically. When Consolidated acquired

the property, it began to explore it by diamond-drilling and soon found that it was vastly larger than the most optimistic estimate of its tonnage when the purchase was made. The present vice-president of and general manager for the company, Mr. S. G. Blaylock, informed the writer that his approximate estimate of one million tons was ridiculed at the time it was made, when the acquirement of the property was under consideration. Up to the end of 1928, 8,219,519 tons of commercial ore had been mined from the deposit. At the present time, ore is being mined at the rate of close to two million tons yearly, and estimates of the life of the mine vary at from 30 to 50 years.

Having obtained possession of the mine, the problem of treating the ore arose, for by comparison with the whole, the concentrations of shipping ore were small, and to make the mine a profitable undertaking it was realized that the whole, or nearly the whole, of the ore would have to be treated. A campaign of research followed that rarely if ever has been equalled. Commercial plants, ranging in their capacity from 50 to 600 tons of ore daily, were erected and scrapped if ineffective with an abandon that astonished the mining world. The exact cost of this work has never been made public, but it is stated that from three to five million dollars was spent on research before the present degree of efficiency was obtained. Slight differences between laboratory and commercial equipment amazingly affected results. One instance of the many may be cited. A laboratory flotation plant made of copper plate gave results approaching those desired; a commercial plant on the same lines built of wood failed. Later it was discovered that by using a small quantity of a solution of copper sulphate in the commercial operation a result equal to that of the laboratory plant was obtained. What appeared to be trifling things often made astonishing differences in results. The products from these experimental plants, even from the inefficient ones, were used to make metals. When the writer visited the smelter in 1920,



Map of Southern British Columbia.
The Tadanac Smelter is at Trail; the Sullivan Mine at Kimberley.

one plant of 600 tons daily capacity and one of 400 tons were in operation on Sullivan ore. The larger plant was using tables and a wet magnetic separator, the latter to remove the pyrrhotite, the smaller was using tables and a modified Minerals Separation flotation plant. The products from both plants were going to the lead smelter and the electrolytic zinc plant. Both of these plants were scrapped later, but from information gained by the smaller one, the present 6,000 ton Sullivan mill was built.

In 1912 the company began its researches on the electrolytic precipitation of zinc from its solutions, and in 1915 first produced zinc commercially. Since then zinc has been added to the company's products, and the output has been steadily increased year by year. The zinc plant was in operation fully seven years before a satisfactory process for the separation of the lead and zinc mineral from the pyrrhotite gangue and from each other had been discovered, and for a time it was operated on selected ore from the mine, having a zinc content of from 15 to 18% and a lead content of 10 to 12%. This ore was crushed, roasted, the zinc extracted or partly extracted from the calcine, and the residue was sent to the lead smelter for the recovery of lead and silver.

During the War, the smelter contributed a considerable tonnage of zinc at 15·5 cents per pound for the service of the Allies when the market price for the metal in the neighbouring republic was nearly double that figure, and even at this rate the company prospered; but after the close of the War, when base metal prices fell while the world's huge surplus stock of metals was gradually being absorbed in industry, the company fell upon hard times. At the close of the War it made the common mistake that the depression in base metal prices would be of only a short duration, believing that metals would be required to repair the ravages of War—as, of course, they were, only there was no money to pay for them—so it maintained the payment of dividends, paying them out of reserve instead of out of earnings. The error was soon realized, but the damage had been done, and a bond issue of $6,000,000 had to be floated to enable the company to carry on operations and continue its programme of expansion and research. There was no difficulty in floating the bond issue, as the potentialities of the Sullivan mine were known, and an effective, though not entirely satisfactory, process for treating the ore had been devised, so friends of the company readily subscribed for the issue. Nor did they suffer, for the majority of the $100 bonds later were retired in exchange for two shares of common stock, each of which to-day is quoted at about $400 per share and finding few sellers at that. The quotation, of course, is based on the potentialities of the shares, as during the last two years the company has paid in dividend and bonus 50% on its $25 par shares and earned between 75 and 90% on them, which would be a poor rate of interest on the quoted price. A large reserve and a contingent fund have been built up; a good deal of which may be needed, as will be shown later.

During 1920, the company brought down on itself much criticism from independent mine operators because instead of paying for ores and concentrates received it issued only warehouse receipts for the metal contents, agreeing to pay when the metal was sold. Few operators could carry on under these conditions, so the majority of the independently operated mines in the Slocan and Ainsworth districts were closed. A few concerns were sufficiently financed to allow of the continuation of development, but very few attempted to ship ore. The company's course, galling as it may have been to those affected, undoubtedly was a right one. Self preservation is a first law with companies as with individuals and if the company could not sell its own metal production it hardly could be expected to buy other people's. This condition lasted only one year.

In 1921, the company put its first zinc schedule into effect. It did not allow the company's customers much for the zinc content of their ores, contending that they should help to pay for the research that had made the treatment of zinc ore possible, but it brought about a revival of mining in the Kootenays, as most of the zinc ores of the district contain silver and the schedule provided for the payment of 80% of the silver content. The schedule has been twice amended in favour of customers; the lead schedule also has been amended in their favour, so that, though made to share in the cost of the research, they were given the benefit of improvement in metallurgical practice as it was effected.

In June, 1922, work on the construction

of the Sullivan concentrator was started, and the plant was put into operation at the end of August, 1923. It originally was intended that the plant should have a daily capacity of 1,500 tons, but during construction the immensity of the Sullivan ore deposit was demonstrated by drilling, so it was decided to increase the size of the mill to a capacity of 3,000 tons daily and the coarse crushing plant to a capacity of between 6,000 and 7,000 tons, the latter Company erected an auxiliary 6,000 h.p. turbo steam plant which proved so successful that a second one was erected in the following year. Since the erection of these plants there has been no further trouble from power shortage. These auxiliary plants consist of seven Babcock and Wilcox boilers, fired by pulverized coal, and three 2,000 h.p. steam turbo generators.

The steady flow of concentrates coming from the Sullivan mill necessitated increases

View of Tadanac Smelter, with the Town of Trail in the foreground.

to provide for further extension. It was at this capacity that the mill went into operation in August, 1923. Owing to the irregularity of the supply of power, which was purchased from the East Kootenay Power Company, the mill could not always be operated at this capacity. The East Kootenay Company, however, was extending its power plants to meet the requirements of the Consolidated Company, but it was realized that it would be several years before this could be accomplished, so, in 1926, when lead and zinc prices were high and increased output desired, the Consolidated in the capacities of the lead and zinc plants at the smelter and of the power plant at Bonnington Falls. The last is operated by a subsidiary company, the West Kootenay Power and Light Company. In 1923 the capacity of the lead department was increased from 150 up to 225 tons of refined lead daily. This was further increased to 275 tons in 1924. The smelting plant had a greater capacity than the refining plant, so in 1924, 35,909,000 pounds of lead bullion was refined elsewhere. The development of the power plants was a slower process and, owing to a shortage of power, as the

zinc plant is the heaviest consumer of electric energy, the capacity of that plant was not increased proportionally. In 1924, 37,312,000 pounds of zinc was sold in the form of concentrate. Extension to the zinc plant was started in 1924 and completed in June, 1925, to synchronize with the completion of the first 20,000 h.p. unit of the new 60,000 h.p. hydro-electric station at Bonnington Falls. A second 20,000 h.p. unit was put into operation in August of the same year and a third at the end of that year.

In 1926 extensions at the Sullivan mill increased its capacity to 4,000 tons daily and the capacity of the lead and zinc plants at the smelter were still further taxed by the completion of a 500-ton mill to treat the tailing of the old gravity mill at the St. Eugene mine. These tailings had been stored in Moyie Lake, adjoining the mine, and were raised by a suction dredge for treatment. The old mill treated rather more than 1,000,000 tons of ore between 1892 and 1916—when it was burned, supposedly by enemy activity—from which about 5,800,000 ounces of silver, 225,000,000 pounds of lead, and 9,400,000 pounds of zinc were recovered. No attempt was made to save zinc until 1909. In the two and a quarter years to the end of 1928, the new flotation mill treated approximately 500,000 tons of tailing from which about 2,000 ounces of gold, 354,650 ounces of silver, 12,690,000 pounds of lead, and 15,550,000 pounds of zinc were recovered. A further addition was made to the lead plant, bringing its capacity up to 400 tons of refined lead daily and a new 100-ton addition was started at the zinc plant, to bring its capacity up to 380 tons daily. But the power question still was a difficulty and until more power was available the addition to the zinc plant could not be operated.

Another 60,000 h.p. hydro-electric plant was started on the Kootenay River at South Slocan, below Bonnington Falls, toward the end of 1926 and was put into operation in April, 1929. No notable additions were made in 1927 at either mine or smelter, the breathing time being used in improving plants and processes already in operation. In 1928 an electrolytic cadmium plant, capable of producing three-quarters of a ton of cadmium daily, an electrolytic gold refinery producing platinum and palladium as by-products, and a plant for producing bismuth were put into operation at the smelter, and work was started on the extension of the Sullivan mill to bring it up to a capacity of 6,000 tons daily. This increased capacity, which is now in operation, is not accompanied by a corresponding increase in lead and zinc production. The milling operations have been markedly improved since the mill first was put into operation and much re-modelling has been done as experience has been gained. It is now possible to treat profitably an appreciably lower grade of ore, and this is being done. The company's metal production was slightly less in the first half of 1929 than in that of 1928, but the profit of operation was greater. The metal prices, too, were greater, which probably played a part in allowing of the treating of lower-grade ore.

For several years the research department has been experimenting on a variety of processes for recovering zinc from lead smelter slag. The lead concentrates and ores that are smelted contain notable amounts of zinc and the residue from the leaching of the zinc calcine, which is smelted for its silver and lead contents, also contains zinc. Consequently, the slag from the lead smelter contains 15 to 20% of zinc. A plant consisting of two rectangular water-jacketed furnaces, in which the molten slag is treated by blowing powdered coal into it, was put into operation in August, 1929. This separates the zinc, which passes out of the furnace as fume and is cooled and collected in bag-houses. The process is said to recover 90% of the zinc content and the two furnaces have a capacity of around 60 tons of zinc daily. Some 500,000 tons of old slag, running about 20% zinc, has been accumulated.

Nothing has been said of the copper-smelting department, which initiated this huge business at Tadanac, because copper-smelting there has been gradually waning, and, though temporarily revived by the Granby Mining, Smelting, and Power Company shipping blister copper from its Anyox smelter, is likely to cease altogether when the Consolidated Company builds a copper smelter and refinery at some point yet to be decided upon on the British Columbia coast, as it has expressed its intention of doing. Should a new and important discovery of copper ore be found in south-east British Columbia the copper department would probably be retained, but at present there are no indications of such a find being

made. Compared to lead and zinc the copper production of the smelter during recent years has been insignificant.

In an article of this length it would be impossible to attempt to describe the several processes used for the reduction of metals at Tadanac; a brief outline of the plant must suffice. The lead department consists of six 264 in. by 42 in. and eight 600 in. by 42 in. Dwight-Lloyd sintering machines, four 50 in. by 180 in. blast-furnaces, an anode casting wheel of 25 ton capacity per hour, two 50 ton drossing furnaces, three 60 ton kettles, one dross re-treating furnace, a 1,116 cell Betts electrolytic refinery, using 16·96 amperes per square foot. The refinery has a capacity of 400 tons of refined lead daily.

The zinc department consists of 23 Wedge mechanical roasters, each 25 ft. diameter with 9 hearths; double leaching (acid and neutral) plant, using Pachucas, Dorr tanks, Genter thickeners, mechanical agitators, American and Kelly filters, centifrugal pumps, etc.; 2,340 zinc precipitating cells, each having 17 lead anodes and 16 aluminium cathodes, using 27 to 30 amperes per square foot. Three 100 ton reverberatory furnaces melt the cathode zinc, which is cast into bars for the market. Dross from the furnaces is heat treated, leached by acid, and electrolysed. The plant has a capacity of 280 tons per day and an additional 100 ton plant will be ready to go into operation as soon as sufficient electric current is available.

Hydro-Electric Station at Lower Bonnington Falls.

The copper plant consists of a 60 ft. by 18 ft. (inside measure) reverberatory, fired by powdered coal; a 426 cell electrolytic refinery, using 17·3 amperes per square foot. The plant has a capacity of 60 tons of refined copper per day.

The silver refinery, which treats residues from the lead and copper refineries, consists of a scorifying furnace, in which impurities are removed by fuming and scorifying. The resulting doré metal is parted by sulphuric acid. The silver sulphate is diluted and the silver is precipitated as cement silver on copper, the gold is separated

electrolytically from the platinum group of metals, the platinum metals are separated, and the copper sulphate resulting from the precipitation of the silver is evaporated and the sulphate crystallized out. The plant has a capacity of 20,000 ounces of silver per day and 2,500 ounces of gold per month.

The company is now installing three Brown-Boveri mercury arc transformers for converting alternating to direct current for the several electrolytic processes; up to now the conversion has been made by synchronous convertors.

Besides the metallurgical plants the smelter is equipped with a foundry, which has turned out castings up to 13½ tons, boiler shop, machine shop, blacksmith's shop, and a welding shop in which both oxy-acetylene and electric welding plants are used. This department furnished most of the plant and makes most of the repairs at the company's smelter, mines, and concentrators.

Recently the company has announced its intention of spending between seven and eight million dollars on the first unit of a synthetic fertilizer plant that will produce superphosphate of lime, ammonium sulphate, and mono- and di-ammonium phosphate, and as soon as the first unit is completed, which is scheduled for two years hence, work on a second unit will be started and will be completed within five years. It is no secret that this plant is being constructed at no desire on the part of the company, but from the necessity of finding some use for the sulphuric acid which has to be manufactured in order to remove sulphur dioxide from the smelter fume. The Canadian farmer has not learned to use fertilizers. Records indicate that Canadian agriculturists spent only slightly more than $2,000,000 on fertilizers in 1928, or about two-fifths of what Canada exported. The record is not encouraging to a company starting on a large fertilizer-manufacturing enterprise. But claims against the company for damage from smelter fume, particularly in the neighbouring State, Washington, had been piling up; an international commission was convened to investigate the claims and it was to this commission that the Consolidated Company presented its plans for at any rate taking the sting out of the fume. Each unit of the projected plant will have a contact sulphuric acid plant capable of making 300 tons of acid daily, which gives some idea of the amount of acid fume that is going into the atmosphere.

The construction of this plant together with the settlements of several hundred claims for damages done by smelter fume is likely to make a considerable inroad on the contingency fund that the company has so wisely built up out of excess profits during recent years.

Since the smelter was started, in 1894, to the end of 1928, it has treated 14,256,036 tons of material and has produced 2,188,039 ounces of gold, 69,364,136 ounces of silver, 2,088,030,000 pounds of lead, 873,422,877 pounds of zinc, and 160,541,324 pounds of copper. The output in 1928 was 1,667,586 tons of material, 23,623 ounces of gold, 7,673,762 ounces of silver, 318,831,578 pounds of lead, 163,530,890 pounds of zinc, and 17,806,306 pounds of copper.

The electric energy for the company's operations is provided by three plants on the Kootenay River, two at Bonnington Falls and one at South Slocan, situated between 13 and 15 miles below Nelson and operated by a subsidiary company, the West Kootenay Power and Light Company, which, besides providing current for the smelter supplies the Granby Consolidated Mining, Smelting and Power Company's Copper Mountain mine and Allenby mill and many towns and settlements en route. It also intends to erect a transmission line into the Slocan district. The stations have rated capacities of 34,000, 60,000 and 60,000 h.p., respectively, capacities that vary considerably with the season, a condition that the company hopes to remove by the erection of a dam across the exit of Kootenay Lake to raise the low-water level six feet. Permission is now being sought for the erection of this dam. The company has received permission from the Provincial Government for the construction of an 80,000 h.p. hydro-electric station on the Pend d'Oreille River, near the international boundary, and a 30,000 h.p. plant on the Adams River, 35 miles north-east of Kamloops. It is understood that the whole of the power from these stations has already been allocated. As soon as the preliminary work has been completed the construction of these new plants will be pushed energetically, but, of course, before the construction of these big power plants a good deal of preliminary work is necessary.

Turning from the metallurgical to the mining operations of the company, in the early days gold-copper ore was obtained chiefly from the company's group of mines

at Rossland, of which the War Eagle, Centre Star, and Le Roi were the chief, and from independent operators in the same camp, and silver-lead ore from the St. Eugene, at Moyie, and from independent operators in the Slocan and Ainsworth districts. In 1910 silver-lead ore began to come from the Sullivan, and by the time the St. Eugene had become exhausted, in 1915, the Sullivan was sending from 45,000 to 50,000 tons per annum to the smelter. The Rossland mines began to show signs of exhaustion before the end of the war; there still was a large ore reserve in them, but development failed to bring in anything like as much new ore as was mined each year. In 1916 Consolidated acquired a controlling interest in the Coast Copper Company which owns the Old Sport mine in the northern part of Vancouver Island and in 1919 control of Sunloch mines, which had developed a considerable tonnage of copper ore at Jordan River, in the southern end of Vancouver Island. After the war ceased and Government-fixed prices were removed, the price of the metal soon dropped to figures that made these properties uninteresting for the time being and their development was not pushed. Moreover, the company needed all its resources for the exploitation of the Sullivan. The company's power subsidiary, however, extended its power line to the Canada Copper Corporation's mine at Copper Mountain and mill at Allenby and the Canadian Pacific Railway built the branch line from Princetown to Copper Mountain by way of Allenby, thus providing feed for the copper department at the smelter.

But the best laid plans miscarry at times. The world was in a state of unrest after the war and labour in particular was fractious. There were strikes in the construction of the branch line, strikes in the operation of the mine, and strikes in the construction of the mill, so that by the time Canada Copper was ready to ship the price of copper had fallen to 13 cents. A going concern might have operated at this price, but a new concern hampered by a heavy bonded indebtedness could not, so after shipping concentrate to Tadanac for a few months Canada Copper closed the mine. It had to pass interest on its bonds, and the bondholders took possession. Allenby Copper Corporation was formed as a go-between to take over the properties and transfer them to the Granby Consolidated Mining, Smelting and Power Company. Granby remodelled the mill and shipped to Tadanac until the end of August, 1928, when the contract entered into between Canada Copper and Consolidated, which Granby took over, expired. Granby sought better smelting and power rates, and, failing to get them, diverted concentrate to the Tacoma smelter.

Seeing how the wind was blowing, and well provided with funds from the profits of its Sullivan mine, Consolidated started a vigorous search for a copper property of its own, and if in that search other properties were found and could be secured on reasonable terms they were not neglected because they happened not to be copper deposits. The result is that to-day the company owns or controls or has options on properties not only throughout British Columbia, but in every Province in Canada with the exception of Prince Edward Island, in Newfoundland, Yukon Territory, and the United States. Options are taken up so often and dropped equally often if proved wanting that it is impossible to keep track of the company's activities in British Columbia and quite hopeless to attempt to follow them beyond; and, for sufficiently good reasons, the company tells the public only what it considers is good for the public to know. Nor does it give information as to the ore reserves at its several properties, costs of operations, and recoveries. The only variation from this rule that I know of is that the cost of mining at the Sullivan is approximately 25 cents per ton, an achievement evidently considered sufficiently remarkable to justify the exception.

The company's major mining operation in British Columbia, of course, is at the Sullivan, a description of which was given in a paper, read recently before the Western Branch of the Canadian Institute of Mining and Metallurgy, by Mr. D. L. Thompson, assistant superintendent. The next largest operation is at the Coast Copper Company's Old Sport, where undoubtedly a considerable tonnage of ore running around 3% copper has been developed above the 1,250 ft. level. The company is now sinking below that level to develop at greater depth. A good tonnage of copper ore has been developed at the Sunloch mine, but little work has been done there during recent years. A vigorous diamond-drilling campaign is being carried on at the George group, in the Bear River section of the

Portland Canal division, and some minable bodies of copper and copper-zinc ore have been penetrated. An effort is now under way to open these by a tunnel. A large amount of exploration has been and is being done at the Big Missouri group. Here rich unrelated narrow lenses of gold ore have been found and an immense body of low-grade material, so low grade that as yet it is not certain that it is ore. Much more work will have to be done before the value—if it has value—of this property can be determined. The Rock Candy fluorspar mine has been and may again be a mine of considerable importance. It produces a high-grade fluorite concentrate, large quantities of which were shipped to Gary, Indiana, prior to the Fordeney tariff going into effect. The mine is now operated intermittently to provide fluorspar for the manufacture of hydrofluosilicic acid which are used as an electrolyte in refining lead bullion by the Betts method at the smelter. The phosphate of lime properties are rapidly becoming important operations and will become more and more so as the fertilizer plant is developed. They are located in that immense belt, croppings of which have been found here and there from Banff south through Idaho and Montana into the States of Utah and Colorado. It is from this belt in Idaho that the Anaconda Copper Mining Company has been quarrying phosphate rock for the manufacture of superphosphate for several years. The quality appears to be appreciably higher in Idaho than in British Columbia, but much more development has been done there. The only other major operation in British Columbia is at the Hunter V mine, at Ymir, which in 1928 produced 10,500 tons of low-grade siliceous silver ore which is used for fluxing at the smelter. The other properties in British Columbia are either old mines, which for the time being are either closed or have been turned over to lessees, or prospects. The St. Eugene mill is still operating at capacity—500 tons daily—on the old tailing, but it is expected that it will clean up the accumulation by the end of the year. It will then be used to treat oxidized ore from the Sullivan dumps, thereby not allowing this material to interfere with the smooth operation of the Sullivan mill, the oxidized ore requiring a different treatment from the freshly mined ore.

The company's prospecting activities in the Province are widely distributed from the Kootenays to the Portland Canal. Most of the exploration is being done by diamond-drilling but surface and underground work are being done at several of the properties in the Omineca division, where several properties give promise of being developed into producers.

In the spring of 1929 the company acquired by purchase the Canadian Northeastern Railway from Vancouver holdings. The line at present has been completed for 14 miles up the Bear River Valley from the town of Stewart, but is now in bad condition. The purchase included a charter giving the right to extend the line to the Finlay River, and with a branch from the main line to the Yukon boundary. Two survey parties have been in the field since the late spring locating a route for the extension. The company has made no announcement as to the purpose to which it proposes to put the railway. It must be remembered, however, that the control of the company's stock is held by the Canadian Pacific Railway and its friends, and it is not unlikely the Consolidated is acting only as an agent for the larger concern in the matter. The railway situation in Canada is complicated, and it is possible the Consolidated company might more easily and cheaply obtain a concession than the Canadian Pacific Railway.

What of the men who built up this organization ? As the present vice-president and general manager so often has emphazized, it has been the result of team work, and and as the team is a large one it is impossible to mention each individual. But a team is not likely to achieve good results without an able captain, and this team seems to have been blessed with unusually capable captains. Messrs. W. H. Aldridge and R. H. Stewart did some splendid work on the foundations. The present skipper, Mr. S. G. Blaylock, stands out pre-eminently, as he guided the company through the troubled waters of post-war days and brought it to its present enviable position. Mention should be made, too, of Mr. W. M. Archibald, chief mining engineer, for his splendid work at the Sullivan mine, and to Mr. J. J. Warren, president, for the skilful way in which he has handled the finances of the company.

I desire to thank Mr. J. D. Galloway, Provincial Mineralogist for British Columbia, for reading this article and for the suggestions he made for its improvement.

BOOK REVIEWS

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

There have been no more interesting developments during recent years than the discovery and initial exploitation of primary platinum deposits in South Africa. While opinions may differ as to the ultimate economic possibilities of these deposits, there can be no question as to their unprecedented magnitude and richness. The famous Merensky Reef—a stratiform body of norite that has been traced intermittently at outcrop within the Bushveld Complex for more than 300 miles—must contain a tonnage of platiniferous rock almost beyond calculation. Along considerable stretches where this reef has been systematically opened up the platinum metals, which occur in intimate association with copper-nickel sulphides, are said to average 6 dwt. over a stoping width of 30 inches. A similar, but somewhat leaner reef has been found strongly developed in the so-called Great Dyke of Southern Rhodesia. Such deposits have never before been recorded.

There are also in the Bushveld Complex numerous pipe-like deposits of platinum-bearing dunite, of which that at Onverwacht is probably the best known. This pipe, with a maximum diameter of about 60 ft., has been followed to a depth of nearly 800 ft., and its platinum content has ranged from a trace to over 1,200 dwt. to the ton of ore, the metal being in this and similar cases in the native form.

These two types of platinum ore-bodies seem to have the greatest promise of economic importance, but the metal is known to occur in other ways in South Africa and on other stratigraphical horizons, some older, some newer, than the Bushveld Series. In older formations, for example, it has been found in ultra-basic intrusions of the Swaziland System; and, in association with osmiridium, it is a familiar constituent of the bankets of the Witwatersrand System—in these latter not primary, but detrital.

In newer formations it has long been known in basic sills of the Karroo System, as at Insizwa, Cape Province, where its occurrence is essentially the same as in the differentiated "nickel-eruptive" of Sudbury. Another remarkable occurrence is in the hydrothermal quartz-specularite veins of the Waterberg District, which occupy fault-fissures of post-Karroo age in the Rooiberg felsites. It has often been detected, too, in the kimberlite filling of the diamond pipes, now generally regarded as late Cretaceous in age.

This repeated concentration of platinum over a vastly long period of time is one of the remarkable features of the occurrences in South Africa, and presents a puzzling problem in metallogenesis.

These various platinum occurrences have been the subject of a large number of widely scattered publications during the last few years, and it is fortunate that a summary of this accumulated knowledge has now appeared in the admirable volume by Drs. Wagner and Schneiderhöhn here under review. It should be said, however, that the work is no mere recapitulation of views already expounded, but embodies much that is new and original.

The section by Dr. Schneiderhöhn, which comprises some 40 out of the 300 pages of the book, deals with phenomena observed and inferences drawn from a microscopic and spectrographic investigation of ores of the sulphidic type. It is illustrated by unusually fine photographs showing the relationships of the rock- and ore-minerals to one another, and closes with a summary of the phases which the magma is supposed to have passed through during consolidation. Here it is interesting to note, in view of the protracted controversy regarding the origin of the platiniferous copper-nickel ores of Ontario, that a separation of immiscible silicate-oxide and sulphide melts, that is, slag and matte, is hypothesized, the former solidifying first as the rock-minerals, the latter afterwards as the primary ore-minerals. Later, as a result of "unmixing in the solid," there separated from these primary sulphides a second generation of ore-minerals, notably pentlandite. The platinum, however, remained in a state of solid solution in the primary iron and nickel sulphides, a fact that is reflected in the difficulties experienced in its commercial extraction from ores of this sulphidic class.

The major part of the volume has been written by Dr. Wagner, and makes both interesting and instructive reading. It treats of such subjects as the mineralogy of platinum, the several modes and localities of occurrence in South Africa, platinum

mining and metallurgy, the present position and future prospects of the industry, the principal operating companies, and current production.

As regards the future Dr. Wagner is frankly optimistic and holds that South Africa is destined to become the world's leading producer of the platinum metals seeing that "her primary deposits of these metals are incomparably the greatest." It is to be hoped that this favourable opinion may be fully justified by later developments.

The book is felicitously dedicated to "Dr. Hans Merensky, mining geologist, super-prospector, and best of friends." The task of seeing the proofs through the press was undertaken and effectively discharged by Professor Arthur Holmes, the charm, lucidity, and precision of whose literary style are so well known to readers of the MAGAZINE. To those concerned with platinum mining or production, and to students interested in the nature and origin of ore-deposits, Dr. Wagner's latest volume will be indispensable.

C. GILBERT CULLIS.

Géologie et Mineralogie Appliquées: Les Mineraux et Leurs Gisements. By HENRI CHARPENTIER. Second edition. Octavo, paper covers, 830 pages, illustrated. Paris: Dunod, 92, Rue Bonaparte.

It has long been a puzzle to the reviewer why a nation that produced a Bleriot should suffer publishers to print scientific books with uncut pages and thus waste a good deal of time and patience before the book can be read: time saved in the study is not less valuable than that saved in travelling.

Géologie et Mineralogie Appliquées, by Henri Charpentier, is the second edition of a text-book in which the attempt is made, in just 75 pages, to write a précis of the whole subject of pure geology; and in the remaining 755 pages to deal not only with the ore deposits of the world, but also with the world's oilfields and coal deposits. The result is that crystallography occupies one page only; petrology is given 10 pages in which the author makes use of the old continental classification of rocks which was finally jettisoned even by its authors over twenty years ago. Such statements as that granite occurs only in the ancient series of rocks; that all modern acid rocks are called "liparites"; and that syenites belong to the ancient series of basic rocks, show clearly that the author has either reprinted a very old edition, or that he is not familiar with the progress made in petrology during the last two or three decades.

The second and more prominent part of the book deals with the application of geology to the study of useful minerals, and it is a matter of regret that the author has not availed himself of the opportunity, when preparing the second edition, of bringing his work up to date. In the chapter dealing with copper deposits it is stated of the richest and most famous copper fields of the world (Butte, Montana) that "Le sulfure noir de cuivre, qui forme la partie supérieure des filons, se mélange en profondeur de chalcopyrite et disparaît presque entièrement vers 200 mètres". Far from this being the case, many of the Butte copper mines are now mining chalcocite at depths from the surface of between 2,400 and 3,000 ft., and even at this great depth the chalcocite, recognized by the leading authorities who have studied the area as being of primary origin, shows no sign whatever of passing into chalcopyrite. The author could easily have ascertained these facts from Sale's classic work "Ore Deposits of Butte, Montana (Trans. Inst. A.M.E., vol. xlvi) in 1913, or from numerous subsequent publications on this world-famous copper field.

Under lead and zinc deposits no mention is made of two of the world's largest producing mines, namely the Bawdwin mine in Burma and Broken Hill, New South Wales; and the Sullivan mine in British Columbia, the largest lead-zinc mine in the world, is mentioned merely by name, and in the wrong locality. Mining areas that have been practically abandoned over twenty years ago occupy space that could, with great advantage, have been given to areas that now supply the bulk of the world's minerals. There is, for example, no justification for devoting several pages to manganese deposits in various parts of the world that have ceased production for a long term of years, and for neglecting even the mention of those of the Gold Coast, which produce 11% of the world's manganese.

WILLIAM R. JONES.

☞ 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

JOHANNESBURG

November 5.

Cape Coast Exploration Co.—Further interesting information regarding the operations of the Cape Coast Exploration Co., Ltd., has been released. It appears that the property owned by the company consists of 56 farms, in extent approximately 226,800 morgen, situated in the divisions of Namaqualand and Van Rhynsdorp. Most of these farms abut on to the sea coast. For the year ended June 30, 1929, revenue amounted to £81,125, while expenditure totalled £20,341 10s. After deducting Government taxation, estimated at £6,182 16s., the unappropriated profit carried forward to the current year amounted to £73,354 17s. Operations were continued on the farm Kleinzee, but by arrangement with the Government production and sales were limited in value to £6,000 per month. A modern plant for the treatment of the diamond deposits is being erected, and it is anticipated that this plant will be completed early in 1930. Owing to restrictions regarding prospecting in Namaqualand, no exploratory work was carried out on the company's other farm properties. Prospecting operations on the farm Kleinzee have indicated that the diamond content of the farm is over 400,000 carats.

A Curious Occurrence of Copper.—Among the reefs in the Bonanza gold mine in the Pilgrim's Rest district, Transvaal, is one known as the " Mill Reef " or " Copper Reef." It consists of two or sometimes three ore-bodies separated from one another by 1 ft. to 4 ft. of quartzite situated on the east side of the main dyke, having the same dip and strike, and usually at a distance of about 18 in. from its wall, but sometimes in contact. The eastern ore-body is from 6 in. to 24 in. thick, while the western or " copper " reef is from 6 in. to 12 in. thick. The two, however, often unite to form lenses up to 14 ft. thick and 40 ft. long. In the oxidized zone the reef filling is honeycombed quartz, with various oxidized copper minerals and sometimes native copper in masses of several pounds weight. Below this the eastern section is chiefly pyrite and quartz, with bornite and chalcopyrite. Sometimes the quartz veins disappear and the body of the reef is of quartzite impregnated with iron pyrites. Leaders up to 4 in. thick often join the two sections, and the copper minerals appear in the eastern section. The west section has a reef filling of bornite, chalcopyrite, copper glance, iron pyrites, more or less in order of plentifulness, with occasionally bismuthinite, bismutite, and malachite. The ore of the " mill reef " yields very little gold on the plates, and the principal product is a concentrate, which is shipped to America. The ore as milled yields 10% of concentrates, which contain 17% to 21% copper, 2½ oz. gold, 2½ oz. silver per ton, and 1% bismuth. The list of minerals contained in the concentrates is unusually extensive, comprising native copper, bornite, copper pyrites, and carbonates of copper, also the oxide, carbonate and sulphide of bismuth, iron pyrites, siderite, etc. The red and black oxides of copper, though fairly plentiful, are not caught in the concentrates.

More Manganese Negotiations.—It is officially announced that negotiations are proceeding between the Manganese Fields, Ltd., and an influential Belgian house. This firm's consulting engineer visited the company's properties in the Postmasburg district early this year, and was so pleased with the prospects that the present negotiations were opened up on his return to Brussels. There is every probability that mining operations will commence on the company's properties at an early date. In addition to the various farms the company owns a valuable area on the town lands of Postmasburg.

Record Gold Output for 1929.—There is every indication that the Transvaal gold output for 1929 will eclipse the high record for 10,358,596 ounces set up last year. Notwithstanding the closing down of the Ferreira Deep and the Wolhuter mines in June last, production for the nine months ended September 30 shows an increase of 84,018 oz. over that for the corresponding period of 1928. While there is so far an improvement of nearly half a million tons in the tonnage crushed this year, the declared revenue per ton at 28s. 2d. is 4d. lower and, although working costs per ton have been reduced by 2d. to 19s. 10d., the working profit per ton, 8s. 4d., is 2d. down. The total working profit for the nine months of this year is £9,663,017 as against £9,719,787, a shortfall of £56,770, but the total amount of dividends declared, £4,186,986, represents an increase of £38,764.

Namaqualand Copper.—Statements have been published in Capetown to the effect

that the South African Copper Co. has decided to exercise its option and take over the extensive copper-bearing areas near Ookiep from the Cape Copper Co., and will spend some two millions sterling on the development of the enormous resources available covering a territory of about 100 square miles. These statements, however, have not been confirmed. Mr. Wilson, the general manager, says that the ore developed to date is all of very low grade. This, together with high freight rates on fuel and the uncertainty regarding water supply for concentrating plants, makes the ultimate exercise of the option doubtful. The option has still 14 months to run, and it would appear that its fate depends materially upon developments during the rest of its course.

Northern Rhodesia's Mineral Output.—The mineral production of Northern Rhodesia is rapidly increasing. The total for the month of August is nearly £40,000 in excess of that for the corresponding month last year, and the general summary shows a remarkable improvement in every branch of mining. Zinc takes first place in regard both to the tonnage mined and aggregate value, with copper a close second in the latter respect. Details of the August output as given in an official statement are as follows: 574·714 tons of copper valued at £43,131 10s., and 2,022·94 tons of zinc, valued at £50,363. The total value of the production during the month was £93,980.

To Prospect in Mozambique.—A company has been formed in Johannesburg for the purpose of prospecting for diamonds in Mozambique, Portuguese East Africa. It will probably acquire from a prospector four prospecting licences entitling them to peg four precious stones claims in the Neves Ferreira district where promising indications are said to have been discovered.

BRISBANE

October 18.

Mount Isa Activities.—There are now over 1,300 men employed in connection with the operations of the Mount Isa Company at the Mount Isa mines, and the population at the township is estimated at about 5,000. The company is receiving commendation for the excellent provision which is being made for the housing and comfort of its employees, and which are such as to go far in neutralizing the disadvantages of climate and isolation which would otherwise be experienced. As a result of the recent visit of Mr. Leslie Urquhart and two other members of the technical staff of the Mining Trust, Ltd., it is intended to expedite the opening of the levels and shafts, as well as the building of the treatment plant, so as to ensure the starting of crushing in August of next year. No hoisting of ore will be attempted until the whole plant is complete and is capable of treating the 2,000 tons of ore daily that is to be the initial output. The Cloncurry warden reports that the diamond-drilling campaign that has been in progress during the last two years will now become more intensive, and that the drilling of ore-bodies on leases other than those which have been proved on the Black Star, Black Rock, and Rio Grande lodes will be carried out. As a result of this further exploration, it is expected that the quantity of ore reserves, now estimated at 25,000,000 tons, will be largely increased.

Queensland Oil Prospecting.—The report recently issued by the Elbof geophysical group who have been operating in the Roma oilfield has been adversely criticized by both the Deputy Chief and Oil Government Geologist, Mr. L. C. Ball, and by Dr. H. I. Jensen, who is consulting geologist for a number of the oil prospecting companies. Mr. Ball affirms that the bulk of the conclusions of the report are not based on geophysical findings, which were practically limited to the small area covered by two prospecting permits, but were those of one geologist attached to the Elbof surveys in regard to the oil prospects of the whole Maranoa district. Dr. Jensen says that the deductions made by the geophysicists are based on suppositions and theories, and not on facts. So far, the verdict of the Elbof people has not been accepted by any of those concerned in the different prospecting schemes, and no boring has been stopped as a result of their report.

The Coal Industry.—The Royal Commission which has been for several months inquiring into the Australian coal industry, more particularly with regard to New South Wales, has given in an interim report. Before this commission was appointed, there was a proposition put forward by the New South Wales Premier, Mr. T. Bavin, and approved by the coal owners, that the cost of producing coal should be reduced by 4s. to 5s. a ton, so as to bring the selling

price to 20s. 6d. The owners were prepared to reduce this price to the extent of 1s. a ton, the miners were asked to submit to a reduction in wages of 1s. a ton, and the balance was to be contributed by the State Government in the shape of a bounty. There was an expectation that if it could be shown that the profits earned by the owners were not more than 2s. per ton the miners would submit to the proposed reduction so far as it affected them. The commission has found that the profits were 1s. 1½d. a ton. Neither side, however, accepts this figure as correct, the owners saying that it should be lower and the miners that it should be much more. The owners are prepared to reopen their mines, which have been closed for seven months, on the basis of the original proposal, and on condition that they shall have absolute discretion in the employment and dismissal of men which they do not now possess; but what was said to be the miners' final word was that they declined further negotiations with the State Government or the mine-owners unless they were prepared to discuss the advisability of reopening the mines "on pre-lock-out rates and conditions." As a result, however, of an election that has just taken place, the Labour party has again come into power in the Federal House of Representatives. During the election campaign it was stated by the deputy leader of the Labour party, Mr. E. G. Theodore, that if that party won, the closed coal mines would be reopened within 10 or 14 days after they took office. To-day's papers announce that a conference has been held, in camera, between the Northern Collieries' Association, the Mining Industries Union, and Mr. Theodore, and that an important decision is pending. Just what that decision amounts to is not known, but there is an impression abroad that a temporary adjustment of the dispute is likely, although the matter is certainly not yet finalized.

The great financial loss that has been suffered by the northern coalfields of New South Wales through this long-drawn-out dispute is indicated by recently published returns which show exports of coal from the port of Newcastle for the nine months ended September 30. During that period only 1,045,477 tons of coal, valued at £1,220,722, was exported, compared with 2,193,212 tons, valued at £2,573,960, during the first nine months of 1928. Of the amount lost it is estimated that at least £1,000,000 represents direct and indirect loss in wages to workers. More than 10,000 miners have been unemployed for more than 32 weeks.

Queensland State Coal Mines.—The four State coal mines of Queensland have incurred a net loss of £164,280, while their total indebtedness to the State Treasury is considerably more than this sum. One of these mines is the Mount Mulligan, in the Chillagoe district, which the Government some weeks ago decided to close down. It has been now arranged, however, for the miners who were working in the colliery to take it over and operate it themselves on the tribute principle.

Old Mount Morgan Company.—After the payment to shareholders of the old Mount Morgan Company of the full face value of their shares, amounting to £1,000,000, there is a balance of £188,290 for distribution among shareholders. The final distribution is being delayed pending the issue of a clearance certificate from the Queensland Taxation Commissioner.

The Whitworth Company. — The directors of the Whitworth Finance and Mining Corporation, of London, which for some months has been operating two of the tin mines in the Herberton district, North Queensland, has engaged a mining engineer to visit the company's mines, and, in conjunction with the local manager, to advise on the most suitable method of dealing with the larger programme that has been foreshadowed. Arrangements have also been entered into with a mining house for the provision of additional capital. The company has at present nearly 100 men employed on the two mines, which are situated at Irvinebank, where treatment works have been bought from the Government, and the first crushing of ore has been put through.

Broken Hill.—In the year ended June 30 last the income from mine production by the Broken Hill South, Ltd., was £958,927, against £863,419 in the preceding year; while the gross mining profit increased from £118,334 to £361,762. After the deduction of £118,651 for profit and loss debts, a net profit of £358,259, or nearly 9s. a share, remained, or more than sufficient to maintain dividends at 1s. a share per quarter. The improvement of nearly £150,000 on the year was attributable to increase in the average price of lead and of the lead content of the crude ore, the more favourable returning charge on lead concentrates, and

a larger return from investments. The Broken Hill Proprietary Company, as well as the Broken Hill Proprietary Block 14 Company, have restarted underground work, after having suspended operations for two years owing to the decline in the price of lead. The higher average price of the metal is primarily responsible for the two mines having been again put into commission. One result will be the employment of about 1,200 men. The ore from these mines will be treated by the remodelled plant of the Sulphide Corporation. One of the two Diesel power units being installed by the corporation was expected to be ready for a trial run at the end of September last. When the whole equipment of this large plant is finished it will be capable of treating 60,000 tons of ore a week.

New Guinea Gold Discovery.—A party of prospectors who returned to Australia from New Guinea the other day reported that they had discovered, on the Oba River, a new goldfield, which they say is even richer than that at Edie Creek and is also more accessible. The two leaders of the party, which has been in New Guinea for ten months, relate that they had had brushes with hostile natives, had travelled over country not hitherto explored by white men, had made long journeys along rivers infested with alligators, and had marched many miles in search of native carriers who had run away ; but how, after many disappointments, success was achieved in the end.

VANCOUVER

November 9.

Canadian National Railway Belt.—Considerable disappointment has been felt at the closing down of work and the withdrawal of all machinery and rails below ground at the Topley-Richfield mine, although those who have been closely following the development of the property are not surprised. When first discovered, in 1926, the property received more attention than any recent discovery in the Province. The Provincial Government resident mining engineer, Mr. Douglas Lay, was so unstinting in his predictions as to its possibilities that many development companies sent engineers to make examinations. These engineers, as a rule, upheld Mr. Lay's good opinion, and it was only because of the extravagant terms asked by the discoverer, Mr. F. H. Taylor, for an entirely undeveloped prospect, that the property was not taken up at once. Finally, the Standard Silver-Lead Mining Company bonded it for $200,000, paid $10,000 cash for the privilege, and spent some $50,000 on exploration before dropping the option. Then the Topley-Richfield Mining Company was formed, and development has been continued steadily for two years under the advice of two well-known consulting engineers. The property has been explored by shaft, drifts, and cross-cuts to a depth of 200 ft. and drilled for 100 ft. deeper. Unrelated pockets of excellent ore have been found from time to time in the development, but no important commercial shoot or ore could be found ; hence the company's decision to close the mine while it still had some $200,000 in cash and 1,000,000 shares in its treasury, and machinery to the value of about $50,000.

Owen Lake Mining and Development Company's tunnel is now in 2,200 ft. and in the next 300 ft. is expected to cut four veins on the Trinch claims, which are the first objective of the tunnel. When these veins have been cut the company will drill an advance bore from the face of the tunnel, and from the result of this plans for the further extension of the tunnel will be made. Up to now the tunnel has cut 12 veins, none of which are known to extend to the surface. Lateral exploration is being done on some of these veins. A Radiore survey of the property is being made. Mr. Noah A. Timmins is expected to visit the property during this month to make an examination of the work done since he acquired control.

Babine Bonanza Metals, a new company backed by Eastern Canadian capital, has acquired the Babine Bonanza mine, developed by the late James Cronin, and is shipping boiler, engine, and compressor to it. The company is said to have $300,000 in its treasury. Its first work will be to extend the B tunnel to below the 180 ft. shaft, sunk by Cronin.

Mr. F. H. Taylor has bonded the eight original claims staked recently on Boo Mountain, 3 miles from Palling station, for $30,000, and will start exploration work on them. The discovery of promising copper-silver-gold ore on these claims resulted in many claims being staked on Boo Mountain.

The Kootenays.—Base Metals Mining Corporation's 300-ton mill is nearing completion, and is expected to go into operation during this month. Mr. Frank Eichelberger,

general manager for the company, reports that the drift on the West Monarch ore-body has been extended 37 ft. in ore averaging 30% combined lead and zinc, the lead slightly in excess, and 4 oz. silver per ton. Assuming the ore-body to hold the thickness and width of that part already developed, he estimates that this development will add 18,000 tons to the 300,000 tons already developed in the Monarch and Kicking Horse mines. In the construction of the mill provision has been made for increasing it to a capacity of 500 tons daily, and this will be done in the spring if development continues to be satisfactory. Addition also has been made to the East Monarch ore-body but further development until the mill is in operation has been impossible, as the portal to the mine is on the precipitous side of a mountain and there is nowhere to store ore. Goldfield Consolidated Development Corporation owns 1,300,000 and Mining Corporation of Canada 700,000 of the 2,000,000 shares Base Metals Corporation has issued. Mining Corporation has now joined Goldfield Consolidated in the same share ratio in finding funds for the development of the Berengaria mine, south of the Bluebell mine, on the east shore of Kootenay Lake.

Shipments of ores and concentrates to the Tadanac smelter have been steadily increasing as the year advances, the last ten days of October, with 17,016 tons, beating all previous records for a ten-day period by more than 1,000 tons. The Consolidated Company's own mines contributed 15,664 tons toward this total, McAllister, at Three Forks, which has been a consistently heavy shipper during summer and fall, 289 tons, and Noble Five, 245 tons. Noble Five now is operating its mill at 100 tons daily, and will continue to do so while power is available. The ore is averaging about 16 oz. silver per ton, 6% lead and 7·5% zinc. The remodelled mill at the Cork-Province mine is treating about 80 tons daily and is shipping 80 to 100 tons of lead and zinc concentrates weekly. The company has exposed the east ore-shoot for 124 ft. on No. 3, 80 ft. on No. 4, and 137 ft. on No. 5 levels. The shoot has a width of about 5 ft. of good milling ore. The cross-cut to the Superior vein is believed to be about 200 ft. from its objective.

Consolidated Mining and Smelting Company has put the first of its three Brown-Boveri mercury arc rectifiers into operation for converting alternating to direct current for the precipitation of zinc. Each rectifier has a capacity of 10,000 to 12,000 amperes at 500 volts. The complete plant, it is said, will be the largest of its kind in the world. Its installation will cost about half a million dollars. The International Joint Commission to consider claims against Consolidated for damages from smelter fume in the State of Washington met at Nelson on November 6, and adjourned to a place and date to be named later without hearing expert evidence and hearing only a few claimants. Besides the State of Washington and county of Stevens, there are some 200 individual claimants.

The French Complex Ore Reduction Company is appealing against the verdict of the Exchequer Court, quashing its patents, in the case of Electrolytic Zinc Process Holding Company *v.* the French Company to the Supreme Court of Canada. The Process Company is composed of big companies operating the electrolytic zinc process, and includes Consolidated, Anaconda Copper Mining Company, and Electrolytic Zinc Company of Australasia. The case was to have been heard in Montreal on October 21, but was moved to the end of the list of appeals. It is expected that it will come up in the first week in December. Consolidated has withdrawn its application for power right on the Lois River, some 50 miles north of Vancouver, in favour of the Powell River Company which has undertaken to spend six to eight million dollars on the development of the river, and on addition to its pulp and paper plant that will increase the company's output one-third or about 36,000 tons of paper yearly. In withdrawing the company's application Mr. J. J. Warren, president, said that he and his fellow directors realized that the power was essential to the Powell River Company while there were other water powers and other smelter sites that would suit his company equally well. He declined to say where they were, but evidently he is negotiating with the Government in the matter, for in a speech made recently at Esquimalt the Hon. S. F. Tolmie, Premier of British Columbia, stated that negotiations for a copper smelter and refinery on the coast were proceeding satisfactorily.

Alice Arm. — Howe Sound Company, through its British Columbia subsidiary, Britannia Mining and Smelting Company, has notified Toric Mines that it intends to exercise its option on the assets of Toric

Mines, and that a new company will be formed at once under the terms of agreement between the two companies to take over the Toric mine and mill. The agreement between the two companies is that in consideration for Britannia assuming Toric liabilities, which amounted to about $29,000, Britannia was to have time to explore the mine, and if the result of the exploration proved satisfactory, Britannia is to form a new company with a capital of 3,000,000 shares and to allot 750,000 shares to Toric for all its assets, which comprise the Toric group of five mineral claims, and a freak mill, rated at 60 tons capacity, Britannia retaining the remainder of the shares in consideration for its developing and equipping the property. Further, Britannia is to have the choice of two options on the shares allotted to Toric, namely (1) it may buy 100,000 within 1½ years at 95 cents per share, another 150,000 within 2½ years at 95 cents, another 200,000 within three years at $1, and 300,000 within five years at $1.37½; or (2) it may buy the whole 750,000 within two years for $500,000 cash. It is reported that more than 90 per cent of the stock of Toric Mines is owned in Great Britain.

TORONTO

November 19.

Sudbury District.—The collapse in mining securities on the Stock Exchange has not been followed by any curtailment of the operations of the International Nickel Company. Its programme of expansion is being vigorously pushed and every effort made to increase production, as, owing to the great demand for nickel, the company has been obliged to refuse many orders. With the Frood mine coming into heavy production in 1930 on a scale of at least 6,000 tons daily the supply will hardly be adequate to meet the growing requirements of the market. The company's financial statement for the quarter ending September 30 showed net profits of $5,627,577 as compared with $5,647,994 for the preceding quarter. For the first nine months of the year net profits were $16,685,753 as against $8,304,771 for the corresponding period of 1928. The Falconbridge, which has nearly completed the construction of a smelter of at least 200 tons daily capacity, expects to begin production in January. Development down to the 1,000 ft. level has indicated ore valued at $100,000,000, and diamond-drilling is being conducted on an extensive scale below the 1,000 ft. horizon to a depth of at least 3,000 ft. The Treadwell Yukon is making good progress with its expansion programme towards its ultimate objective of 3,000 tons of ore per day. The difficulties presented by the complex character of the ore have been largely overcome, and zinc-lead recoveries have latterly been sufficient to cover operating expenses. The shaft on the Errington will be deepened to 1,500 ft., and lateral development is meeting with favourable results. At the Lake Geneva property of the Towagmac Exploration Company excavation is in progress for the erection of a new mill with flotation equipment of 50 tons of ore per day, which can be increased to 100 tons per day by the addition of another flotation unit. The machinery will be brought in as soon as the lake is sufficiently frozen to bear transport and it is hoped to have the mill in operation in the spring. The ore reserves are estimated at 85,000 tons. Laboratory tests show that the ore can easily be treated by a flotation process with a recovery of 90% of the lead and zinc content. Sudbury Offsets has encountered an important additional deposit of nickel-copper ore by diamond-drilling which is being continued in the hope of locating other ore-bodies. Sudbury Basin, Ltd., has been conducting a diamond-drilling campaign with satisfactory results, having cut an ore-body about 30 ft. wide of excellent grade about 3,500 ft. to the east of the main deposit.

Porcupine.—The production of bullion by the gold mines of the Porcupine area during October amounted to $1,921,922, as compared with $1,564,582 for September. This rate of production has been considerably lessened by the destruction by fire of the mill of Dome Mines, Ltd., on October 28, entailing a loss of about $500,000, which is covered by insurance. The policy of the management as regards rebuilding has not yet been announced. There has been no cessation of underground work, which is being carried on more extensively. Driving is now in progress on the lower levels to pick up the ore-body indicated by diamond-drilling, and ore valued at approximately $1,000,000 has been added to the reserves. Although production will be halted for six months or longer there is to be no stoppage of dividends, which will be paid from the

dividend assurance fund. From present indications Hollinger Consolidated will close the current year with an ore reserve of well over $45,000,000, or at a point of between five or six years ahead of requirements at the current rate of output. At the beginning of the year the ore reserves are estimated at 6,557,000 tons, carrying an average of $7·81 per ton. During the past 10 months the average grade drawn from the mine has only been $6 per ton, the policy of the management being to conserve the high-grade as much as possible to stabilize the basis of production. The mill is treating about 4,500 tons a day. Ventures, Ltd., is having an examination made of the Coniaurum mine of which it secured the control last spring, preparatory to carrying out an extensive programme of development to the depth of 4,000 ft. At present the mill is working steadily, treating an average of about 230 tons per day. About 220 men are at work on the property. The McIntyre Porcupine is steadily carrying out its campaign of expansion. No. 11 shaft has now been completed and put into operation for hoisting the entire output. Two veins showing good widths have been intersected on the 3,750 ft. level in new territory and some good discoveries have been made in the older sections of the property, substantially increasing the ore reserves. The annual report of Vipond Consolidated for the year ending August 31 showed gross profits of $300,544 before depreciation and other charges, which compares with $185,930 for the previous 12 months. The mill produced bullion to the value of $797,114 from the treatment of 100,540 tons, representing an average recovery of $7·93 per ton.

Kirkland Lake.—The output of this field is well maintained, the production of bullion in October amounting to $1,148,728 as compared with $1,120,096 in September. The list of producing mines is headed by the Lake Shore which is making steady progress with its expansion programme. During the quarter ending September the mill treated 108,823 tons with a recovery of $1,400,000. Development work at depth is materially adding to the company's ore reserves. A large tonnage of high-grade ore has been opened up on the 1,800 and 2,000 ft. levels. The annual report of the Teck-Hughes for the year ended August 31 shows net operating profits of $2,802,583 as against $2,836,512 for the previous year, the net surplus for the year amounting to $2,543,518. The mill treated 381,150 tons of ore, with a recovery of $4,889,127, being an average of $14·76 per ton. Development at depth has indicated that the general conditions as to quantity and grade of ore between the 2,000 and 3,000 ft. levels corresponds to those obtaining between the 500 and 2,000 ft. levels. At the Wright-Hargreaves, a rise put up from the 2,000 to the 1,875 ft. level showed the ore to widen out to 40 ft., with a grade of between $7 and $10 to the ton. Ore grading from $8 to $10 over a width of 6 ft. is being taken from the 2,000 ft. level. The Kirkland Lake gold mine has completed the sinking of its shaft to the 4,000 ft. level, and is making preparations for lateral work on three levels, the lowest being at 4,000 ft., the deepest working in the camp. On the 3,600 ft. level an ore-body opened up for 125 ft., yielded high-grade ore over a width of 6 to 8 ft. The Bidgood has obtained good results from diamond-drilling, which indicate favourable changes in geology and mineralization at depth. A winze is being put down from the 850 ft. level to a depth of 1,000 ft. The Mindoka in the Boston Creek area of the camp is putting down a shaft and has made some shipments of copper to the Noranda smelter. The Ritchie is making steady progress in development, the vein opened up on the 500 ft. level yielding encouraging assays.

Rouyn.—The Noranda has declared its initial dividend establishing a quarterly dividend rate of 75 cents a share, representing an annual rate of $3, and calling for a total disbursement throughout the year of $6,505,698 on the 2,168,566 issued shares. This is the third largest distribution of dividends being made throughout Canada. At present the monthly production is about 4,000,000 lb. of copper and $160,000 in gold and silver. From the gross value in production a profit of 60% before depreciation is being realized. Early in 1930 monthly production should be nearly doubled, but the percentage of profits will remain the same. Later in the year when the enlarged concentrator is in operation outputs and profits should be increased. The Waite - Ackerman - Montgomery is shipping about 4,000 tons of ore a month to the Noranda smelter which will be substantially increased with the completion of the enlarged smelter. The company is realizing profits of about $60,000 per month.

Many of the companies which entered this field with high expectations have discontinued operations, the results obtained being disappointing. Among those which continue active development work are the Amulet, Abana, Rhyolite, Granada, Gilbec, and Newbec.

MANITOBA.—Great activity prevails in the transport of machinery and supplies for the mining companies by the Hudson Bay railway. Large quantities of freight are unloaded at various points to await transport to the mining camps over the winter roads. Preparatory construction work in the meantime is making good progress on the Flin Flon and Sherritt Gordon properties, and the latter company has signed a contract for power involving the construction of a 40 mile 110,000 volt transmission line. The Mandy has taken over on option the Baker-Patton property of the Callinan Flin Flon Company, on which it is carrying out an extensive diamond-drilling campaign. The Manitoba Flin Flon has obtained good results from the exploration of several groups of claims on which work will be continued throughout the winter. Following an examination of the property of the Jack Nutt Mines in the tin field of South-eastern Manitoba, by Campbell Hunt of London, British and American capitalists have become interested and will advance funds for development on a large scale. Production of gold at Central Manitoba Mines is being maintained at present capacity of the plant, with tonnage running from 150 to 160 tons daily.

CAMBORNE

December 5.

THE PRICE OF TIN.—The fall of the price of tin metal to a lower level than any experienced since 1922, due mainly to the continued over-production of the metal, completely turns the tables upon those prophets who, two or three years ago, loudly—very loudly—trumpeted their predictions of a coming famine in tin!

The average price of tin metal in 1914 was a little over £150 a ton. In 1920 the price, at its highest point, touched £420, but by 1922 dropped to the lowest point, of £140, in the post-war slump, when mining operations were at a standstill in Cornwall, the average price for that year having been about £160. In the first week of the current month £174 10s. was recorded.

The immediate effect of this further decline in price upon Cornish tin mines is naturally severe, and an immediate re-adjustment of development expenditure becomes imperative in most of them. Fortunately the chief old-established mines possess substantial reserves of ore-ground, and some of them reserves of cash as well. The newer mines are not so well provided for a prolonged period of low prices.

It is noteworthy, however, that, at the moment, there is no indication of a suspension of operations, even temporarily. Where wolfram occurs in association with cassiterite, more attention is being paid to the former, especially in South Crofty, where it has been decided to resume operations on the company's wolfram mine at Castle-an-Dinas.

SILICOSIS.—The perplexities of mine officials are perceptibly increased by the inclusion of tin mines in the list of industries dealt with by the "Various Industries (Silicosis) Scheme", 1928, issued as a Statutory Order by the Home Office, under the "Workmen's Compensation Act," 1925, and which came into force last February, having been hurriedly launched by the Home Secretary of the late Government, in a vague and incomplete form. A few months' experience proves the scheme to be unjust and unworkable in its application to Cornish mines.

Efforts to cover silicosis risks under the scheme, by means of insurance have led to the discovery that insurance companies are by no means keen on issuing policies, because of the vagueness and uncertainty as to what the risks may be. In one instance a premium of £10 per cent. on the wages has been quoted, and in another, a condition is attached that a satisfactory medical certificate be submitted in respect of each employee, or a signed statement furnished that medical reports have been secured, showing that no employee is suffering from silicosis, or fibrosis of the lungs.

An addition of £10 per cent. to the wages-sheet is too heavy a commitment to be seriously considered, especially in these critical times, and obviously the condition laid down in the second case is an impossible one.

The whole matter, after months of consideration, resolves itself, apparently, into the adoption of one out of three courses, namely:—

1. To insure with some insurance company on the best terms available, irrespective of what they may be.

2. To carry the risks, without being able to know what they are, and chance the consequences.

3. To cease to employ workmen unless they are medically certified free from silicosis.

That the third alternative is being taken in several mines should not surprise anybody.

Realizing the shortcomings of the scheme, a Departmental Committee has recently taken evidence from 21 witnesses, including one Cornish witness only, Dr. Chown, of Tehidy Sanatorium; and, as a result of their report, further legislation is intended to be carried through the House during the present session. This will include arrangements for the establishment of competent medical boards, and it may be taken for granted that the aim of the Government will be to make conditions relating to silicosis in Cornish mines very much the same as those existing in South Africa, and to render employees liable for partial, as well as for total, disablement.

In doing this it is to be hoped that initial conditions will not be allowed to bear unnecessarily hardly upon owners or upon workmen. A defect of the scheme now in operation is that it makes the liability for compensation to fall upon the last employer of the claimant. Hence a new mine, such as Poehigey, might be compelled to pay from £300 to £600, according to the number of dependants, on account of a workman, recently engaged, but who had spent his best years in a defunct mine, such as Tresavean or Wheal Grenville (from which compensation cannot be recovered), or even in mines in foreign lands! This is a hardship that calls for alteration.

The workmen, too, have their hardships ahead of them, in that they will not be able to obtain employment unless they are certified "fit." Here is a matter for serious consideration from another point of view—that of Unemployment and the Dole!

PERSONAL

J. M. Callow has left for the United States.

I. J. A. Diamond has left Johannesburg on a visit to Southern Rhodesia.

O. T. Gorton is back from Uganda.

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

Austin Y. Hoy is back from the United States.

Dudley J. Inskipp has left for South Africa.

Charles Janin has returned to the United States.

C. E. Jobling has returned to Burma.

R. J. Lemmon has joined Imperial Chemical Industries, Ltd., as Metallurgical Engineer.

George Mellor has returned from Brazil.

C. A. Mitke has left for the United States.

J. Nile has left Cornwall to take up an appointment at the Nantymwyn mine in South Wales.

A. L. J. Queneau has left for the United States.

James Roberts has left for Italy.

Horace P. Robertson has returned from South Africa.

W. H. Rundall, of Messrs. Pellew-Harvey and Co., is back from the United States.

A. R. Thomson, manager of the Wankie Colliery, Rhodesia, is visiting Australia.

T. H. Vincent has returned from Brazil.

Robert Woodward, one of the founders of Edgar Allen and Co., Sheffield, and chairman since 1915, has resigned his seat on the Board. Charles K. Everitt, who succeeds Mr. Woodward as chairman, joined the company in 1881.

J. A. MacVicar, for some years diamond-drilling expert with the Sullivan Machinery Co in England and elsewhere, died at Montreal on October 21. Readers will remember him as a valuable contributor to our columns.

Leonard S. Austin died at his home in Los Angeles on October 29, at the age of 83. For many years he was engaged in smelting operations in the United States, and in 1903 became professor of metallurgy and ore-dressing in the Michigan College of Mines. On this side of the water he was well known as the author of "Metallurgy of the Common Metals."

Dr. Percy A. Wagner died of enteric fever at Johannesburg on November 11 at the early age of 44. He did much excellent service for the Geological Survey of the Union of South Africa and wrote many valuable reports. His book "The Diamond Fields of Southern Africa" is a classic, and his latest book "The Platinum Deposits and Mines of South Africa" is a work of the same calibre.

TRADE PARAGRAPHS

Head, Wrightson and Co., Ltd., of Stockton-on-Tees, issue a booklet devoted to Nissen stamp mills which require no description here.

Adam Hilger, Ltd., of 24, Rochester Place, London, N.W. 1, issue booklets devoted to the practice of spectrum analysis and spectrographic outfits for metallurgical analysis.

Metropolitan Vickers Electrical Co., Ltd., of Trafford Park, Manchester, send us the October issue of their *Gazette*, which contains the continuation from the August issue of the description of the Perak River hydro-electric scheme, which article is fully illustrated.

United Engineers, Ltd., of Singapore, send us the second issue of their Magazine, a publication which besides containing a quantity of bright reading matter carries a lot of advertising which serves to show the agencies handled by this firm for a variety of British manufactures.

Mond Nickel Co., Ltd. (Bureau of Information on Nickel), of Imperial Chemical House, London, W.S. 1, issue a bulletin on the nickel alloy steels which were employed in the construction of the "Golden Arrow" with which Sir Henry Seagrave recently broke the world's speed record for automobiles.

Ruston and Hornsby, Ltd., of Lincoln, issue one or two attractively prepared booklets and leaflets on the subject of their excavators in general and the Ruston No. 4 in particular. One of these contains a number of illustrations to show Ruston

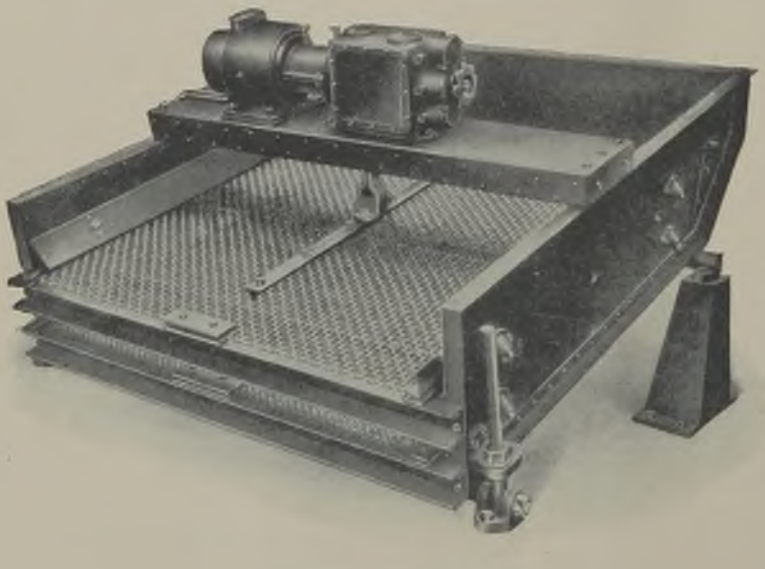
draglines and shovels employed in a variety of operations in different parts of the world.

Westinghouse Electric International Co., of 2, Norfolk Street, London, W.C. 2, send us the December-January issue of their Magazine, together with a booklet devoted to multiple retort stokers which are built in three distinct types, the dump grate stoker, the dump grate stoker and agitator, and the clinker stoker grate dump. Leaflets devoted to high speed synchronous motors and motor generators are also enclosed.

South-Western Engineering Corporation, of Los Angeles, California, publish a second revised and enlarged edition of their notes on flotation practice by Lord and Snyder in collaboration with other members of the staff of the corporation. This booklet, which covers some 60 odd pages, and is fully illustrated, contains notes on the behaviour of various minerals, reagents, gangue interference, beneficiation of oxidized ore, selective flotation, molybdenite flotation, cyanidation and flotation, machines and their functions, and a number of typical metallurgical reports. Copies may be obtained from THE TECHNICAL BOOKSHOP.

Machinery Exhibition recently held in London. This screen, which is suitable for all classes of sizing, is of the high-frequency vibration type as may be seen from the accompanying illustration. It will be noticed also that it can have 1, 2 and 3 surfaces, and may be built open or closed. The vibrator is simple in operation, and requires only $\frac{3}{4}$ h.p. Capacity figures for coal are given as follows: $1\frac{1}{2}$ in. square 100 tons per hour (with extra screening length), $\frac{1}{2}$ in. square 50 tons per hour, $\frac{1}{4}$ in. square 10 tons per hour, the corresponding figures for coke being 50, 25 and 5.

Sullivan Machinery Co., of Salisbury House, London, E.C. 2, inform us that Sullivan Machinery Co. (Africa) Proprietary, Ltd., have established an office and warehouse at N'Dola, Northern Rhodesia. A stock of the company's products, and spare parts for them, will be carried at N'Dola. Also beginning on January 1, this same company will have an office in Geneva House, corner of Loveday and Marshall Streets, Johannesburg. The company also issues further catalogues of drilling equipment. These include a Sullivan Type 60 oil-field drilling rig for deep tests and wildcat drilling and Sullivan diamond drills for core drilling. Each booklet is fully illustrated with typical installations, and some examples of practice. A Type 60 rig is recommended for use up to 6,000 ft. in depth, the following strings of casing being possible: 1,000 ft. of $11\frac{3}{4}$ in., 2,500 ft. of $8\frac{5}{8}$ in., 4,000 ft. of $6\frac{5}{8}$ in., 5,000 ft. of $4\frac{3}{4}$ in., 5,500 ft. of 3 in. inserted joint casing; in addition, this type will drill an open hole with 6,000 ft. making a 3 in. hole and taking a 2 in. core.



THE SUNDERLAND SCREEN.

Mirrlees, Bickerton and Day, Ltd., of Mirrlees House, Grosvenor Gardens, London, S.W. 1, and of Stockport, inform us that the Panama Corporation, Ltd., has ordered three 6-cylinder 450 b.h.p. Mirrlees Diesel oil engines coupled to G.E.C. alternators which will supply electricity for operating the equipment at the Remance Gold Mines on the Veraguas Concession. Power will be taken from these engines to drive crushing and other metallurgical plant, air-compressors, pumps, hoisting engines and workshop machinery and current for lighting both on the surface and below ground, the whole design and lay-out having been carried out under the direction of Mr. Hugh Marriott.

Sunderland Forge and Engineering Co., Ltd., of Pallion, Sunderland, have sent us a descriptive leaflet of the Sunderland screen which was referred to in these columns in our issue of October in connection with the Shipping, Engineering and

International Combustion, Ltd., Grinding and Pulverizing Offices, of 11, Southampton Row, London, W.C. 1, report that new orders have been received for the following equipment: For England: One $4\frac{1}{2}$ ft. by 16 in. Hardinge ball-mill for Bideford Black; one 5 ft. by 22 in. Hardinge ball-mill for chalk; two Raymond mills for slate chippings; one No. 0000 Raymond pulverizer for Prussian Blue. For India: One 3-roller Baby Raymond mill for plumbago; one

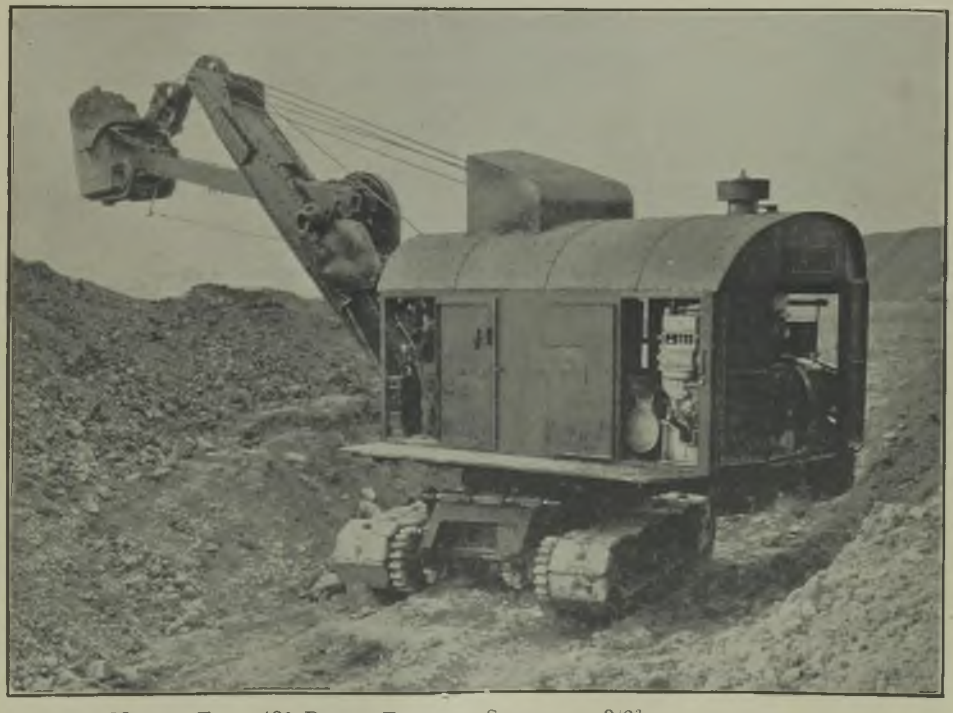
4½ ft. by 16 in. Hardinge ball-mill for tin ore; one 3-roller Raymond mill for unspecified oxide. For South America: Two 6 ft. by 36 in. Hardinge ball-mills for gold ore. For France: One No. 00 Raymond pulverizer for graphite; one Hardinge ball-mill for zinc and lead ore; one Hum-mer screen for Portland Cement; two Hum-mer screens for Portland Cement. A more recent announcement informs us of the following further orders:—For England: Two 4 ft. by 5 ft., type 39, S.S. Hum-mer screens for coal; four 4 ft. by 5 ft., type 39, S.S. Hum-mer screens for coke breeze; one 3-roller Baby Raymond mill for limestone; one similar mill for limestone; and one No. 0 Raymond pulverizer for clay. For France: One 5-roller Raymond mill for waste slag; one 3 ft. by 18 in. Hardinge ball-mill for limestone; one No. 0000 Raymond pulverizer for gas coal.

RANSOMES-RAPIER-MARION DIESEL-ELECTRIC EXCAVATORS

During a recent visit to Waterside Works, Ipswich, we were shown, either in operation or in course of erection, several types of Marion excavators which are now built in this country. We particularly were attracted by the Diesel-electric types. The general features of the Marion direct-current design on their excavators were described in these columns in December, 1928. It is remarkable that the old steam navvy should possess so many desirable characteristics, and it was apparent that the electric shovel described at that time gave results more nearly approaching those obtained with a steam-driven machine than could be obtained by fitting with a.c. motors. The flexibility and cheap working of the Diesel-electric excavators make them an economical as well as a handy machine to instal.

Many advantages are said to be gained by employing the Diesel-electric powered excavator in place of the cheaper form of Diesel engined excavator in which the power is transmitted through rotating shafts, gears, and friction clutches. Stated briefly, it has been proved by actual working records that the higher first cost of the Diesel-electric is more than recovered in two or three years' operation by a higher output of material excavated, a lower maintenance and repair cost, and a lower fuel cost. Also, under similar working conditions the Diesel-electric excavator is capable of 10 to 20% greater output than the same size machine with mechanical transmission. In addition the greater flexibility and smoothness of operation give it a considerably longer life.

Two reasons advanced for the superiority of Diesel-electric excavators are: (*a*) The Diesel-electric excavator will excavate more material per hour, even when fitted with a smaller engine, because the flexibility of the electric transmission makes the cycle of operations faster, and the ease of handling the controls enables the operator to work faster and for a longer period without getting fatigued. In addition, the action of the electrical transmission is automatic and foolproof. The driver does not waste time over the careful manipulation of clutch levers, as there are no clutches to worry about. Also the efficiency of the transmission is higher, and the electrical system enables maximum starting torques to be given with low consumption of power and fuel. (*b*) Maintenance, repair, and fuel costs are lower because the power is applied gradually and without shock, for there are no friction



MARION TYPE 480 DIESEL-ELECTRIC SHOVEL OF 2/2¾ CU. YD. CAPACITY.

clutches. The power taken from the Diesel engine is definitely limited by the electrical system, so that neither the engine nor the machinery of any motion can be overloaded, and it is impossible to stall the engine. Also the motors will speed up under light loads and slow down under heavy loads, thus imitating closely the flexible operation of a steam engine. In addition the Diesel engine always runs at its most economical speed, and there are fewer moving parts. Each motor is geared direct to its job with the minimum of gear reductions. Finally the engine is properly balanced, running with very little vibration and is completely enclosed, so that no working parts are exposed to grit and dirt. All the machinery is easily accessible. There is ample space to walk round and inspect all parts.

The illustration shows a type 480 Diesel-electric Marion excavator at work. These machines are fitted, in this country, with either Ricardo or McLaren-Benz Diesel engines.

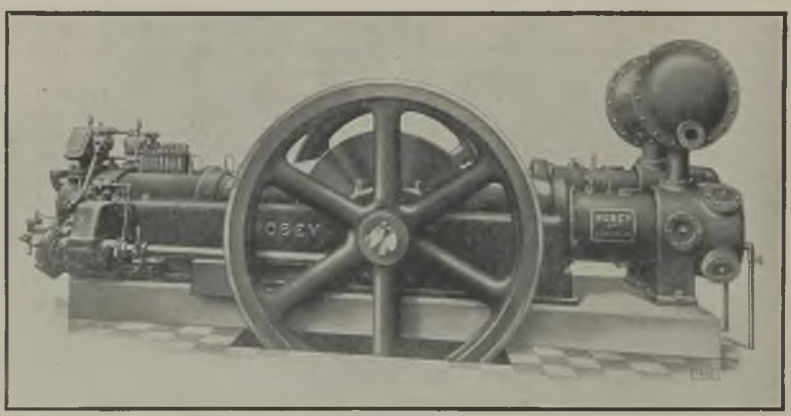
Lead Wool Co., Ltd., of Snodland, Kent, were showing samples of their lead wool and joints made of this material, also small portable air-compressors and a variety of pneumatic tools.

J. Halden and Co., Ltd., of 8, Albert Square, Manchester, were displaying drawing office equipment of all kinds, together with theodolites and various other surveying instruments.

Carl Zeiss (London), Ltd., of 79, Wells Street, London, W. 1, were showing levels of different types and theodolites, optical squares, and drop rods for rapid setting out.

The Wallwin Company, of Warwick, were showing samples of their non-chokeable pumps for dealing with water-borne solids including belt driven and direct coupled of the horizontal type, and also for vertical drive.

Francois Cementation Co., Ltd., of Doncaster, were showing samples of their Betonac hardening material for adding to cement and sand instead of



Robey Straight Line Oil-Driven Compressor of 500 cu. ft. capacity.

PUBLIC WORKS, ROADS AND TRANSPORT CONGRESS AND EXHIBITION

This was held at the Royal Agricultural Hall, London, N., from November 18–23, and among the various exhibits the following proved of some interest to mining men :—

Frederick Parker, Ltd., of Leicester, were showing Monarch granulators and crushing rolls and also Blake type crushers.

Bromford Tube Co., Ltd., of Birmingham, were showing hot finished weldless steel tubes of every description up to 10 in. bore.

Winget, Ltd., of Grosvenor Gardens, London, S.W. 1, were showing single toggle stone crushers and granulators.

Tangyes, Ltd., of Birmingham, were exhibiting a 39 b.h.p. heavy-oil engine and a number of centrifugal and ram pumps.

Gardner-Denver Co., Ltd., of 3, Wilson Street, Drury Lane, London, W.C. 2, were showing samples of their portable air-compressors, pneumatic tools, and rock drills and accessory parts.

Goodwin, Barsby and Co., Ltd., of Leicester, were showing a 30 in. granulator, a 24 in. by 12 in. lever type stone-breaker, and 30 in. by 18 in. fine crushing rolls.

the ordinary aggregate for producing a concrete surface.

Marshall, Sons and Co., Ltd., of Gainsborough, were showing fixed and portable horizontal oil engines respectively of 50 and 16 b.h.p., the former being a Diesel cold-start four-cycle type and the latter a semi-Diesel two-cycle type.

Thomas and Bishop, Ltd., of 37, Tabernacle Street, London, E.C. 2, were showing a variety of belt treatings and joint materials, notably Cling-surface and Erusa belt treatings and Permac jointing material.

William Jones, Ltd., of 154–5, Upper Thames Street, London, E.C. 4, were showing light locomotives, both Diesel and petrol, and other light railway material such as dump cars, portable track, and crossings.

Robey and Co., Ltd., of Lincoln, had an interesting exhibit of a straight line Diesel engined air-compressor, operated by a Robey Diesel engine of 110 b.h.p., with a capacity of 500 cubic feet of free air per minute at a pressure of 100 lb. per square inch. The unit is illustrated in the accompanying photograph.

Hadfields, Ltd., of Sheffield, exhibited crushing machinery, notably a portable breaker and screen, a 24 in. disc crusher, a 16 in. by 5 in. solid steel granulator, also hollow and solid mining drill steel and spare parts for crushing machinery.

F. C. Hibberd and Co., Ltd., of 16, Northumberland Avenue, London, W.C. 2, were exhibiting Planet petrol locomotives of 20, 10, and 6 h.p., having respective haulage capacities on the level of 35, 25, and 20 tons.

Atlas Diesel Co., Ltd., of Hart Street, London, W.C. 1, were showing portable air-compressors with a piston displacement of 114 and 127 cubic feet per minute, having respective capacities of 85 and 98 at 90 lb. per sq. in. pressure, together with a number of pneumatic tools.

British Steel Piling Co., Ltd., of 54*a*, Parliament Street, London, S.W. 1, in addition to various sections of sheet steel piling, exhibited an interesting model showing the use of sheet steel piling in an important civil engineering contract in Egypt.

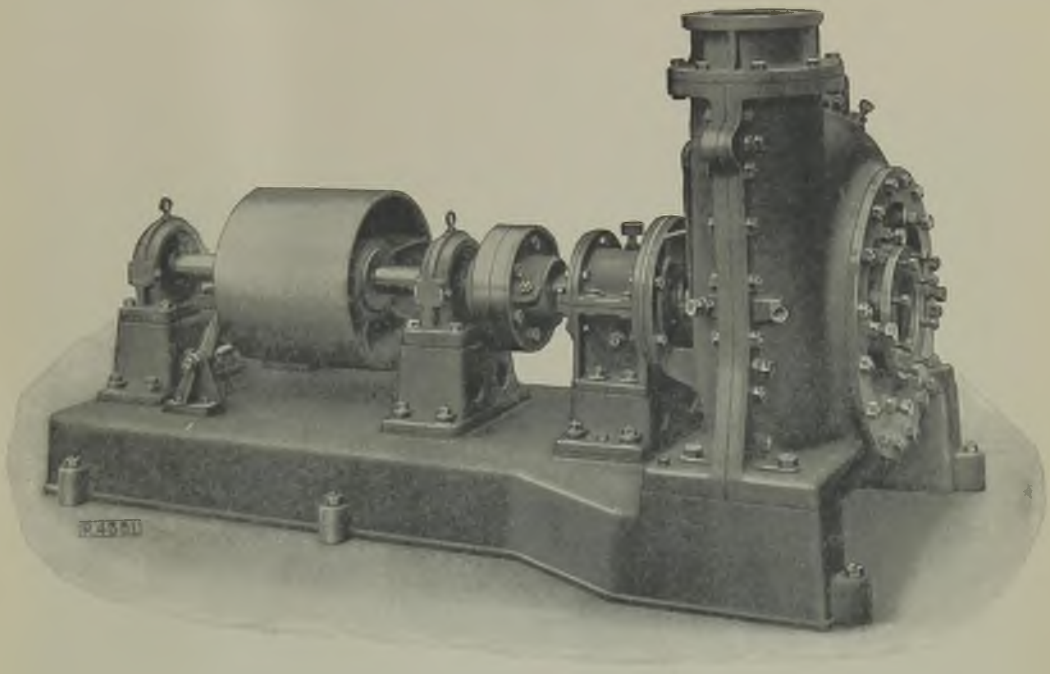
Patent Lightning Crusher Co., Ltd., of 14*a*, Rosebery Avenue, London, E.C. 1, were showing sizes 1 and 2 of their well-known crusher and granulator, having capacities of respectively 5–6 and 15 tons per hour, and various types of lining plates and screens.

Cooke, Troughton and Simms, Ltd., of Broadway Court, London, S.W. 1, had a complete range of surveyors' levels, theodolites and tacheometers, fitted with new internal focussing system of low constant type, and a variety of staves and drawing office equipment.

H. R. Marsden, Ltd., of Leeds, were showing a Blake-Marsden 24 in. by 20 in. " X " type lever motion stone-breaker, a set of Blake-Marsden 30 in. by 16 in. crushing rolls, a " Niagara " Counterflow screen No. 3 (double deck), and also a magnetic pulley and separator for dealing with tramp iron.

Blackstone and Co., Ltd., of Stamford, were showing their well-known horizontal single-cylinder heavy-oil engine of 55 b.h.p. with special spring injection device, which renders it clean and quiet in running and reliable. They also had a 3 in. unchokeable pump direct-coupled to a 5 b.h.p. petrol engine.

International Combustion, Ltd., Grinding and Pulverizing Offices, of 11, Southampton Row, London, W. C. 1, were showing a Hum-mer Screen which is well-known to readers of the MAGAZINE, and also a laboratory Ro-Tap screen as made by the W. S. Tyler Company of Cleveland, Ohio, which has been described in these columns in the past.



GRAVEL PUMP BY RUSTON AND HORNSBY, LTD.

Ruston and Hornsby, Ltd., of Lincoln, in addition to an exhibit of one of their power shovels adapted as a back acting trencher with a petrol-paraffin Dorman four-cylinder engine, were making a special feature of a new gravel pump which is capable of passing solids almost equal in diameter to that of the suction pipe. For instance, an 8 in. pump will pass a stone, the greatest dimension of which is 7 in. This pump is shown in the accompanying photograph. It will be seen that it is fitted with a friction clutch pulley which is operated by a hand lever which permits starting up under load and instant stopping in case of blockage.

Broom and Wade, Ltd., of High Wycombe, were showing a portable air-compressor direct-coupled to a Lister 12–14 h.p. petrol engine having an output of 55 cubic feet per minute at 100 lb. pressure. Another machine was fitted with a 32 h.p. Dorman engine that was capable of an output of 150 cubic feet at 100 lb. pressure. A stationary belt-driven compressor for delivering 200 cubic feet at 100 lb. pressure was also exhibited.

Kerr, Stuart and Co., Ltd., of Stoke-on-Trent, were showing a Diesel engine lorry which was

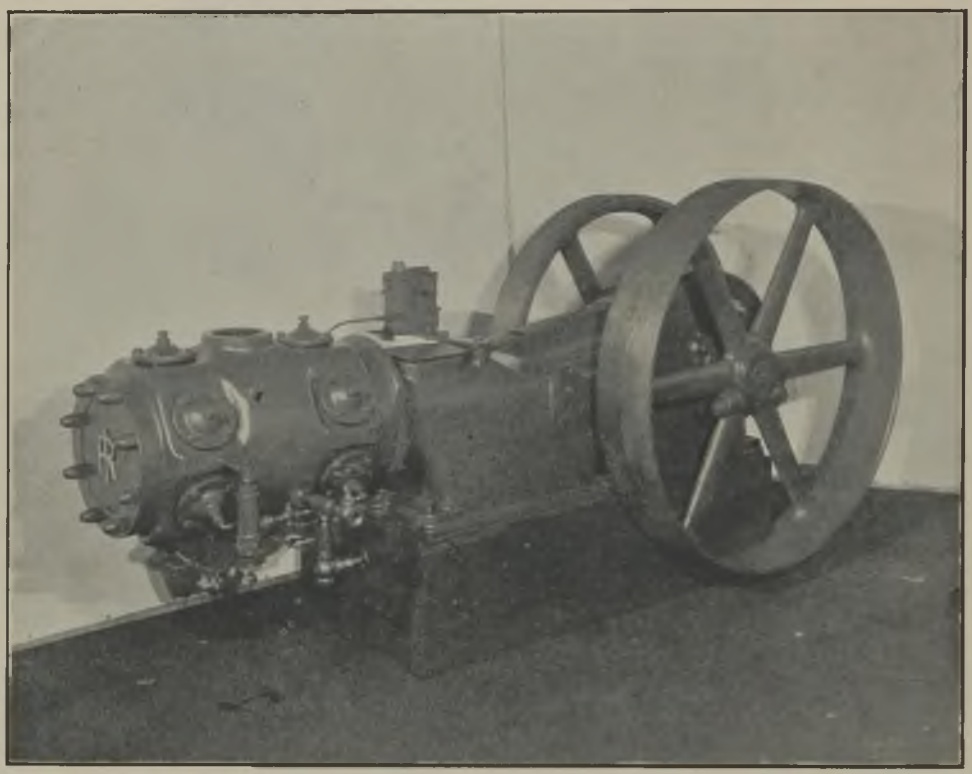
attracting considerable attention. This lorry which in every other respect is standard is fitted with a 60 h.p. airless injection Diesel engine similar to the McLaren-Benz type, and is calculated to travel 10–14 miles per gallon of Diesel oil on a 7 ton load. The engine is made by **J. and H. McLaren, Ltd.,** of Leeds.

Holman Bros., Ltd., of Camborne, had the distinction of presenting on their stand what probably proved to be the single most interesting exhibit to road making contractors. This was the Vortex silencer, which is fitted to road rippers and is designed to eliminate the noise made by these drills by some 60 per cent. Other exhibits included

which are of the usual convertible type, full circle revolving. A ½ yard machine weighs approximately 10 tons, and is capable under average conditions of obtaining an output of from 20 to 30 cubic yards per hour.

R. H. Neal and Co., Ltd., of Longfield Avenue, Ealing, London, W. 5, were showing models of Austin trench digging machines which consist of an endless bucket chain operated in much the same way as in standard dredge practice. They were also showing models of Barber Greene ditchers and mechanical handling plant.

Ross Patents, Ltd., of 2, Victoria Street, London, S.W. 1, were exhibiting models of their feeders for



INGERSOLL-RAND SINGLE CYLINDER STRAIGHT LINE AIR-COMPRESSOR.

portable air-compressors, Hele-Shaw-Beacham rotary single stage air-compressor, and Hele-Shaw-Beacham air motors.

Ingersoll-Rand Co., Ltd., of 165, Queen Victoria Street, London, E.C. 4. Of principal interest on this stand was the new air-compressor which is here illustrated. As will be seen, it is of the horizontal single-cylinder double-acting type having inlet and discharge valves arranged radially around the cylinder. Special plate air valves are used, operated independently. The machines are made in a range of capacities for pressures of 80 to 100 lb. per square inch, and for driving by an electric motor with short belt drive or for direct coupling to synchronous motors or oil engines. There are at present sizes of 20, 40, and 74·5 b.h.p. with corresponding outputs of 138, 204, and 461 cubic feet of free air per minute at 100 lb.

Priestman Bros., Ltd., of Hull, were exhibiting parts of their ⅓ and ½ yard universal excavators,

controlling the flow of material from storage hoppers. These are capable of handling any granular material of whatever size and by adjustment it is possible to produce either a wide and slow-running stream or a narrow quick-running one.

Metal Union, Ltd., of 66, Broad Street Avenue, London, E.C. 2, English Agents for **Schramm, Inc.,** of West Chester, Pennsylvania, and also for the **Cleveland Rock Drill Co.,** of Cleveland, Ohio, were showing air-compressors, a product of the former concern, in portable types. A number of Cleveland pneumatic tools was also exhibited. The manufactures include stationary air-compressors of 1, 2, 3 and 4 cylinders, vertical, and all types of rock drills.

Huntington, Heberlein and Co., Ltd., of 47–51, King William Street, London, E.C. 4, were showing their H.H. type jigging screen which consists of a steel body carrying the screen frames mounted on a series of laminated spring legs, the

actuating mechanism being an unbalanced pulley which is driven by a 3 h.p. engine or small electric motor. Another exhibit was an "Overstrom" vibrating screen. An unbalanced pulley running at 1,700 r.p.m. gives a vigorous vibration of small amplitude in this case.

Wellman Smith Owen Engineering Corporation, Ltd., of Victoria Station House, Victoria Street, London, S.W. 1, were exhibiting essential parts of the Wellman-Denholm ½ cubic yard universal excavator. This is a machine suitable for light duties and is made in the convertible form for use either as a shovel, dragline, crane, clamshell, etc. It may be equipped with a 30 h.p. petrol or paraffin engine or a Diesel engine or electric drive, and is mounted on caterpillars. It is said to be a particularly fast operating machine.

Reavell and Co., Ltd., of Ipswich, were showing three sizes of portable air-compressor sets, engine driven with capacities of 74, 118, and 153 cubic feet per minute respectively. The two smaller sets are vertical compressors, and the largest a compressor of the quadruplex type. Other types of compressors shown included a two-cylinder single-acting belt driven machine of 177 cubic feet per minute, and a single-cylinder machine of similar type with a capacity of 59 cubic feet per minute, both being suitable for working a pressure of 100 lb. per sq. in.

Climax Rock Drill and Engineering Works, Ltd., of Carn Brea, Cornwall, and 4, Broad Street, Place, London, E.C. 2, were showing a variety of rock drills, and also for demonstration purposes some interesting model drills which served to show the action of the moving parts. Among recent products of this firm to which attention was drawn is the Climax Hay dust trapper. This device has been evolved by Capt. P. S. Hay of the Safety in Mines Research Board and aims at the trapping of the dust which arises in drilling. The trapper was described in principle in the MAGAZINE of September, 1926.

METAL MARKETS

COPPER.—There was a rather easier tendency in evidence in this market during November, electrolytic in New York at one time receding from 17·95 cents per lb. to 17·80 cents, subsequently, however, recovering to 17·90 cents when the cheaper sellers had exhausted their offers. Standard values in London also declined quite substantially, but recovered from the worst. Developments on Wall Street, which were mainly adverse, were, of course, not without their influence on the copper market, and the industrial outlook in the United States, upon which copper values must remain highly dependent, is at the moment very obscure. Producers are curtailing output in an effort to maintain control, but there is no doubt that the ramp in prices witnessed in this market not so long ago has caused many consumers to divert their attention to alternative metals and this factor may eventually prove a decisive one.

Average price of cash standard copper: November, 1929, £69 8s. 4d.; October, 1929, £72 17s. 2d.; November, 1928, £68 2s. 3d.; October, 1928, £65 11s. 4d.

TIN.—Prices fluctuated considerably last month, but towards the latter part of November, after a further heavy decline, it looked as if sentiment were beginning to recover, despite the fact that the statistical outlook remained rather discouraging. It was then announced that the Tin Producers' Associaiton had formulated a scheme for controlling the output of some of the smelters, but the market was disappointed apparently with the scope of the project and values subsequently suffered a further sharp relapse. On balance, however, prices only lost a few pounds per ton on the month. The quotation is now so cheap that it is beginning to attract the interest of fresh bull speculators, while undoubtedly it will discourage output all over the world. In the near future, therefore, supply and demand should begin to get into closer equilibrium again.

Average price of cash standard tin: November, 1929, £180 13s. 7d.; October, 1929, £190 17s. 7d.; November, 1928, £232 19s. 5d.; October, 1928, £222 2s. 1d.

LEAD.—This market was weak throughout most of the past month, although some recovery was seen towards the close. The easiness of the spelter market was a bear point, but the lead position itself was, and remains, rather adverse, there being no shortage of supplies, whereas demand from consumers is slow. The American situation has developed adversely, the quotation in New York being marked down from 6·75 cents to 6·25 cents per lb. For the time being the Lead Producers' Association seems to have lost control of the European position to a large extent.

Average mean price of soft foreign lead: November, 1929, £21 12s. 7d.; October, 1929, £23 4s. 9d.; November, 1928, £21 7s.; October, 1928, £21 18s. 9d.

SPELTER.—November was a disastrous month for the spelter market, prompt prices declining from £22 on November 1 to £19 12s. 6d. on the 29th. Superabundant supplies, a poor demand, and the announcement that the existing Cartel is to terminate at the close of the year with rather poor prospects of a successful reconstruction being achieved, were all contributory factors in the fresh downward movement in prices. The outlook remains obscure but clearly the drop in prices must have offset much that is adverse in the situation.

Average mean price of spelter: November, 1929, £21 2s.; October, 1929, £23 2s. 6d.; November, 1928, £24 16s. 3d.; October, 1928, £24 3s. 3d.

IRON AND STEEL.—Prices of Cleveland pig iron remained steady during the month. There was a fairly good demand for early delivery, but makers are rather anxious about the outlook for 1930, as their books are not over-full with business for the early part of the New Year. Output was curtailed owing to the stoppage of furnaces due to mechanical troubles. No. 3 Cleveland pig iron G.M.B. remained at 72s. 6d. per ton, but some merchants were willing to shade this figure. Hematite was a firm market, and East Coast Mixed Nos. moved up to 78s. 6d. minimum for early delivery, while some makers asked up to 81s. for forward. British finished steel was steady during the month, thanks to a fair home demand, though export sales left much to be desired. Continental steel was erratic and rather easy, but merchant bars have been stabilized at a fixed level of £5 5s. per ton f.o.b., and it is hoped to extend this scheme of price-fixing to other products. It is possible that the European Raw Steel Cartel will announce another cut in output shortly.

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.	
Nov.	£	s.	d.	£ s. d.	£	s.	d.	£ s. d	£	s.	d.	£ s. d.	£	s.	d.	£	s.	d.	£ s. d.		d.	d.	s. d.
11	69	3	9	68 14 4½	82	10	0	—	175	12	6	178 12 6	20	10	0	21	5	0	22 15 0		22¾	22¾	84 11½
12	67	1	3	67 3 1½	82	10	0	73 10 0	174	16	3	178 2 6	20	10	0	21	12	6	23 0 0		23⅛	22⅞	84 11
13	68	7	6	68 7 6	82	10	0	—	175	12	6	178 17 6	20	13	9	21	12	6	23 0 0		23⅛	22¾	84 11½
14	68	1	3	67 13 9	82	10	0	—	177	18	9	180 18 9	21	5	0	21	16	3	23 5 0		23⅛	22 13/16	84 11½
15	68	18	9	68 17 6	82	10	0	74 15 0	180	7	6	183 3 9	21	15	0	21	17	6	23 5 0		23⅛	22¾	84 11½
18	69	7	6	69 6 3	82	10	0	—	180	7	6	183 7 6	21	16	3	21	17	6	23 5 0		23⅛	22⅞	84 11½
19	70	1	3	69 3 9	82	10	0	75 0 0	179	10	0	182 2 6	21	13	9	21	15	0	23 5 0		23⅛	23	84 10¾
20	69	1	3	69 1 3	82	10	0	—	179	15	0	182 12 6	20	13	9	21	7	6	22 15 0		23⅛	22⅞	84 10
21	70	0	0	69 10 0	82	5	0	—	184	2	6	186 12 6	20	1	3	20	17	6	22 10 0		23⅛	22 15/16	84 10¾
22	71	15	0	70 16 3	83	5	0	76 10 0	186	2	6	188 11 3	20	2	6	21	8	9	22 10 0		23⅛	23	84 11½
25	72	0	0	70 18 9	83	10	0	—	190	3	9	192 10 0	20	7	6	21	8	9	22 15 0		23⅛	22⅞	84 11½
26	71	7	6	70 5 7½	83	10	0	76 15 0	188	12	6	191 7 6	20	5	0	21	6	3	22 15 0		23⅛	22 15/16	84 11⅝
27	69	1	3	68 1 3	83	10	0	—	184	17	6	187 17 6	20	2	6	21	7	6	22 15 0		23⅛	22⅞	84 11½
28	69	12	6	68 10 0	83	10	0	—	176	12	6	179 12 6	19	17	6	21	8	9	22 15 0		23⅛	22⅝	84 11½
29	69	3	9	68 4 4½	83	10	0	76 0 0	180	0	0	182 17 6	19	12	6	21	10	0	22 15 0		23⅛	22 1/16	84 11½
Dec.																							
2	68	8	9	67 18 9	83	10	0	—	174	7	6	177 7 6	19	15	0	21	6	3	22 15 0		23⅛	22 9/16	84 11½
3	67	8	9	67 8 9	83	10	0	75 0 0	177	16	3	180 17 6	20	0	0	21	5	0	22 10 0		23⅛	22⅝	84 11⅝
4	68	18	1½	68 16 10½	83	10	0	—	176	12	6	179 11 3	20	3	9	21	6	3	22 10 0		23⅛	22⅝	84 11⅝
5	68	16	3	68 13 9	83	10	0	—	174	1	3	177 6 3	20	7	6	21	6	3	22 10 0		23⅛	22⅝	84 11⅝
6	68	6	3	68 1 3	83	10	0	75 10 0	173	7	6	176 11 3	20	2	6	21	6	3	22 10 0		23⅛	22 1/16	84 11⅛
9	68	13	9	68 9 4½	83	0	0	—	177	12	6	180 17 6	20	6	3	21	7	6	22 10 0		23⅛	22⅝	84 11⅛
10	68	16	3	68 6 3	83	0	0	75 15 0	181	2	6	184 6 3	20	3	9	21	6	3	22 15 0		23⅛	22 1/16	84 10½

ANTIMONY.—English regulus was still commanding about £45 to £52 10s. per ton at the close of November. Spot Chinese material was quoted at £32 10s. to £32 ex warehouse, but about £29 10s. per ton c.i.f. was about the value of material for shipment from the East.

IRON ORE.—During November little or no fresh business of any importance was transacted, most mines and works being well booked for some time to come. Prices are nominally unaltered on the basis of 24s. 6d. per ton c.i.f. for best Bilbao rubio.

ARSENIC.—Cornish 99% white remains at about £16 per ton f.o.r. mines, while high-grade Mexican stands at about £17 to £17 10s. c.i.f. Liverpool.

BISMUTH.—A steady business continues at 7s. 6d. per lb. for merchant lots.

CADMIUM.—Demand has improved somewhat just recently, and sellers are firm in their ideas at 3s. 11d. to 4s. per lb., according to quantity.

COBALT METAL.—This article has been in very fair request, but the price position is unaltered: officially 10s. per lb. is quoted, but less is accepted for good orders.

COBALT OXIDES.—A moderate turnover is reported at the unaltered quotations of 8s. per lb. for black and 8s. 10d. for grey.

PLATINUM.—Demand has been disappointing for the season of the year, a good demand from the jewellery trade usually being met with about this time. Prices are consequently somewhat easier at about £12 15s. to £13 5s. per oz.

PALLADIUM.—A quiet business is passing at about £6 5s. to £6 15s. per oz.

IRIDIUM.—Interest has been very restricted, and quotations are easier at about £40 to £42 10s. per oz.

TELLURIUM.—In the absence of any appreciable business quotations remain nominal at 12s. 6d. to 15s. per lb.

SELENIUM.—A fair demand continues in evidence at 7s. 8d. to 7s. 9d. per lb. ex warehouse for high-grade black powder.

MANGANESE ORE.—Russia is rather firmer in its ideas of prices, washed Tchiaturi ore being held for about 1s. 1d. per unit c.i.f. Best Indian remains at 1s. 1¾d. per unit, but these quotations can only be considered nominal, as business is at a very low ebb.

ALUMINIUM.—Some very fair business has been seen recently, mainly covering 1930 requirements. Prices remain at £95, less 2%, delivered for ingots and bars.

SULPHATE OF COPPER.—This market has remained very steady, prices being unaltered at £27 to £27 10s. per ton, less 5%, for English material.

NICKEL.—Business is maintained on a large scale and there is every prospect that the increases in production which are being planned will be needed. Prices stand at £170 to £175 per ton.

CHROME ORE.—Consumption remains quite brisk, but supplies are fully equal to demand, and prices keep steady at £4 to £4 5s. per ton c.i.f. for good 48% material.

QUICKSILVER.—Some stringency in spot supplies was seen during November, but as demand has not attained very large proportions quotations have not altered much, and spot is priced at £23 per bottle.

TUNGSTEN ORE.—Demand has been at a standstill, and there has been a fairly wide range between buyers' and sellers' ideas. Latterly this has narrowed somewhat and for December-January shipments from China the present value is about 30s. to 32s. per unit c.i.f. Buyers are beginning to show a little more interest, but the market is still very quiet.

MOLYBDENUM ORE.—Only small quantities have changed hands, but the value is fairly clearly defined at 37s. 6d. to 38s. per unit c.i.f.

GRAPHITE.—This market does not vary much, good 85 to 90% raw Madagascar flake remaining at £25 to £28 per ton c.i.f. and 90% Ceylon lumps at £25 to £26 c.i.f.

SILVER.—The silver market during November was chiefly remarkable for the almost total lack of interest on the part of buyers. On November 1 spot bars stood at 22 1/16d., but owing to the extreme quietness of the market quotations eased to 22½d. on November 11. A little Eastern buying occasioned a slight recovery in values, but towards the end of the month dullness developed again, and on November 30 spot bars closed at 22 9/16d.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
November, 1928	832,461	40,023	872,484
December	821,582	38,179	859,761
January, 1929	840,344	36,108	876,452
February	778,559	36,725	815,284
March	830,829	35,700	866,529
April	836,474	35,649	872,123
May	858,991	38,607	897,598
June	821,352	34,677	856,029
July	853,370	36,110	889,480
August	850,952	38,649	889,601
September	814,707	34,846	849,553
October	853,609	35,081	888,690
November	827,952	33,641	861,593

TRANSVAAL GOLD OUTPUTS.

	October.		November.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	88,500	£144,369	84,500	£141,025
City Deep	91,500	25,084	87,500	23,297
Cons. Main Reef	59,600	22,434	59,000	22,264
Crown Mines	232,000	74,181	221,000	70,069
D'rb'n Roodepoort Deep	41,800	14,237	40,500	13,613
East Rand P.M.	149,000	40,258	143,300	38,851
Geduld	85,500	27,526	83,000	26,554
Geldenhuis Deep	67,500	15,570	66,000	14,879
Glynn's Lydenburg	6,300	1,960	6,000	2,221
Government G.M. Areas	210,000	£397,626	202,000	£384,497
Kleinfontein	53,800	12,614	51,300	11,668
Langlaagte Estate	83,000	£112,830	79,000	£111,911
Luipaard's Vlei	23,000	6,237	22,800	5,985
Meyer and Charlton	17,300	£20,390	16,800	£19,145
Modderfontein New	152,000	73,119	147,000	72,472
Modderfontein B	71,000	25,160	69,000	24,742
Modderfontein Deep	45,900	24,308	44,200	23,358
Modderfontein East	70,500	20,882	68,500	20,284
New State Areas	78,000	£142,969	76,000	£144,910
Nourse	62,000	17,860	59,500	17,126
Randfontein	220,000	£220,297	213,000	£214,672
Robinson Deep	78,100	21,325	77,700	21,261
Rose Deep	60,500	12,383	59,000	12,086
Simmer and Jack	76,400	19,499	75,400	18,986
Springs	73,000	£146,738	67,700	£136,845
Sub Nigel	25,800	20,890	24,400	19,644
Transvaal G.M. Estates	13,600	4,877	13,150	4,732
Van Ryn	40,500	£40,370	40,000	£40,179
Van Ryn Deep	65,000	£106,122	62,000	£104,587
Village Deep	60,000	15,661	57,000	15,152
West Rand Consolidated	90,000	£97,980	87,000	£96,846
West Springs	70,000	£83,128	67,700	£78,901
Witw'tersr'nd (Knights')	55,000	£50,614	52,500	£49,726
Witwatersrand Deep	42,000	9,381	36,000	10,290

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.	£
Sept., 1928	2,485,700	27 11	19 7	8 4	1,040,368
October	2,612,500	27 9	19 5	8 4	1,092,162
November	2,539,700	27 9	19 7	8 2	1,041,713
December	2,505,500	27 10	19 8	8 2	1,024,654
January, 1929	2,627,320	28 1	19 9	8 4	1,095,070
February	2,403,720	28 6	20 3	8 3	990,942
March	2,581,600	28 3	20 0	8 3	1,062,331
April	2,606,420	28 1	19 11	8 2	1,068,103
May	2,694,610	28 0	19 10	8 2	1,100,461
June	2,543,550	28 3	19 10	8 5	1,065,191
July	2,649,560	28 1	19 8	8 5	1,112,246
August	2,661,800	28 1	19 9	8 4	1,111,834
September	—	—	—	—	1,056,839
October	—	—	—	—	1,115,744

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
November 30, 1928	190,870	16,803	4,880	216,628
December 31	187,970	16,059	4,444	208,473
January 31, 1929	192,526	15,845	50,56	213,427
February 28	196,150	15,940	5,635	217,725
March 30	197,646	16,065	5,787	219,498
April 30	197,412	15,900	5,554	218,866
May 31	195,733	15,852	5,473	217,058
June 30	192,595	15,928	5,029	213,552
July 31	190,031	15,914	4,845	210,790
August 31	190,062	15,867	5,071	211,000
September 30	190,567	15,733	4,814	211,114
October 31	189,739	15,533	4,555	209,827
November 30	186,941	15,320	4,561	206,822

PRODUCTION OF GOLD IN RHODESIA.

	1926	1927	1928	1929
	oz.	oz.	oz.	oz.
January	48,967	48,731	51,356	46,231
February	46,026	46,461	46,286	44,551
March	46,902	50,407	48,017	47,388
April	51,928	48,290	48,549	48,210
May	49,392	48,992	47,323	48,189
June	52,381	52,910	51,762	48,406
July	50,460	49,116	48,960	46,369
August	49,735	47,288	50,611	46,473
September	48,350	45,838	47,716	45,025
October	50,132	46,752	43,056	46,923
November	51,090	47,435	47,705	—
December	48,063	49,208	44,772	—

RHODESIAN GOLD OUTPUTS.

	October.		November.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,400	11,440	24,400	11,460
Globe and Phœnix	6,016	4,794	6,040	5,053
Lonely Reef	5,600	4,197	5,500	4,156
Mayfair	1,600	886	1,210	467
Rezende	6,400	2,874	6,400	2,855
Shamva	46,000	19,547	10,500	£20,801
Sherwood Starr	4,800	£9,640	4,200	£9,523
Wanderer Consolidated	6,849	756	6,600	1,543

WEST AFRICAN GOLD OUTPUTS.

	October.		November.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	6,099	£10,909	—	—
Ashanti Goldfields	9,425	11,110	9,760	11,231
Taquah and Abosso	8,510	£14,038	8,750	£14,548

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.	New South Wales.
	Oz.	Oz.	Oz.	Oz.
November, 1928.	31,466	3,111	865	550
December	36,097	—	493	208
January, 1929	27,384	—	260	445
February	28,177	1,997	117	474
March	25,848	2,974	816	—
April	39,166	—	617	—
May	28,026	3,018	493	467
June	33,139	2,368	465	8
July	28,086	1,421	1,203	—
August	37,032	2,178	567	—
September	32,751	1,739	381	—
October	35,445	—	—	—
November	28,460	—	—	—

AUSTRALASIAN GOLD OUTPUTS.

	October.		November.	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.)	4,594	8,266	3,744	5,676
Blackwater (N.Z.)	3,050	5,565	3,200	6,051
Boulder Persev'ce (W.A.)	5,887	12,887	5,109	11,781
Grt. Boulder Pro. (W.A.)	9,176	27,335	7,006	21,335
Lake View & Star (W.A.)	9,100	16,756	—	—
Sons of Gwalia (W.A.)	13,772	10,970	13,442	11,589
South Kalgurli (W.A.)	3,246	16,319	6,757	14,773
Waihi (N.Z.)	18,110‡	{ 6,395* / 44,018†	16,990§	{ 6,192* / 37,924†

* Oz. gold. † Oz. silver. ‡ 4 weeks to October 19.
§ 4 weeks to November 16.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	October.		November.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	4,050	2,744	4,100	2,654
Champion Reef	8,010	6,023	8,115	6,016
Mysore	17,505	8,431	17,121	8,314
Nundydroog	11,090	6,681	11,000	6,726
Ooregum	13,500	6,645	13,536	6,238

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	October.		November.	
	Tons	Value £	Tons	Value £
Chosen Synd. (Korea)	9,480	12,930	—	—
Frontino& Bolivia (C'lbia)	1,960	7,191	2,000	7,087
Lena (Siberia)	—	15,808	—	12,600
Lydenburg Plat. (Trans.)	3,600	665*p*	3,500	778*p*
Marmajito (Colombia)	1,020	4,248	980	4,877
Fresnillo	94,097	100,848*d*	—	—
Onverwacht Platinum	2,715	438*p*	2,662	454*p*
Oriental Cons. (Korea)	—	97,500*d*	—	100,270*d*
St. John del Rey (Brazil)	—	44,500	—	46,000
Santa Gertrudis (Mexico)	51,147	107,706*d*	—	—

d dollars. *p* Oz. platinoids.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

January, 1929	5,840	July, 1929	5,802
February	4,896	August	5,610
March	5,236	September	5,332
April	5,433	October	5,966
May	5,405	November	6,135
June	5,523	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Sept.	Oct.	Nov.
Batu Caves	30	24	28
Changkat	100	56	65
Chenderiang	27	26⅜	28
Gopeng	86	80	83
Hong Kong Tin	50½	50½	50½
Idris Hydraulic	32⅜	35⅜	38½
Ipoh	43¼	39½	45
Jelapang	36	36	21⅜
Kampar Malaya	—	—	80
Kampong Lanjut	—	—	60
Kamunting	84	103	72
Kent (F.M.S.)	39	42	45
Kepong	34	31	38
Kinta	30	31	33
Kinta Kellas	32⅜	44⅜	31
Kramat Pulai	13½	14½	—
Kuala Kampar	105	110	80
Kundang	23	24	25
Lahat	12½	14	15
Larut Tinfields	76½	82	82
Malaya Consolidated	53¼	58¼	89½
Malayan Tin	143	119	119
Meru	27½	30	30½
Pahang	222	222	222⅜
Penawat	—	—	68½
Pengkalen	77½	77½	71
Petaling	226	210	178
Rahman	53½	59½	59⅜
Rambutan	10	10	10
Rantau	32	56	58
Rawang	40	40	30
Rawang Concessions	100	170	200
Renong	44⅜	57¼	104⅜
Selayang	20½	22	23
Southern Malayan	172½	172½	172⅜
Southern Perak	59½	65⅜	50¼
Southern Tronoh	21	41	45
Sungei Besi	45	45	48
Sungei Kinta	68½	50	49
Sungei Way	83¼	77½	77½
Taiping	31	35	38
Tanjong	30	38⅜	41⅜
Teja Malaya	5	5¼	—
Tekka	45	45	46
Tekka-Taiping	27	24½	26
Temoh	35⅜	34	44
Tronoh	99	112½	118

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Sept.	Oct.	Nov.
Amari	11	12	—
Anglo-Nigerian	35	46	—
Associated Tin Mines	278	256	250
Baba River	4	5½	—
Batura Mongana	2⅛	2	—
Bisichi	92	95	100
Daffo	10	10	10
Ex-Lands	60	62	—
Filani	8	7½	5⅜
Jantar	40	47	37
Jos	19½	22½	39
Juga Valley	20	20	25
Junction	2¼	2½	3
Kaduna	48	51⅜	—
Kaduna Prospectors	25	27	—
Kassa	27	27½	—
London Tin	—	245	255
Lower Bisichi	8½	7¼	8¼
Mongu	50	50	70
Naraguta	44⅜	45	—
Naraguta Durumi	20	24	19
Naraguta Extended	25	22	20
Naraguta Karama	37	37	—
Naraguta Korot	20	20	—
Nigerian Base Metals	39	48	—
Nigerian Consolidated	20	20	20
N.N. Bauchi	150	—	—
Offin River	4	5½	8⅜
Ribon Valley	19	22	—
Ropp	105	—	—
South Bukeru	7½	8½	8½
Tin Fields	6⅜	5½	3⅜
Tin Properties	33	22	25
United Tin Areas	23	28	—
Yarde Kerri	9	7	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Sept.	Oct.	Nov.
Anglo-Burma (Burma)	30½	30½	21
Aramayo Mines (Bolivia)	449	351	435
Bangrin (Siam)	69½	57½	44⅞
Berenguela (Bolivia)	41	38	—
C'nsolidated Tin Mines (Burma)	150	104	100
East Pool (Cornwall)	87¼	87½	—
Fabulosa (Bolivia)	145	167½	197
Geevor (Cornwall)	69	68	67
Jantar (Cornwall)	21	23	—
Kagera (Uganda)	28	28	28
Northern Tavoy	—	—	55
Polhigey (Cornwall)	35	35	35
San Finx (Spain)	37⅓*	34½*	—
Siamese Tin (Siam)	143½	145	134½
South Crofty (Cornwall)	68⅜	69½	68
Tavoy Tin (Burma)	50	45	40
Theindaw (Burma)	7	8	3
Tongkah Harbour (Siam)	100	69	73
Toyo (Japan)	—	—	30
Wheal Kitty (Cornwall)	40	39	45
Wheal Reeth (Cornwall)	—	—	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		October.	Nov.
Broken Hill South	Tons lead conc.	5,969	5,434
	Tons zinc conc.	5,086	5,317
Burma Corporation	Tons refined lead	6,750	6,750
	Oz. refined silver	607,000	607,000
Bwana M'Kubwa	Tons copper oxide	699	459
Electrolytic Zinc	Tons zinc	4,102†	4,151‡
Indian Copper	Tons copper	214	226
Messina	Tons copper	590	—
Mount Lyell	Tons concentrates	3,799*	—
Namaqua	Tons copper	180	—
North Broken Hill	Tons lead conc.	8,750	—
	Tons zinc conc.	5,980	—
Poderosa	Tons copper ore	1,392	1,410
Rhodesia Broken Hill	Tons lead	—	—
	Tons slab zinc	1,253	1,265
San Francisco Mexico	Tons lead conc.	2,853	1,893
	Tons zinc conc.	3,461	2,066
Sulphide Corporation	Tons lead conc.	1,851	2,049
	Tons zinc conc.	2,545	2,603§
Tetiuhe	Tons lead conc.	1,073	1,051
	Tons zinc conc.	1,967	2,080
Union Minière	Tons copper	12,700	—
Zinc Corporation	Tons lead conc.	5,036	—
	Tons zinc conc.	4,421	—

* Four weeks to Nov. 6. † Four weeks to Oct. 16.
‡ Four weeks to Nov. 13. § Four weeks to Nov. 16.

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

		Sept.	Oct.
Iron Ore	Tons	530,338	561,544
Manganese Ore	Tons	27,257	22,139
Iron and Steel	Tons	229,082	248,499
Copper and Iron Pyrites	Tons	31,350	25,064
Copper Ore, Matte, and Prec.	Tons	3,318	919
Copper Metal	Tons	9,785	16,202
Tin Concentrate	Tons	8,358	7,732
Tin Metal	Tons	537	931
Lead Pig and Sheet	Tons	25,127	20,299
Zinc (Spelter)	Tons	12,051	10,823
Zinc Sheets, etc.	Tons	2,009	1,715
Aluminium	Tons	2,568	1,703
Quicksilver	Lb.	133,339	80,373
Zinc Oxide	Tons	1,072	1,138
White Lead	Cwt.	12,413	15,190
Red and Orange Lead	Cwt.	3,003	3,743
Barytes, ground	Cwt.	46,889	65,338
Asbestos	Tons	2,489	3,254
Boron Minerals	Tons	1,723	707
Borax	Cwt.	27,383	12,011
Basic Slag	Tons	4,360	3,439
Superphosphates	Tons	3,340	8,032
Phosphate of Lime	Tons	41,957	14,326
Mica	Tons	296	263
Sulphur	Tons	7,022	8,752
Nitrate of Soda	Cwt.	22,556	25,778
Potash Salts	Cwt.	596,048	589,602
Petroleum: Crude	Gallons	34,629,875	51,163,829
Lamp Oil	Gallons	17,216,805	23,506,195
Motor Spirit	Gallons	74,508,827	70,037,259
Lubricating Oil	Gallons	8,077,891	10,488,878
Gas Oil	Gallons	9,401,359	9,456,037
Fuel Oil	Gallons	31,350,101	22,633,726
Asphalt and Bitumen	Tons	16,241	9,954
Paraffin Wax	Cwt.	113,119	139,667
Turpentine	Cwt.	69,028	42,664

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES

In Tons.

	Sept.	Oct.	Nov.
Anglo-Ecuadorian	14,961	15,012	14,427
Apex Trinidad	34,610	36,060	34,140
Attock	5,429	4,781	3,730
British Burmah	5,648	5,613	5,411
British Controlled	34,430	36,569	31,206
Kern Mex	891	832	770
Kern River (Cal.)	4,702	4,849	1,739
Kern Romana	5,170	3,527	2,592
Kern Trinidad	5,095	4,868	4,336
Lobitos	26,954	28,768	28,669
Phœnix	42,276	42,291	48,442
St. Helen's Petroleum	12,091	9,690	7,802
Steaua Romana	78,970	78,320	70,640
Tampico	3,226	3,084	2,927
Trinidad Leaseholds	31,450	31,700	30,400
Venezuelan Consolidated	3,845	5,220	5,054

QUOTATIONS OF OIL COMPANIES SHARES.

Denomination of Shares £1 unless otherwise noted.

	Nov. 8, 1929	Dec. 9, 1929
	£ s. d	£ s. d.
Anglo-American	3 1 9	3 6 11
Anglo-Ecuadorian	18 3	16 3
Anglo-Egyptian B	2 7 6	2 5 6
Anglo-Persian 1st Pref.	1 6 9	1 6 6
" " Ord.	4 2 6	3 15 0
Apex Trinidad (5s.)	1 5 0	1 6 3
Attock	2 11 3	1 17 6
British Burmah (8s.)	6 9	6 10
British Controlled ($5)	4 9	4 0
Burmah Oil	4 1 3	3 16 3
Kern River, Cal. (10s.)	6 6	6 6
Lobitos, Peru	1 18 9	1 17 6
Mexican Eagle, Ord. (4 pesos)	18 0	15 3
" " 8% Pref. (4 pesos)	16 9	15 0
Phœnix, Roumania	10 9	9 6
Royal Dutch (100 fl.)	33 7 6	33 5 0
Shell Transport, Ord.	4 13 9	4 15 0
" " 5% Pref. (£10)	9 10 0	9 10 0
Steaua Romana	10 0	10 0
Trinidad Leaseholds	4 1 3	3 18 0
United British of Trinidad (6s. 8d.)	7 6	6 6
V.O.C. Holding	2 18 9	2 16 10

PRICES OF CHEMICALS. December 7.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		16	6
" 80%	"	1	16	6
" Glacial	per ton	66	0	0
Alum	"		8	10	0
Alumina, Sulphate, 17 to 18%	"		6	15	0
Ammonia, Anhydrous	per lb.				10
" 0·880 solution	per ton	15	10	0
" Carbonate	"	27	10	0
" Nitrate	"	24	0	0
" Phosphate	"	40	0	0
" Sulphate, 20·6% N.	"	9	17	0
Antimony, Tartar Emetic	per lb.				10¾
" Sulphide, Golden	"				7
Arsenic, White	per ton	16	0	0
Barium Carbonate, 94%	"	5	10	0
" Chloride	per ton	10	10	0
" Sulphate, 94%	"	5	0	0
Benzol, standard motor	per gal.		1	7½
Bleaching Powder, 35% Cl.	per ton	6	15	0
" Liquor, 7%	"	3	5	0
Borax	"	14	0	0
Boric Acid	"	25	0	0
Calcium Chloride	"	5	10	0
Carbolic Acid, crude 60%	per gal.		2	5
" " crystallized, 40°	per lb.				7½
Carbon Disulphide	per ton	24	0	0
Citric Acid	per lb.		2	0½
Copper Sulphate	per ton	26	15	0
Cyanide of Sodium, 100% KCN	per lb.				7
Hydrofluoric Acid	"				6
Iodine	per oz.		1	0
Iron, Nitrate	per ton	6	0	0
" Sulphate	"	1	15	0
Lead, Acetate, white	"	40	0	0
" Nitrate	"	33	5	0
" Oxide, Litharge	"	37	10	0
" White	"	38	0	0
Lime, Acetate, brown	"	7	10	0
" " grey, 80%	"	16	0	0
Magnesite, Calcined	"	9	10	0
Magnesium, Chloride	"	6	15	0
" Sulphate	"	3	5	0
Methylated Spirit 64° Industrial	per gal.		1	5
Nitric Acid, 80° Tw.	per ton	21	0	0
Oxalic Acid	per cwt.	1	13	0
Phosphoric Acid	per ton	29	15	0
Potassium Bichromate	per lb.				4⅜
" Carbonate	per ton	26	2	6
" Chlorate	per lb.				2¾
" Chloride 80%	per ton	9	0	0
" Hydrate (Caustic) 90%	"	31	0	0
" Nitrate, refined	"	20	10	0
" Permanganate	per lb.				5⅜
" Prussiate, Yellow	"				6¾
" " Red	"		1	9
" Sulphate, 90%	per ton	11	5	0
Sodium Acetate	per ton	20	0	0
" Arsenate, 45%	"	26	0	0
" Bicarbonate	"	10	10	0
" Bichromate	per lb.				3¼
" Carbonate (Soda Ash)	per ton	6	0	0
" " (Crystals)	"	5	5	0
" Chlorate	per lb.				2½
" Hydrate, 76%	per ton	14	10	0
" Hyposulphite	"	9	0	0
" Nitrate, 96%	"	9	17	0
" Phosphate, comml.	per cwt.		11	0
" Prussiate	per lb.				4¾
" Silicate	per ton	9	10	0
" Sulphate (Salt-cake)	"	2	15	0
" " (Glauber's Salt)	"	2	5	0
" Sulphide	"	9	10	0
Sulphur, Roll	"	10	10	0
" Flowers	"	12	0	0
Sulphuric Acid, 168°	"	6	5	0
" " free from Arsenic, 144°	"	4	0	0
Superphosphate of Lime, 33%	"	3	0	0
Tartaric Acid	per lb.		1	4½
Turpentine	per ton	44	10	0
Tin Crystals	per lb.		1	6½
Titanous Chloride	"				10
Zinc Chloride	per ton	12	0	0
Zinc Dust	"	32	0	0
Zinc Oxide	"	42	0	0
Zinc Sulphate	"	9	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	Nov. 8, 1929. £ s. d.	Dec. 9, 1929. £ s. d.
SOUTH AFRICA:		
Brakpan	3 18 9	3 14 9
City Deep	8 6	6 3
Consolidated Main Reef	18 6	17 0
Crown Mines (10s.)	3 2 6	3 2 6
Daggafontein	1 2 6	1 0 0
Durban Roodepoort Deep	10 6	10 0
East Geduld	1 16 3	1 16 3
East Rand Proprietary (10s.)	11 3	10 9
Ferreira Deep	6 3	6 0
Geduld	3 6 3	3 5 0
Geldenhuis Deep	5 0	5 0
Glynn's Lydenburg	2 6	2 6
Government Gold Mining Areas (5s.)	1 16 3	1 16 3
Langlaagte Estate	1 0 0	1 1 3
Meyer & Charlton	9 6	8 9
Modderfontein New (10s.)	4 13 9	4 12 6
Modderfontein B (5s.)	14 6	15 6
Modderfontein Deep (5s.)	1 6 3	1 6 10
Modderfontein East	1 7 6	1 7 6
New State Areas	1 12 0	1 12 6
Nourse	9 6	9 0
Randfontein	6 3	5 6
Robinson Deep A (1s.)	13 0	13 9
" " B	8 6	9 6
Rose Deep	5 3	4 9
Simmer & Jack (2s. 6d.)	3 3	3 6
Springs	3 5 0	3 2 6
Sub Nigel (10s.)	1 13 9	1 13 9
Van Ryn	6 6	6 0
Van Ryn Deep	1 13 9	1 14 6
Village Deep	6 0	7 0
West Rand Consolidated (10s.)	6 0	5 6
West Springs	17 0	17 0
Witwatersrand (Knight's)	8 6	8 3
Witwatersrand Deep	4 3	3 0
RHODESIA:		
Cam and Motor	1 1 3	1 1 3
Gaika	4 3	4 0
Globe and Phœnix (5s.)	10 0	9 3
Lonely Reef	18 9	18 9
Mayfair	1 0 0	17 6
Rezende	15 0	16 3
Shamva	3 9	2 3
Sherwood Starr	1 3 9	1 2 6
GOLD COAST:		
Ashanti (4s.)	1 1 0	1 4 3
Taquah and Abosso (5s.)	1 9	1 6
AUSTRALASIA:		
Golden Horseshoe (4s.), W.A.	1 9	1 9
Great Boulder Proprietary (2s.), W.A.	2 0	2 0
Lake View and Star (4s.), W.A.	11 6	9 6
Sons of Gwalia, W.A.	1 9	1 3
South Kalgurli (10s.), W.A.	13 9	14 4
Waihi (5s.), N.Z.	12 0	13 0
Wiluna Gold, W.A.	18 6	15 9
INDIA:		
Balaghat (10s.)	4 9	4 6
Champion Reef (10s).	9 9	9 6
Mysore (10s.)	12 9	13 6
Nundydroog (10s.)	16 3	15 6
Ooregum (10s.)	8 0	7 0
AMERICA:		
Camp Bird (2s.), Colorado	1 9	1 3
Exploration (10s.)	8 6	7 6
Frontino and Bolivia, Colombia	7 6	7 6
Mexican Corporation, Mexico	13 0	11 3
Mexico Mines of El Oro, Mexico	2 6	2 6
Panama Corporation	1 0 0	18 0
St. John del Rey, Brazil	16 9	17 0
Santa Gertrudis, Mexico	11 9	12 0
Selukwe (2s. 6d.), British Columbia	5 0	4 3
MISCELLANEOUS:		
Chosen, Korea	13 9	11 3
Edie (5s.), New Guinea	18 9	16 3
Lena Goldfields, Russia	2 0	1 3
COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	1 5 0	1 0 6
Esperanza Copper, Spain	1 1 6	1 1 3
Indian (2s.)	2 3	2 0
Loangwa (5s.), Rhodesia	6 6	5 10
Luiri (5s.), Rhodesia	5 3	4 0
Messina (5s.), Transvaal	17 6	17 6
Mount Lyell, Tasmania	2 0 9	1 19 6
Namaqua (£2), Cape Province	16 3	16 3
N'Changa, Rhodesia	2 0 0	1 16 3
Rhodesia-Katanga	1 11 3	1 10 0
Rio Tinto (£5), Spain	45 18 9	44 0 0
Roan Antelope (5s.), Rhodesia	1 13 9	1 11 3
Tanganyika, Congo and Rhodesia	2 3 9	2 1 3
Tharsis (£2), Spain	4 18 9	4 13 9

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

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.

THE GEOLOGY OF NORTHERN RHODESIA

During the recent International Geological Congress held in South Africa an excursion party visited the Northern Rhodesian mining districts, and for the benefit of the party a pamphlet describing the geology of Northern Rhodesia was prepared by J. A. Bancroft and R. A. Pelletier, geologists to the Rhodesian Anglo-American and the Loangwa Concessions respectively. This pamphlet is here reproduced in full, and as readers may wonder at the absence of maps and other illustrations it should be stated here that no such illustrations accompanied the pamphlet, presumably because the authors have not yet completed their mapping and studies.

PHYSIOGRAPHY.—The territory known as the Protectorate of Northern Rhodesia lies between longitudes 22° E. and 33° 35′ E. and between latitudes 8° 15′ S. and 18° S. It is bounded on the west by Angola, on the north-west by the Belgian Congo, on the north-east by Tanganyika Territory, on the east by the Nyasaland Protectorate and Portuguese East Africa, and on the south by Southern Rhodesia and the mandated territory of South-West Africa; comprising in all an area that is computed to be about 278,950 square miles. Situated in the heart of Africa, Northern Rhodesia lies on the watershed of the two great rivers of Africa, the Congo and the Zambesi.

The greater part of Northern Rhodesia forms part of the Central African Plateau, an elevated ancient peneplain underlain largely by Precambrian rocks. This table-land has an elevation of about 3,500 to 4,000 ft., but in the eastern and north-eastern portions of the country, in the Serenje district, warping during unlift has increased the general altitudes to 5,000 and even 6,000 ft. Though the marginal regions of the plateau are eroded and dissected the interior portions have not yet experienced the new cycle of erosion due to uplift, and, over most of the country, the characater of the original peneplain is still well preserved. The topography is very gently rolling, and in certain regions almost absolutely flat. Over large areas the bed-rock is concealed beneath a deep mantle of soil interrupted at intervals by isolated hills or kopjes or by low ridges composed of the more resistant rocks, quartzites, mica schists, granite, etc., etched out by differential erosion from the general surface of the plain. The minor drainage channels are ill defined, due to lack of gradient, and "dambos"—which are broad grass-covered depressions—delineate their course and comprise about a third of the total area.

In the eastern portion of the country the continuity of the Precambrian is interrupted by the broad down-faulted valleys of the Luano, Loangwa, and Lukushashi Rivers which constitute the penetration into Northern Rhodesia of the most westerly extensions of the Great Rift Valley system of Eastern Africa. These valleys, which are up to 20 miles broad and 1,000 to 2,000 ft. below the level of the table-land, are still underlain by practically horizontal sediments of Karroo Age, long since removed by erosion from the adjoining portions of the plateau area.

GEOLOGICAL FORMATIONS.—By far the major part of Northern Rhodesia is underlain by Precambrian rocks. Quite extensive areas are occupied by formations of Karroo Age (Permian to Jurassic), and the western and south-western portions of this country are believed to be more or less covered with a veneer of beds belonging to the Kalahari system, possibly late Cretaceous and Tertiary.

In contrast with many parts of the world, and even with Southern Rhodesia, volcanic rocks and their metamorphosed equivalents do not play an important part in the Precambrian history of this country. Each successive Precambrian system is especially characterized by great thicknesses of sandstones, shales, and conglomerates, exhibiting variable degrees of metamorphism. Numerous areas, some of which are quite extensive (and yet their extent in aggregate constitutes a small percentage of the whole) are underlain chiefly by dolomites and limestones. Up to the present time fossils have only been found within the Karroo system.

The following is a table showing provisionally the sequence and relative ages of the rocks in this country:—

LATE CRETACEOUS (?) AND TERTIARY.

(9) Kalahari Series.

Unconformity.

PERMIAN TO JURASSIC.

(8) Karroo System.

Unconformity.

PRECAMBRIAN.

(7) Kundelungu (or Tanganyika) Series.
(May belong to early Palæozoic.)

Unconformity.

(6) Basic Intrusive Igneous Rocks.
(May at least in part be later than (8).)

(5) Younger Granites.

(4) The Bwana M'Kubwa Copper-bearing Series.

Great Unconformity.

(3) M'Kushi Gneissoid Granites.

(2) Broken Hill Series.

Unconformity (?).

(1) Basement Schist Series.

(1) *The Basement Schists.*—These rocks represent the intensely altered equivalents of an ancient sedimentary series, together with a very minor proportion of metamorphosed igneous rocks, all of greater age than the great batholithic intrusions of the M'Kushi gneissoid granites. Thus in Northern Rhodesia, as in Precambrian areas the world over, the most ancient rocks rest on a foundation of intrusive rocks younger than themselves.

The Basement Schists, together with the granitoid

gneisses, cover a relatively large proportion of this country, occurring as continuous exposures over hundreds of miles, or as elongated areas representing truncated anticlinal structures which separate basins occupied by the younger rocks. Mica schists, quartz schists, and highly indurated quartzites, developed through the metamorphism of a series of very ancient siliceous sediments, constitute the major portion of this basement complex. These rocks have wide distribution but are especially well exposed in that portion of the country drained by the Loangwa, the Lukushashi, and the Lunsemfwa Rivers and their tributaries. In many areas, elongated remnants of these rocks, greatly indurated and silicified, occur as roof-pendants in the midst of the granitoid gneiss. Owing to their superior resistance to weathering as compared with the granites these roof-pendants now give rise to hills and ridges. The Mita Hills on the Lunsemfwa River a few miles north of the M'Kushi road are a good example. Locally, the micaceous quartzites are the least altered of these rocks, and yet within short distances they grade into true mica schists in which no trace of clastic structure remains. The quartz schists are distinctive and massive rocks composed of quartz to the exclusion of almost all other constituents. They may be glassy, but usually have a coarse sugary or granular texture.

In addition, the Basement Schists include a great diversity of metamorphic rocks widely distributed but which in aggregate amount to only a small fraction of the complex as a whole. Chlorite schists, the metamorphosed equivalents of igneous or volcanic rocks, which were intruded into the ancient sediments previous to the advance of the gneissoid granites, are perhaps the most important. Some hornblende schists also appear to have a similar origin, though amphibolites originating from the alteration of calcareous sediments have been definitely recognized. Garnetiferous schists, cyanite and andalusite schists, derived from former argillaceous sandstones, are quite common. Banded ironstones with thin bands of jasper also occur. In a few localities thin lens-like bodies of crystalline limestone have been observed.

The Basement Schists of the country resemble in some respects those of Southern Rhodesia, but with the substantial difference that they include a much lesser proportion of altered volcanic and intrusive igneous rocks. Iron formations also appear to be of much more limited distribution. On the whole, these rocks seem to be more closely analogous to the "série cristallophyllienne," the oldest Precambrian series of the Belgian Congo.

(2) *The Broken Hill Series.*—Resting on the Basement Schists, the rocks included in this series underlie extensive areas in the central and southern portions of Northern Rhodesia. They are tightly folded and are intruded by both the M'Kushi granitoid gneisses and by the younger granites.

Shales and phyllites with interbedded dolomitic limestones are the most distinctive members of this series, and are well exposed along the railway at Broken Hill and at Lusaka. Towards the base, the shales and phyllites become progressively more arenaceous and pass to sandstones and quartzites. Though interbedded conglomerates have been repeatedly observed, no definite basal conglomerate has yet been recognized, and their actual delimitation from the older complex is still a matter of considerable uncertainty. In certain areas these formations pass without evidence of any structural unconformity to rocks exhibiting a far greater degree of metamorphism and which lithologically would appear more closely affiliated to the Basement Schists. It is highly probable that some of these rocks are Broken Hill Series in a more advanced stage of metamorphism. In short, the Broken Hill shales and dolomitic limestones may represent the upper portions of the series which locally have experienced relatively less metamorphism.

The dolomitic limestones increase in importance towards the upper limit of the series. They are for the most part dense fine-grained crystalline rocks. The extensive zinc and lead deposits at Broken Hill and the Star zinc deposit near Lusaka occur within them. In fresh exposures the shales are bluish-grey but assume a brownish colour on weathering, and in many places they become micaceous and pass into typical phyllites. Faint parallel lines indicate the bedding, and disseminated carbonaceous matter is often present.

In the Kafue Concessions about 100 miles west of Broken Hill numerous copper deposits, notably the Sable Antelope, the Crystal Jacket, and the Silver King, occur within limestones and sandstones of this age. Several manganese deposits have also been discovered within the phyllites and appear to belong to a definite horizon within these rocks. Graphitic schists have been noted at widely separated points.

In certain areas the Broken Hill Series are intersected by a great wealth of quartz veins carrying disseminated iron pyrites and occasionally a few grains of chalcopyrite. It is in areas occupied by the Basement Schists, the Broken Hill Series, and the M'Kushi gneissoid granites that colours of gold have been found in numerous streams. A few relatively small veins of quartz containing gold have been found.

(3) *The M'Kushi Gneissoid Granites.*—This name has been assigned to the extensive bodies of gneissoid granites which invade the Basement Schists and Broken Hill Series, but are older than the Bwana M'Kubwa Copper-bearing Series. Usually highly foliated biotite-granites which are frequently coarsely porphyritic, they in places have the composition of diorites. In numerous instances, and especially toward the central portions of the larger batholiths, they grade into massive grey granites which, like the gneissoid phases, are often abundantly strewn with phenocrysts of orthoclase.

The degree to which these rocks are exposed over many areas, both large and small, is indicative of the profound depths to which erosion has been carried within the areas in which they occur. The largest single area occupied by them, as disclosed by mapping to date, is that which extends for about 15 miles east of Broken Hill northward to and beyond M'Kushi, a distance of over 65 miles.

(4) *The Bwana M'Kubwa Copper-bearing Series.*—Because of the extent and widespread distribution of its copper deposits, this series of rocks are, from an economic point of view, of major importance. The name "Bwana M'Kubwa" has been selected for this series because (*a*) the first copper mine to be operated in this series of rocks in Northern Rhodesia bears this name, and (*b*) in the native language Bwana M'Kubwa means "the big master," and is only applied to individuals regarded by the natives as being very important. In the course of their work within the N'Kana Concession, the geologists of the Rhodesian Selection Trust have been calling these rocks the "Roan Series."

The Bwana M'Kubwa Series is believed to be the same as the Katanga Series or "La Sêrie Schistocalcaire" of the Belgian Congo. There is a possibility that it may be equivalent in age to the Lomagundi Series of Southern Rhodesia.

With a great unconformity at its base this series of rocks, for the most part, is distributed within synclinal basins truncated by the surface of the peneplain and separated from each other by areas of the older rocks. In so far as is known at present, their distribution is confined to an area northward from latitude 14°30′S. and westwards from longitude 29°E. They are also known, however, to occupy certain areas eastward from the Luapula River in north-eastern Northern Rhodesia.

In some instances these basins are veritable textbook illustrations of relatively narrow individual synclines with varying cross-sections; in other cases the rocks within broad basins have been cast into a succession of folds and in at least a few localities faulting has taken place. The most continuous of these synclines yet outlined is that which, attaining a width of over 12 miles, extends from about 15 miles south-east of Bwana M'Kubwa to the north-westward through N'Dola, Mufulira, and Mokambo to and beyond Tshinsenda. It is on the south-western limb of this syncline that the Bwana M'Kubwa and the Mufulira mines are situated. The N'Kana and the Chambeshi mines lie within a separate synclinal, while the Roan and Muliashi properties occupy still another. The N'Changa mine, 95 miles north-westward from N'Dola, is developing ore-bodies on both limbs of a synclinal lobe which protrudes toward the east from an extensive basin of these rocks. Numerous other synclinal basins are in process of being delineated as mapping proceeds.

This series of rocks may readily be sub-divided into distinctive formations to which names have not yet been assigned. These formations vary considerably in the different synclinal basins, and yet it is reasonably certain that correlation may be established. These sub-divisions are as follows:—

(*a*) At the base of the series there is a great thickness (200 to 1,500 ft.) of felspathic sandstones or quartzites with some beds of conglomerate. In one and the same syncline these basal beds may vary from 200 to over 1,000 ft. thick, thus giving some idea of the irregular topography of the land surface on which they were laid down. At the N'Kana, the Chambeshi, and the Roan Antelope mines, and on the "River Lode" limb of the N'Changa mine, a bed of conglomerate forms the uppermost member of these basal beds. In each of these localities this is known as the foot-wall conglomerate because immediately above it rests a copper-bearing horizon.

(*b*) Argillaceous sandstones (or argillites) and banded shales, often in part schistose and usually containing more or less dolomite and carbonaceous matter, following in sequence and varying from 20 to 120 ft. in thickness, constitute the ore-bearing horizon at the Roan Antelope, N'Kana, Chambeshi, and on the "River Lode" limb of the N'Changa property. It seems probable that the impure dolomite of the Central Lode at Bwana and of the middle ore-body at Mufulira corresponds, at least closely, to this horizon.

(*c*) There then follows a variable thickness—up to at least 200 ft. in places—of felspathic and argillaceous sandstones and quartzites with some relatively thin layers of interbedded shales. It is in the lower portion of these hanging wall felspathic quartzites that the major part of the copper values occur on the "Dambo Lode" limb of the N'Changa syncline.

(*d*) These beds are followed by a great thickness of dolomitic shales with some intercalated beds of massive impure dolomite. In places this formation is known to exceed 1,200 ft. in thickness and is followed by:—

(*e*) Several hundred feet in thickness of light grey dolomite with some thin shaly beds. This is the formation that is believed to contain the rich deposits of oxidized copper ores in the Belgian Congo.

(*f*) Conformably overlying this dolomite formation rests a great thickness of shales with a few beds of sandstone or quartzite. Within the N'Kana Concession this formation has been named the "Christmas Series" by the geologists of the Rhodesian Selection Trust. Some of the more quartzitic bands contain disseminated pyrite, while some of the argillaceous sandstones and shales have perfect rhombohedral crystals of siderite, up to ½ in. across, abundantly scattered through them. In one or two localities, low values in copper have been found in these rocks.

(5) *Younger Granites.*—Intrusive into the Bwana M'Kubwa Series and older rocks are batholiths and numerous stocks of granite which vary from grey to pink and reddish in colour. Some of the individual batholiths occupy areas of a few thousand square miles. Usually massive, these granites, however, are in places somewhat gneissoid. In some instances they have the composition of quartz syenites which occasionally contain an abundance of prominent phenocrysts of orthoclase. These granites, and especially their pegmatitic phases, occasionally contain a few scattered grains of chalcopyrite and pyrite. The ore-bodies at Lunsemfwa and M'Tuga occur chiefly as disseminated chalcopyrite in portions of bodies of the younger pink biotite-granite, with associated pegmatitic and aplitic phases, which have there invaded the older M'Kushi gneissoid granites. Numerous instances might be pointed out where altered sedimentary rocks within the radius of contact influence of these granites contain copper deposits. It is believed that it was during the advance and cooling down of these granite bodies that mineralizing solutions were liberated which led to the development of the important copper deposits of Northern Rhodesia.

(6) *Basic Intrusive Igneous Rocks.*—Of widespread and frequent occurrence are sheets, dykes, and relatively small irregular intrusive bodies of gabbro, diabase, norite, anorthosite, etc., which invade the Bwana M'Kubwa Series and all older rocks. These rocks are believed to be contemporaneous in age with the Grand Dyke of Southern Rhodesia, the Bushveld Complex of the Transvaal, and, probably, with the Keeweenawan basic intrusives of the Canadian Shield. It is possible that in part they may represent intrusive equivalents of the Karroo basalts, but it is not yet known whether or not any of them are intrusive into the Tanganyika (Kundelungu) Series.

(7) *The Kundelungu or Tanganyika Series.*—Resting unconformably on the sedimentary formations previously described and more recent in age than the younger granites, this series includes sedimentary strata some thousands of feet in total thickness. In the course of geological work

this series has been encountered to the eastward of the Luapula River and within certain areas north-westward from N'Changa. Reported to be typically developed eastward from Lake Tanganyika and in the vicinity of Lake Mweru, where they have been named the Tanganyika Series, these rocks are known to the geologists of the Belgian Congo as "Le Systeme du Kundelungu." Its base is marked by beds of well-stratified conglomerate in which some of the pebbles and boulders are subangular, while a few may be found which exhibit striation. A glacial origin has been attributed to this conglomerate, but having as yet not seen other than specimens of the conglomerate, the authors of this paper reserve judgment.

In ascending sequence upon the conglomerate there are (*a*) fine-grained argillaceous limestones and calcareous shales, a few hundreds of feet in thickness, (*b*) reddish to brown shales and flagstones, also hundreds of feet thick, and (*c*) a few thousands of feet in thickness of bluish-grey to red sandstones. Some of the limestones are so dense as to possess a porcelain-like texture. Some of the sandy beds display ripple-marks and sun-cracks.

In the belief that the basal conglomerates are of glacial origin and that they may appropriately be correlated with the definitely glacial Dwyka conglomerate of South Africa, some of the Belgian geologists have assigned a Karroo Age to this series. This seems an unwarranted conclusion when it is considered that no fossils have been found in this great series of rocks and yet only 150 miles to the south-eastward there are Lower Karroo (Ecca) rocks containing fossils and with no glacial conglomerate at their base, while further to the south-westward fossils have also been found in beds of Upper Karroo (Stormberg) Age. It seems more probable that P. Fourmarier, who may well be regarded as the leading authority on the geology of the Congo, is correct in correlating this series with the Waterberg system of the Transvaal which is believed to be pre-Devonian in age.

(8) *The Karroo System.*—The oldest rocks definitely belonging to this system occupy the broad, flat-floored rift valleys of the Luano, Lukushashi, and Loangwa Rivers. At least several hundreds of feet in thickness, they comprise conglomerates and coarse-grained sandstones, shales and thin irregular bands and nodules of a dense fine-grained limestone. Plant remains, including *Glossopteris* and silicified wood have been observed in these rocks. In places the river-gravels on the floors of these valleys are strewn with fragments of silicified wood, of which the largest noted was a portion of a tree trunk 6 ft. long and up to 18 in. in diameter. Coal seams are present within these rocks in the Luano Valley, and there have been rumours of the presence of coal within them in the Lukusashi Valley. There is no doubt that this is the same facies of the Karroo as is so typically developed in the Wankie coal-bearing area of Southern Rhodesia. It is equally certain that strata corresponding with the glacial Dwyka conglomerate and the Lower Ecca Shales of South Africa are not present in these areas.

Southward from the Kafue River, and 20 miles or more west of the railway, and also westward from the Kafue River above Mamwala and from the lower portion of its tributary, the Lunga River, considerable areas of the surface of the plateau are occupied by horizontal to very gently dipping sandstones and shales. Sandstones appear to be both beneath and above the shales, which latter include some layers, up to 15 in. thick, of a very dense fine-grained argillaceous limestone. The beds of limestone lack continuity and are often more or less concretionary. About 20 miles west of Monze railway station, limestone of this character contains some fossils, specimens of which were submitted to Dr. A. 'du Toit, who reports them to be *Estherina*, of a type which may indicate a Rhætic age for these rocks. Tentatively they are being correlated with the Stormberg Series of the Union, while at least some of the sandstones are presumed to be identical in character with the Forest Sandstones of Southern Rhodesia.

Northward, for about 30 miles from the Zambesi River at Livingstone, and westward, from the railway approximately to the Umgwezi River, there is a succession of basaltic lavas which are regarded as being of Upper Karroo Age. The northern border of this area is very irregular and is fringed by numerous outlines of these basalts. How far these rocks extend to the east of the railway is not known. Some of the basalts contain olivine. The amygdules within the upper and lower portions of these lava flows are filled with quartz, zeolites, and frequently contain celadinite, a green silicate of iron, magnesium, and potassium which, because of its colour, has often been mistaken as an indication of the presence of copper.

(9) *The Kalahari Series.*—Within certain areas to the north of the Zambesi River and westward from the railway, a few occurrences of poorly consolidated flat-lying sandstones are believed to belong to this series. Some of these sandstones possess such a relatively high proportion of ferruginous cement as to be called "ironstones." Westward towards Barotseland, from the Lufupa River, a tributary of the Kafue River, much of the country is mantled with sands which are of wind-blown origin, but have been modified in their distribution by the heavy rainfall of successive rainy seasons. Occasionally within these sands typically facetted pebbles are in evidence. Considerable areas in Barotseland are reputed to be covered with Kalahari sands. To-day, Northern Rhodesia experiences about seven months of dry, fine weather and five months in which from 30 to 65 in. of rain fall. Within recent geological time, an approach to desert conditions must have prevailed.

(*To be continued.*)

THE MANAGEMENT OF ELECTRICALLY-DRIVEN DREDGES

At the meeting of the Malayan Tin Dredging, Mining, and Research Association held on September 8, a paper entitled "Notes on Electrical Dredges" was read by R. A. Duncan, of Malayan Tin Dredging, Ltd. The advantages obtained by the use of electrical power may be summed up as follows:—(1) The electric motor is compact and takes up little space; (2) the power is easily conveyed to the motor, for an electric cable can be passed through small spaces and around obstacles where it would be almost impossible to fit steam, hydraulic, or pneumatic pipes; (3) when once in position, a motor requires little attention and continues to work with high efficiency at all loads for long periods.

Steam plant with reciprocating engines in the

early days of their life give wonderfully efficient service, but conditions on board a dredge militate against a prolonged period of efficiency and reliability. It is seldom possible to get good water for the boiler, and consequently, inspection and cleaning are frequent operations involving lengthy stoppages. Since the paddock is the only source of supply for cooling water to the condenser, some trouble may be expected there from time to time. The discomforts of working in close proximity to a steam boiler, engines, and steam pipes in a hot climate need not be stressed, and the space which this cumbersome plant occupies is another disadvantage. Transport of coal and water, sometimes over a considerable distance, is another item to be considered.

On an electrically-driven dredge the cost of coal and water transport is eliminated, the dredge is cooler and cleaner, maintenance is reduced, and the reliability factor is increased. Motors take up little space, there is an absence of vibration, and there is not the same stiffening required as in the case of reciprocating engines. The electric motor with its small weight and compactness can be placed close to the drive, thus obviating the need for long lines of shafting.

The initial cost of electrical plant is much lower than that of steam plant of similar capacity. For the complete electrical equipment, including " dredge to shore cable " for a dredge of 140,000 cu. yd. capacity, the cost is £4,400. If the current is taken from a public supply company and sub-station equipment and overhead lines supplied, the cost would be approximately an additional £900. Steam plant for a similar dredge would cost £8,500 and the necessary spares which must be carried may increase this figure by £600 to £800. These are actual figures obtained from dredges installed in 1927–1928.

Maintenance.—The operation of electric plant is simple and the amount of maintenance required is small, but a few general notes on care and maintenance may be useful to all who are in charge of a dredge. It frequently happens that a fault, arising during the absence of the electrical engineer in charge, may be detected by the staff which if not remedied at once should be reported immediately, for this promptitude may prevent a serious breakdown, loss of running time, and vexation to the dredging staff in general.

It is seldom that a dredge engineer will be required to attend to overhead lines; his duties really begin at the dredge terminal pole, to which his shore cable is attached. The terminal pole is provided with a three-phase isolating switch for interrupting the supply to the dredge. On each phase of this switch are arcing horns which make and break contact before and after the switch blades. When this switch is opened an arc is formed across the narrow gap of the horns as they separate, and is blown upwards by electromagnetic effect and the action of the heated air in the region, until it is lengthened and ultimately extinguished. These horns prevent arcing and burning of the main contacts. It is essential that this switch should be opened and locked when any work is being done on the cable, for although protection against shock, etc., is good, one can never be too careful in handling cables that are carrying high tension current. This precaution is especially emphasized when the cable has been in service for a long time and the insulation has deteriorated to some extent. A sharp bend or twist is liable to displace the cores or split the insulation if it is at all brittle, which is a likely condition if the cable has been exposed to the sun on the tailings for a few years.

Cases have occurred where a wireman who was binding the cable pushed an end of the binding wire into the cores and caused a blow-out. Only the efficient earthing of the cable prevents a fatality in such an event. It might be mentioned here that the armouring on a cable is not only intended as a mechanical protection but also as an earthing conductor.

It should not be necessary to stress the importance of keeping the masthead switch locked against interference from unauthorized persons, and this is essential when men are handling the cable or working on the H.T. cable-drum slip-rings.

The makers of cable advise that no cable should be bent in a circle, or arc of a circle, whose radius is less than 10 times the diameter of the cable; and when the cable is D.W.A. this factor should be increased to 20, otherwise the cores become displaced and the life of the cable consequently impaired.

In moving the cable when travelling across the paddock and when shifting the cable to a new terminal pole, it is essential that no twists or kinks should be allowed to develop. It often happens that the coolies pull the slack along the tailings and pile it up one layer over another, the slack thus obtained being pulled to another position without the coils and twists being sorted out.

With ordinary care there is no reason why a shore cable should not last for six or eight years.

At the H.T. cable-drum slip-rings there is little supervision necessary, except that the slip-ring cover must be kept from direct contact with rain and water from other sources. Although the cover joints are machined there is always a trace of moisture liable to find its way along the shaft from the point where the cable enters, and the bakelite insulation which is a very hygroscopic material is seriously affected by moisture. Should a flash-over occur here, the masthead switch on the terminal pole should be opened by the European operator, not by a native chargeman, and word sent immediately to the power station explaining what has happened and what has been done.

The H.T. cubicle may be regarded as the control centre and from this point all the electrical plant on the dredge can be isolated. On the cubicle are the two H.T. circuit breakers which control the supply to the main transformer and to the lighting transformer respectively. There is a point about these switches which is worthy of mention. Attempt should never be made to interrupt the supply by opening the isolating knife switch on top, before opening the oil-immersed circuit breaker. This is only intended as an isolating switch to facilitate inspection of the oil circuit breaker and has a very slow opening movement.

At the moment when contact is broken, a very high pressure discharge takes place from the transformer and the arc thus formed at the contacts will spread upwards and outwards under the influence of its own magnetic field and the heated air; with the small clearances provided between phases, and between phases to earth, a short circuit is inevitable, which in all probability will destroy the switch. The correct procedure is to open the oil circuit breaker first because it has the tendency to break the circuit at zero pressure, and any arc

that is likely to form is rapidly quenched in the oil.

It would be idle to suggest that a circuit containing a transformer or other highly inductor apparatus should never be broken by means of an air break switch. A well designed air break switch will interrupt the supply to a transformer provided the clearance to earth is adequate and that the phases are suitably guarded and spaced. This type of switch, however, is seldom used in practice, except as a means of isolating a piece of apparatus after the current has ceased to flow.

When closing the H.T. isolating switch attempt should never be made to force it in. This switch is provided with interlocks which prevent it being closed if : (*a*) The cover on the oil-immersed circuit breaker is not screwed down tight ; (*b*) if the oil tank is not screwed up into position ; (*c*) if the circuit breaker is for some reason or other closed ; (*d*) if the door into the cubicle is open or the sliding bar which secures the door is not in position.

The oil-immersed circuit breaker when closed is held in that position by a voltage coil which is supplied at 110 volts from a potential transformer inside the cubicle. If the power fails, or the voltage drops below a certain limit, the iron plunger which is held up by the magnetic action of this coil will drop and release the circuit breaker. It may happen when closing the switch that the voltmeter shows normal voltage, but this switch will not remain closed and will immediately drop back when the hand is released. This will probably indicate that the no-volt coil is not being energized and the H.T. fuses on the P.T. will be the first place to look for the fault.

There are other reasons which will cause the switch to drop out while trying to close it ; for instance, a fault on the H.T. side of the transformer, or a fault on the L.T. windings, or in some part of the L.T. system. In this case the overload coils would operate and release the switch, which has a loose handle to prevent it being held in against the operation of the overload tripping mechanism. This feature on any circuit breaker is important, as otherwise the switch may be closed on a fault and considerable damage done before the operating handle is released. As far as possible all trip-coils and other similar apparatus should be tested weekly; if a circuit breaker is not tripped occasionally it may fail to operate under fault conditions. Opening and closing a switch a number of times every week also assists in keeping the contacts bedded, and it is necessary periodically to clean up the main and arcing contacts, any blobs of molten metal being filed down.

As soon as possible after a fault it is advisable to inspect all circuit breakers which may have been affected, cleaning up contacts and adding oil to replace any which has been expelled. Periodical tests should be made to ensure that the overload trip-coils will operate at the specified overload, and also to check the time delay setting. This can be done by means of a battery, ammeter, switch, and resistance, inserted in place of the C.T. and the current checked for each value of overload setting.

L.T. Switchgear.—What has been said of the high tension circuit breaker equally applies to the low tension switches, as these are similar in design and fitted with interlocks, so that the switch, the motor, and the operator are protected. If the circuit breaker will not close, it should not be forced, otherwise the operating mechanism may be damaged. The cover and the oil tank should be examined, to see that they are screwed tightly in position, and that the controller is in the " off " position. It will not be possible to close the circuit breaker unless these conditions obtain, for obvious reasons.

All connections in the controller gear should be examined daily to ensure that contact is good, that there are no signs of heating, that bolts and screws are tight, that the main contacts on the switches and controllers are bearing evenly over the whole contact area, and that all three phases are making and breaking contact simultaneously. All traces of copper filings and dust should be removed from the controller contacts, and the insulation carefully wiped down with a dry cloth for, next to moisture, dust is most fatal to the insulation of electrical gear.

Transformers.—In order to obtain the full advantage for the use of a transforner, it is essential that it should be accommodated in a well ventilated position, which at the same time affords protection from rain and water from other sources. Too much stress cannot be laid upon the necessity of providing adequate ventilation, as it is the thermal conditions which decide the life of a transformer, and the author urges that provision should be made to permit of a free passsage for currents of air around the transformer. It often happens that the workmen on board avail themselves of the hot currents of air around the transformer chamber to dry their wet clothes, and in hanging these around the expanded metal sides, they obstruct the passage of cooling air. This should not be permitted nor should anything that is likely to shield the transformer from draughts of air be tolerated. The makers specify that the highest permissible working temperature on any transformer must not exceed 85° C. if " B " grade oil is used, and 90° C. if " A " class oil is the insulating medium.

Most transformers are fitted with calcium chloride breathers which extract the moisture from the air that is drawn into the tank when the temperature drops. The calcium chloride must be replaced frequently, as owing to its deliquescent nature it rapidly disappears in a moist atmosphere. To emphasize the importance of keeping the transformer oil free from water, and how drastically the insulating properties of the oil are affected by the presence of exceedingly small traces of moisture, experiments show that if water be added to dry oil to the extent of one part in 10,000 the breakdown pressure across the British standard spark gap of 0·15 in. may be reduced to considerably less than one-half of the breakdown pressure of dry oil. Switching in and out should be cut down to a minimum. When switching in, the transformer is always subject to the shock of steep-fronted pressure waves and heavy current rushes, both of which tend to weaken the insulation between turns of the coils electrically and mechanically, thus increasing the possibility of a breakdown between turns of the windings.

The neutral point in the L.T. windings is solidly earthed, the reason being that this reduces to a minimum the possible danger to human life should contact accidentally be made with a live low-pressure conductor and obviates the possibility of high pressure being present in the L.T. winding when a breakdown between high and low pressure windings occurs. There are many reasons for earthing the

neutral point of a transformer, two of which have already been given. If a fault occurs in the insulation of any part of the L.T. system that part will be immediately disconnected either by the tripping of the L.T. circuit breaker in the circuit concerned or by the H.T. circuit breaker, because an earth on any phase in an earthed system is actually a short circuit across that phase, and the heavy rush of current from the phase to the neutral point will operate the overload trips on the circuit breakers. The voltage to earth is only 58% of the line voltage when the neutral is earthed, and consequently the dielectric stress on the cable or other insulation is less by that amount. For the above reasons it is well to regard the earth connections from the transformers, motors, and switchgear with the same degree of respect as is given to the live cables, and to make sure that the contact to earth is good and not subjected to the corrosive action of water and rust, or the probable insulating effects of oil.

Motors.—The troubles that arise in direct coupled motors and in machines with three or more bearings can generally be traced to misalignment and the following notes indicate the precautions that should be observed.

A firm and rigid foundation is essential, and a common error is to assume that a cast iron bed-plate is rigid, and that it is only necessary to bolt it down. Unless steps are taken to ensure the bed-plate being level and properly supported along its entire length, bearing and other troubles are sure to develop. In machines with a coupling such as the auto-synchronous and other pump motors the coupling bolts should be removed and feelers inserted at the top, bottom, and sides between the couplings. When the machine is in line the gap in all four places is exactly uniform. The couplings must also be in line around the periphery and this can be checked with a straight edge. When a machine is mounted on slide rails these should be carefully levelled up in both directions before the bed-plate is put down on them. They must be checked with the straight edge across the ends of the rails and along their length. When three rails are installed, a feeler gauge should be tried between the rails and the straight edge in each position to make sure that the rails are all equal heights from the foundation.

It is obvious that any error in the alignment of the slide rails will be reproduced in the bed-plate and therefore in the bearings. Flexible couplings are provided against accidental misalignment but it cannot be too strongly emphasized that the flexible couplings should not be regarded as eliminating the necessity for correct alignment between the machines. Incorrect alignment invariably results in rapid wearing of the flexible coupling and if this occurs the alignment should be immediately checked. An electric motor will give maximum service with the minimum of attention if ordinary precautions are observed such as keeping it free from dirt, moisture, acids, and oil. So unobtrusive in its action is the motor that its very presence is overlooked and its existence almost forgotten. Unlike its fellow workers the steam and oil engine, it does its job silently with the minimum of fuss and in consequence it very often does not get the attention it deserves until it suddenly refuses to function, when it may then be too late. The steam engine never fails to claim constant attention with its complaining action. If it has symptoms of going wrong, the attendant cannot fail to hear about it, but the electric motor invariably refuses with startling suddenness to do its job, and it is this characteristic which must be guarded against.

Insulation tests should be taken weekly to ascertain the condition of the windings and connecting cables; and at least once every month the clearance between the rotor and the stator should be checked.

Generally speaking most of the faults which occur can be traced to the control gear which is always more liable to go wrong than the motor itself. The most common faults to be encountered in every-day practice are :—

(*a*) The motor refuses to start and makes a humming noise. Assuming the supply to the switch is all right, the first place to look is in the circuit breaker and the controller for contacts which are not touching. Having ascertained that the contacts are bearing, a break in the starting resistance must be looked for, and lastly a break in the stator or rotor windings.

(*b*) The motor starts with difficulty and will not run up to normal speed. Here again the controller contacts and resistance should be examined for a break in one phase or a short circuit in the rotor between-windings and coils.

(*c*) When the motor is running it shows an excessive load or no load at all on the ammeter and makes a humming noise. A break in one phase of the stator connections or windings is indicated, or a faulty connection or a break in the rotor circuit.

(*d*) The motor drops considerably in speed as the load increases and finally stops. This may be due to one or two causes such as the voltage being too low, or the motor having been wrongly connected up, that is, star instead of delta. In the latter case it is unlikely to happen except when a new motor is installed. In the former case a low voltage will be noticeable in the lights and other motors.

What has been said of the need for good ventilation in transformers is equally important in the case of motors. Each motor is provided with a fan —one or two depending on the type of machine— to draw currents of air through the windings. The usual type of motor on the dredges has one fan drawing air in at one end of the windings and expelling it at the other. On the yoke or stator frame of this type inspection holes are provided for examining the stator core, taking temperatures and cleaning, etc., but these covers must never be removed for any length of time while the motor is running. It frequently happens that the men in charge remove these covers to allow an increased current of air into the windings if the motor is running hot. This procedure is entirely wrong and defeats the whole object of the ventilating system, because the cooling air which is drawn into windings naturally takes the easier path through the inspection doors, with the result that only half of the windings are being cooled, and that part most remote from the fan will increase in temperature. Not infrequently the author has found a coolie's sarong or coat hanging on the discharge vent, and although conditions there are ideal for drying clothes, the practice is one which should be severely discouraged. A few of the smaller types of motors are fitted with a fan at each end of the rotor which draws the air through the inspection holes at the middle of the stator and discharges it at either end.

The oil wells on each motor should be drained once a month, the wells flushed clean with paraffin, and new oil put in. The oil which is drawn off can be used elsewhere or sent back to the workshop to be filtered and cleaned.

It is desirable at all times that the motors should be kept up to full load, where it is possible, because a motor that is running lightly loaded pulls down the power factor of the system. Since it is inevitable that a number of the motors cannot be kept up to full load, provision has been made to keep up the power factor by the installation of an auto-synchronous motor. This motor is so designed that when running at full load the leading current which it takes from the line compensates for the lagging currents which the other motors take. It is essential, therefore, that this motor be kept running at full load.

Earthing.—It must never be taken for granted that a motor or other piece of apparatus is in good contact with earth if it is bolted down on a metal foundation. There is always the possibility that it may be partially insulated by grease, dirt, or rust, and in such circumstances there might be an appreciable potential difference between the apparatus and earth, sufficient to be dangerous or uncomfortable during fault conditions. All apparatus for that reason should be independently earthed by means of bonding wires which will be efficiently clamped to the hull of the boat; or, if the apparatus is installed on shore the earth conductors should be clamped solidly to water pipes that are immersed in water or buried in the ground; failing that, they should be connected to an earth plate or length of pipe sunk into the ground and deep enough to be in contact with water all the year round. A length of pipe is a much more suitable arrangement than a plate for earthing purposes because it can be driven into the moist soil, and the top end can be kept above ground, so that the earth connection can be examined or opened for testing purposes. The same attention should be given to the earthing bonds as is given to live cables, because under fault conditions these are expected to carry fault current and maintain the apparatus at earth potential.

TANTALUM AND COLUMBIUM (NIOBIUM)

In a paper on metals of the tungsten and tantalum group, published in *Industrial and Engineering Chemistry* for November, C. W. Balke gives details of the metals tantalum and columbium, their properties and preparation. In making the following extract we retain the name columbium though this metal is called "niobium" outside the United States.

Ores containing tantalum and columbium are found only in pegmatite dykes, and only one type of mineral is known, both of the elements being nearly always found associated with each other. Where the tantalum predominates the mineral is usually called tantalite. Where columbium is present in large quantities the mineral is known as columbite. Specimens of columbite from Greenland have been found which are nearly free from tantalum, and the author has examined specimens of tantalite from South Africa which are very nearly free from columbium. Up to the present time the chief source of high-grade tantalite containing 60% or more of Ta_2O_5 has been one mine in Australia. Columbites occur in the Black Hills of South Dakota carrying from 15 to 50% tantalum oxide, associated with relatively large amounts of columbium oxide.

The preparation of tantalum and columbium metals involves the separation of these two elements by chemical means, and the most suitable method for accomplishing this is through the recrystallization of the double fluorides of these elements with potassium. The finely divided ore is fused with caustic soda, which converts part of the metallic acids into iron salts and sodium salts. Both sodium tantalate and sodium columbate are insoluble in water containing free alkali. If this mixture of iron tantalate and sodium tantalate is treated with hydrochloric acid, the iron is completely removed and a nearly white crude mixture of the acids of columbium and tantalum remains. These acids are then dissolved in hydrofluoric acid and the solution is filtered and treated with the requisite amount of potassium fluoride to convert the tantalum into the double fluoride, K_2TaF_7. With properly regulated concentrations practically all the columbium will remain in solution and the tantalum double fluoride will precipitate out, solubilities being in the ratio of about 1 : 12. This double fluoride of tantalum can then be purified by recrystallization from water containing a small amount of hydrofluoric acid. Pure water cannot be used, as this converts part of the tantalum into an insoluble basic salt. Columbium does not show this same property and this method has been utilized in separating the two elements. The purification of the columbium double oxy-fluoride, which has the formula $K_2CbOF_5.H_2O$, is far more difficult because the soluble impurities, which consist of fluorides of tin, tungsten, titanium, etc., accumulate with the columbium. Tin and tungsten may be removed by converting the columbium back into double fluoride. Titanium has been removed on a laboratory scale by the recrystallization of the salt K_2CbF_5 from fairly concentrated hydrofluoric acid, but the character of this reagent is such that it is almost impossible to make this a commercial process.

The oxides of these elements are readily produced from the purified double fluorides by treating their solutions with ammonia. This precipitates tantalic or columbic acid, which may be washed and ignited to oxide. These oxides cannot be reduced except to a lower oxide in hydrogen; therefore, the methods used for producing tungsten and molybdenum are not available. It need only be said here that the method of reduction employed in practice is a complicated one and involves the use of specially designed electric furnaces.

Columbium has a colour almost identical with that of platinum, whereas tantalum is considerably darker and often shows a decided bluish cast. The true melting point of columbium is as yet unknown, but probably lies above 2,000° C. The melting point of tantalum is about 2,850° C.

Nearly all of the physical properties of columbium are yet to be determined. Both these metals show a great avidity for the common gases, hydrogen, oxygen, and nitrogen. Tantalum will take up seven hundred and forty times its volume of hydrogen when heated in this gas and is converted into a very brittle compound of hydrogen. The

same is true of columbium. They both readily absorb nitrogen and when heated in the air oxidation begins at about 400° C. At more elevated temperatures these metals oxidize quite rapidly, forming the pentoxides. The density of columbium is about 8·3, the density of tantalum 16·6. Unlike tungsten and molybdenum, these two metals are exceedingly ductile at room temperature in the equiaxed or annealed condition; in fact, they are more ductile than copper, silver, or gold in that they can be worked mechanically to an almost unlimited extent without becoming so strain-hardened that further working becomes impossible. Needless to say, owing to the readiness with which they react with the common gases, all heat treatments or annealing operations can be carried out only in suitably constructed vacuum furnaces. One of the greatest problems in connection with the manufacture of tantalum was found in the development of vacuum pumps of sufficient capacity to make these operations commercial, for the vacua required are of a very high order. All the mechanical work on these metals is done at room temperature. This is again a marked distinction between these two metals and tungsten and molybdenum.

Chemically, tantalum and columbium are characterized by extreme resistance to attack by even the stronger mineral acids with the single exception of hydrofluoric. Hydrofluoric acid itself in a pure condition acts but slowly upon them. This is due to the fact that the hydrogen which is ordinarily evolved from the action of acids on metals is absorbed by the metal and a thin sheet of these metals will become very brittle after a short exposure to this reagent, owing to the formation of hydride. Both metals are inert to the action of even aqua regia. The main distinction so far noted is the greater solubility of columbium in hot concentrated sulphuric acid. Both metals function as valve metals because of their insolubility and the insolubility of their oxides in acid solutions.

When a strip of tantalum and a strip of lead are introduced into a dilute solution of sulphuric acid and a source of alternating current is applied, the tantalum immediately becomes coated with a film of oxide, probably impregnated with tiny bubbles of oxygen. Very quickly current will flow in one direction, electrons moving from the tantalum plate into the solution to discharge hydrogen ions, but no electrons flowing in the other direction. This property of tantalum has been utilized in the construction of several million units used as auxiliary equipment for the operation of radio sets, charging railway signal batteries, and other commercial uses where small quantities of direct current are required from an alternating current source.

It is possible that the production of a film on tantalum by electrolytic oxidation may result in the use of tantalum for the manufacture of art objects and some types of jewelry. A number of attractive colours can be produced by this process, and, although the electrolytic film is very thin and the colours are due to light interference, the film itself is exceedingly hard and durable.

The properties of columbium now known are due largely to a sample of columbium prepared in 1907 by von Bolton, who prepared a regulus of the metal by an alumino-thermic process and then melted the metal repeatedly in a vacuum electric furnace. The specific heat of columbium is given as 0·06 to 0·07, which is about twice that of tantalum; its heat of combustion is 2,350 calories per gram. In the ease with which it may be worked, columbium resembles nickel more closely than tantalum. In the annealed condition it is an exceedingly ductile metal, more ductile, in fact, than tantalum, although this is contrary to some of the accounts hitherto published.

THE BANKET DEPOSITS OF THE GOLD COAST

In the issue of the MAGAZINE for December, 1928, a summary was given of a paper on the banket gold deposits of the Gold Coast which had been read by Arthur Bray at a meeting of the Institution of Mining and Metallurgy. At the conclusion of his paper, Mr. Bray put forward the view that all the evidence was in favour of a deposition of the gold by subsequent mineralizing solutions. Further evidence is now to hand and Dr. N. R. Junner in an appendix to Memoir No. 1 of the Gold Coast Survey, called "The Geological and Mining Features of the Tarkwa-Abosso Goldfield," written by O. A. L. Whitelaw, says that in his opinion and in that of Mr. Whitelaw and of Sir Albert E. Kitson the gold was originally of alluvial origin. Extracts from Dr. Junner's paper are given here.

The gold is rarely visible to the naked eye, and some of it is so finely divided that it appears like dust in thin sections when viewed under the high-power objective. In the foot-wall quartzite of the West Reef at the Abosso mine, certain small green pebbles are surrounded by small specks of visible gold. Thin sections of two green pebbles from the West Reef, Abosso mine, have been described, in which finely divided gold occurs in the pebbles. This gold is apparently not connected with fracture-planes. Thin sections of the banket from the Taquah and Abbontiakoon mines show that the gold usually occurs in minute grains and as crystals around the quartz pebbles and in the matrix of the banket. The gold in many cases is intimately associated with hematite and in places it is seen to be embedded in the re-crystallized quartz of the matrix.

The question of the origin of the gold in the banket of the Tarkwa-Abosso goldfield has been discussed by Halse, Professor Truscott, and Collings. The two former writers regarded the gold as of alluvial origin and Collings has stated his belief in the infiltration theory. The Director of the Geological Survey, Gold Coast, Sir Albert E. Kitson, regards the gold as of alluvial origin, and Mr. Whitelaw in the present Memoir gives evidence in support of this theory. As a result of a brief study underground of the banket in the Taquah and Abosso mines, and from the microscopical examination of numerous thin sections of banket, the writer has come to the same conclusion.

The microscopical features in support of the alluvial origin of the gold are as follows, namely:—(1) The intimate connection of the gold with hematite. The hematite is undoubtedly of detrital origin, and directly associated with it are detrital crystals of zircon and rutile. At both the Taquah and Abosso mines the presence of much hematite in the banket is regarded as favourable for good gold values. In thin sections the gold is seen in

many cases to be embedded in the hematite. (2) Gold occurs in certain pebbles from the West Reef at the Abosso mine. The gold is not connected with fracture-planes unless the fractures are of sub-microscopic dimensions. (3) The extreme rarity of sulphides and carbonates in the banket and adjoining wall-rocks, and the absence or extreme rarity of minerals containing silver, arsenic, antimony, etc. These facts are very strong evidence in support of the alluvial origin of the gold. Sulphides and carbonates are present in all the auriferous quartz-reefs that are being worked in the Gold Coast, and the wall-rocks adjoining the reefs are usually impregnated with pyrite, ankerite, sericite and arsenopyrite. (4) The microscopical structure of the quartz of the matrix of the conglomerate does not resemble that of vein-quartz. The structure of the matrix quartz resembles that of a re-crystallized sandstone.

Other features which are in support of the alluvial origin of the gold are as follows :—(1) The wide distribution of the gold in the banket both longitudinally and laterally. Not only does the gold occur in the conglomerate over a longitudinal distance of at least ten miles along the main outcrop, but it is also present in the conglomerate where it outcrops on the crests of folds near Akontansi and Kotraverchy and the conglomerate is known to be auriferous in the syncline between Tarkwa and Akontansi. It is difficult to conceive a continuous quartz-reef of this magnitude in arenaceous beds, as the tendency is for all quartz-reefs in arenaceous beds to split into ramifications and stringers of quartz. (2) The fineness of the banket-gold from the Tarkwa-Abosso goldfield is very high, namely, 950–1,000. Horwood states " It is well-known that one of the chief characteristics of placer gold is that it is exceptionally pure." Although this is generally true it is not invariably so, and too much stress must not be laid on the criterion of the fineness of the gold. Horwood argues that as the fineness of the Witwatersrand gold is only 875–900, the gold in the latter case is probably not of alluvial origin. This conclusion is not warranted.

The fact that the gold in the banket is in a very finely divided state and is not waterworn is not a valid argument against the detrital origin of the gold, as Goodchild has pointed out for the gold of the Rand. One of the characteristic features of the alluvial gold obtained by panning the streams of the Gold Coast is its finely divided character and its sharp outlines. A good deal of the alluvial gold near Obuasi, and much of the lode gold from the Ashanti Goldfields mine at Obuasi is just as finely divided as the gold in the banket at Tarkwa and Abosso. Furthermore, that some re-crystallization of the gold took place during the metamorphism of the banket is very likely, but in general there appears to have been very little migration of the gold.

Collings regards the presence of tourmaline crystals in the banket as due to pneumatolysis which would be an accompanying phenomenon of the deposition of the gold, and believes that the gold and tourmaline were derived from some deep-seated magma. Examination of thin sections of the rocks from the Tarkwa-Abosso goldfield has shown that tourmaline occurs not only in the banket, but in the sandstones in which the banket occurs, and in the Tarkwa and Dompim phyllites far removed from the banket ; indeed, tourmaline is present in nearly all the sediments of the goldfield. The tourmaline in all these cases is of the same type and in several places in the Tarkwa phyllites it is more abundant than it is in the banket. The tourmaline in the banket and in the phyllites has been derived chiefly from detrital grains of tourmaline in these sediments.

It is of interest to compare the banket deposits of the Gold Coast with those of the Witwatersrand. (1) The general geology, structure and metamorphism of the rocks of the two goldfields are similar. (2) The minerals in the two bankets are fairly similar. The chief differences are as follows :—Black iron sand (hematite) is abundant and pyrite and carbonate are extremely rare in the Tarkwa banket, while the Rand banket contains no black iron sand, but has a good deal of pyrite and in places a moderate amount of carbonates. Gregory, Halse, Young, and Mellor have suggested that at least some of the pyrite in the Rand banket is pseudomorphous after black iron sand. The banded pyritic quartzite of the Rand, according to Young, is lenticular and shows current-bedding. The banded hematite-sandstones associated with the banket of the Tarkwa-Abosso goldfield show the same features. (3) The state of sub-division of the gold in the two bankets is similar. (4) The gold from the Tarkwa banket is much purer than that from the Rand banket. Its fineness is 950–1,000 against a fineness of 875–900 for the Rand gold.

THE GENESIS OF COAL

At the Indian Science Congress held in October, Dr. Cyril S. Fox, of the Geological Survey of India, delivered the presidential address in the Section of Geology, taking for his subject "Geological Aspects of the Formation of Coal". We quote his views herewith, and would remind readers that these may be read in connection with the author's article in the MAGAZINE for January, 1927, on the " Nature of Coal as Determined by Petrographic Methods in Polarized Light under the Microscope." To beginners the earlier article will be of value in explaining the meaning of such words as vitrain, durain, and fusain.

The primary material from which ordinary coal is formed consists of the debris of land plants, namely, logs, roots, branches, twigs, leaves, spores, etc., whose chemical composition, considered in terms of an ultimate analysis, as carbon, oxygen, hydrogen, and nitrogen, is remarkably uniform, and has been so in past geological ages since the Palæozoic era.

The terrestrial plant material, namely, leaves, dead twigs and trunks, etc., was rapidly submerged in fresh or salt water, and finally settled down in the stagnant, aseptic waters of swamps or lagoons. These conditions were evidently fatal for the continuance of plant life, but highly preservative of the plant structures.

The attacks by fungi and micro-organisms, however active in the plant material before and during the shallow stages of immersion, are considered to have ceased as the maturing mass sank in deeper water or was covered by further plant debris. It is thought that the fungi attacked

the cellulose components—the sap wood and medullary rays of the higher plants—at a time when damp, aerobic, rather than water-logged, anaerobic, conditions prevailed.

The attack of micro-organisms (bacteria), judging from the behaviour of matured silage, cannot have been long continued in the submerged plant material in the relatively aseptic waters which appear to have permeated the peaty mass. It is possible these conditions were more severe, and that the gelatinization of the cellulose components of the maturing peat was quicker in sea water than in fresh water. This is credited to the acidity due to the sulphur compounds which appear to have been present, and which, as pyrite, characterize marine coals generally.

The main processes in the maturing of peat and its subsequent conversion into primary coal are considered to be of a chemical character and involve all the plant components, cellulose, hemicellulose, lignin, lignocellulose, and suberin. It is believed that all these substances are not different chemical compounds but largely mixtures of cellulose with lignin and fatty compounds. These substances, however durable in themselves to chemical attack, are, in the conditions involved, slowly incorporated in changes which result in the production of a gelatinous substance (a complex colloid) of the nature of or identical with dopplerite.

The other parts of plants, spores, sheaths of sporangia, the walls of wood cells, etc., which appear to be indestructible or particularly resistant, are not involved in the production of the black, dopplerite jelly. They remain embedded in the gelatinous mass and are responsible for the recognition of the plant structures observed in coal. All the cellular spaces, wood cells, etc., are, in newly formed coal, filled with the jelly. In spores, etc., the body is composed of resinous matter.

The appearance of the gelatinous substance, which presumably permeates the matured peat layer, is accompanied with the elimination—measured in percentages of the original plant substances—of water, oxygen, hydrogen, nitrogen, and carbon in the form of various gases. The whole mass at this stage slowly suffers transformation into primary coal or black lignite.

The hardening of the gelatinous substance takes place slowly under water, but it is evidently accelerated by alkaline solutions. In many instances, it appears that the hardening had been accomplished before the overlying sediments were deposited. In its hardened form the pure gelatinous material is thought to be primary (colloidal) vitrain. The darkening which is associated with the hardening is ascribable to de-volatilization.

The cellular structure of wood and other plant sections remain unobliterated in the primary vitrain. Where the vitrain has its purest development and least internal structure it appears to occupy areas of original cortex fragments and is easily recognized in the bright laminæ of coal. Where cell structure is evident the vitrain is an infilling in what was true woody material and is not readily recognized as vitrain in hand specimens. In the laminæ where much earthy matter has settled or the plant material was very finely broken up, the vitrain is not so evident.

With the deposition of further sediment and the loading of the primary coal a new series of changes begins. The primary vitrain suffers carbonization, accompanied by the expulsion of water, methane, and other gases. This de-volatilization process is due to the heat generated by the pressure on the primary vitrain. With additional pressure the heat continues to de-volatilize the vitrain until the stages of vitrain in bituminous coals are passed and an anthracite is formed. If the pressure and heat are great the cell and other plant structures are distorted and almost entirely obliterated.

The temperatures attained in the production of anthracitic vitrain have been estimated at from 450 to 500° C. At this stage practically 75% of the volatile components are expelled. The resinous bodies appear to have disappeared also, and the inert constituents become conspicuous if present in appreciable amount in the original peaty mass.

It is presumed that in all these processes the material has remained below ground-water level under anaerobic conditions. The several stages in the de-volatilization of primary vitrain are thought to correspond to the several classes of coal ordinarily met with. These must obviously grade insensibly from one to the other, being modified only by the prevalence of one or other accessory such as spores, oily substances, or inert matter (water and clay, etc.).

The disappearance of the vitrain from within the cavities of the wood cells and between the fibres and the appearance of fusain is possibly due to excessive heat, the result of catalytic action in these capillary spaces. Lenticles of severely carbonized woody material, the well-known mineral-charcoal or fusain, are always found more abundantly in the palæozoic coals. This material contains free carbon in a fine powdery condition, possibly in minute flakes. Free carbon must occur for the same reasons in those scattered wood fragments which are a part, with other comminuted plant debris, of durain. There is probably little free carbon in lignitic types of fusain and probably considerable amounts in anthracitic vitrain.

Although vitrain is probably a complex, colloidal constituent, chemically, it has physical properties which suggest great uniformity of substance—particularly in the same coal-seam of a given locality—if the seam has not been disturbed by igneous intrusions or tectonic forces. It is probably similar in the same class and condition of coal. An exact grading can bring the phases of a classification into use for comparing the degree of carbonization a coal has undergone.

The specific gravity of vitrain increases from about 1·2 in lignitic (dry, ashless) vitrain to over 1·4 in anthracitic (dry, ashless) vitrain. Contained water (moisture) increases the specific gravity of vitrain of all degrees of de-volatilization. The specific heat of vitrain decreases from the lignitic to anthracitic types from about 0·4 in the former to 0·2 in the latter on a dry, ashless basis. Increase of moisture increases the specific heat of all vitrain. It is well-known that the heat conductivity of coals is low; a hard sandstone probably has ten times the conductivity of normal bituminous coal.

Vitrain is the chief caking constituent in normal coal. An anthracitic vitrain has weak caking properties. A high percentage of "contained water" (moisture) in vitrain indicates loss of caking character. By adding hydrocarbons to anthracitic vitrain or by suitably de-hydrating high moisture vitrains it is possible to secure a caking character in such vitrains. The pure vitrain in coal is thus the fundamental substance in that and all classes of coal.

Quicksilver Extraction in Nevada.—In the *Engineering and Mining Journal* for September 28, W. G. Adamson describes the quicksilver deposits in the Relief mining district, near Lovelock, Nevada, with special reference to the mining and metallurgical practice at the property of the Pershing Quicksilver Co., which is the leading producer there. Operations originally commenced in 1912, but it has only been since 1926, when consolidations were effected, that work on a fairly large scale was started. A rotary calcining furnace, 4 ft. by 60 ft., was built at the beginning of 1928 for the coarse ore, and an eight-hearth Nichols-Herreshoff roasting furnace for treating fine ore was completed six months later, and all the plant has been at work since. We give herewith an extract describing the details of the metallurgical work, in which the usual practice is followed of roasting the cinnabar with the volatilization of the quicksilver and the production of sulphurous acid, with the subsequent condensation and deposition of the quicksilver.

The ore is first crushed to 1½ in. in a jaw crusher and then raised in a bucket elevator to a ½ in. vibrating screen. Material passing through the screen falls directly into a fine ore bin, and the oversize is sent to another bin, from which it is fed into the 4 ft. by 60 ft. Gould rotary calcining furnace. The resulting calcine is discharged from the furnace into a sinter bin and allowed to remain there about two hours before settling on to a continuously moving apron conveyor and taken to the rear of the furnace building, where it is removed by a 20 h.p. drag-line scraper.

The fine material is carried from its bin on a 16 in. by 40 ft. belt conveyor to the eight-hearth, 16 ft. diameter Nichols-Herreshoff roasting furnace and elevated to the top hearth of the furnace in a belt-bucket elevator. Discharge from the furnace is by gravity through a chute on to the same apron conveyor which handles the coarse calcine from the rotary furnace.

The two furnaces are equipped with separate condensing systems up to the last stage, in which operation low-temperature gases from both furnaces enter the same wooden settling tanks.

Exhaust gases from the rotary furnace are first pulled through two 48 in. Rees cyclones by a small high-speed fan, and about 96% of the contained dust is eliminated. The dust settles into hoppers at the bottoms of the cyclones and is blown out on to the dump by means of compressed air. The gases are forced from the cyclones into a battery of 48 8 in. by 8 ft. cast-iron pipes ¼ in. thick arranged in six rows of eight each. Over 80% of the quicksilver condensation takes place in these pipes, the aim being to discharge the gases into vitrified tile pipes at a temperature a little above the condensing point of water. From the cast-iron condensers the gases are pulled through a 22 in. vitrified tile pipe into a battery of 112 8 in. by 10 ft. pipes of the same material arranged in fourteen rows of eight each. A fan placed between the tile condensers and the wooden tanks pulls the gases from the first row of iron pipes through the pipe system and forces them into the settling tanks.

The gases from the Herreshoff furnace are first pulled through a 67 in. cyclone, which exhausts about 72% of the total dust, and then through a 58 in. cyclone, which exhausts about 20% of the total dust, the much finer dust accounting for the lower cyclone efficiency compared with the cyclones on the rotary furnace. The cleaned gases are then pulled through 64 8 in. by 8 ft. black iron pipes and 32 monel-metal pipes of the same size arranged in twelve rows of eight each in the same battery. Monel pipes were substituted for the tile pipes in the other unit. A fan driven by a variable-speed motor pulls the gases from the metal cyclones through the condensing pipes and forces them into two small redwood tanks, fashioned on the cyclone principle, which are 5 ft. in diameter and 10 and 12 ft. high, respectively. From these the gases pass into the four 12 by 16 ft. high redwood settling tanks, a 40 ft. wood-stave stack on the last tank drawing away the residual gases.

Under ordinary conditions the ore passes through the rotary furnace running at a speed of 72 revolutions an hour in about 55 minutes. It is dropped into the calcine bin at a cherry heat, the object of the bin being to allow any remaining mercury in the ore to sublimate and to effect a saving in fuel by preheating the combustion air drawn into the furnace. The ore remains in the Herreshoff furnace on the average for 1 hour and 45 minutes. The rotary furnace has a capacity of about 50 tons of the coarser material a day, and the Herreshoff a capacity of about 85 tons of the fine material.

In practice, the method of handling the dust made by the two furnaces has proved extremely satisfactory. The rotary furnace has shown itself to be inherently more of an offender than the rabble-stirred unit from a dust standpoint, but, with the former treating coarse ore, the only dust resulting is that made by the calcining operation and the abrasive action of the revolving tube. The cyclones on the Herreshoff furnace collect an average of 135 cu. ft. of extremely fine dust every 24 hours, 80% of this being arrested in the first cyclone.

The rotary furnace is equipped with a No. 9 Witt high-pressure burner, which injects the oil and air together at 50 lb. pressure. Two No. 90 Mahr triple atomizing burners are kept fired regularly on hearth No. 4 of the Herreshoff furnace (the hearths are numbered from the top down, exclusive of the top or drying hearth), and a smaller burner is kept fired as a booster on hearth No. 2. Two burners are installed on hearth No. 6, but are used only in heating up the furnace. The Herreshoff furnace is equipped with a recording pyrometer, which indicates the temperatures on hearths No. 4 and 6 and of the gases entering and escaping from the cyclones. The average temperature on hearth No. 4 is 1,300° F., and on hearth No. 6 is 1,000° F. Gases entering the cyclones have a temperature of 470° F. and on leaving them a temperature of 450° F. A recording pyrometer on the rotary furnace indicates the temperature of the gases entering the condensing pipes, which is about 470° F.

The iron condensing units of each furnace are cleaned every other day, and the tile condensers of the rotary furnace once a week. When cleaning the condensers, the speed of the fan between the pipes and the redwood tanks is increased and the iron doors on the cement receiving chambers are opened. The free mercury runs into a concrete launder, which has an outlet into one of two submerged cast-iron pots having a capacity of 100 flasks each. The "soot" is removed by a scraper, and hoed in a metal-lined box, no lime being allowed to assist in the extraction. The residue is dumped at intervals on to the conveyor belt leading to the Herreshoff furnace.

SHORT NOTICES

Dust in Quicksilver Plant.—The introduction of the rotary kiln for calcining mercury ores introduced dust losses which had not previously been encountered. In *Engineering and Mining Journal* for November 9 George H. Horne deals with the solution of this problem on mines in California.

Oxides in Pig Iron.—Certain inclusions in steel originate in the blast furnace which is supplying pig-iron for steel making. The action of such oxidic inclusions during the subsequent manufacture of steel are discussed by C. H. Herty and J. M. Games in Bulletin 308 of the Bureau of Mines, Washington.

Coal Washing.—A study of the washing characteristics of bituminous coals from the important coal-fields of the Eastern and Central States of the Union by H. F. Tancey and Thomas Fraser is contained in Bulletin 300 of the Bureau of Mines, Washington.

Alice Arm, B.C.—A report on the mineral deposits of Alice Arm district of British Columbia by George Hansar is contained in part A of the Summary Report, 1928, of Geological Survey of Canada.

Chromite.—*Economic Geology* for November contains an article by L. W. Fisher on the origin of chromite deposits. The author considers the importance of primary crystallization *in situ* has been over-emphasized, and he considers that hydrothermal solutions causing serpentinization have been important by dissolving magmatic chromite and redepositing it with the hydrothermal silicates.

Wabana Iron Ore.—The origin of the Wabana iron ore in Newfoundland is discussed by A. O. Hayes in *Economic Geology* for November.

Graphite in Quebec.—In *Economic Geology* for November G. W. Bain describes the graphite deposits found in Argenteuil County, Quebec.

Iron Mask Cobalt-Silver Mines.—An occurrence of a mineralized contact between diabase and limestone on this property is described by F. F. Osborne in *Economic Geology* for November.

Earth Resistivity.—The value of measurements of earth resistivity is spreading to civil engineering work, and details of two systems of measuring it are given in Information Circular 6171 of the Bureau of Mines, Washington.

RECENT PATENTS PUBLISHED

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

8,625 of 1928 (287,925). Staalsyndicaat Dr. Ledeboer, The Hague, Holland. A process for the direct production of iron or steel by reducing iron ore and separating the molten iron in a furnace heated by a surface combustion burner, so arranged that no free oxygen comes into contact with the material in the furnace.

9,051 of 1928 (319,798). W. H. Fordham, Baldock, Herts. In an improved magnetometer for magnetic surveying the single vertical control magnet is replaced by two such magnets, which are mounted with poles reversed. These two magnets can be moved independently and the device is said to increase the accuracy and range of the instrument.

17,763 of 1928 (319,392) and **16,344 of 1929 (319,605).** The Bradley-Fitch Company, Minneapolis. Refinements in the ammonia leaching process for manganese ores. Increased recovery and the selective removal of undesired impurities are obtained.

18,980 of 1928 (313,430). Société Minière et Métallurgique de Penarroya, Paris. Zinc ores, particularly finely ground ores such as flotation concentrates, are mixed with an organic material such as damp sawdust prior to calcination. The porosity of the calcined material renders it suitable for reduction in distillation furnaces.

23,291 of 1928 (320,177). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Improvements in the carbonyl process for metal extraction. Regenerated carbon monoxide is purified before being returned to the extraction circuit, with beneficial results.

23,898 of 1928 (320,185). D. Enzlin and J. A. Eklund, Johannesburg. Refractory precious metal ores are crushed to —200 mesh in an acid "activator" solution containing mercuric, zinc, and sodium chlorides, and free chlorine. The resulting pulp is passed over steel or nickel surfaces coated with zinc or tin amalgam, whereby the precious metals are extracted.

27,414 of 1928 (320,218). A. Chahnazaroff, Baku, Russia. An improved bore-hole clinometer.

29,833 of 1928 (320,765) and **30,293 of 1928 (320,769).** D. Hodge, London. Expanding tamping-blocks for bore-holes which can be used over and over again.

34,269 of 1928 (302,574). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Cerium has been used for refining iron and steel as it has the property of combining with the oxygen, sulphur, nitrogen and phosphorus present in the molten metal, and transferring them to the slag. In the present patent, alloy steels are made by the addition to the molten steel of cerium alloyed with the desired additional element.

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.

Handbook of the Geology of Great Britain. Edited by Dr. J. W. Evans and Dr. C. J. Stubblefield. Cloth, quarto, 556 pages, illustrated. Price 24s. London: Thomas Murby and Co.

Hydrogen Ions. By Hubert T. S. Britton. Cloth, octavo, 515 pages, illustrated. Price 25s. London: Chapman and Hall.

Dana's Manual of Mineralogy. Fourteenth edition. By Professor William E. Ford. Cloth, octavo, 476 pages, illustrated. Price 20s. London: Chapman and Hall.

Technical Chemists' Handbook. By Dr. George Lunge. 3rd edition revised by Dr. A. C. Cumming. Cloth, pocket size, 262 pages, illustrated. Price 12s. 6d. London: Gurney and Jackson.

Die gravimetrischen Verfahren der angewandten Geophysik. By Dr. Hans Haalck. Paper backs, quarto, 205 pages, illustrated. Price 16·80 marks. Berlin: Gebrüder Borntraeger.

Gmelins Handbuch der anorganischen Chemie. 8 Auflage. Eisen. Teil A, Lieferung 2 pp. 225–312 and Teil B, Lieferung 1 pp. 1–312. Paper backs. Price, Part A 13·50 marks; Part B 46 marks. Berlin: Verlag Chemie.

Geologie von Perú. By G. STEINMANN. Paper backs, octavo, 448 pages, illustrated, with geological map. Price 28 marks unbound, or 32 marks bound. Heidelberg: Carl Winters Universitätsbuchhandlung.

The Principles and Practice of Lubrication. By Professor A. W. NASH and Dr. A. R. BOWEN. Cloth, octavo, 315 pages, illustrated. Price 15s. London: Chapman and Hall.

Geologic Structures. By BAILEY and ROBIN WILLIS, 2nd edition. Cloth, octavo, 518 pages, illustrated. Price 20s. London: McGraw-Hill.

War Letters to a Wife. By ROWLAND FEILDING. Cloth, 382 pages, illustrated. Price 15s. London: The Medici Society.

Disrupted Strata. By M. H. HADDOCK. Cloth, large octavo, 104 pages, illustrated. Price 16s. London: Crosby Lockwood.

The Physiographical Evolution of Britain. By Dr. L. J. WILLS. Cloth, octavo, 376 pages, illustrated. Price 21s. London: Edward Arnold.

Report of H.M. Electrical Inspector of Mines for the Year 1928. Paper backs, 44 pages. Price 6d. London: H.M. Stationery Office.

Standing Committee on Mineral Transport. First report to the Minister of Transport and the Secretary of Mines. Paper backs, 96 pages. Price 2s. 6d. London: H.M. Stationery Office.

Report of the Scientific and Industrial Research Council of Alberta, 1928. Paper backs, 53 pages, illustrated. Edmonton: The King's Printer.

Canadian Geological Survey. Summary Report, 1928, Part A. Paper backs, 210 pages, illustrated, with maps. Ottawa: The King's Printer.

The Geological and Mining Features of the Tarkwa-Abosso Goldfield. By O. A. L. WHITELAW, with appendix by Dr. N. R. JUNNER. Gold Coast Geological Survey Memoir No. 1. Folio, 46 pages, with geological map and sections. Price 5s. London: The Crown Agents for the Colonies.

Moraines and Shore Lines of the Lake Superior Region. By FRANK LEVERETT. Paper folio, 72 pages, illustrated, with map. Price 50 cents. Professional paper 154–A of the U.S. Geological Survey, Washington.

The Mount Spurr Region, Alaska. By STEPHEN R. CAPPS. Paper backs, illustrated with map. Pages 141–72 of Bulletin 810–C of the U.S. Geological Survey, Washington.

Geology of the De Queen and Caddo Gap Quadrangles, Arkansas. By HUGH D. MISER and A. H. PURDUE. Paper backs, 195 pages, illustrated, with map. Price 75 cents. Bulletin 808 of the U.S. Geological Survey, Washington.

Geology of the McCalls Ferry—Quarryville District, Pennsylvania. By E. B. KNOPF and A. I. JONAS. Paper backs, 156 pages, illustrated, with map. Price 35 cents. Bulletin 799 of the U.S. Geological Survey, Washington.

Formulas and Tables for the Construction of Polyconic Projections. Compiled by C. H. BIRDSEYE. Paper backs, 126 pages. Price 25 cents. Bulletin 809 of the U.S. Geological Survey, Washington.

Recent Mining Developments in the Creede District, Colorado. By ESPER S. LARSEN. Paper backs, illustrated. Pages 89–112 of Bulletin 811–B of the U.S. Geological Survey, Washington.

Mineral Resources of the United States in 1928. (Preliminary Summary.) By F. J. KATZ and M. B. CLARK. Paper backs, 116 pages. Price 20 cents. Washington: Bureau of Mines.

Carbon Black in 1928. By G. R. HOPKINS and H. BACKUS. Mineral Resources of the United States, 1928—Part II (pp. 31–5). Price 5 cents. Washington: Bureau of Mines.

Malayan Trade Annual, 1929. Edited by PHILIP C. COOTE. Paper boards, 109 pages, illustrated. Price 2s. 6d. London: Sampson Low, Marston and Co.

Rubber Producing Companies, 1929. Paper boards, 690 pages, Price 7s. 6d. London: The Financial Times.

The Identity Theory. By BLAMEY STEVENS. Paper backs, 32 pages. Price 1s. Bradford: The Country Press.

COMPANY REPORTS

Luipaard's Vlei Estate and Gold.—This company was formed in 1888 and works gold-mining properties in the far west Rand. The report for the year ended June 30 shows that 268,700 tons of ore was treated yielding gold worth £291,254, or 21s. 8d. per ton, while the working cost was £256,229, or 19s. 1d. per ton. There was thus a working profit of £35,025. Licences, rents, etc., brought in £13,827, which brought the total profit up to £48,852. Development during the year exceeded last year's figures, the total footage developed being 33,884 as against 22,041 in the previous year. The ore reserves are increased from 605,000 tons averaging 5·16 dwt. per ton on June 30, 1928, to 879,000 tons averaging 5·4 dwt. per ton. An important feature of the year's development is the completion of the pilot drive on the 22nd level which has connected the East and West mines. This drive has proved the continuity of both Main and South reefs throughout this area.

Messina (Transvaal) Development.—This company was formed in 1905 to work copper deposits in the Northern Transvaal. The report for the year ended June 30 shows that 64,874 tons of ore averaging 3·99% copper was produced from the Harper mine, and 176,480 tons averaging 2·35% copper from the Messina, making a total of 241,354 tons averaging 2·79% copper. At the concentrator 248,385 tons of ore and low-grade slag was treated, yielding 15,929 tons of concentrates averaging 40·52% copper. The smelting plant produced 6,341 tons of copper. Development continued in a satisfactory manner, and at 713,388 tons of proved ore averaging 3·12% copper, together with 197,071 tons probable ore averaging 2·74% copper, there is a substantial increase on the year before, when only 576,800 tons of ore was proved. The profit for the year was £150,549, from which £100,000 was distributed as dividends, equal to 40%.

Lydenburg Platinum Areas.—Formed in 1925 with a capital of £1,600,000 shares of £1 each, of which 1,460,000 shares are issued and fully paid, this company reduced the issued capital by £1,168,000 to £292,000 in January last. The company works platinum properties in the Lydenburg district of the Transvaal. The report for the year ended June 30 shows that 41,465 tons of ore was milled as compared with 36,924 the year before. The total recovery was 8,510 oz. of

platinum group metals and the amount realized by sales was £105,951 as compared with £95,214 the year before. The ore reserves are estimated at 126,700 tons averaging 4·0 dwt. platinum group metals, an increase of 26,400 tons on the previous year. The year's working resulted in a net profit of £37,710, of which £18,250 was distributed as dividends.

Witbank Colliery.—This company was formed in 1896 to develop coal deposits in the Transvaal, and it is now controlled by the Central Mining-Rand Mines group. The report for the year ended August 31 last shows that in November, 1928, the Uitspan section was closed down and the staff transferred to the Southern Section on which productive operations commenced on October 1, 1928. Development on the Central Section has been kept well advanced. Before closing down, the Uitspan Section output was 34,700 tons of coal, while the Central Section output was 542,867 tons as against 587,468 tons the year before. The output from the new Southern Section was 289,041 tons, which brought the total output up to 866,608 tons or 7,836 tons more than the previous year. The profit for the year was £41,647 out of which £17,227 has been distributed as dividends equal to 5%.

Wankie Colliery.—This company was formed in 1899 to develop coal deposits in Rhodesia, and further properties have been acquired more recently. The report for the year ended August 31 shows that the sales of coal amounted to 816,296 tons and of coke 100,293 tons, as compared with 724,186 tons and 184,342 tons respectively the year before. The increase in coal sales has been largely to the Belgian Congo and to the Rhodesian Railways. The estimated coal reserves (exclusive of the new colliery) proved by actual development are 10,394,832 tons, a decrease of 66,217 tons on the estimate of the previous year. During the year 268,363 tons of coal were raised from No. 2 colliery, where the coal seam worked is 30 ft. thick, although only the lower 18 to 20 ft. is being worked at present. There was a profit on the year's working of £129,431, from which £118,750 was paid as dividends equal to 12½%. Lower profits were mainly due to the railway strike of early 1928.

Jantar Nigeria.—This company was formed in 1912 to acquire alluvial tin properties in Northern Nigeria. The report for the year ended September 30 shows that 475 tons of tin concentrates were won as compared with 284 tons the year before. The output was apportioned as follows: Jantar, 241 tons; Kura I, 210 tons; and Kura III, 24 tons. The reserves of tin ore are estimated at 2,426 tons. The net profit for the year was £12,680, which was carried forward.

Filani (Nigeria) Tin.—This company was formed in 1911 and works alluvial tin property in Northern Nigeria. The report for the year ended December 31, 1928, shows that 44 tons of tin concentrates were won during the year as compared with 49 tons in the previous 18 months to December 31, 1927. The year's working resulted in a loss of £1,687, mainly owing to labour troubles and the scarcity of water.

Broken Hill South.—This company has worked a lead-zinc-silver mine at Broken Hill, New South Wales, since 1893. The report for the year ended June 30 last shows that 318,700 tons of ore averaging 14·3% lead, 11·5% zinc, and 5·8 oz. silver per ton was sent to the mill. The output was 64,055 tons of lead concentrates, averaging 66·6% lead, 6·4% zinc, and 26 oz. silver per ton; and 60,541 tons of zinc concentrates averaging 49·6% zinc, 2·4% lead, and 1·7 oz. silver per ton. The amount of ore treated was less than the year before by 17,580 tons, mainly owing to forced stoppages of the plant. The net profit for the year was £358,259, as compared with £208,362 in the previous year. Dividends absorbed £180,000, equal to 22½%. The ore reserves are estimated at 4,250,000 tons, which is the same figure as at the end of the previous year.

Pahang Consolidated.—This company was formed in 1906 to acquire lode-tin mines in the State of Penang, F.M.S. The report for the year ended July 31 last shows that 188,400 tons of ore was milled for a yield of 2,526 tons of tin concentrates, and that 53 tons of alluvial tin was also won, bringing the total output up to 2,579 tons, as compared with 2,509 tons the year before. The profit for the year was £98,243, from which £11,500 has been distributed to preference shareholders and £56,250 to holders of ordinary shares, equal to 20% on the latter. A large amount of development work was done during the year, chiefly east of the fault in Willinks Mine. Some 2,000 ft. of payable ore was exposed at and below the 500 ft. level, the principal increase being on the 900 ft. level. Encouraging development occurred on the Kabang lodes and also in the Myah mine, but no new discoveries of alluvial tin were made.

Chenderiang Tin Dredging.—This company was formed in 1914 to take over alluvial tin properties in the State of Perak, F.M.S. The report for the year ended March 31 last shows that the dredge treated 980,000 cu. yd. of ground, recovering 133 tons of tin concentrates. With ore obtained by hydraulicking and gravel pumping, the total output amounted to 274 tons of concentrates. The total area of property in March last was 1,624 acres, of which 589 have been worked out. After allowing for depreciation of dredge and other gear, the year's working resulted in a loss of £3,875. The ground treated by the dredge during the year gave poor results, and the hydraulicking recoveries were unsatisfactory.

Sione Tin (F.M.S.).—This company, formed in 1927, works alluvial tin property near Kuala Lumpar. The report for the year ended July 31 shows that the dredge was completed and dredging started on April 10, 1929. Since dredging commenced 7·42 acres have been worked out, recovering 81 tons of tin concentrates which were of exceptional purity. The net profit for the four months ended July 31 amounted to £2,513, which was carried forward.

Tekka.—This company is a reconstruction, formed in 1920, of an old company of the same name which was formed in 1907. It works an alluvial tin property in the Kinta District, F.M.S. The report for the year ended March 31 shows that 563 tons of tin concentrates were won as against 435 tons in the year before. The profit for the year was £48,217, and of this £26,893 was distributed as dividends. There was also a distributed bonus of 6d. per share which absorbed £8,964.

Burma Corporation.—This company was formed in 1919 to acquire the undertaking of Burma Mines, Ltd. It works a group of silver-lead, zinc, and copper mines at Bawdwin in Upper Burma. The report for the year ended June 30 records an output of 78,716 tons of refined lead and 7,376,841 oz. of refined silver as compared

with 72,388 tons and 6,954,665 oz. in the previous year. During the year 463,057 tons of ore had been treated averaging 19·7 oz. silver, 22·6% lead, 12·9% zinc, and 1·07% copper, as compared with 429,845 tons averaging 21·5% silver, 23·5% lead, 14·9% zinc, and 1·3% copper in the year before. In addition to the lead and silver recovered, 62,346 tons of zinc concentrate was shipped to Europe with 3,003 tons of nickel speiss, and 10,719 tons of high-grade copper matte was recovered from the blast furnaces. The ore reserves at the end of the year were 4,140,969 tons assaying 21·2 oz. silver, 25·9% lead, and 15·8% zinc as compared with 4,092,751 tons, assaying 21·5 oz. silver, 25·9% lead, and 16% zinc at the end of the previous year. The net profit for the year amounted to Rs. 1,40,64,566, of which Rs. 1,35,41,689 was distributed as dividends equal to 10%.

Weardale Lead.—This company has worked lead mines in Weardale, county Durham, since 1883. The report for the year ended September 30 shows that 4,144 tons of lead concentrates and 7,777 tons of fluor spar were produced, as compared with 5,148 tons and 5,654 tons, respectively, in the previous year. There was also an additional 140 tons of lead ore from mines in the company's royalty area worked for other minerals. The chief producer was again Boltsburn mine, but development of the Allendale mines shows that they are likely to increase in importance. The unfortunate fire which destroyed the dressing plant at the latter property seriously curtailed production, but the erection of a new plant is being vigorously proceeded with. The profit for the year was £15,530 of which £3,558 was used to write down property, etc., and £9,792 distributed as dividends equal to 10%.

Trinidad Leaseholds.—This company was formed in 1913 by the Central Mining and Investment Corporation to develop oil lands in Trinidad. The output of this company and of Apex and other companies is treated at the company's refinery at Pointe-a-Pierre. The report for the year ended June 30 last shows that 431,584 tons of crude oil was produced and oil purchased from other companies amounted to 449,940 tons, these figures being 129,756 tons and 126,794 tons respectively greater than the figures in the previous year. At the refineries 927,430 tons of crude oil was treated, an increase of 277,747 tons on the year before. After allowing for depreciation and other charges, the net profit for the year amounted to £432,840, from which £393,468 was distributed as dividends equal to 30%. The pipe-line from the Guayaguayare is almost completed and deliveries from this field to Pointe-a-Pierre are expected shortly.

British Burmah Petroleum.—This company was formed in 1910 to acquire oil lands in the Yenangyaung field, Burma, and a refinery at Rangoon. The report for the year ended July 31 last shows that the production of the wells on the Yenangyaung field continues to decline, but that the falling off has been partly counteracted by new production from Block 52 N. at Singu. Efforts are being made to discover fresh sources of supply. The gross trading profit was £245,378 as compared with £203,156 the year before. After allowance for debenture interest and redemption, depreciation, etc., a net profit of £107,981 was left, out of which £96,899 was distributed in dividends, the rate being 7½d. per 8s. share, as compared with 4½d. the year before.

DIVIDENDS DECLARED

Camp Bird.—Pref. 4%, tax free, payable January 1.

Central Mining.—8s., payable December 4.

Chinese Mining and Engineering.—2s., tax free.

Ferreira Deep.—2s. 6d., less tax, payable November 13.

Frontino and Bolivia.—Pref. 1s., less tax, payable January 1.

Great Boulder Proprietary.—3d., less tax, payable December 18.

International Nickel.—25 cents, less tax, payable December 31.

Ipoh Tin Dredging.—7½d., less tax, payable December 18.

Kaduna Prospectors.—3d., less tax, payable December 16.

Kaduna Syndicate.—6d., less tax, payable December 16.

Kagera.—7½%, less tax, payable November 19.

Kleinfontein Estates.—1s., less tax, payable December 10.

Lahat Mines. — 6d., less tax. payable December 16.

Lonely Reef.—3s., less tax, payable January 31.

Lydenburg Platinum Areas.—6d., less tax, payable December 19.

Marmajito Mines.—Pref. 2s., Ord. 6d., less tax, payable January 1.

McCreedy Tins.—5%.

Messina Copper,—1s., less tax, payable January 4.

Pari Tin.—6d., less tax.

Patino Mines and Enterprises.—4s., less tax, payable December 24.

Premier Gold.—6 cents, payable January 4.

Rawang Concessions.—1s., less tax, payable December 14.

Santa Gertrudis.—1s. 6d., less tax, payable January 9.

Seremban.—1½d., less tax, payable December 14.

Siamese Tin.—6d., less tax, payable December 18.

South-West Africa Co.—1s. 6d., less tax.

Sulphide Corporation.—Pref. 3s., Ord. 2s. 3d., payable January 16.

Tekka.—4½d., less tax, payable December 4.

Vereeniging Estates.—1s., less tax, payable January 28.

Wankie Colliery.—6d., less tax.

Weardale Lead.—1s. 6d., less tax.

NEW COMPANIES REGISTERED

Columbus Syndicate.—Registered as a private company October 17. Nominal capital: £20,000 in £1 shares. Objects: To prospect gold properties in South America, etc. Directors: L. Elliot, J. B. Thomson, and A. H. Lewis. Office: 65, London Wall, E.C. 2.

River Tin Deposits.—Registered as a private company November 25. Nominal capital: £100 in 10s. shares. Objects: To acquire any mining leases and setts, mines, mining rights and mineral properties in Cornwall or elsewhere in the British Isles, to adopt an agreement with R. B. Hirsch, to acquire and turn to account the leasehold tin mining properties and other assets comprised therein, and to carry on the business of miners, mining engineers, refiners, and amalgamators of minerals, ores and metals, etc.