The Mining Magazine

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EDITORIAL

IN March last we had occasion to comment on the ethics of accepting professional employment in Russia, having regard to the prevailing régime. One of our American contemporaries is now advising technical men to leave the country at once, not on account of ethical considerations, but for reasons of personal safety.

ELSEWHERE in this issue are a number of illustrations supplementing the article, published in October, 1929, by Mr. John F. Shipley describing the Kurra Falls Hydro-Electric Station in Northern Nigeria. The station has now been completed and is supplying power to a number of tin properties in the vicinity.

MINING men will have noticed with interest the appointment of Mr. G. Howard Ferguson as the new High Commissioner for Canada in London, because before he became Premier of Ontario Mr. Ferguson was Minister of Mines in that province. This is believed to be the first occasion on which a Canadian High Commissioner has had any special knowledge of mining.

THE price of silver continues to decline with disastrous effect upon world markets owing to the continued depreciation of eastern credit. There seems ample evidence available that some standardization of silver prices is now overdue and a fixation of the metal as currency at, say, 2s. or 2s. 6d. an oz. would go a long way towards the restoration of confidence in world conditions. The situation might well be considered in conjunction with the predicted decline in gold production.

IN the New Year Honours Sir Ernest Rutherford, chairman of the Advisory Council of the Committee of the Privy Council for Scientific and Industrial Research and late president of the Royal Society, is raised to the peerage and Mr. Frank Edward Smith, who is Secretary of that committee and of the Royal Society, is awarded the K.C.B. Sir John Scott Hindley, Commercial Advisor, Mines Department, since 1918, is also elevated to the peerage, while Sir Richard Gregory, the editor of our distinguished contemporary *Nature*, receives a baronetcy.

WITH great promptitude the Commonwealth Government, having come to the conclusion that a bonus to help the gold-mining industry of Australia was desirable, has passed the measure into law in the form that was outlined here last month, with the difference that it is to be payable on the average output of the three preceding years instead of only the past year. One of the conditions on which the bonus is offered—that insisting on the treatment of all ore that will pay working expenses—is meeting with some opposition from the managers, who contend that it takes the control out of their hands and vests it in the Government.

BY the death of Lord Melchett industry has lost one of its greatest leaders. He will be best remembered to the mining and metallurgical community by reason of his association with the Mond Nickel Company, of which he became chairman in 1909, on the death of his distinguished father, Dr. Ludwig Mond. Under his chairmanship the mines of the company developed rapidly and with the acquisition in 1911 of the famous Frood property a new smelter was erected at Coniston. About this time also the refinery in South Wales was increased from two plants to seven, with a tenfold increase in output. Since 1925 the precious metals refinery at Acton has grown to be the largest platinum refinery in the world. Lord Melchett received the Gold Medal of the Institution of Mining and Metallurgy in 1928.

MR. W. PELLEW-HARVEY, who has been elected president of the Institution of Mining and Metallurgy for the coming year, has had quite a wide experience. Born at Truro, he received his early training in mining and metallurgy partly in his native county and partly in South Wales during the period 1882 to 1889 and was at Vivian's, the well-known firm of those days in Swansea. In 1890 he left for Canada and became interested in gold mining in British Columbia, starting in business on his own account in Vancouver. Here Mr. Pellew-Harvey was

employed by the leading banks and other important undertakings as an independent consultant and he also acted unofficially for the Government of British Columbia at the time of the Klondyke gold rush, when he was deputed by the Finance Minister to receive the gold from the miners upon which royalties were due. These consignments were assayed and melted and in respect of these warrants were issued to the miners which were honoured by the banks. In 1901 Mr. Pellew-Harvey returned to London and established himself in Walbrook, in partnership with Mr. E. Nelson Fell, on whose retirement, in 1904, he continued the practice and subsequently removed to London Wall. His professional engagements have taken him to Russia and Siberia, where as one of the first engineers to enter that territory he was associated with the Spassky and Atbasar copper properties. He has also visited Spain, Norway, India and Burma, Australia, North and South Africa, and the United States. In 1926 Mr. Pellew-Harvey took Mr. W. H. Rundall into partnership.

Ore Deposits in Germany and Northumberland

The main event of the last meeting of the Institution was the presentation of a paper by Dr. J. W. Gregory on " The Copper-Shale (Kupferschiefer) of Mansfeld " and the presence of Dr. Gregory was no doubt partly responsible for the good attendance at a December meeting when members have so many other calls on their time, although the similarity of the Mansfeld occurrence to the copper fields of Northern Rhodesia may also have been an additional attraction. Two further papers on a British enterprise were also presented at the December meeting, these being by Mr. G. Trestrail and dealing with the Settlingstones witherite mine in Northumberland, the first describing the deposit itself and the second a device for controlling mine dams. The last two papers were, in the absence of the author abroad, introduced by Mr. Allen Howe and Mr. Humphrey Morgans respectively.

As Professor Gregory says in the introduction to his paper, Mansfeld is unique in mining history, having been continuously worked for seven and a quarter centuries and having up to 1913 yielded 800,000 tons of copper. During the war period the district was of the greatest importance to Germany and is still the main German source of copper production. The copper ore is a thin bed of Upper Permian shale or marl, which lies above the Rotliegende, Lower Permian, and below the Zechstein, a bituminous limestone at the base of the Upper Permian. The purport of Professor Gregory's paper is to determine the origin of the copper in the Kupferschiefer and the mode of deposition of the shale itself. An admirable summary was given of the various theories of the origin of the ore which have been advanced and the author showed how opinions have wavered between the syngenetic, or contemporaneous, and the epigenetic, or subsequent, origin of the ore. The author himself, while holding the opinion that the copper is syngenetic in origin, points out that some of the arguments for the epigenetic theory appear weighty and that many authorities on ore genesis and on the Northern Rhodesian copper fields hold it for the German copper-shale. He shows that the case turns largely on the Rücken, the numerous small faults which cross the shale. These form parallel ridges which produce cross-bars on the floor of the mine workings which are compared to railway sleepers. In the author's view the Rücken have been of great influence in the redistribution of the copper subsequent to contemporaneous deposition with the shale, but that they were not the fissures by which the copper found its way to the shale seems to be unquestionable. The very spasmodic occurrences of copper —Sanderz—below the Kupferschiefer and the occasional nodules—Hieken—in the overlying limestones have been used to forward the epigenetic theory, but their irregular occurrence and the peculiar fact that by far the greatest part of the copper is in the calcareous shale rather than in the equally convenient and more receptive limestone are points that cannot be explained by the epigenetic theory. In addition the scanty evidence in favour of the mineralization of the Rücken and the fact that the truly epigenetic deposits occurring in the same field are entirely dissimilar can only favour a syngenetic origin of the copper. Finally, it may be said that Professor Gregory believes the copper to have been derived from the pre-existing Harz massif and the shale itself to have been deposited in a lagoon which now forms the Mansfeld basin. The discussion following the reading of this paper was initiated by Professor Cullis, who, after congratulating the author on his capacity for

seizing the essentials of any problem which might engage his attention, felt substantially inclined to agree with him as to the origin of the Mansfeld copper, a similar view being taken by Sir Albert Kitson, Mr. Allen Howe, and Dr. J. A. L. Henderson. Dr. W. R. Jones, however, was definitely in favour of the epigenetic theory, although none of his views could be held seriously to challenge the conclusions of the author. Other speakers were Mr. Murray-Hughes, who advanced the adsorptive capacity of the shale as a reason for the presence of the copper within it, and Dr. Kingston, who spoke of his experience in Northern Rhodesia. Altogether it may be said that no case was produced which could be held to show that the Mansfeld deposit and those of Northern Rhodesia were of similar origin.

The papers on the Settlingstones mine, Northumberland, introduced as they were in the absence of their author, received rather less attention than was, perhaps, their due. The second, which described a device for controlling the water discharge from a dam in connexion with a pumping installation in this mine, might well be of interest to those in charge of other properties where similar conditions exist. The first, however, describes a witherite deposit in the lower Carboniferous rocks of the North of England which has interesting features, the most striking, perhaps, being the complete change of mineralization on opposite sides of a fault, the lode to the east being worked for lead, whilst the lead is completely absent west of the fault.

The Metal Position

The year which has just concluded will go down in history as the period of the great slump, for, although the prices touched may not be the lowest on record, they have been depressed to a point which has not been seen in the experience of many of those now associated with the industry. Each of the major non-ferrous metals has had its own peculiar vicissitudes, but there is one feature which has been common to all—over-production as a result of the inflated prices which prevailed previously. Possibly the excess output would not have been apparent but for the severe depression in the industries of the world, but who will say that this falling-off in industrial activity is not in part attributable to inflated values? To descend from the general to the particular, copper is a good example of what happens when attempts are made to keep prices above their natural level. As is well known, some few years ago an organization was formed in America to eliminate competitive selling, at least so far as export business was concerned, and with the avowed intention of stabilizing prices. In this it succeeded up to a point, the value of electro being maintained for a year or so at 18 cents f.a.s. New York. This suited producers admirably and production responded to the stimulus, which was all right so long as consumption was good. When the latter fell off, however, the stocks grew enormously; whereas at the end of 1929 the American refined stocks amounted to 171,320 short tons, by the end of November, 1930, they had grown to 369,832 tons. Stabilization, so-called, then became a farce and prices eventually dropped to about 9·50 cents in America, or about £45 in Europe. At that point the attractiveness of a low price, combined with talk of concerted curtailment in the world's output, induced buying and values improved somewhat. That, however, is history. What of the future? It is a little difficult to become enthusiastic about prospects when such large stocks exist, but it should be remembered that the adverse features must be already reflected to a large degree in the price, that depression in trade is not perpetual, and that there are some signs in America of returning confidence in the shape of an increased interest in the steel market. Besides, even if consumption may be slow to expand, there are prospects of further curtailment in output, which may prevent stocks increasing further, even if they do not assist in effecting some reduction in the surplus.

So far as tin is concerned, the year just ended was characterized by continued propaganda, much of it somewhat misleading, and by persistent manipulation of the market by one or other of the various speculative groups, who for so long have been floundering in a commodity which they do not understand. History can hardly hold a like example of such misjudgment and mismanagement as do the recent records of tin. The market might have been saved in some degree from its troubles had it not been for the obstinacy of a group determined at one and the same time to force production from the various properties which it controlled and from the new ones which it had brought into being and to raise prices. The output of these concerns and the increased

output also from other and older properties whose managements were naturally only too glad to take advantage of the very profitable prices still ruling when the "bull" campaign began came on a market already showing signs of flagging consumption. Instead of allowing falling prices, entirely justified by events, to bring about a gradual restoration of equilibrium by forcing the closing of one uneconomic concern after another, the Tin Producers' Association was formed, which put up a scheme for restriction whereby small high-cost and hopelessly uneconomic units and big low-cost concerns all curtailed proportionately. The plan failed. At the end of the year a new scheme—a quota scheme—was proposed to cut down output by force of law and it remains to be seen whether, if this comes into being, it will have any better fate than its predecessor. The Governments of the Federated Malay States, Dutch East Indies, Nigeria, and Bolivia are to be asked to limit exports of tin or tin ores to an extent sufficient to enable consumption to eat into and reduce to a more normal level the heavy stocks. Whether these various Governments will combine and come to the rescue remains to be seen. Any permanent cure can only come from economic pressure, restoring natural conditions. The quota scheme now under consideration is at best an artificial and arbitrary interference with individual liberty of action and for this reason will not be generally welcomed. What is really wanted is less Government interference, not more. By way of comfort it may be remarked that the price level of tin to-day is distinctly below the average cost of production and supplies therefore a powerful incentive to curtail output. This impulse will make itself felt during the next few months, opening the door leading to better days.

The past year witnessed a considerable fall in lead prices, quotations falling from a high level of £21 15*s.* to the lowest price since 1911—namely, £14 12s. 6d.—whilst the position of producers has been complicated by the collapse of the silver market. Probably the outstanding feature of the European position in 1930 was the marked decline in German consumption, which more than offset the increased quantities taken by Russia, mainly in the first half of the year. Imports last year attained a record high level and stocks here must have very substantially increased, perhaps by as much as about 50,000 tons. The Lead Producers' Association was not much in the limelight, but it held off the market much of the surplus metal and probably saved prices from heavier depreciation. Towards the end of 1930 the agreement between the Broken Hill companies and their miners expired and the present position is one of uncertainty. The Broken Hill Industrial Council, however, is advising the men to accept the companies' terms and it seems probable that Australian production will be continued as at present, and, with the Mount Isa property coming into production this year, it may be increased. The year 1931 opens with consumption at a low level, not only here, but on the Continent and also in the United States, with little to suggest an early expansion in trade, but, on the other hand, it has to be noted that prices are lower than for a long time past and any improvement in consumption should reflect itself in values. Apart from the United States, which does not affect Europe directly, and Australia, production shows little tendency to decline.

The position of spelter has been the reverse of happy for some time and the depression became acute during the closing months of 1930, when values touched the lowest level for about forty-five years. The reasons for this were twofold, the first being overproduction, largely as a result of improved metallurgical processes, whilst the other contributory factor was the decline in consumption. The latter condition could not be regarded as exceptional, seeing that the same remark would apply with equal force to most commodities, but it was probably more accentuated in the case of spelter than in that of other non-ferrous metals owing to the exceptional slackness of the galvanized sheet trade, due to a number of causes, including the unsatisfactory trade position in India. During the past year strenuous efforts were made to reconstruct the Cartel (which had lapsed at the end of 1929), with the object of regulating output to demand, but agreement amongst the various producers proved to be impossible and the project had to be dropped. Although the market has worn a depressed appearance and there is little sign of any improvement in consumption, the price is already very low, and there is one respect in which this market is healthier than copper, tin, or lead—its freedom from any attempt at price control by artificial means—and this leads to hopes of recovery when trade improves.

REVIEW OF MINING

Introduction.—The New Year gives promise of an improvement on 1930, although this is, perhaps, not saying a great deal. The tendency is for metals to improve, whether they are supported by schemes or not, provided there are no serious labour troubles.

Transvaal.—The output of gold on the Rand for December was 867,202 oz. and in outside districts 41,290 oz., making a total of 908,492 oz., as compared with 884,753 oz. in November. The total for 1930 was 10,719,760 oz., constituting a record. The number of natives employed on the gold mines at the end of the month totalled 203,473, as compared with 205,030 at the end of November.

The accompanying table gives details of the dividends paid by the Rand gold mining companies during 1929 and 1930. Perhaps the most noteworthy features are the return of Simmer and Jack and of Robinson Deep "B" shares to the list, in place of Village Deep, and the further reduction in the New Modderfontein distribution :—

	1st half, 1929.	2nd half, 1929.	1st half, 1930.	2nd half, 1930.
	s. d.	s. d.	s. d.	s. d.
Brakpan	4 9	5 0	4 3	4 6
Consolidated Main Reef	1 0	1 0	0 9	1 3
Crown	3 3	3 3	3 3	3 6
Durban Roodepoort Deep	—	—	0 3	0 6
Geduld	3 0	3 3	3 3	3 3
Geldenhuis Deep	0 6	0 6	0 9	1 0
Government Areas	2 3	2 3	2 3	2 3
Langlaagte Estate	1 6	1 6	2 0	2 0
Modderfontein B (5s.)	2 0	2 0	2 0	2 0
Modderfontein Deep (5s.)	3 3	3 6	3 3	3 3
Modderfontein East	2 0	2 0	2 0	2 0
Modderfontein, New	7 0	7 0	6 9	6 6
New State Areas	1 6	1 0	1 6	2 0
Nourse Mines	—	0 6	0 6	0 9
Robinson Deep (A 1s.)	1 6	1 6	1 6	1 6
Robinson Deep (B)	—	—	—	7½
Rose Deep	—	—	0 6	0 6
Simmer and Jack	—	—	—	1½
Springs Mines	3 6	3 9	3 6	4 0
Sub Nigel	2 0	2 0	2 0	3 0
Van Ryn	0 6*	0 6*	0 6*	0 6*
Van Ryn Deep	3 6	3 6	3 0	3 0
Village Deep	0 6	0 6	†	†
West Springs	1 0	1 0	1 0	1 0
Witwatersrand Gold	—	0 6	1 0	1 0

* Tax free. † Mine now owned by Robinson Deep.

The above distributions bring the year's mining dividends up to a total of £8,644,309, representing an increase of over £230,000 upon the result for the previous year.

In issue of the MAGAZINE for October last reference was made to small stopes being opened up in the footwall of an old stope above the 7th level in the New Kleinfontein mine. Towards the middle of December the company announced that recent work done tended to prove that the new ore was not a faulted portion of any known reef, but an undenuded fragment of an older series. The reef in question carries erratic values and three stretches aggregating 800 ft. have proved payable, running 5 to 7 dwt. over a stoping width of 42 in. It will be recalled that similar occurrences have been met with in other Far East Rand mines.

The report of Potgietersrust Platinums for the year ended September 30 last shows that the company's earnings have been seriously affected by the price of platinum. The first four months of the year under review were profitable, but for the remainder of the year operations were conducted at a loss. The report states that a number of claims have been abandoned.

Diamonds.—Following the announcement in November last of the postponement of the payment of its usual half-yearly preference dividend by the Premier (Transvaal) Company, it may be noted that the Consolidated Diamond Mines of South West Africa Company is following a similar course. At the annual meeting of De Beers Consolidated Mines, however, it was announced that the usual half-yearly distribution on the preference shares would be made.

At the beginning of the month the International Committee for Diamond Trade and Industry published the details of the restriction scheme which came into force in the diamond-cutting industry on January 4. Among the various countries affected it may be noted that the restriction in South Africa will amount to 50%.

Southern Rhodesia.—The output of gold from Southern Rhodesia during November last was 44,351 oz., as compared with 45,006 oz. for the previous month and 46,219 oz. for November, 1929. Other outputs for November were : Silver, 6,915 oz.; copper, 115 tons ; coal, 77,836 tons ; chrome ore, 7,348 tons ; asbestos, 3,271 tons ; mica, 4 tons ; scheelite, 2 tons.

Northern Rhodesia.—Following the announcement in these columns last month concerning the proposed fusion of the interests of the Rhodesian Congo Border Concession and the N'Changa and Bwana M'Kubwa companies, it should be stated that at the

various meetings held for the purpose the resolutions were approved.

The report of the Rhodesian Congo Border Concession, Ltd., for the year ended June 30 last shows the most important asset of the company to be the N'Changa Extension ore-body, of which it is impossible to give any accurate estimate of tonnages or grades, as the results of boring have not shown the same regularity as has been usual in the district. The ore-body is now being rapidly developed, two shafts being sunk, of which No. 1, on the foot-wall, had reached a depth of 492 ft. and No. 2, the main shaft, a depth of 150 ft. by the middle of December. Metallurgical investigations are being actively pursued and use is being made of the segregation plant on the Alaska property of the Southern Rhodesia Base Metals Corporation to test that process on a large scale.

The report of Roan Antelope Copper Mines, Ltd., for the three months ended September 30 last states that the drilling programme was completed during the quarter and the reserves now available are considered sufficiently substantial to justify the suspension of drilling. There are estimated to be 108,000,000 short tons of ore, averaging 3·4% copper, which figure includes 37,000,000 tons, averaging 3·6% copper, in the Roan Extension area.

An eighth progress report on the Kansanshi mine has been issued by the Rhodesia-Katanga Company and states that development work has now reached a stage where sufficient ore reserves are assured to warrant the installation of a treatment plant capable of an output of 50,000 tons of copper annually and that the design of such a plant is in hand. The mine will be started as an open-cast working with no overburden to remove and the tonnage of ore available for this method of mining is stated to be sufficient to supply the treatment plant for two or three years. Meanwhile development is being curtailed pending a decision as to railway connexions with the Benguela railway.

The report of the Kafue Copper Development Co., Ltd., for the period ended June 30 last states that the Sable Antelope mine appears to be one of the most important properties held by the company in Northern Rhodesia and that it is receiving chief attention. Mapping is in hand to locate the best position for drill sites. The existence of coal measures at the foot of the Katungwe escarpment west of the Silver King has been proved and these it is stated probably extend north-west as far as the Hot Springs outcrop.

Shareholders of Rhodesian Anglo American have been informed that it is proposed to increase the capital of the company to £6,500,000 by the creation of 3,000,000 additional shares of 10s. each and also to issue debentures carrying conversion rights. The company is largely interested in the Rhodesian Congo Border merger and part of the new capital is required in connexion with this scheme, under which the company agreed to underwrite £2,500,000 of the new debentures which are to be issued.

Tanganyika Territory.—The report of Bukoba (Tanganyika) Tinfields for the fifteen months ended December 31, 1929, states that after adjustments had been made under the agreement with the Billiton Tin group an area of 15 square miles remains under exclusive prospecting right to the company. Tin winning on the Grey Tin Creek area was suspended at the end of May, 1929, and all prospecting has since been discontinued.

Nyasaland.—Shareholders of Nyasaland Minerals have been informed that the company is voluntarily to be wound up and that a liquidator has been appointed.

Gold Coast.—In the last issue of the MAGAZINE reference was made to interesting developments on the Ashanti Goldfields property and it was stated that the main cross-cut on No. 26 level had cut the reef. Later advice shows that the intersection was made at 333 ft. from the main shaft and that at this point the reef is 14 ft. wide, assaying 2·2 dwt. It will be recalled, however, that similar low values were obtained when the reef was first encountered on the level above, subsequent development there proving high-grade ore. For the year ended September 30 last a final dividend of 65 per cent. is recommended, making the total for the year 100 per cent., and it is also proposed to capitalize £125,000 of the reserve, distributing the 625,000 shares thus created as fully paid bonus shares to the shareholders in the proportion of one for every two held.

During the year ended June 30 last the Bibiani (1927) company completed the reclamation of the old mine workings and new ground was opened up on Nos. 3 and 4 levels from No. 1 shaft. No. 4 shaft was sunk to No. 4 level and new electrical and compressor plant installed. A progress report issued on the return of the consulting engineer, Mr. J. S. Watkins, from the

property states that developments on the west lode warrant a tentative estimation of ore in sight amounting to 150,000 tons, averaging 11 dwt.

In the report of Ariston Gold Mines (1929), Ltd., for the year ended September 30 last, it is stated that the North Shaft, temporarily closed by a run of ground, is now open and that the skips are again working to the 16th level. An extraordinary meeting held at the end of last month resolved that the capital of the company should be reduced to £327,040 2s. 6d. by the cancellation of lost capital and that it should be subsequently increased to £500,000 by the creation of 1,383,679 shares of 2s. 6d. each.

Morocco.—The report of the Morocco Minerals Syndicate for the year ended December 31, 1929, states that after examining the Afrau property the engineer consulted expressed the opinion that the mine had no commercial value. No further work is to be undertaken at present.

India.—Shareholders in the Indian Copper Corporation have been informed by circular that the output for the 11 months ended November 30 last was 2,625 tons, the largely increased outputs for October and November being mainly due to improved crushing facilities. At the same time the ore grade shows marked improvement, averaging over 3%. The rolling mill has been brought gradually into operation, the output of yellow metal sheet increasing from 42 tons in August last to 160 tons in November.

Australia.—The report of the Golden Horse Shoe (New) for the period from its inception in September, 1929, to September 30 last states that the original dumps which were acquired were estimated to contain 2,553,164 tons of material assaying 7s. 10d. per ton, of which 45% of the value should be recoverable, and that the retreatment plant would exhaust them in five years. Operations were commenced in January last and during the period under review 255,770 tons was retreated, yielding 3s. 8d. per ton, the working profit being 1s. 7d. per ton.

The announcement of the discovery of a new goldfield at Larkinville, in Western Australia, probably locates that mentioned elsewhere in this issue by our Brisbane correspondent. It is stated that fair sized nuggets have been found and the area contains quartz veins and wide schist lodes.

Malaya.—The output of Hongkong Tin for the year ended August 31 last was 950 tons of concentrates from the treatment of 1,235,904 cu. yd. of ground, 10·6 acres of the company's ground being worked. During 1930 operations have been restricted, but the profit for the year was £48,161 and dividends equal to 25% have been paid, absorbing £37,500.

During the year ended June 30 last Meru Tin produced 273 tons of tin concentrates, the total mining revenue being £30,348. The total yardage treated was 728,200 from an area of 15 acres. It is considered that the work of the company is hampered by lack of capital, the year's operations showing a loss.

Mexico.—The report of Esperanza, Ltd., for the year ended June 30 last shows a net loss of £726, increasing the debit balance to £12,266. An extraordinary meeting of shareholders is to be called to put the company into voluntary liquidation.

Panama.—Although the past month has witnessed a revolution in Panama, news has been received to the effect that it has in no way affected the operations of the Panama Corporation.

Russia.—Owing to the fact that the accounts for 1929 had not been received from Russia, the Lena Goldfields company found it impossible to prepare a balance sheet for that year. Accordingly it was directed by the Board of Trade that the accounts for the previous year might be presented at the annual meeting held last month.

Yugoslavia.—During the period ended September 30 last the operations of Novo Brdo mines were continued in the Kijnitsa valley and in the Janjevo concession. The condition of the lead and zinc market has since led to the temporary cessation of work in the area.

Fanti Consolidated.—During the year ended December 31 last the Fanti Consolidated Investment Co., Ltd., made a profit of £33,098, which, with the balance of £5,321 brought in, made an available sum of £38,419. A dividend of 6d. per share is to be paid, which will absorb £33,750, leaving £4,669 to be carried forward.

Anglo-Continental Mines.—The report of Anglo-Continental Mines Co., Ltd., for the year ended December 31 last shows a loss of £13,706 and the credit balance is reduced to £45,150. It is stated that losses on investments totalled £14,472 and the company's half share of loss on an expedition to Tanganyika was £1,111, while credits to profit and loss account amounted to only £3,156.

MINING ALLUVIAL TIN WITH DRAGLINE EXCAVATORS

By S. A. WESTROP, B.Sc.

The author suggests a method of mining alluvial tin which might be advantageously applied to some low-grade deposits.

The object of this article is to suggest a practical method of layout for working small alluvial tin properties by mechanical means at a low rate per cu. yd. as a substitute for gravel pumping operations, especially for properties on which water power is not readily available. With slight modifications, the method proposed can be applied equally well to alluvial gold deposits. The writer is acquainted with the Nigerian tin fields and also with parts of the Eastern tin field of Malaya and South Burma, and the scheme is the result of investigation on various properties.

FIG. 1.—DRAGLINE AT WORK ON THE SUKKUR BARRAGE.

The suggested method of working is applicable to grounds varying from five to thirty or more feet deep and either carrying tin throughout its depth, or with varying percentages of overburden which carry no values, and with varying percentages of large stones. Such stones form a strong obstacle against gravel pumping as they gradually fill up the working face and cannot be moved by the monitor.

There are several methods of mechanical excavation which could be employed to deal with these small properties. For instance, a steam shovel might be used to dig the material, loading it into trucks which would then be hauled to the washing plant. This method, while having the merit of being simple, must however, be expensive since the cost of a haulage system from the shovel to the washing point would probably amount to about twice the actual cost per yard of the machine in digging the ground and loading the trucks. In fact, any method which involves the use of trucks, rails, and locomotives, even if only required to carry the actual pay gravel, raises the cost of operation to a high figure and it requires rich ground to stand the cost per yard involved. In spite of this, on rich hill-side properties where water is not readily available and the tin bearing ground occurs in large pockets, the most economical method is to use mechanical shovels and trucks in the way thus described and a number of such deposits are being successfully worked in this manner. What is required on many properties, however, is a mechanical means of working whereby the one excavating machine will carry out all the operations without recourse to additional handling or re-handling equipment for any portion of the material excavated. The solution lies in the use of the dragline excavator, with a jib varying in length from 40 ft., which is the minimum size recommended, to 80 ft. or more. The accompanying diagrams illustrate how the length of the jib affects the operation.

The dragline excavator is now becoming such a familiar object in mining and contracting operations, that it seems hardly necessary to enter into a long description

of it. It should suffice to say that it is a machine practically identical with the mechanical shovel as far as base, revolving frame and main machinery units are concerned. The digging part of the machine, however, is entirely different. The jib of the machine is much longer than the jib of the shovel and is also usually held inclined at a smaller angle to the horizontal. A heavy digging bucket is suspended on a steel rope running over a sheave at the point of the jib. A second steel rope, known as the "drag-rope" is connected to this bucket by means of chains and shackles, and the motive parts of the machine are arranged so that the main engine power can be used for either pulling the drag-rope, which enters the machine through a fair-lead suspended at about the junction of the jib with the front end of the machine, or, alternatively, it can hoist the bucket by pulling on the rope passing over the jib point.

Two further functions of the motive power of the machine are to propel the machine, which is usually mounted on caterpillar tracks, giving it the ability to negotiate difficult ground or steep slopes, and secondly, to rotate the upper part of the machine with respect to its base.

The bucket, which is provided with digging teeth, is so shaped and attached to the hoist and drag-ropes, that when it is lowered and a pull is applied to the drag-rope, a powerful digging action is exerted by the teeth of the bucket so that it fills as it is dragged towards the machine. Surprisingly hard ground can be dug by these machines. When the bucket is full the hoist rope is actuated, while still retaining a pressure on the drag-rope. This raises the bucket clear of the excavation and the machine then swings to the point where it is to dispose of the material, which is then dumped by releasing the pull on the drag-rope.

Expressed roughly, the machine has the ability to dig from a point rather further away from its centre line than the length of its jib and to dump the material dug in any direction from its centre line at a radius up to this length. The machine can dig to a depth which varies with the material, the nature of the cut and the length of the jib. A dragline with a 50 ft. jib, can usually dig to a depth of 20 to 25 ft. on an end cut, such as would be used in mining tin deposits.

It is the long working and dumping reach of the dragline which makes it an instrument of such potential value for mining alluvial deposits and when it is recognized that the machine covers all the ground which lies in the circle described by the point of its jib for the purpose of either digging or dumping, the value of using as long a jib as possible becomes apparent, since the area will vary as the square of the jib length. The dragline has the advantage of standing at work on the original level ground, backing away from the excavation dug behind it and to its sides.

The working costs of a dragline under the tropical conditions which will usually be met with in tin mining, will vary considerably in accordance with the following factors :—

(*a*) The nature of the digging.
(*b*) The output obtained.
(*c*) The local cost of wages and fuel.
(*d*) The skill of the operators.
(*e*) The care and supervision of the machine.
(*f*) The management of the machine for economical working.

These are widely divergent factors, but, fortunately, official figures are available from some of the large irrigation projects in the East, giving the costs averaged over a number of years and a large number of machines. The official records of the Sukkur Barrage show that eighteen 1 cu. yd. diesel-driven draglines digging canals under very adverse health and living conditions, extremes of temperature, and incessant sand storms, yet averaged as inclusive working costs between the years 1925 up to July, 1930, for an aggregate of 807 consecutive working months, 2·59 pence per cu. yd. dug, with an average monthly output of 23,000 cu. yd., working three shifts per day. The above figures included all costs of every description excepting that alone of interest and depreciation which, writing the machines off into the work, amounts to only slightly over one half-penny per cu. yd. A photograph of a dragline excavator at work on this barrage is given in Fig. 1.

Averaged for such a large number of machines for such a long period, the above quoted figures can, therefore, be taken as a very reliable standard on which to judge excavation costs in the tropics. Work in canal digging, however, is rather more straight-forward than that in mining tin and the machine is less liable to delay and interruption on the score of selective mining between overburden and pay gravel and

other causes. On the other hand the costs on the Sukkur Barrage were achieved under general conditions far less favourable from many points of view than exist on most tin properties. Therefore, on balance, if 50% be added to the figures quoted, arriving at a cost per yard of 3·9, say 4 pence per cu. yd., this should give a very safe figure for the actual working costs in the operations mentioned below of mining the ground and including delivery of the gravel into the washing plant.

Bearing in mind the capabilities and cost of operation of a diesel dragline machine which have been mentioned, it remains

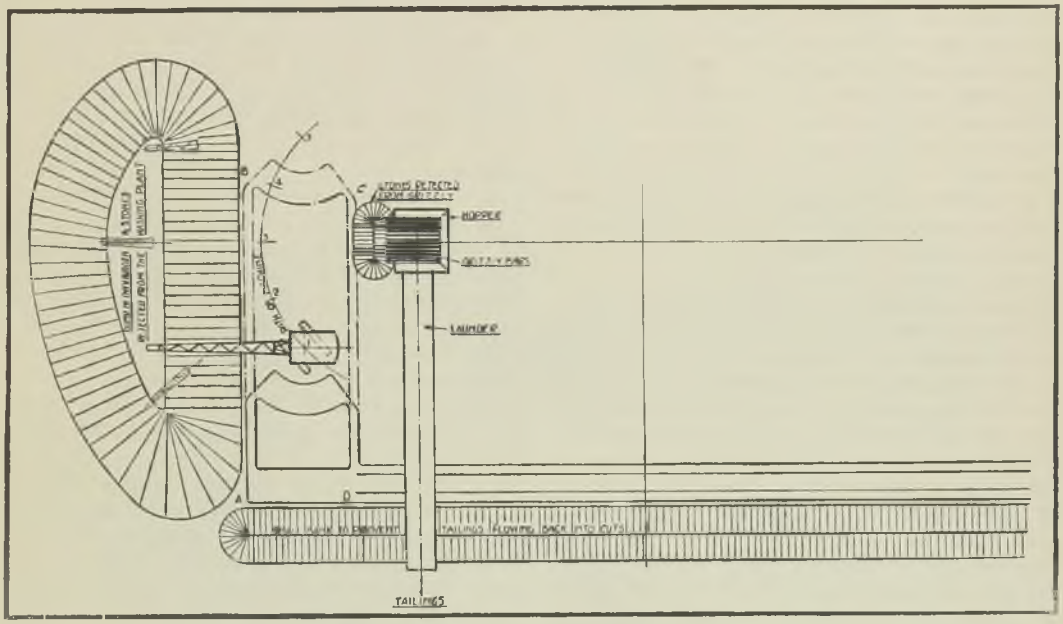


Fig. 2.—Dragline making First Cut.

necessary to evolve a practical scheme whereby it can be adapted to continuous mining and handling of overburden, pay gravel, and large stones where they are present, without calling for re-handling or trucking operations. The solution for many properties lies in the use of a semi-portable washing plant for the pay gravel which will consist essentially of a hopper with grizzly, into which the dragline bucket will dump. A sufficient water supply for washing and disintegrating the gravel will be available, playing on the material on the grizzly bars and sluice box below, which leads on to a launder with the proper slope and length for concentrating the tin. The dimensions of the hopper and the launder will depend upon the size of the dragline bucket and the outputs it is desired to maintain. The hopper and launder should be made up in units of such a weight that they can be lifted by the dragline itself, using its hoist rope as a crane with the bucket detached. It is by this means that the washing plant will be moved to its new position for each cut.

The best arrangement of hopper, grizzly, and launder, will depend upon local conditions and will probably require a certain amount of experiment in each case. The points to look for are simplicity and lightness in construction, a satisfactory rejection of stones from the grizzly and of the pebbles from the top part of the launder which will not travel with the tailings. The rejection of stones from the grizzly can probably be effected by manual operation of the water jets playing on to the material dumped on the bars. The pebbles from the launder will be handled, as usual, by the natives engaged in raking therein for tin concentration.

A suggested size of hopper mouth for working with a half yard dragline bucket will be about 10 ft. by 10 ft. with sloping sides to the grizzly bars having an area of, say, 6 ft. by 8 ft. Below the grizzly bars, a box 6 ft. by 6 ft. with a bottom slope of about 1 in 25 corresponding to that found necessary for the launder. The bottom end of this box would be open, leading direct

to the launder. The grizzly bars will slope at right angles to the slope of the box below so that the stones are rejected at right angles to the line of the launder and in the direction from which the dragline is feeding the hopper. The importance and value of this provision, is that when the stones rejected from the grizzly and shovelled out of the launder, have reached a sufficient pile, the dragline bucket can be quietly lowered alongside the hopper unit to pick up these stones and deposit them on the overburden dump as explained below.

For the half yard bucket, an over-all height of about 14 ft. to the mouth of the hopper, 10 ft. to the centre of the grizzly bars, 8 ft. to the bed of the box below the grizzly and 4 ft. for the final rejection of the tailings from the end of the launders, the launder being about 100 ft. long, may prove to be about the dimensions required in practice. However, as stated previously, this part of the plant is a matter for experiment as it depends largely upon the nature of the material being washed and the fineness of the tin concentrate.

The hopper and grizzly unit, it is suggested, should be made removable from the box below, being attached to it by four simple bolts. By arranging this the weights of the unit can be kept within such limits that the dragline can handle them and the hopper and grizzly can be turned about with respect to the box and launder so as to face either right hand or left hand feeding by the dragline. "Hopper" is rather a misuse of the term, since it is not intended to give storage capacity, but rather to guide each load of material dumped into it direct on to the bars for immediate disintegration by the water jets. It would, in practice, be open at the side facing the dragline so as to give free access to the dragline bucket and the three enclosed sides would be provided with baffle boards to prevent splashing.

A half yard dragline under average conditions can be relied on for 30 cu. yd. an hour over the whole time of its operation, including stoppages and moves, and while at work digging, will probably excavate at a rate of about 60 cu. yd. an hour.

The method of mining given below allows simultaneous mining of overburden and pay gravel. That is, one bucket full of overburden can be dug and rejected, the next bucket being in the pay gravel and loaded into the hopper. Thus, if the ground being dug contains tin throughout, the washing plant would require to be able to deal with 60 cu. yd. an hour or with larger sizes of machines and buckets, practically a pro-rata figure to that named for the half yard machine. If, however, the ground contains 50% of overburden that can be rejected, then the size of the washing plant and width of the launder can be correspondingly reduced. It is, therefore, obviously important to have full information regarding the nature of the deposit, before deciding the size of the washing plant. With a high percentage of overburden, quite a small washing plant should suffice. The actual suggested method of mining may be outlined as follows.

Most tin properties are on a slope and in the majority of cases, there is either a stream still running through them or else a disused stream bed, following the natural slope. Often such properties follow the bed of the valley and thus are long and fairly narrow in character. Almost any property will have a definite down stream boundary and fairly well defined side boundaries can be drawn which determine the limits between payable and unpayable ground. A commencement is made at the down stream boundary of the property and provision must be made to dispose of the tailings from the first series of cuts across the property. This usually can be done by leading them into the stream bed below the property and in this connexion the tailings that will have to be disposed either below or on the down stream boundary, are only that proportion of the pay gravel that will wash down the launder which is contained in the first series of cuts across the property. These cuts will be about 100 to 150 ft. long, according to the size of the machine.

The overburden and stones will remain in the cut and extra ground will not be required to dispose of this material down stream. If it is not possible to lead the tailings off the property down stream, it will usually be found that there is either a piece of unpayable ground adjacent, on to which they can be led, or else a small piece at the down stream end of the property would be sacrificed temporarily for a tailings dump. For the purpose of the drawings reproduced here, it has been assumed that there is ground available at the bottom end of the property and for the first series of cuts off the property, a small earth bund 3 or 4 ft. high has first been dug by the machine, the width of the property, and the tail end of the

launder rests on this bank and discharges just over it.

A first cut, as shown in Fig. 2, is commenced on the down stream boundary with its side limit resting on the boundary line between payable and unpayable ground, previously discovered by prospection. The sketches have been drawn to represent the extreme and most difficult conditions which a half yard machine with a 40 ft. jib can handle and these consist of digging ground to a total depth of 20 ft. its caterpillars on a path shaped as an arc of a circle, having its centre in the middle of the hopper.

Thus, reverting to Fig. 2, the excavation A.B.C.D., approximately 100 ft. by 30 ft. is dug by the machine while standing at points marked from "1" to "5." During this time, valueless overburden has been dumped on the unpayable ground at the side of the property where shown, at the same time the pay gravel has been dug and dumped into the washing

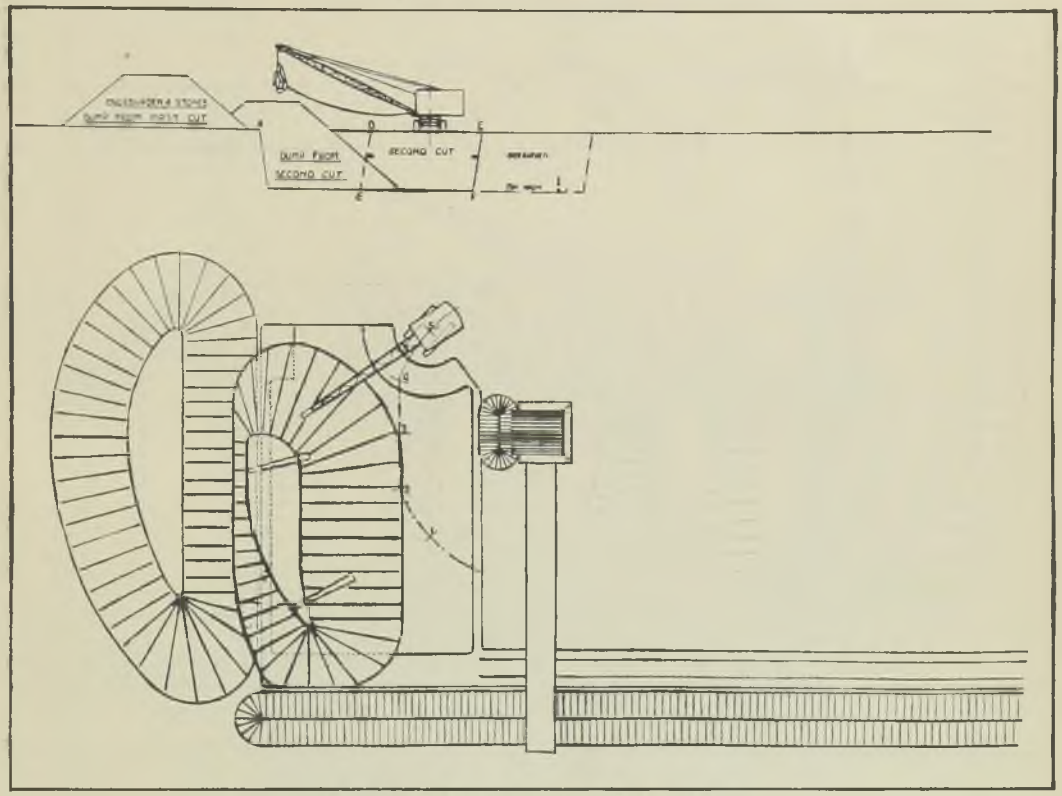


FIG. 3.—DRAGLINE MAKING SECOND CUT.

with a maximum content of 13 ft. of overburden and stones rejected. This machine can handle suitable ground to any less depth and proportion of overburden, stones and pay ground, than the figures just named. The larger machines, with longer jibs, can handle deeper ground and larger quantities of overburden. For the ground named, the 40 ft. jib machine can make a cut approximately 100 ft. long and 30 ft. wide with steep side slopes, while remaining at a constant dumping distance from the hopper. This is achieved by moving the machine on plant according to the rate at which it has been uncovered. The hopper unit and launder stands with its centre line about 15 ft. from the edge of the first cut and parallel to it. The tailings, as shown, are led over the small bund that has been built across the bottom of the property, the stones being rejected from the grizzly on to the pile shown near "C." It must be remembered that the portion of the excavation of the first cut near "C" will be the last to be dug by the dragline and will be firm ground on which to carry the stones until the cut

is practically completed, when the stone pile is removed, together with the overburden to the dump, while the machine stands at about the figure "5" on the sketch.

As soon as the cut is opened out near "A" and "B," a pump would be installed to keep the excavation dry and supply water for washing. This latter supply might require augmenting according to local conditions. If water is scarce, it may be necessary to have a settling pool for the tailings from which water can be regenerated. It should be noted that in this cut, all the required mining conditions are fulfilled.

Overburden is not washed and goes on to unpayable ground, tailings go on to unpayable ground, stones and pebbles are rehandled by the machine from the rejection pile of the grizzly to the overburden. In addition, a dry excavation to bed-rock is obtained and should the latter be hard and uneven, it will be possible to have a few natives working in the bottom, cleaning up the pockets into baskets, which they can dump at minimum cost to a point convenient for picking up by the dragline bucket. The first cut will not have such a large cubic content as subsequent cuts, since it will have side slopes all round.

A typical content will be obtained in cut "XX" marked in Fig. 5. This will have the full content of, say, 100 by 30 by 16 ft. or about 1,800 cu. yd. At 30 cu. yd. per hour per half yard bucket, this gives 60 hours' work on the cut before the washing plant has to be removed. If the machine is worked on a three shift basis, this is about $2\frac{1}{2}$ days' work or, working two short shifts, about five days' work.

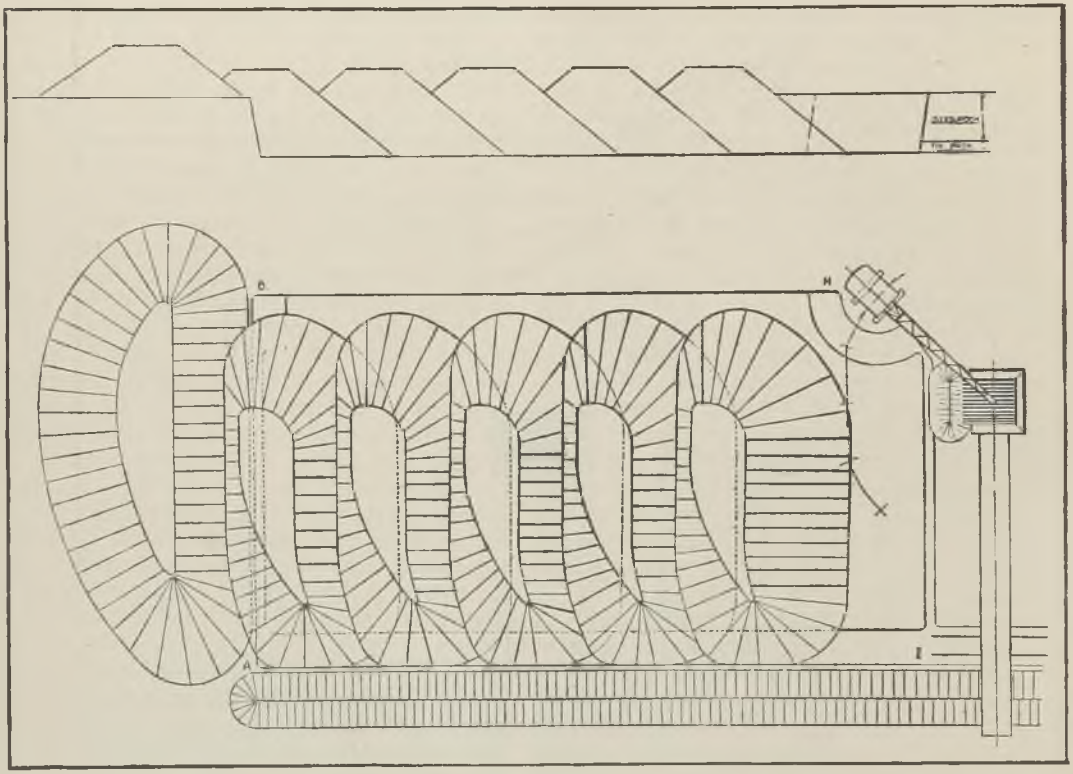


FIG. 4.—DRAGLINE COMPLETING SIXTH CUT.

An examination of Fig. 3 will show how the machine operates the second cut. The path of the machine is not on a true arc with respect to the washing plant, but the size of the hopper of the latter gives sufficient margin to permit the machine dumping into the hopper when working from position "3" marked. The overburden and stones are dumped as shown into the excavation made by the first cut. The washing plant stands in the same relative position to the second cut as it did to the first cut, that is to say, on a parallel line to

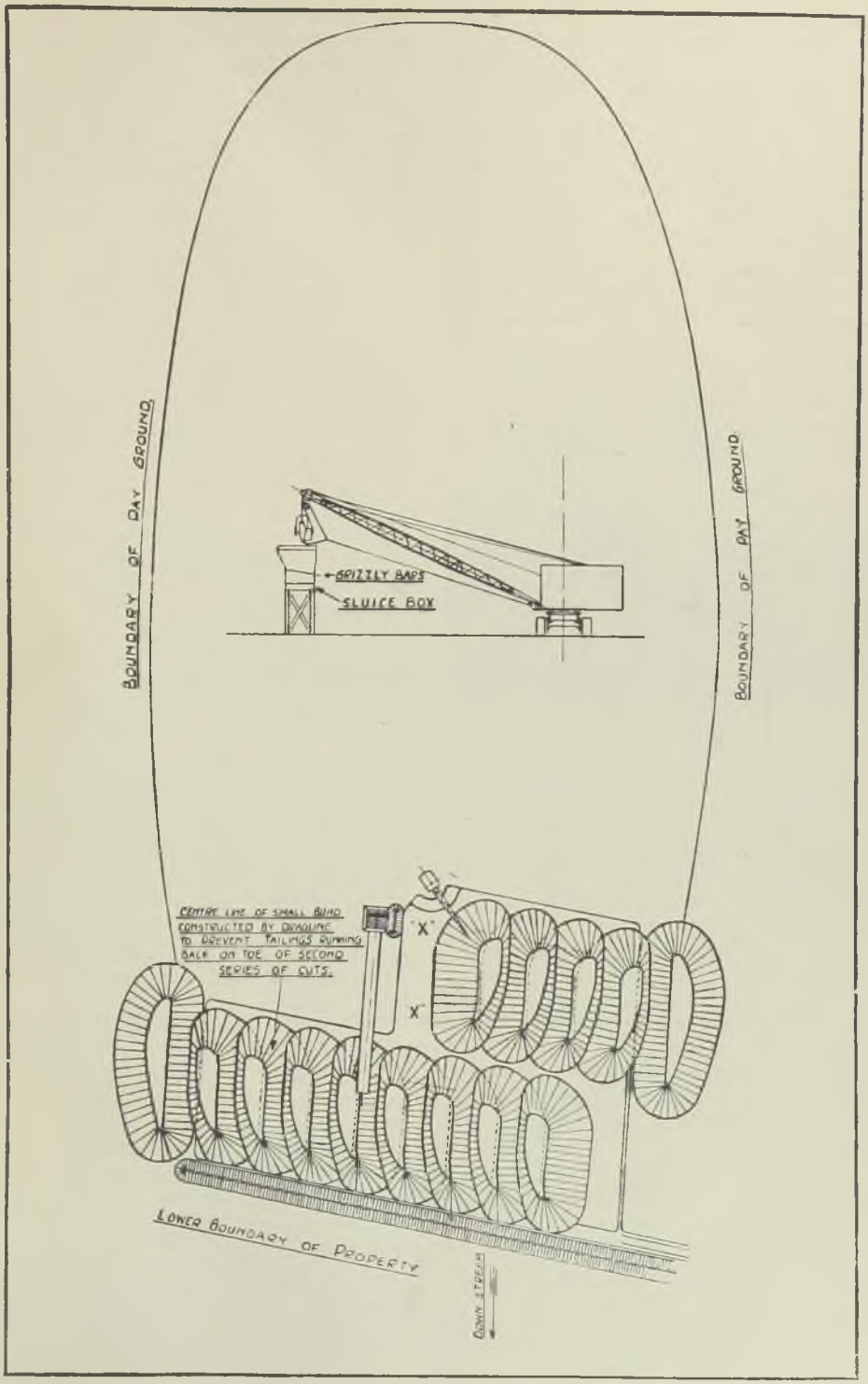


FIG. 5.—GENERAL ARRANGEMENT OF PROPERTY.

its previous line and 30 ft., the width of each cut, from it.

The elevation shows the relative positions of machine, cuts one and two, and overburden spoils from these cuts. It will be seen that at "G" the toe of the overburden spoil of the second cut is apparently encroaching on the toe of this cut. It must be remembered that the machine would have actually cut out the section D.E.F.G. in advance of the spoil pile, so that in practice, the bed rock could be cleaned up before the dumped-material could encroach on the pay gravel.

The third and subsequent cuts across the property until the opposite edge of payable

FIG. 6.—DRAGLINE WORKING AURIFEROUS GRAVEL IN ALASKA.

ground is reached, are practically similar to the second cut. Fig. 4 shows the machine finishing the sixth cut. The shape taken up by the overburden piles and other details are clearly shown. The whole rectangular piece A.B.H.I. has been worked. During this process it may have been necessary, according to the lie of the ground, to remove the pump from its first position suggested near "D" in Fig. 2 to other positions in the excavation close to the line A.I. in Fig. 4.

Fig. 5 shows the general arrangement of working the property with the boundaries and a number of cuts marked on it. In this sketch, it will be noted that the machine has made one complete series of cuts across the width of the property and is engaged on the second series of cuts. The machine has turned round and the second series of cuts are being handled across from right to left instead of from left to right. This has several advantages in that the move for the machine and washing plant at the end of the first series of cuts will only be a short one and that it will permit sufficient space on unpayable ground at the sides of the property to dispose of the overburden and stones from the first cut of each series of cuts. By having the hopper and grizzly removable from the sluice box below, it is, as explained previously, a simple matter to reverse the connexions so that the washing plant is in the same relative position to the machine.

The disposal of the overburden in the second series of cuts is the same as in the first series, the disposal of the tailings is effected by leading these in between the overburden dump piles in the old workings of the first series of cuts. This is done as shown in Fig. 5, the machine, as it completes each cut not throwing up uniform piles of overburden as shown on the sketches, but filling up, with a small bund, the triangular sectional gaps between the overburden piles on the lines shown in Fig. 5 The tailings from each of the cuts of the second series, are led over this bund and dispersed in the area between the spoil piles. By this means, the toe of the second series of cuts is kept dry and clean working is ensured.

Fig. 5 also shows a dragline dumping into the hopper. The jib of the dragline can be inclined at whatever angle is necessary to give clearance for the bucket over the mouth of the hopper. For long working reach, however, it is necessary to keep the angle of the jib as flat as possible, compatible with obtaining the required clearance.

With reference to the scheme as outlined above and by the sketches, it must be remembered that the extreme conditions of working with a smallest size of dragline, the deepest ground and highest percentage of overburden have been chosen. On most properties, the conditions met with do not call for more than 50% of overburden and stones to 50% of pay gravel. Under these conditions a somewhat wider cut can be made and the overburden stones and tailings can be disposed of with greater ease.

The above method gives continuous mining, involves the purchase of no unnecessary land and wastes none of the deposit. There will be certain elements of care necessary in operating the machine, that material is not dropped from the bucket on top of natives working in the launder or operating the nozzles playing on the grizzly, but this should not represent a serious obstacle since shelters can be incorporated in the design of the washing plant at these points, or in practice, the operator would take care to avoid this risk.

The dragline is an accurate machine which can dig to surprisingly fine limits and can select the tin gravel underneath the over-burden without much difficulty. It can also dig ground of considerable hardness and there are few alluvial tin properties where the digging would be too hard for the machine. Another advantage of the machine is its ability to do constructive work in building roads and levelling on the property, preparatory to opening it up, to dig water-courses, and to clear the property by pulling tree stumps, etc., as mining proceeds.

As stated previously, it is safe to allow a figure of 4d. per cu. yd. for all the various digging operations of the dragline. The actual cost of the whole operations will depend on the amount of overhead expenses that are necessary, which are not directly connected with the machine and the actual costs of operating the washing plant and concentrating the tin wash—down to the point where it is shipped to the smelter. The latter charges again, will depend upon local circumstances and would require calculation for each individual property since the tin content will vary, as will the percentage of pay gravel to over-burden, and so on.

The figure for washing, when expressed against the whole cubic contents of the ground, including overburden, may vary between 1d. and 4d. per cu. yd. An average figure should be in the neighbourhood of 2d., thus bringing the total cost of working the ground to 6d. per cu. yd. To this will have to be added depreciation on the machinery and the general overheads. The latter, again, is a figure depending entirely on the outputs obtained from the mine in comparison with its capitalization and the staff employed. The charge for interest and depreciation will depend upon whether the machine is used on single, double or three-shift workings and for a diesel dragline in continuous work will represent between ½d. and 1d. per cu. yd.

A résumé of safe cost figures would indicate :—

	Per cubic yd.
Inclusive working cost of dragline .	4d.
Inclusive working cost of washing tin over total yardage . .	2d.
Interest and depreciation of plant .	1d.
Establishment overheads, say . .	1d.

This gives a total inclusive cost of every kind of 8d. per cu. yd. With tin at £120 per ton, the 80% concentrates are worth about 10d. per pound. Under these conditions, ¾ lb. to the yard ground is on the verge of payability and 1lb. and over ground could be handled with profit.

It should be noted that the above cost figures are merely safe indications of what may be achieved. The dragline operating cost figures have been increased deliberately above the general average reported for such machines in order to leave scope for improvement in actual practice. Local conditions define each one of the costs in the total make-up, with corresponding possibilities of reduction or increase.

A diesel driven machine, carrying a half yard bucket on a 40 ft. jib, will cost erected at work somewhere about £3,000. The washing plant, which would mostly be constructed locally, should not cost more than

Fig. 7.—Dragline Placer Mining in Alaska.

£500. Working at the flat rate of 30 yards an hour on a single shift of nine hours a day, about 7,000 cu. yd. a month should be dug. Working two short shifts a day which is common practice to utilize the daylight hours, about 10,000 cu. yd. per month can be handled. The corresponding output of concentrate merely depends upon the pay-content per yard. By using a machine with a three-quarter yard bucket, about 15,000 cu. yd. per month should be averaged, or, with a one yard bucket, 20,000. Diesel drive has now been used on draglines for seven or eight years and since most of the machines in operation with Indian drivers in India have diesel drive and have proved so highly successful, it would appear that they can be used with the utmost confidence in remote mining districts. Their advantages are that their fuel requirements are very low and cheap and the usual boiler water difficulty of steam machines is avoided.

In order to save time, it will probably be advisable to duplicate the washing unit since doing this will present the advantage of practically continuous mining. The second unit would be erected in its correct alignment while the first is at work and when a cut is completed, the launder and the washing plant that has been in use can be thoroughly cleaned up while the machine carries on with the next cut.

For a small rich deposit averaging say 2 lb. to the yard, there would appear to be strong possibilities of good profits with the above method of working, since a plant costing in all, including pumps, say £4,000, should be getting an output of nearly ten tons a month, working two shifts a day. In any case, dragline working should be cheaper than gravel pumping on most properties.

The present low price of tin has made a number of properties unpayable by the usual methods of working, and some of these might be able to re-open profitably by means of draglines. It is not a new application to work alluvial deposits with draglines since there are a number of records of dragline machines in the Yukon and elsewhere that have mined gold deposits with success, such an one being shown in Figs. 6 and 7. The drawback to successful working with draglines in the past has been the difficulty in devising a layout which would permit continuous mining operations without continually moving the washing plant and it is believed that the above scheme may solve the problem.

THE MECHANICS OF AERIAL ROPEWAYS

By G. BRILLO

In this article the author, who is a director of Ceretti and Tanfani Co., Ltd., describes the mechanics of aerial ropeways. In a succeeding article he will deal with the engineering design and mathematics of the subject.

The adoption of aerial ropeways is very old, and must be at least as old as the rope itself. It is believed that in distant ages steel wire was used in China and India to perform transport over rivers. The first project worthy of consideration, however, is that of the Dutch engineer Wybe Adam Von Harlingen who in the year 1644 constructed in the Free State of Danzig an aerial ropeway with hemp ropes, mono-cable type with continuous movement, for the transport of the materials necessary to erect a fortress. In England an aerial ropeway for the transport of passengers was erected in the year 1830 above the railway between Manchester and Liverpool. It was not, however, until the year 1868 that transport by mono-cable aerial ropeway was applied on a practical scale by Charles Hodgson, and later by J. Pearce Roe, and by the German engineers Bleichert and Pohlig, and the Italian engineers Ceretti and Tanfani as far as the bi-cable is concerned.

Aerial ropeways are not only advantageous in hilly country, or when no other means of transport is possible, but may be erected with equal advantage on flat country. They are especially useful when there is a great traffic of goods as for instance in the Colonies, and in many cases the solution of transport problems by the aerial ropeway has turned mines and collieries which otherwise have been failures, into successes.

At this point it will be convenient to describe the most complex and complete aerial ropeway plant, that is, the bi-cable, proceeding afterwards to a brief description of the mono-cable type, which may be considered as a variation of the former.

On a bi-cable plant two fixed ropes called "carrying ropes" are stretched between the two terminals. These ropes are parallel, and are placed at a distance apart varying

from 5 to 16 ft. On these run the carriers to which the motion is given by another endless rope placed above or below the two carrying ropes, and to which the carriers are gripped. All along the line these ropes are supported by trestles, of which the height and the distance between them vary according to the profile of the ground. The carrying ropes are anchored to one terminal, and maintained in tension at the other by means of counter-weights. At the two terminals, stations are erected, in one of which is placed the anchorage mechanism of the carrying ropes, and the driving gear of the hauling rope, and at the other—the tension devices of the carrying and hauling ropes and the return gear of the hauling rope. Should the line exceed a certain length, or should it become necessary to deviate from the straight line, an intermediate station would have to be provided.

As has been said, the endless hauling rope runs continuously parallel to the carrying ropes, pulling the carriers along. One side of it hauls the loaded carriers from the point of departure to the point of arrival, and the other side hauls the empty carriers from the latter point to the former, as is shown in Fig. 1.

Ropes.—These are made of the best crucible steel, the carrying ropes being usually of the spiral type, or of the locked or semi-locked type. Another type of carrying rope is now manufactured which consists of a spiral rope having an exterior of shaped wire as in the case of the locked coil rope, the quality of steel sheath being softer than that of the internal rope.

It is difficult to say which type of rope is to be preferred, as all have their advantages and disadvantages. The spiral rope, being made of better quality steel, is lighter in weight than a corresponding locked or semi-locked one, in addition to having a more suitable section to resist the bending stresses, but its rough surface increases the co-efficient of friction between rope and saddles, and rope and carriers, and subjects the rope to a great number of extra vibrations. The locked and semi-locked type of ropes instead have a smooth surface which avoids these disadvantages.

The hauling rope is usually of stranded construction, with a hemp core, and has a minimum of 42 to a maximum of 144 wires. Here the choice lies between Lang's lay and ordinary lay. Experience has taught that the Lang lay rope has some small advantage over the ordinary lay one.

Rope-makers have recently manufactured new types of hauling ropes, some of which are free from twist and some made of wires which have been twisted prior to the making. In these ropes broken wires do not get out of the rope, the life being therefore much longer.

The carrying ropes are anchored at one terminal by means of an end socket to a strong bed of ferro-concrete, and at the other terminal are maintained in tension by means

Fig. 1.—Ropeway Station, showing hauling and carrying ropes.

of counter-weights. The idea of having counter-weights is that a constant strain is maintained upon the ropes in spite of variation in temperature and position of load. On light lines of no great length, the ropes are usually maintained in tension by a screw tightener, which can be controlled by hand, or sometimes by spring tension devices. The sections of carrying rope have to be connected together by means of special muff couplings, but the hauling rope, although also in sections, has to be of an absolutely uniform circumference as the carriers have to be coupled or locked to it, and it has to run inside the grooves of the driving and the return sheaves; therefore these sections have to be spliced.

TRESTLES.—The trestles are usually steel structures, generally having a pyramid shape, but may also be made of wood or re-inforced concrete (Fig. 2). The distance between them as well as their height varies with the profile of the line. The idea of distributing the trestles is to have as far as possible a catenary curve when the profile is concave and where the profile is convex to have a very light angle of pressure of the ropes on the head of the supporting trestles (Figs. 3 and 4).

FIG. 2.—REINFORCED CONCRETE TRESTLE.

The normal height of trestles varies from 12 to 100 ft. (although trestles up to 170 ft. have been constructed), and the spacing between them varies from 10 to 1,000 yds., although spans as long as 1 mile are in existence. The main structure of the trestles carries at the top 4 brackets (Fig. 2). The two top ones support the shoes or saddles which are specially grooved casted pieces on which the carrying ropes are placed and the lower brackets carry the supporting rollers and the guiding rods for the hauling rope. The length of the shoes varies with the length of the span, the longer the span the longer the shoe. Three types of shoes are generally manufactured, short, medium and long. The guiding rollers are only made in two diameters, about 6 in. and 12 in. The 6 in. type are placed on trestles between short spans, and the 12 in. on trestles between long spans. Steel and timber trestles are fixed to concrete foundation blocks.

INTERMEDIATE ANCHORAGE AND STRETCHING DEVICES.—Sometimes, owing to the length of the line, it is not advisable to have long uninterrupted sections of carrying ropes. Usually one carrying rope can give satisfactory results, and feel the tension and the regulating action of the counter-weight when the distance between the two terminals is within two miles. Beyond that distance, it is not advisable to go. For longer distances it is necessary to divide them in three sections. This is done by means of intermediate anchorage and stretching devices which are special structures to which one section of the carrying rope is anchored and in which are the counter-weights (or anchorage) of the adjacent section of the carrying rope (Fig 5).

The continuity of the "run way" for the carriers is obtained by connecting the two sections of the carrying rope thus divided by a rail with special connecting tongues. The hauling rope however passes through the stretching device uninterrupted, and is supported by rollers or batteries of rollers.

STATIONS.—Stations are situated at the terminals of the line, but when the length exceeds a certain distance (say 5 miles), other stations are placed in between. It may also be that angles are necessary, necessitating the provision of an "angle station". Therefore stations may be classified into three groups—end stations or terminals, intermediate stations, and angle stations.

Inside the stations, the place of the carrying rope is taken by an overhead rail which connects the end of the inlet carrying rope to the end of the outlet one. The continuity between the rope and rail, and vice versa is obtained by means of connecting tongues. The overhead rail is supported by means of cast iron brackets or by means of special supports. Close to the inlet section of the rail is placed the unlocking frame of the carriers, the locking one being at the outlet section of the said rail (Fig. 6). The overhead rail inside the station does not necessarily have to be only one circuit, but many circuits and side lines may be constructed, connected to the main one

FIG. 3.—ROPEWAY SPAN OVER CONCAVE PROFILE.

by means of hand or automatic switches. The carrying ropes can be anchored inside the stations or stretched by means of counter-weights.

The hauling rope winds itself round sheaves usually having a diameter equal to the distance between the carrying ropes. If the station is a driving one, the grip or adherence between hauling rope and sheaves is given by means of multiple grooved sheaves and counter-sheaves, the main sheave being put in motion by a special driving gear driven by a motor. At a return station, the hauling rope is wound round a single grooved sliding sheave which is connected to the counter-weight. In case of the plant being self-propelling, that is when the load is in favour of the slope, a speed regulator and brakes are supplied instead of driving gear.

FIG. 4.—SPACING OF TRESTLES OVER CONVEX PROFILE.

An intermediate station may be considered as two stations back to back. Both may be driving, or both may be return stations, or one may be driving, and one may be the return station. At an angle station between two very short sections of the line it is not advisable to break the continuity of the hauling rope. This type of station is known as an automatic angle station in which although the carrying ropes are interrupted, the hauling rope passes round sheaves, no locking or unlocking frames are supplied, but the carriers pass through the stations without interruption on their journey. No driving or tension gears are therefore necessary, but tension and anchorage arrangements are installed for the two adjacent sections of the carrying ropes.

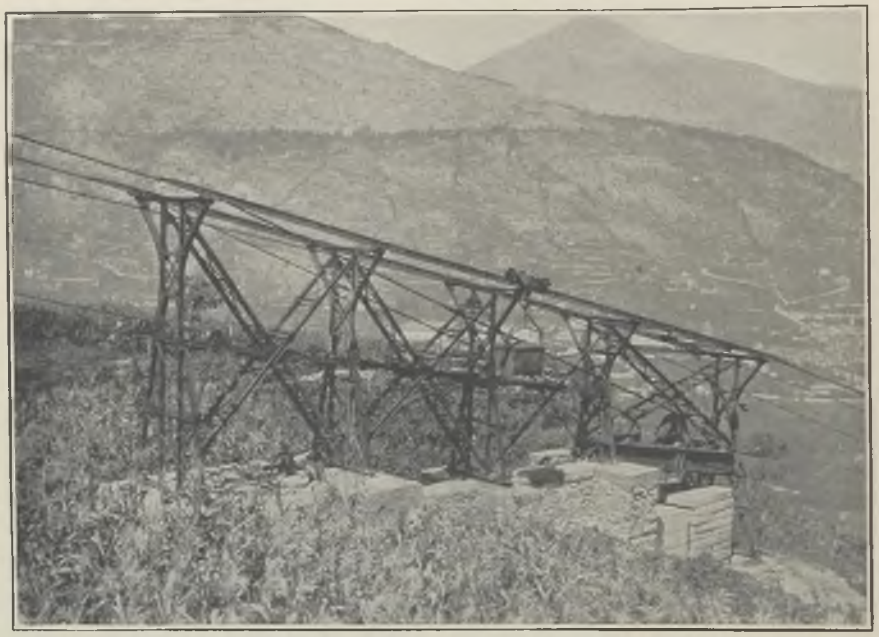


Fig. 5.—Intermediate Anchorage and Stretching Gear.

Carriers.—The carriers consist of three parts :—the runner, the hanger, and the container (bucket, platform, or skip). The runner comprises two, four, or sometimes more truck wheels, deeply grooved to run on the carrying ropes. When the number of wheels is more than two, each couple of wheels is mounted in a special frame which is pivotted both vertically and horizontally to accommodate itself to curves of small radius. The hanger is usually made of wrought iron, and the bucket in sheet iron, or sometimes of wood.

In the eventuality of timber being transported, suitable chains are supplied with the hanger.

Grippers.—The gripper is the mechanical means by which the carriers automatically lock themselves to, and unlock themselves from, the hauling rope. They may be divided into grippers working by contact and grippers working by friction. The latter are those by which the hauling rope is locked by two jaws, and these can also be divided into two groups, namely, those on which the pressure on the jaws is regulated at the moment of the locking and is constant on the whole line ; and those on which the pressure on the jaw is variable and varies according to the load and the gradient of the line. In the first group, the gripper is usually fixed to the hanger itself, whilst in the second it is always part of the runner. The gripper may be placed on the runner above the point of contact between the wheels and the carrying ropes, or below it. The first case is the so-called " overhead grip ", and the second the so-called " below-grip ".

Locking Frames.—The operation of locking and unlocking the carriers to and from the hauling rope through the grippers is obtained automatically by means of very simple locking and unlocking frames which are placed at the entrances and exits of the stations.

Mono-cable Plant.—In this system no carrying ropes are used, only a hauling rope which has to perform the double duty of carrying and hauling. Stations, intermediate stretching devices, trestles, carriers, etc., are more or less the same as those designed for the bi-cable system, bearing in mind, of course, that in the mono-cable system they have not got the necessary appliances relating to the carrying rope. The disadvantages of a mono-cable system are as follows :

(1) The running and maintenance expenses are usually greater than in the bi-cable system.

(2) Having to perform two duties at the same time, ropes wear out more quickly, and the running is not so satisfactory as when these duties are performed by two separate ropes.

(3) Although the mono-cable aerial ropeway may be cheaper for small capacities, it is usually not used for heavy duty.

In an aerial ropeway for continuous movement, the capacity per carrier ranges from a minimum of 4 cwt. (or perhaps a little less) to a maximum of 2·5 tons, and the capacity per hour on a single line from a minimum of 5 to a maximum of 250/300 tons. This capacity is only obtained with the bi-cable system, as with a mono-cable system, it is not advisable to go more than 30 tons per hour.

In Spain between Grenada and Motril a ropeway has been constructed having a length of 40 kilometers (25 miles) which when completed by another extension will reach a length of 30 miles. In North and South America there are ropeways with greater length than this one. Speed on aerial ropeways, that is the speed of the hauling rope, is between 200 and 600 ft. per minute on plant with continuous movement. Greater speeds than this can be obtained on the "jig-back" or to-and-fro type of ropeway.

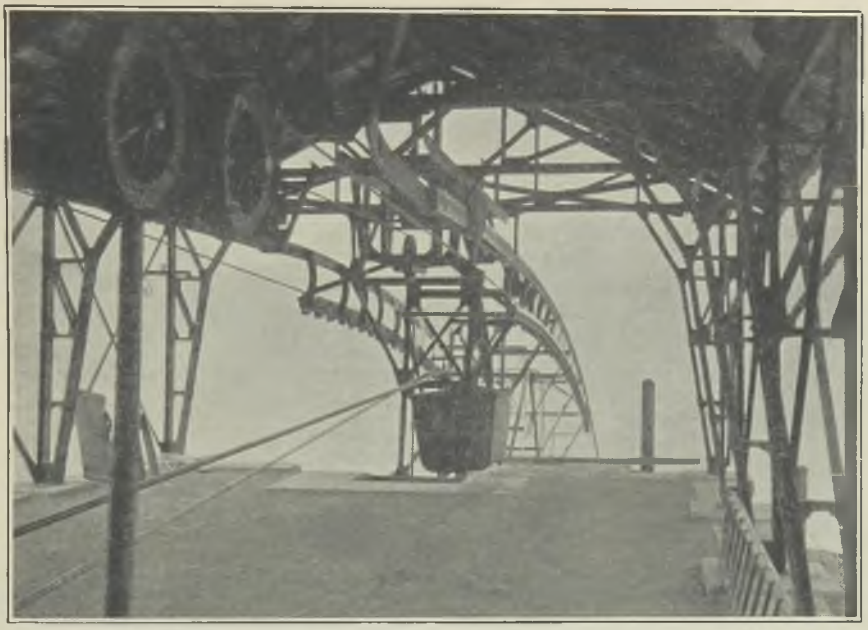


Fig. 6.—Interior of a Terminal Station.

Passenger ropeways of the "jig-back" type are constructed on two systems—the Italian and the German. On the German system rope breakages are countered by devices gripping the carrying ropes, on the Italian system by devices gripping a third rope called the "brake rope". On the latter system the brake rope, although motionless, is not fixed, but can be put in motion by means of a special winding gear, and therefore when a car has been stopped on the line through the failure of the hauling rope, the brake rope, which is gripped by the safety brakes can bring the two cars to the stations. In the German system another little car has to be hauled close to the main one, and the

passengers have to be transferred at the point where the braking has taken place.

Lastly there is one other type of aerial ropeway, the "cableway" or "Blondin." The cableway may be considered as a crane on which the carrier instead of running on a fixed girder, runs on a rope. Generally this type of ropeway is very short, very seldom exceeding the distance of 600 to 700 ft. It usually only has one carrying rope and one carrier which travels across it. The bucket, or platform, containing the load may be lowered at any point of the line from the carrier to the ground and hoisted up again. This type of cableway is especially used in the construction of dams, bridges, etc. Their practical capacity ranges from a minimum of 1 to a maximum of 20 tons.

The cost of an aerial ropeway varies with the section of the ground (profile), with the planimetric route of it (i.e. if straight or with angles) and with the carrying capacity etc. It is therefore impossible to give a reliable formula for it. The following table however gives the approximate cost of a straight and normally constructed bi-cable plant where L is the length of the line in yards.

Capacity per Hour Tons.	*Cost of Mechanical Parts in £'s at the Works.*
10	0·57 L + 200
20	0·68 L + 220
30	0·79 L + 260
40	0·91 L + 320
60	1·16 L + 380
80	1·27 L + 400
100	1·42 L + 400

The above table gives only the prices for the mechanical parts, i.e. ropes, mechanisms in the stations and stretching devices, fittings for trestles, carriers and telephone. To this figure, in order to have the cost of the Plant in working order, must be added the cost of the structures (steel or timber or concrete), foundations, electric motor with accessories, transport and erection. These costs usually amount to 80 or 90% of the total cost of the mechanical parts.

The running expenses including men's wages, power consumption, lubrication, wear and tear, depreciation, and interest usually varies between 1d. (and sometimes less) and 6d. per ton mile, according to the length and capacity per hour of the plant.

METALLURGY IN SOUTH AFRICA

By S. W. SMITH, D.Sc., Hon.D.Sc.(Witwatersrand), A.R.S.M.
Chief Assayer, the Royal Mint.

(*Concluded from the December issue, p.* 336.)

THE PRETORIA MINT.—Although the arrangements made for the visit of the Empire Congress to Pretoria did not include a visit to the Mint, any attempt to give a general survey of metallurgical activity in the Transvaal would be incomplete without a reference to the work of this establishment. A mint existed in Pretoria under the Republican Government, but the present buildings are entirely new and were completed in 1922. The primary function of the Mint is that of coining British sovereigns, as a branch of the Royal Mint in London, while a further purpose is that of providing the subsidiary coinages of silver and bronze for currency in the Union of South Africa.

From a metallurgical standpoint, therefore, the Mint constitutes an important and, at the present time, one of the comparatively few establishments in South Africa where the adaptation of non-ferrous alloys to general use is practised and where the varied operations which are involved in this aspect of metallurgical work can be seen. These operations entail fundamental considerations with regard to practice in melting, casting, rolling, cutting and stamping and also with regard to the necessary equipment for carrying them out efficiently. A detailed description of the plant and procedure has appeared in a paper by the Superintendent of the Operative Department (Mr. J. T. Becklake) in the *Journal* of the South African Institution of Engineers (September, 1928), a lengthy abstract of which was given in the MAGAZINE for November, 1928.

Since the commencement of operations at the Mint in 1923 the work has steadily increased owing to the fact that a considerable proportion of the refined gold which is produced annually at the Rand Refinery is converted to currency. Up to the end of 1929 some 65,000,000 gold coins (mainly sovereigns) and some 24,000,000 silver coins had been struck. The gold coinages at Pretoria are in fact now by

far the largest of those within the British Empire.

THE PLATINUM INDUSTRY OF THE TRANSVAAL.—Reference has already been made, in the preceding article, to the steps which are taken to recover the metals of the platinum group from the Rand "banket." The main interest with regard to these metals in recent years, however, has arisen from the discovery and exploitation of platinum as a primary product from the platiniferous rocks of the Bushveld Igneous Complex in the Central Transvaal, to the west, north, and east of Pretoria.

THE ROYAL MINT, PRETORIA.

The metallurgical problems which are involved in this recovery of platinum as a primary product are radically different from the operations by which this metal is recovered in other parts of the world where it is obtained either as a by-product in the treatment of other minerals or else from detrital deposits. Difficulties of extraction have been encountered which have been due not only to the fact that there are marked differences in the character of the platinum-bearing minerals in different districts, but also to the fact that the condition in which the platinum itself occurs varies considerably. When found in the free state it is generally very finely divided and when in association as sulphides the difficulties in this respect are very much accentuated. Consequently, in the evolution of the processes which have been devised to overcome these difficulties, there are necessarily considerable variations in regard to procedure. To the metallurgist these are of particular interest as showing how modifications of well-established procedures in regard to other metallurgical operations have been successfully adapted to the requirements of this pioneer work. It may be mentioned that articles on platinum in South Africa appeared in the MAGAZINE in July and September, 1929.

The present metallurgical position with regard to the platinum industry in the Transvaal was admirably reviewed in a joint paper which was presented to the Congress by Mr. F. Wartenweiler (Consulting Metallurgist to the Johannesburg Consolidated Investment Co.) and Mr. A. King (Consulting Metallurgist to the New Consolidated Goldfields Co.). Several other valuable papers were also presented which deal with the developments which have taken place in particular districts—geographically separated by considerable distances and mineralogically different in regard to the problems of extraction.

The varying nature of the occurrences of platinum in these districts is of great interest,

but it must suffice to say that all the important occurrences, which have been discovered so far, lie in the outer and lower portions of the great body of igneous rocks constituting the Bushveld Complex. These portions consist of norite and allied rocks, forming a basin-shaped sheet and it is in the basic and ultra-basic rocks of this sheet that important occurrences are found.

Of those districts which give promise of economic importance, both as regards the magnitude of the occurrences and the regularity of the values, those situated on what is known as the Merensky horizon, stretching from Rustenburg, in the west, through Potgietersrust to the north and across to Lydenburg in the east, appear to come first. The platinum-bearing rocks in these districts are pyroxenite-norites and they have been developed both in the oxidized and sulphide portions of the deposits with which are associated nickel, copper and iron sulphides of magmatic origin.

Another occurrence however, in the Lydenburg district, and one which has the distinction of having furnished the first mine and extraction plant in the world to recover platinum from a primary ore, is that at Onverwacht in the western part of the district. Here the ore-body in which the platinum is found is an almost vertical columnar "pipe" of hortonolite-dunite. Similar bodies or "pipes" have been developed at Mooihoek and Driekop with a central reduction plant at Maandagshoek not far away.

The reduction plant at Onverwacht was in operation from February, 1926, to the end of 1929 and had produced some 28,000 fine ounces of platinum. Messrs. Wartenweiler and King give a brief description of the extraction plant which is illustrated by a flow-sheet. A more exhaustive account of the development of this pioneer plant was given, in 1929, by Messrs. T. K. Prentice and R. Murdoch in a paper to the Chemical, Metallurgical and Mining Society of South Africa, an abstract of which was given in the MAGAZINE for April, 1929. A further paper by Messrs. J. E. Healey and T. K. Prentice was presented to the Congress.

Briefly, the recovery of the platinum at Onverwacht is effected by gravity concentration and the concentrates are further enriched by an amalgamation process promoted by activating re-agents in the form of zinc-amalgam, copper sulphate and sulphuric acid giving a yield of 97·5% on the concentrates so treated. An overall recovery of nearly 83% has been effected, the final product assaying 75% of platinum. At Maandagshoek the dunite ore is treated by gravity concentration followed by flotation, but the concentrates are not so amenable to treatment by amalgamation as at Onverwacht.

Coming now to the pyroxenite ores of the Merensky horizon; of the three districts mentioned in which developments have occurred, that which is assuming major importance is the Rustenburg district to the west of Pretoria. Here the pyroxenite horizon has a greater precious metal content and two plants have been erected—one at Waterval and another by the Potgietersrust Company in the same district. The former came into operation in August, 1929, and the latter is nearing completion.

The Waterval plant is equipped for the treatment of 10,000 tons of oxidized ore per month by gravity concentration and in the near future the tailings may be treated by flotation before being discharged. The platinum metals occur mainly as arsenides and sulph-arsenides in a fine state of division which of course, adds greatly to the difficulties of gravity concentration.

The Rustenburg plant of the Potgietersrust Company is equipped with a primary and secondary gravity concentration section followed by a flotation section. At present the oxidized ore is mined selectively, but when the treatment of the sulphide ore is reached the economic question will decide whether concentration by flotation alone will supersede the present combination of the two processes. Messrs. Wartenweiler and King, in their review, give flow-sheets indicating the detailed procedure at all these plants.

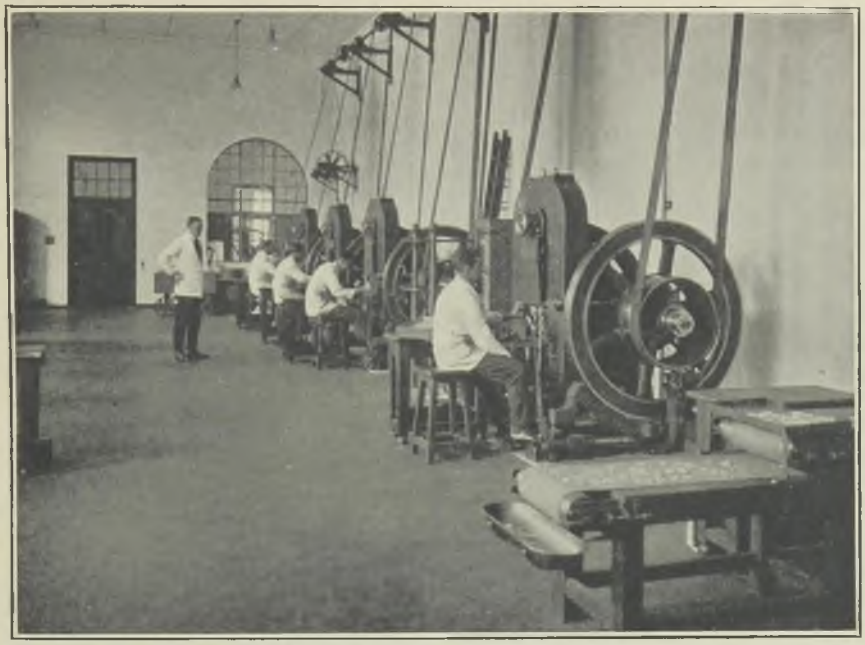
The question of the subsequent treatment of concentrates to furnish a marketable product is one which is common to all these varying practices. The solution of this problem has been the subject of a vast amount of experimental investigation. As already indicated, an amalgamation process has been successful at Onverwacht in treating the clean dunite concentrate in which the platinum mineral is unassociated with objectionable elements. A second method has been applied to a sulphidic concentrate by which the material is smelted to a matte from which the platinum metals are recovered by a wet treatment. A third method has

been developed under the direction of the Rand Mines, Ltd. and is known as the Chlorine process. A full account of the pioneer work in regard to this process was given by Messrs. R. A. Cooper and F. W. Watson in a paper to the Chemical, Metallurgical and Mining Society of South Africa in April, 1929, and which was abstracted in the MAGAZINE for July, 1929.

The Potgietersrust Co. has now erected a working plant at Government Areas, on the East Rand, for the treatment of the concentrates produced at their properties at Rustenburg and at Potgietersrust. The concentrates are roasted, then mixed with salt and subjected to the action of free chlorine at a temperature of about 550° C. The platinum metals are thus rendered soluble in acidulated water together with the accompanying copper and nickel. Precipitation of these metals is then effected by suitable re-agents; the copper by powdered limestone, as a basic carbonate; the platinum metals by zinc dust, as a metallic sponge, and the nickel as a hydrated oxide by calcium hypochlorite. Promising recoveries have been obtained and the process is said to be applicable to concentrates derived either from oxide or sulphide ores.

THE MESSINA COPPER MINING INDUSTRY.—The operations of the Messina Development Company in the extreme north of the Transvaal, near the Limpopo River, were fully described in a paper to the Congress by Mr. A. B. Emery, the General Manager. Although a visit to the property could not form a part of the general itinerary, a number of the members availed themselves of an invitation to accompany Mr. Emery across country from Bulawayo on the return journey from Northern Rhodesia.

Since the early days, from 1906 to 1914, when wagon transport was the only means of communication, this Company has adopted successful measures to combat the difficulties and to add to the amenities of life in this tropical enterprise. New reduction works were installed in 1914 and from that date to the end of 1929 some 63,000 tons of copper had been produced, the present annual output being about 6,500 tons. This refined copper averages 99·9% and is free from objectionable impurities.



ROYAL MINT, PRETORIA: COINING PRESSES.

The ore consists of sulphides of copper practically free from iron pyrites, and averages 3% of copper.

From the metallurgical standpoint the procedure which is followed presents many unusual features which arise from the particular conditions and the steps by which the present practice has been evolved. Some 60% of the copper sulphides can be freed

by crushing to ½ in. to yield clean concentrates by jigging. The jigs and tables recover some 52·8% of the total copper, thus reducing the duty of the subsequent treatment by flotation. These concentrates are readily freed from excessive moisture and are suitable for smelting in the reverberatory furnaces.

The flotation plant is designed to treat coarse sand and has been evolved locally to overcome difficulties which were experienced in the earlier stages. The Messina machine consists of a long trough-shaped horizontal box without the usual slope from feed to tails end and with a discharge higher than the feed. Each compartment has a separate froth control to fix the grade of concentrates, and the finished concentrates are produced in the same unit as the final tailings, the middlings also being returned to the same unit. The overall recovery of the plant is given as 95·58%.

The record which Mr. Emery gives of the difficulties which the war created in regard to the economic disposal of concentrates and matte and the final success which attended the efforts to produce refined copper without the prohibitive expense of installing a modern converter plant, constitutes a striking example of metallurgical courage and achievement.

The reverberatory smelting plant was originally designed to operate the Welsh Nichols-James process modified by pulverized coal firing. Three furnaces were stepped down in elevation so that the matte from No. 1 could be tapped into the "Reaction" furnace (No. 2) and thence to the "Refining" furnace (No. 3) from which the refined copper was to be cast by ladling.

Owing to the large accumulation of concentrates there was an urgent need for a greatly increased capacity for producing ingot copper from matte averaging from 60–65%. Attempts, which were ultimately successful, were made to "blow" the matte in the No. 2 furnace, functioning as a stationary converter. Difficulties were experienced, of course, with the tuyeres, but finally, by tapering the tuyere pipes, using very large ball valves, and plugging off the tuyeres by oil-cooled plugs pushed in from the outside, it was found possible to meet the requirements.

Since 1924, this stationary converter has been in regular use and 31,500 tons of 99% copper have been produced. At the end of the "blow" the metal is tapped into No. 3 furnace, refined in the usual way with compressed air, and poled with freshly cut poles of "blue gum." The refined copper in the earlier stages of ladling assays 99·92% and is not allowed to drop below 99·80%. The success of this procedure, which was adopted as a matter of expediency, is a fitting reward of great efforts which were made at a critical time in the history of this company.

Tin in the Transvaal.—An important contribution to the proceedings of the Congress was a paper by Messrs. W. J. Gau and J. Irvine Jameson giving a general survey of the exploitation of tin occurrences in the Central Transvaal during the past 20 years or so. This paper, in fact, constitutes the first record of the actual mining and metallurgical operations in this field.

The chief areas of economic importance are situated in the Bushveld Complex to the north of Pretoria and lode mining operations are in progress at the following places:—

(1) At Zaaiplaats and Groenfontein in the Red Granite, where the cassiterite is found in masses of altered granite which are roughly circular in cross section and are known as "pipes." The cassiterite is coarsely crystalline, and the ore is comparatively free from impurities so that the treatment is straightforward and a high extraction is obtained.

(2) At Mutue Fides and Stavoren in a coarse red granite (granophyre). The former of these is in operation. Apart from certain "pipe" occurrences the bulk of the ore is obtained from replacement deposits. Here again the character of the ore enables concentration to be effected by the normal dressing plants.

(3) At Rooiberg and Leeuwpoort in quartzites. There is abundant evidence at the former place of ancient workings which are regarded as being of very early origin. The plant at Rooiberg treats from 2,300–2,500 tons per month, and until ore from the Nieuwpoort mine became available no particular difficulties were encountered in treatment.

At Leeuwpoort the plant has a capacity of 7,500 tons per month, but, owing to the very fine dissemination of the cassiterite and the presence of iron, both as pyrites and as oxides, there is more difficulty in recovering the values. The equipment, therefore, which has been provided is more

elaborate and the flow-sheet a more complicated one.

The latter half of Messrs. Gau and Jameson's review is devoted to a detailed description of the procedure at the Leeuwpoort mine which for some years has been the most productive tin mine in South Africa. Flow-sheets are given of the concentration plants at the various properties referred to in the paper, and some of these were reproduced in an abstract of this part of the paper which was given in the MAGAZINE for May last.

SOUTHERN RHODESIA.—A session of the Congress was held at Bulawayo under the chairmanship of Sir James MacDonald the President of the Rhodesian Chamber of Mines and the friend and biographer of Cecil Rhodes.

From Bulawayo the party divided, one proceeding through Southern Rhodesia to Fort Victoria, Salisbury, Eiffel Flats, Shabani and Selukwe, while the other party proceeded northwards to Broken Hill, Bwana M'Kubwa, N'Dola, and the copper fields of Northern Rhodesia.

The writer accompanied the latter party so that he has no first-hand knowledge of the metallurgical activities in Southern Rhodesia. These activities have, of course, centred mainly round the production of gold, the occurrence of which is wide-spread and of unique interest from the presence everywhere of evidence of ancient workings. Since the occupation by the pioneers in 1890 there have been some hundreds of producing properties, although in recent years the greater proportion of the gold has been contributed by nine large companies operating their own mines.

Members of the Congress visited the Cam and Motor mine at Eiffel Flats, and the Wanderer mine at Selukwe. Visits were also made to the asbestos mines at Shabani and to the chromite mines at Selukwe.

The history, progress and future prospects of mining enterprise in Southern Rhodesia were admirably reviewed in a paper by Mr. F. P. Mennell which was contributed to the proceedings of the Congress at Bulawayo.

NORTHERN RHODESIA.—(*a*) *The Rhodesia Broken Hill Development Co. Ltd.*—An admirably organized visit was made to the various sections of the plant of this important metallurgical enterprise situated on the main line some 370 miles north of the Victoria Falls. Possessing as it does the first and only electrolytic zinc works in South Africa it constitutes a remarkable example of metallurgical achievement in tropical regions. A series of flow-sheets

ZINC PLANT: RHODESIA BROKEN HILL.

were provided by the management covering the operations in the various sections and before proceeding to an inspection of the plant brief lectures were given by the officials in charge of these sections relating to points of special interest.

The zinc plant was in full operation and the stages in the procedure may be briefly described. The ore, which consists of silicates, carbonates, oxides, and phosphates of zinc, is first prepared for leaching, the coarse material being dry crushed and the finer portions wet crushed with zinc sulphate solutions to avoid dilution.

In the Leach Section proportions of these two products together with a small quantity of manganese ore are treated with dilute sulphuric acid and the solution and slime passed on to settlers each of 20,000 gallons capacity. The liquor is decanted to the silica precipitation vats which are steam heated to 60–65° C. and here the silica is thrown down as a granular gel together with iron and vanadium phosphates. These are removed by a succession of Moore vacuum filters giving zinc solutions which now contain only traces of copper and nickel. Meanwhile the slimes from the settling vats have been coagulated by steam heating and the liquors separated by Moore filters and allowed to rejoin the original solutions. A final purification is now effected by the addition of calcium sulphate, arsenious oxide and zinc dust which removes the traces of nickel. After filter-pressing, the purified solutions pass to the electrolytic division and thence to the cells. Each of these contains 42 cathodes and 41 anodes and there are two units of 72 cells. The cathodes are of aluminium and the anodes of cast lead. After stripping, the zinc is melted in a reverberatory furnace of 120 tons capacity, from which the slab zinc is cast at a purity of 99·96% and marketed as the "Sable Brand."

Extensive plant was also seen in operation for the concentration and separation of the sulphides of lead and zinc. The "North" section is equipped for water concentration, while the "South" section is equipped with flotation machines for handling the slimes.

An interesting exhibit was arranged at the Mine offices showing the stages in the development of a process for the recovery of vanadium for which purpose a portion of the plant is being adapted.

Members of the Congress carried away with them happy recollections of the courtesy of the officials and of their readiness to furnish any information which was sought. The hospitality of the Government of Northern Rhodesia at the Country Club was also a memorable feature of this visit.

(*b*) *Bwana M'Kubwa Copper Mining Co.*—This property, which is on the site of ancient workings and within a short distance of the newly discovered copper fields of Northern Rhodesia, was opened up from 1902 onwards until the present company was formed in 1922. Operations are confined, at present, to the oxidized ore, which consists mainly of malachite with some chrysocolla, and the process of extraction has been specially designed for the extraction of the copper from these minerals.

An admirable paper was presented to the Congress by Mr. C. S. van der Poel (the metallurgist of the company), in which the metallurgical operations were fully described. The stages were clearly and completely indicated by five accompanying flow-sheets.

The ore is prepared for treatment by primary and secondary crushing plants. As originally designed the plant was equipped with revolving drum furnaces for the calcination of all the crushed ore, but subsequently this treatment was restricted to the over-size while at present the tendency is to dispense with this operation altogether.

The ore from the secondary crushing plant is classified into sands and slimes which undergo separate leaching for the extraction of the copper by solutions of cupric ammonium carbonate.

The curtailment of the furnace treatment minimized the values passing to the slimes and resulted in a better recovery which is mainly effected from the clean sands. These are treated in nine circular tanks, 54 ft. in diameter and 13 ft. 6 in. high, each taking some 1,100 tons of ore. These tanks are wet-filled by Butters and Mein distributors, and have water-sealed covers. The ammoniacal solution of cupric ammonium carbonate is allowed to percolate upwards until a few inches of solution rises above the ore. Each tank is "still" leached for a period and then placed in circuit with others until the enriched solution from the last tank goes forward to the evaporation plant. The purpose of this latter operation is threefold—to precipitate the copper as oxide, to remove water from the system, and to recover the ammonia as a distillate.

This plant also receives the copper-bearing solutions from the Slime Plant in which the leaching and extraction is effected in Merrill slime presses. Each of these presses contains 45 frames with a space of 4 in. between the filter leaves giving a 4 in. cake of slime. Cupric ammonium carbonate solution from the sand plant is pumped through the charge, followed, of course, by a weaker solution and a water wash. Finally, the traces of ammonia and copper-bearing solutions are expelled by air under pressure and the residues are sluiced out without the necessity of opening the filters.

The precipitated copper oxide from the evaporators is pumped through Sweetland filters and the caked material dried to from 12 to 18% of moisture.

The smelting and refining is effected in a reverberatory furnace. Before charging, the oxide is mixed with from 10 to 15% of tar—obtained from the gas plant. After skimming the molten bath, air is blown in to saturate the metal with oxide and the final slag is removed. The refining is effected in the usual way by "poling" under a layer of charcoal. The metal, as cast in a Walker wheel, averages 99·88% of copper.

The successful operation of this process constitutes a notable metallurgical achievement in the pioneer work of copper production in Northern Rhodesia.

From Bwana M'Kubwa to the more recent developments in Northern Rhodesia is but a short distance and interest will be centred in the near future on those vast undertakings which are in course of construction in these fields. The metallurgy of copper will, in a few years, occupy a position here which it has not hitherto attained in any other part of the Empire.

Cell Building: Rhodesia Broken Hill.

In concluding the last of these three short articles on the metallurgical aspects of the meetings in South Africa, one feels how inadequately they reflect the vast amount of time and energy which was so generously given by those who organized the visits and by those who compiled the material contained in the seventy-one papers and the numerous technical brochures which were specially prepared for those who took part in these meetings. The representatives of Great Britain, of Canada, Australia, India, the Malay States, and other parts of the Empire, were all deeply impressed by what had already been achieved in South Africa and were even more impressed by the immense possibilities of the future.

KURRA FALLS POWER SCHEME

In the MAGAZINE for October, 1929, an article was given by John F. Shipley on the Kurra Falls Hydro-Electric Station, Northern Nigeria. Now that the scheme is completed, the accompanying illustrations may be used further to illustrate that article.

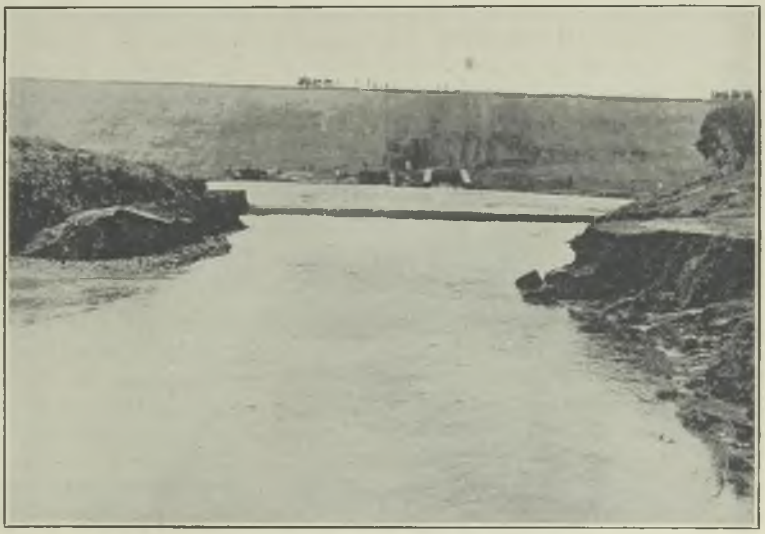
POWER HOUSE AND PIPE LINE.

INTERIOR OF POWER HOUSE.

LOWER END OF PIPE LINE.

Main Dam.

33 KV. Transmission Line (Barakin Lahadi–Durowa).



Downstream Face of Main Dam.

NEWS LETTERS

JOHANNESBURG

December 10.

Another Diamond Field (?).—It is reported in Bulawayo that an alluvial diamond deposit has been discovered on the Rhodesian side of the Limpopo River. Two miners, de Blanche and Fourie, whose headquarters are at Messina, state that they have struck what appears to them to be a very promising stretch of gravel about four miles in length. Unfortunately in their letter to the Mining Commissioner, Bulawayo, they make no report of finds of stones, if any.

Emerald Mining Results.—The general manager of the Beryl Mining Company, which is operating in the Leydsdorp Emerald Fields, Northern Transvaal, reports that during the period November, 1928, to October, 1929, the gross sales of the Beryl Mining Company's emeralds amounted to £11,255 18s. 3d., while London charges for cutting and selling were £2,512 0s. 5d., showing a net revenue of £8,743 17s. 10d. Mining expenses were £2,947 15s. 2d., and head office, administration, etc., £1,519 4s. 5d., a total of £4,466 19s. 7d., leaving a profit of £4,276 18s. 3d. Gross sales effected from November 1, 1929, to the end of August, 1930, totalled £8,393 11s. 3d., while London charges for cutting and selling were £2,173 16s. 11d., showing a net revenue of £6,219 14s. 4d. The total weight of crystals dispatched to London over the 12 months ended October, 1929, amounted to 270 lb., gross sales for which totalled £11,255 18s. 3d., and over the ten months a total of 300 lb. has been consigned, against which gross sales are shown at £8,393 11s. 3d. There are, however, of the 300 lb., some 20 lb. in transit to London, together with a substantial stock of cut goods ready for sale. Prices have been affected by the general severe depression in the precious stones market and sales of the poorer class goods have been restricted.

The total crystal content of the ground worked averages just under ½ lb. per ton treated, and the weekly average quantity dispatched for cutting represents approximately 1¾% of the total recovery. With the increased tonnage treated, reduction in native labour, etc., costs have fallen to 1s. per ton treated, and the total monthly expenditure at the mine does not exceed £280, to which has to be added a further £100 to cover all administrative and head office charges. In view of the low cost of working and the many facilities offered in breaking ground with only very small charges of explosives, thus reducing any injury to crystals to a minimum, it is particularly desirable to maintain the open-cast method of mining to as great a depth as possible and it is with this in view that mining is being continued from the surface until such time as the northern wall of the mine is reached. The area then opened will approximate some 12,000 sq. ft., of which, it is anticipated, by virtue of previous work together with the results obtained in the prospect shaft, approximately 6,000 sq. ft. will yield in the neighbourhood of 1 lb. of crystals per ton treated, and the area then opened will make it possible to continue the open-cast work to a considerable depth. It is hoped under the present programme of work, that the deeper level may be commenced towards the end of this year.

Manganese Industry's Prospects.—The branch line connecting the Postmasburg manganese fields with the South African Railway system was opened by the Minister of Railways on November 4. A few days later the Manganese Corporation's loading plant in Durban Harbour was brought into commission and it is hoped that the corporation will now be able to settle down to regular shipments on a big scale. The guaranteed tonnage for the first twelve months is 200,000, and for the next nine years 350,000. It is interesting to compare these figures with those of other important manganese-producing countries and with the total world trade in high-grade ore. Thus Indian exports in 1928 were 834,144 tons, Russian 933,000 tons, West African (Gold Coast) 376,913 tons, and Brazilian 359,651 tons. The figures for 1929 are not all available as yet. The total known world production for 1928 amounted to 2,868,700 tons, and for the previous two years exceeded three million tons. Thus even when the Postmasburg fields are turning out 350,000 tons, this will not represent much more than 10% of the world total, which does not suggest a serious dislocation of market conditions. On the other hand, even if this country puts a still greater share on the markets of the world, it is hoped that the grade and properties of the ore will ensure its absorption at remunerative prices.

Gold Recovery from Murchison Range Ores.—A demonstration has been given

here of a new process of recovering gold from stibnite ores. Several prominent mining experts were present. The demonstration was carried out by Dr. Annable, metallurgical chemist in charge of the Ferro Alloy, Proprietary, Limited, of Port Elizabeth, where for the past fifteen months he has been carrying out experiments on antimonial ore from the Murchison Range and similar occurrences in Rhodesia. The furnace, roasting concentrates, was shown in operation, but the main demonstration was the panning of concentrates before roasting and after roasting by the process. The former showed no traces of gold in the pan, but the roasted concentrates, after some six hours' treatment in the furnace along with a mixture of certain chemicals obtained as by-products from existing industries in the Union, showed a well-defined tail of gold, but not all the gold present according to original assays. It was explained that a great percentage of the gold in the concentrates after roasting was present in the roasted mass in a very finely divided state.

BRISBANE

November 18.

Progress at Mount Isa.—According to the latest reports from the Government Inspector of Mines and the local warden, the water difficulty at the Mount Isa mines, North Queensland, is still causing anxiety to the management and is retarding development work considerably. The mill is expected to be ready soon for testing purposes, but until the connexion is completed between the Urquhart and supply shafts the mine cannot furnish any tonnage of ore. The driving of the main haulage level which will connect the two shafts has been delayed owing to the great influx of water at the man and supply shaft. During the first fortnight of October the flow there was 2,000,000 gallons a day. Work in the east drive from this shaft to the Urquhart shaft had been suspended on September 20 and it was also found necessary in the middle of October to suspend operations temporarily in the west drive from the Urquhart shaft. This latter drive was in 702 ft. from the shaft when work was suspended until a water door, already constructed, was put in place. To complete the connexion between the two shafts there remained at the end of October about 1,000 ft. of driving to be done. In the diamond drilling campaign on the Black Star lode, No. 11B bore-hole has been deepened to 1,345 ft., No. 5C to 1,942 ft., No. 4C to 999 ft., and No. 1D to 1,869 ft. Assays from 1,816 ft. to 1,819 ft. averaged 17·2% lead, 0·2% zinc, and 3·2 oz. silver per ton.

Australian Coal Trade.—As the cost of producing coal in New South Wales was, as a result of the late stoppage in the mines of that State, reduced by some 4s. or 5s. a ton, and as no such reduction has been made in the adjoining State of Queensland, it is not surprising that the coal trade of the latter has continued to fall more seriously than ever, with the result that broken time has become the rule at most of the collieries. At length the proprietors have made a move to reduce wages, the reductions asked for ranging up to as much as 18%, and they say that, failing acceptance, the matter will be referred to the Southern Local Coal Board appointed under the Commonwealth Industrial Peace Acts. So far from accepting the proposal, the miners have decided to resist it to the utmost, even to the extent of calling out all or any of the men.

The prediction made during the 15-months coal stoppage in New South Wales that most, if not all, of the overseas trade then being lost would never be regained, is proving to have been only too well founded. Returns of exports from Newcastle, lately published, for the nine months ended September 30, 1929, and for the corresponding period of this year, show that notwithstanding that in the 1930 period the associated collieries worked four months and only two months in the last year's corresponding term, there was a heavy decrease in the latter nine months. In the period ended September last the actual quantity sent overseas and to Inter-State destinations was only 650,496 tons, valued at £890,449, whereas the tonnage similarly despatched in the like 1929 period was 1,045,477 tons, valued at £1,220,722.

Coal for the East.—A Sydney coal merchant (Mr. R. W. Gibbs), who has lately returned from a visit to the East, has informed a Press representative that there is no hope, under present conditions, of any coal being exported from Australia to that part of the world. The coal supplies for the East are coming from Japan, Borneo, and Sumatra. From these countries, where coloured labour is used to work the mines, Mr. Gibbs says coal is being delivered on the

basis of 19s. a ton, and even British owners cannot compete against such a price, which is lower than the f.o.b. rate in Australia. For Australia to secure any of this trade Mr. Gibbs considers it will be necessary to come back to the 1914 or pre-war level.

More Outside Capital.—Yet another group that has obtained mining concessions in Queensland is one consisting of English and Scottish capitalists, represented by Mr. Alexander Macdonald. The concession in this case covers areas at Cardross, an old mining centre some 20 miles south-west of Chillagoe, North Queensland. Here several years ago some thousands of tons of copper ore, which also contained high gold values, was mined and smelted locally. Several of the mines in the locality are said to carry 1 oz. gold per ton, while from others the average yield is reported to be 1½ oz. This is said to be one of the inducements for the investment of overseas capital in the venture. It is intended to start operations on a large scale on the holdings early next year. Mr. Macdonald, who has had a large experience in prospecting and mining in North Queensland, is now on his way to London for the purpose of creating a corporation to work the mines, involving a capital, it is understood, of £1,000,000.

Silver-Lead Discoveries near Mount Isa.—During the past month some excitement was caused by reported discoveries of silver-lead 12 miles north-east of Mount Isa. At first the reports from the locality were of a glowing nature and a dozen applications for mineral leases at the spot were promptly lodged with the local warden. The report of this official, however, considerably modified earlier accounts. It appears that the applications cover ground adjoining and surrounding a lease called the Turtle Dove from which eight tons of ore has been obtained by the holder in the past five months, while the areas now taken up mainly include ground held under mineral lease tenure five years ago and later abandoned. In the past month some prospecting has been done on the new leases and some narrow irregular veins of high-grade galena have been found, but at latest reports there was no surface indication of any large ore-body.

Other Cloncurry Mining.—In the large Cloncurry mineral belt, in North Queensland, copper mining for many years received chief attention until the discovery and development of the Mount Isa lead-zinc-silver mines. There are still extensive deposits of cupriferous ores yet remaining to be exploited. The principal mines have for some years been worked on tribute and, despite the extremely low price of copper that has ruled so long, a considerable quantity of the metal is still being mined. In some cases the material is being stacked to await a better market and at the time of writing there are some indications of an improvement in this respect. In the month of October 500 tons of ore, containing 126 tons of copper and 394 oz. of silver, was despatched from the district for treatment at the Chillagoe State smelters; while 23 tons, containing some 6 or 7 tons of metal, was sent away for treatment at the Port Kembla works, in New South Wales. The Trekelano mine, near Duchess, which is held by private owners, and which has been closed down since last April, is now being unwatered, and by this time the breaking of ore will have been resumed. The ore from this mine, which produced 5,162 tons last year, will also be sent to the Chillagoe smelters. The mineral returns from the Cloncurry field for last month include 17½ tons of cobalt, which was obtained from a mine near Koolamurra, and which has been sold to a southern buyer.

Western Australian Gold Find.—A find of gold, which is described by some mining authorities as the most important alluvial discovery for many years, has been made between Coolgardie and Norseman, Western Australia. Numerous slugs of gold, weighing from a few pennyweights to 26 oz. per ton, are said to have been unearthed, while an exceedingly rich quartz vein, from which some tons of high-grade ore has been bagged, has been found about two miles from the alluvial deposit. Representatives of English capitalists have taken options on the new field.

Mount Lyell's Reduced Profit.—For the year ended September 30 last considerably reduced profits are disclosed by the Mount Lyell Mining and Railway Company, Ltd., Tasmania. A net profit of £131,177 was struck, after writing off £29,327 for prospecting and development, £29,027 for depreciation, and £16,118 for taxation. This compares with £324,128 in the previous year and £200,051 in 1927–28. A dividend of 10%, against 20% in 1928–29, took £128,919, apart from interest allowed on prepayments on the new issue.

POH

December 5.

Restriction.—The course of the tin market remains a matter of anxiety to all concerned in the mining of tin ore. Expressed opinions as to the wisest policy for producers can still in effect be classified as restrictionist and anti-restrictionist. The former have advocated a number of methods of restriction, but to be successful there must be no weak or doubtful factors in the solution. Prominence has been given locally to the "Lovett scheme" which includes among its chief features provision of capital on a large scale and selling forward on the security of ore reputed to exist in tested, but unworked ground. The value of ore in ground to be worked and the margin of profit thereon are the bases on which capitalizations for mining chiefly depend, but in this case it would be a difficult task to verify the claims and data put forward by applicants so many and various.

The anti-restrictionists are chiefly the owners of large low cost dredging propositions, the best of which could certainly continue to produce profitably and on a large scale at prices for the metal even lower than the present. However, it must surely be deplorable folly for even such low cost producers to flood the market while exhausting their properties by extraction and sale of the ore at a price depressed by their own policy.

A very large amount of British capital is invested in properties and in equipment for working where dredging is not applicable; and indeed only certain types of alluvial deposits can be completely and cheaply worked out by dredging, so that other methods must in any case be employed though these may now be temporarily rendered unprofitable. A competition for survival, not of the fittest, but of the cheapest for the moment must be widely and permanently injurious, and if allowed to continue will cause serious damage in Malaya and to British interests both here and at home. It has been suggested that the F.M.S. Government should interpose being in the position of a trustee for the rulers and people of the Federated and Unfederated States who have directly or indirectly a large interest in the mining industry, and also for the protection of the very large British interests concerned.

F.M.S. Statistics.—During October there was no material improvement in the relation of supplies, stocks and consumption. The total production has increased, chiefly by the action of certain dredging companies, and the proportion from properties owned and worked by Europeans has risen from 37% of the total in September to 49% in October. The output from mines owned and worked by Chinese is nearly the same in amount as in the previous month; but their proportion of the total is less by 7%. Official Statistics of exports and imports for November show a total exported of 8,551 tons from all Malayan ports, of which 5,932 tons went to the United States. This total is higher than for any month since May.

The production of gold chiefly from the Raub Gold Mine in Pahang, with a much smaller output from the Batang Padang district in South Perak, does not show any marked fluctuations. The Raub mine has returned an average of about 1,830 oz. per month for the last six months.

Outlook for the Future.—It is not to be concealed that any further maintained reduction in the price of tin will disastrously affect many open-cast mines of which the great majority are owned and operated by Chinese. It is also clear that former inefficient methods will no longer serve both because much of the richest and most easily worked ground has been exhausted and because costs of labour and equipment have risen in proportion to the value of the product. There must be extensive reorganization and probably a good opportunity for experienced and trustworthy advice and management by engineers whose experience is not limited to local conditions.

VANCOUVER

December 10.

Review.—Until now the mining industry in British Columbia, taken as a whole, has survived the general depression amazingly well. Of late years four or five big companies have provided about 80% of the metal production. This year they will provide a much higher percentage, as, with the exception of the gold producers and the group of high-grade silver producers on Wallace Mountain, it has been impossible for the small concerns to carry on at current base metal and silver prices. The Consolidated Mining and Smelting Company of Canada, Britannia Mining and Smelting Company, and Premier Gold Mining Company have endeavoured to combat decreased metal prices by greater production and as a result

returns to date indicate that if the rate of production is maintained till the end of the year the outputs of silver, lead, and zinc will be the largest in the history of the Province. The Granby Consolidated Mining, Smelting and Power Company is not as fortunately situated as the other concerns. The greater part of its reserve is in the Copper Mountain mine, where, owing to a variety of conditions, the cost of copper production is appreciably higher than at Anyox or Britannia. It operated its Copper Mountain property at a loss for several months in the hope that copper prices would improve, but on November 15 it completely shut it down. Consequently, the copper output of the Province will fall slightly below that of last year. The gold output will be about the same as in 1929. Though the ore output will be more, the gold output of the Premier company will be less than in 1929, but this will be off-set by increased outputs from the Pioneer and Reno mines, and appreciable contributions from the Union, Planet, and several small concerns. The production from the Nickel Plate mine is expected to be about the same as that of last year. Unless something unexpected happens the coal output will be the smallest in the last 25 years. The deplorable condition of the coal mining industry has aroused the attention of the Federal and Provincial Governments and it is probable that some aid will be forthcoming from the Federal Government. The coal situation of Canada is peculiar. The mines are situated in the extreme east and west, but the most thickly populated part is in the centre of the Dominion, near to the United States coal-fields. As a result some $100,000,000 is spent annually by Canadians in the United States for coal. For long it has been felt that it should be possible to find some way whereby the major portion of this business could be diverted into Canadian channels and thereby give work to Canadians that now is going to citizens of the U.S.A. This matter is likely to receive very close attention from the Dominion Government on the return of the Premier.

The Kootenays.—The Consolidated Mining and Smelting Company of Canada has declared the customary dividend of 5% and bonus of $5 per share, covering operations for the second half of this year. This with a like dividend and bonus in the first half entails total disbursement for the year of approximately $6,715,000. The company estimates its gross profits for the year at $7,000,000, less about $1,000,000 which will have been spent on the exploration and development of non-productive properties. The estimated net profit of the West Kootenay Power and Light Company, the whole of the stock of which is owned by Consolidated, is estimated at $750,000. The company's earnings, therefore, are more than enough to cover dividend and bonus disbursements, and taxes, but not enough to do this and provide for depreciation and depletion, allowances for which will be charged to the contingent reserve, which has been established to meet just such conditions as now exist. The directors give notice of their intention sharply to curtail explorations and development on unproductive properties until the present depression shall have passed away. This probably accounts for the closing of the Emerald silver-lead-zinc mine, on Sibola Mountain, where, though work done to date indicates that a considerable reserve of ore can be developed, the provision of transport facilities to get the ore to the market will entail the expenditure of some half a million dollars. The directors state that they do not expect the present low base metal prices to continue through 1931. They announce that the manufacture of sulphuric acid, triple superphosphate, and monammonium phosphate will commence at the new fertilizer plant before the close of this year, but that the ammonia plant will not be put into operation until next September. This will complete the first unit of the fertilizer plant, and afterwards fertilizers of various descriptions will be produced at the rate of 400 tons daily. When completed the first unit will have cost approximately $10,000,000. This is some $2,000,000 more than the early rough estimate, but the capacity of the plant will be correspondingly larger. The mercury-arc rectifier for transforming alternating into direct current for the precipitation of electrolytic zinc at Tadanac has proved so satisfactory that a plant of 20% greater capacity is being installed at the Warfield fertilizer plant in connexion with the electrolytic hydrogen plant. In co-operation with the Governments of the three Prairie Provinces, the Canadian Pacific Railway Company, and manufacturers of agricultural machinery, the Consolidated company has conducted large-scale field experiments in the Prairies with fertilizer made in its small pilot plant at Tadanac. These experiments have demonstrated that the fertilizer

increases the grain yield; causes earlier maturity, thereby lessening danger from early frost before the grain has matured; and produces stronger plants that are better able to resist the attack of rust and other pests.

Reno Gold Mines October clean-up yielded 1,842 oz. of bullion, having a value of approximately $18,700, or $3,000 more than any previous clean-up. Mr. R. V. Neiley, managing director, reports the outlook at the property as " never better," and if the road can be kept open to the mine, similar clean-ups may be expected for some time. A rotary snow plough has been shipped to the mine and every effort will be made to maintain operations during the winter. Spokane interests are reopening the old Queen gold mine, in the same district. A considerable tonnage of commercial ore is said to have been left in the mine by previous operators and the first work will be to clean out the old workings to make this available. Euphrates Mines has let a contract to a Spokane firm to erect a 3,700 ft. aerial ropeway from the bottom adit on the Ell Tee vein to the Great Northern Railway tracks. A considerable tonnage of high-grade gold ore has been developed above the adit. The company expects to start shipping ore to Tadanac early in the new year.

Portland Canal.—Premier Gold Mining Company reports the output of the Prosperity mine for October was 1,487 tons having an average value of $31·03 per ton. This brings the shipments for the first ten months of this year up to 15,647 tons, which yielded 1,240,060 oz. silver and 360·6 oz. gold. The mine was brought to production in November, 1929 and in the 12 months to October 30 last has yielded ore to the gross value of $508,830 and resulted in a net profit of $192,155·24.

Bridge River.—Pioneer Gold Mines will increase the capacity of its mill from 100 up to 200 tons daily. The clean-up for November resulted in bullion to the value of $57,500. The mine is developed to a depth of 1,000 ft. and a drive at that level has exposed ore having an average value of $23 per ton across 3 to 5 ft. for a length of 800 ft. On No. 8 level, 125 ft. above, ore having an average value of $100 per ton was exposed across 2 ft. 3 in. for a length of 80 ft. Eastern interests are now negotiating for the acquirement of the adjoining Coronation and Lorne groups, on which a complete mining and power plant and camp have been constructed by Lorne Gold Mines and a considerable amount of underground development has been done. These properties have been idle since Messrs. Stobie, Forlong and Company, the sponsors for the company, failed.

TORONTO

December 19.

Sudbury. — International Nickel is steadily carrying out the policy of curtailing its output in view of present market conditions. In order to stimulate the demand for nickel its research department is pursuing investigations to discover new uses for nickel in accordance with the policy successfully carried out at the close of the war when the urgency demand for the metal for armaments suddenly ceased. The company has increased by one-third its appropriation for research purposes. Ore hoisting capacity at the Frood Mine will be supplemented in the near future by the installation of a new electric hoist in No. 4 shaft, formerly the Mond shaft, which will operate to a depth of 4,100 ft., the present depth of the shaft being 3,350 ft. The copper refinery at Copper Cliff is working satisfactorily, it has a capacity of 10,000 tons of copper per month and at present is refining at the rate of about 6,000 tons, much of the metal being stored. Mining and smelting operations at the Falconbridge, which were temporarily discontinued on account of the accumulation of matte at the refinery and to allow an addition to be made to the smelter, will be resumed early in January. The addition to the furnace will increase its capacity to 450 tons daily, but for some time it is not proposed to exceed the old rate of 200 tons per day. Underground, lateral work will be carried on at the 500 and 725 ft. levels. The Treadwell Yukon, the mill of which remains closed down, is actively pushing underground work. An exploration drive is being run eastward from No. 2 shaft on the 1,500 ft. level to test the mineralization at that horizon and locate the downward extension of the vein opened up on the upper levels. A group of Toronto financiers have taken over a property at Three Duck Lake in Chester township where rich gold showings have been encountered, and work will be actively carried on during the winter.

Porcupine.—During November the seven producing mines of the Porcupine area yielded bullion to the value of $1,517,137 from the treatment of 243,658 tons of ore,

as compared with the October output of $1,507,071 from 206,715 tons of ore. The Hollinger is treating ore at the rate of between 4,400 and 4,500 tons daily. The gold content of the ore milled this year has averaged $6·60, with a recovery of $6·15 per ton. Underground work has developed ore in excess of mill consumption and the ore reserves at the close of the year are expected to show a substantial increase since last year. The company has declared an extra dividend of 5 cents per share by way of bonus. The new mill of the Dome mines is operating satisfactorily, treating about 1,000 tons of ore per day and will be gradually stepped up to its full capacity of 1,500 tons. Development work carried on steadily during the year has opened up ore reserves sufficient to keep the mill in operation for four years, placing the company in a strong position. The McIntyre Porcupine has been mainly engaged in opening up the ore-body cut in a south cross-cut on the 3,625 ft. level, stated to be 29 ft. in width and assaying $9·00 to the ton. Ore reserves have been substantially increased. The output during the first ten months of the year amounted approximately to $3,850,000, the recovery averaging about $8·25 to the ton. The Vipond Consolidated will put down its shaft an additional 500 ft. to the 1,700 ft. level, at which horizon lateral work will be undertaken to reach the porphyry deposit in the centre of the field, in association with which good values were obtained on the upper levels. At the Canusa what is believed to be the main ore-body has been cut by diamond drilling, the core showing 7 ft. of fine sulphide ore. The company has been financed for development on an extensive scale.

Kirkland Lake.—The bullion output of the Kirkland Lake area during November was valued at $1,481,937, produced from 122,477 tons of ore, as compared with $1,489,098 for October from 121,758 tons. The mill of the Lake Shore is handling upwards of 2,000 tons of ore per day. The 2,000 ft. level on the north vein system is opening up better than any level above, and work on the south vein system has shown an improvement in the grade of ore. This deposit contains moderately high-grade ore in a large volume, only a small proportion of which has been mined. The Teck-Hughes mills are treating an average of approximately 1,000 tons per day with a recovery of $18 per ton. The construction of a further mill unit of 300 to 350 tons capacity is making good progress and should be completed by April. Development work on five new levels from the 25th to the 30th horizon has been started. Cross-cutting on the lower levels is expected to locate the ore before the end of the year. At the Wright-Hargreaves, alterations to the mill have been completed, increasing the rate of production to 700 tons per day of an average value of $11 per ton. The programme of development at depth is being proceeded with and work on the 2,400 ft. level is meeting with very good results. A new 2,500 cu. ft. compressor is being installed. Considerable additions have been made to the ore reserves and it is now estimated that these will reach between 800,000 and 1,000,000 tons by the end of the year. Recent improvements in the mill of the Sylvanite have enabled the rate of production to be stepped up to 270 tons of ore per day. The extension of main workings to 2,500 ft. in depth is to be pushed forward. The work so far done at the 2,000 ft. level has substantially increased the ore reserves. The Kirkland Lake gold mine has set a new record for production, the output for the first 11 months of the year being valued at £380,000. On the 4,300 ft. level, the present bottom level, good values have been encountered east of the dyke. An encouraging feature is that both the width of the veins and the grade of ore have been found to show improvement at depth. The Barry-Hollinger will sink its shaft to a depth of 2,500 ft. approximately 750 ft. below the present bottom level. Production is at the rate of about $18,500 a month.

Rouyn.—Mining operations in the Rouyn field have been temporarily checked by the low prices of copper and zinc. Under more favourable market conditions the base metal mines of this area would spring immediately into profitable production. The two principal producers at present are Noranda, which is curtailing its copper output and devoting attention mainly to the production of gold, and the Granada Rouyn gold mine, the output of which averages $1,000 per day. Other mines are more or less marking time, but have large ore reserves on which to produce on an extended scale. These mines include the Waite-Montgomery, Abana, Amulet, and Newbec.

Manitoba.—The Flin Flon recently made its first shipment of three cars of copper and zinc for refinement to England, previous shipments having been to the United States

and Canadian refineries. Production has been temporarily halted by the burning out of the main shaft of the converter, necessitating the closing down of the plant. Advantage was taken of the opportunity to make needed repairs on other parts of the installation. Good progress is being made in the construction work on the plant of the Sherritt-Gordon mines, all the equipment and machinery has been installed and the plant is expected to be ready for production by the end of January. The concentrator will have a capacity for handling 1,500 tons of ore per day. The ore so far indicated is between 5,000,000 and 6,000,000 tons, which is expected to yield about 70 lb. of copper per ton. The officials believe that owing to the low operating costs and the favourable contracts for smelting, the Flin Flon production can be profitably carried on even at the present low price of the metal. Central Manitoba is opening up new ore-bodies, and has prepared for an active winter campaign. During the first nine months of the year 34,954 tons of ore were treated with a production of $306,344, being a recovery of $8·76 to the ton. The mill is treating an average of 130 tons per day.

CAMBORNE

January 5.

1930.—The year in Cornwall, as in other mining districts, has been one of disapppointment and tin prices fell to such a low figure that one after another all the producing mines in the county suspended operations except at East Pool and Agar and at the Castle-an-Dinas. Compared with 1922–23 the position is, however, far more favourable and promising in relation to prospects of a resumption of operations. Eight years ago the underground reserves of the mines had in some cases been practically exhausted by the Government's demands for "war material" and cash reserves had been spent in the endeavour to "keep things going." At the present time underground reserves in several of the mines have not been depleted and in some instances substantial cash reserves remain in hand, ready for application when circumstances justify a resumption of work.

East Pool and Agar.—A profit of £7,404 was shown at the last annual meeting and £5,000 was added to the previously existing reserve of £10,000.

South Crofty.—The profit for 1929 was £7,838 and the accounts at the last annual meeting showed £46,627 cash at bank and in hand.

Geevor.—In the financial year ended March 31 the profits amounted to £9,458 and cash reserves to £31,467, of which £20,000 was placed in 5% War Loan in August.

Other Mines.—Wheal Kitty, Polhigey, and Jantar are less favourably placed financially, but development up to the time of suspension had given good results.

The black tin marketed by the six principal mines during the year is as follows:—

	Tons		Tons
East Pool & Agar	900	Wheal Kitty	351
South Crofty .	629	Polhigey .	256
Geevor . .	540	Jantar .	230

In 1929 the companies mentioned sold 3,735 tons of black tin.

Mining Development Scheme.—The secretary of the Non-Ferrous Sub-Committee of the Metalliferous Mines Advisory Committee has written to the East Pool and Agar, South Crofty, and Dolcoath companies asking their opinion concerning certain portions of the scheme prepared by the joint committee of the Chamber of Mines and Cornish Institute of Engineers, more particularly relating to the advantages which might attend an amalgamation of the three companies. In the scheme emphasis was laid upon the desirability and importance of immediately resuming operations at and from Roskear shaft, as the efficient plant installed there is intact and ready for immediate use and as at least 200 men could be at once employed, a number to be gradually increased as work proceeded.

PERSONAL

A. O. Brown has returned from Portugal and left for Norway.

Edwin D. Candlish is leaving for Northern Rhodesia.

J. L. Ford is home from Nigeria.

C. Frazier is home from Angola.

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

C. J. Inder has returned from Panama.

A. C. Martin has returned to Burma.

Ernest Parsons is home from East Africa.

A. V. Paull is returning from Venezuela.

J. W. Pertwee is returning from Venezuela.

J. Dudley Pollett has left for Sierra Leone.

F. Maxwell Stuart is returning from Peru.

L. C. Stuchey is home from Spanish Morocco.

J. S. Watkins has returned from West Africa.

Percy Whitehead is home from Bolivia.

J. S. Whitworth has returned to F.M.S.

J. S. Williams is home from India.

Harley B. Wright is returning to the Gold Coast.

Sir Henry Montagu Rogers, chairman of East Pool and other Cornish companies, died on Jan. 6.

W. J. Wellington died suddenly at Falmouth on December 9, 1930, at the age of 50. He was an Associate of the Institution of Mining and Metallurgy and had been professionally engaged in Montana, Burma, and France, as well as in Cornwall.

Alexander Smart died on December 28, 1930, at the age of 71. Since 1896 he had been consulting engineer for De Beers Consolidated, Rand Mines, Ltd., and Messrs. A. Moir and Co. He was a Member of the Institution of Mechanical Engineers and had been in partnership with Mr. F. Maeers since 1927.

Sir Francis Grant Ogilvie, who died on December 14, 1930, at the age of 72, was a former Principal of the Heriot-Watt College, Edinburgh, later a secretary of the Board of Education for the Science Museum and the Geological Survey, and from 1920 until last year chairman of the Geological Survey Board.

Henry M. Ami, who has died in Canada at the age of 72, was on the Geological Survey of the Dominion from 1882 to 1912 and in 1917 was attached to the British Embassy at Washington in charge of war metals and minerals. He was a Fellow of the Geological Society of London and was awarded the Bigsby Medal in 1903.

Gordon Duff was killed as a result of a trolley accident at Panposh, India, on November 21, 1930, at the age of 52. He graduated from the Royal School of Mines in mining in 1900, and held various posts in South India till 1905. In that year he was appointed Prospector in Chief, Mysore Reef and General Exploration Co., in Egypt. From 1906–1913 he was Underground Agent and Superintendent, Cape Copper Co., India, and from 1913 till the date of his death he was General Manager, Bisra Stone and Lime Co. (Messrs. Bird & Co.), Birmitrapur, India.

Robert James Frecheville died at Monte Carlo on December 20, 1930, at the age of 84. He graduated from the Royal School of Mines in 1869 and was for many years in consulting practice in London. He was a Member of the Institution of Civil Engineers and also of the Institution of Mining and Metallurgy, of which latter he served on the Council. He began professional work in Nova Scotia and then, after three years spent in the mining districts of Nevada, Colorado, and California, served from 1873 to 1877 in the mining department of the Japanese Government. Later he managed the El Callao gold mines in Venezuela and returned to this country in 1880, when he became Inspector of Mines for the West of England.

TRADE PARAGRAPHS

Menck and Hambrock, G.m.b.H., of Altona, Hamburg, Germany, are now represented in this country by James McEwan and Co., Ltd., of Evelyn House, 101, Finsbury Pavement, London, E.C. 2.

Bureau of Information on Nickel of the Mond Nickel Co., Ltd., of Imperial Chemical House, London, S.W. 1, has published a further bulletin on nickel cast iron which deals with the properties of this alloy, the practical application in cast iron, and a variety of associated information.

J. Pohlig, A.G., of Köln, Germany, issue an attractively illustrated booklet drawing attention to their transporting and conveying equipment. This contains photographs of elevators, waggon tippers and other colliery plant, together with ropeways and conveying belts serving the different sections of the undertaking.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, report that new orders have been received for the following equipment: For England: Two 4 ft. by 5 ft. 1-surface, type 39, Hum-mer electric screens for coke; eight R.L. 11 mills for coal; one 4 ft. by 7 ft. 1-surface, type 39, Hum-mer electric screen for coal; and one 4 ft. by 6 ft., type 60, Hum-mer electric screen for clinker. For Japan: One R.L. 5 mill for copal gum.

Hardypick, Ltd., is the name by which the **Hardy Patent Pick Co., Ltd.,** of Sheffield, will in future be known. They point out that it has been found advisable to dissociate the name from the idea that the firm are makers of picks only. Among other specialities which they make for the mining industry may be mentioned, rock-drilling machinery, haulages, deep boring and alluvial boring plant, air-compressors, grinding, conveying, and elevating machinery, and magnetic separators.

G. A. Harvey and Co. (London), Ltd., of Woolwich Road, London, S.E. 7, inform us that in spite of trade depression they are making an important extension to their works. A new building is in course of construction to meet the requirements of their steel plate construction and steel furniture and equipment departments. Only two years ago a large extension was made to their works, but the rapid development of the two departments mentioned has necessitated this further addition.

Thomas Locker and Co., Ltd., of Ellesmere Works, Warrington, inform us that they are exhibiting at the British Industries Fair, Birmingham, in February. There will be many exhibits of particular interest including the electrically operated screen "Supreme" (Traylor Patent); woven wire screens; perforated metal screens in various metals, strengths and apertures; wedge wire screens; wedge bar screens; woven wire conveyor bands; perforated metal and woven wire trommels—in fact, a complete range of screens for every need.

John Bedford and Sons, Ltd., of Lion Steel Works, Sheffield, issue a booklet which is fully illustrated with photographs and drawings and covers some 30 pages describing their hollow drill steel which is made by the patent copper-core process. This deals with the essential features required of present day drill steel and goes on to consider how far these requirements are met by the copper-core drill steel and gives a description of the manner in which it is produced. This is followed by matter giving comparisons with various brands of drill steels. Notes are added with reference to the correct temperature of manufacture and the use and treatment of drill steel including the heat treatment necessary, observations on forging, hardening, furnace construction, and other useful information for the user.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, inform us that an arrangement has been made between themselves and the **Allis-Chalmers Manufacturing Company,** of Milwaukee, U.S.A, in which the former will manu-

facture at Sheffield and sell in certain parts of the British Empire and Asia various types of Allis-Chalmers grinding and crushing machinery. This arrangement does not apply to Canada and the sales organization of the company in Paris, London, and South Africa will not be affected in any way, but firms in the crushing, grinding, and cement industries will have in many instances the advantages of the combined technical resources of the two companies, together with British manufacture should they prefer it. Further information as to the range of Allis-Chalmers equipment in which Edgar Allen are interested will be supplied from time to time.

Sulzer Bros., of 31, Bedford Square, London, W.C. 1, issue a catalogue devoted to mine ventilating fans. This sets out the duties which a mine fan has to perform and emphasizes the fact that the fan has also to withdraw vitiated air from the mine and must therefore be able in its various parts to withstand corrosion and be easy of access for cleaning. Their fans are made in ranges having efficiencies between 70 and 75% depending on the quality of the masonry ducts and the smoothness of all the other surfaces with which the air comes in contact. For the smaller types with impellers up to 4 ft. diameter the exact characteristics have been determined by accurate nozzle tests at the works and those of the larger fans have been established as opportunities permitted by tests in completed installations. The fans are made in a wide range of sizes extending from 37 h.p. for 19 cubic metres of air per second to 580 h.p. for 182 cubic metres per second.

METAL MARKETS

Copper.—Prices of electrolytic copper in New York moved erratically during December. Opening the month at about 12 cents per lb. f.a.s., they steadily weakened until down to 10 cents was being accepted. Subsequently, however, there was a recovery to 10·50 cents. It was obvious, however, that sentiment on the other side of the Atlantic, owing to the poor state of industry and the huge unabsorbed stocks, was nervous. In London Standard Copper underwent a similar decline and subsequent partial recovery. The outlook for the metal is scarcely reassuring at the moment, as although production is certainly being cut down, what the position really needs is for the demand from consumers to broaden out again and there is no indication of any such development being imminent. Conditions in Europe, apart from France, are highly unsatisfactory.

Average price of Cash Standard Copper: December, 1930, £46 16s. 4d.; November, 1930, £46 3s. 8d.; December, 1929, £68 7s. 3d.; November, 1929, £69 8s. 4d.

Tin.—Prices of tin eased during December owing to a general lack of confidence until towards the close of the month when announcements regarding an ambitious new scheme of output-control infused the market with a stronger tendency and a small gain was recorded, on balance. The new scheme invites the Governments of tin-producing countries to limit output by legislation and allots the countries concerned certain percentage-quotas of the total world production based on certain statistics for 1929. Apparently it is thought that the Governments in question will be favourably disposed towards the project, but this remains to be seen. Meanwhile, consumption remains dull and the world "visible supplies" during the past month recorded a substantial further increase.

Average price of Cash Standard Tin: December, 1930, £111 12s. 4d.; November, 1930, £113 11s. 10d.; December, 1929, £179 10s. 2d.; November, 1929, £180 13s. 7d.

Lead.—The market was easy last month, and although the usual "squeeze" on the part of the big market interests was witnessed towards the close, when needy "shorts" were forced to pay higher prices for the metal they required, prices registered quite an appreciable loss on balance. There is evidence to show that world stocks are still increasing and it is estimated that in the U.K. alone supplies of new metal this year have been about 45,000 tons in excess of consumption. It is possible that the dispute between the Australian miners and employers may hamper, if it does not definitely interrupt, shipments from Australia, but on the other hand the big Mount Isa properties in Queensland are about to go into operation. It rather looks as if producers will be forced to curtail production on a bigger scale than at present if surplus stocks are not to expand further, as there are no signs at the moment that any improvement in consumption is about to occur.

Average mean price of soft foreign lead: December, 1930, £15 5s. 8d.; November, 1930, £15 18s. 7d.; December, 1929, £21 9s. 6d.; November, 1929, £21 12s. 7d.

Spelter.—The general tendency of values, despite a rather firmer tone at the end of the month, was easy during December. The market has remained in a dull and rather hopeless condition, as supplies on both sides of the Atlantic are far in excess of current market needs. The ambitious schemes of producers, who until recently were planning a further wholesale expansion in output, will undoubtedly have to be modified considerably until the world recovers from its present economic troubles. Meanwhile, owing to the failure of the effort to establish the Spelter Cartel, it seems likely that a process of ruthless elimination will force the non-economic plants to suspend operations. Thus eventually the situation should become sound again—and sooner than if the market were artificially maintained by a Cartel or other producers' organization.

Average mean price of spelter: December, 1930, £13 9s. 9d.; November, 1930, £14 19s. 5d.; December, 1929, £20 7s. 5d.; November, 1929, £21 2s.

Iron and Steel.—The British iron and steel market remained in a dull and gloomy condition last month. There was a tendency for the blast furnaces to accumulate a certain stock again, particularly as a result of the Christmas and New Year holidays, and consumers were inclined to anticipate further reductions in pig iron prices. Cleveland makers, however, made no change in quotations, and No. 3 foundry remained at 63s. 6d. East Coast Hematite (Mixed Nos.) was fairly steady at between 70s. 6d. and 71s. The finished steel mills remained poorly employed.

Iron Ore.—There was no improvement in the iron ore market during December. Business was practically at a standstill, and as most ironmasters have large tonnages still to be delivered against 1930 contracts there is little prospect of any early revival in business. Best Bilbao rubio is quoted nominally at about 16s. to 16s. 6d. per ton c.i.f.

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.		Electrolytic.	Best Selected.			Soft Foreign.	English.			
	Cash.	3 Months.			Cash.	3 Months.			Cash.	Forward.	
Dec.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
11	46 1 10½	46 1 10¾	51 0 0	—	108 18 9	110 1 3	13 15 0	15 8 9	16 15 0	15 8/16	15 9/16	85 1½
12	45 8 1½	45 5 7¾	50 0 0	47 10 0	108 6 3	109 6 3	13 12 6	15 2 6	16 10 0	15 7/16	15 10/16	85 1½
15	45 8 9	45 0 7½	49 10 0	—	106 13 9	107 16 3	13 10 0	15 2 6	16 10 0	15¼	15½	85 1½
16	44 5 7½	44 1 10½	48 10 0	46 0 0	105 12 6	106 16 3	13 6 3	14 17 6	16 5 0	14½	14¾	85 1½
17	43 13 9	43 10 7½	47 10 0	—	104 11 3	105 13 9	13 5 0	14 12 6	16 0 0	14 11/16	14 13/16	85 1½
18	45 3 9	45 1 3	47 16 3	—	105 18 9	107 3 9	13 10 0	14 16 3	16 5 0	14½	14 9/16	85 1½
19	45 11 3	45 6 3	48 10 0	46 0 0	105 17 6	107 1 3	13 11 3	14 16 3	16 5 0	14⅝	14 11/16	85 1½
22	47 5 7½	46 19 4½	49 10 0	—	114 3 9	115 12 6	13 16 3	15 0 0	16 10 0	15 1/16	15	85 1½
23	46 6 3	46 1 3	49 5 0	47 15 0	111 1 3	112 8 9	13 15 0	15 3 9	16 10 0	14 13/16	14¾	85 1½
24	46 11 3	46 7 6	49 10 0	—	115 17 6	117 2 6	13 15 0	15 3 9	16 10 0	14¾	14 11/16	85 1½
29	47 13 1½	47 8 1½	50 15 0	—	117 6 3	118 15 0	13 12 6	15 1 3	16 10 0	14⅞	14 9/16	85 1½
30	46 16 3	46 11 3	50 0 0	48 5 0	118 1 3	119 11 3	13 15 0	15 2 6	16 10 0	14¾	14 7/16	85 1⅝
31	46 9 4½	46 9 4½	49 12 6	—	116 11 3	118 1 3	13 15 0	15 0 0	16 5 0	14 7/16	14⅝	85 1⅝
Jan.											
2	45 18 9	45 16 3	49 2 6	47 5 0	116 11 3	118 1 3	13 6 3	14 5 0	15 15 0	14 1/16	14 7/16	85 1½
5	46 13 1½	46 9 4½	49 10 0	—	119 8 9	120 18 9	13 7 6	14 12 6	16 0 0	14½	14 7/16	85 0¾
6	45 13 1½	45 11 10½	49 0 0	47 0 0	118 11 3	119 18 9	13 7 6	14 7 6	16 0 0	13 11/16	13⅝	85 1
7	46 1 3	45 18 9	49 0 0	—	121 13 9	123 3 9	13 7 6	14 6 3	15 15 0	13⅞	13 11/16	85 0¾
8	45 6 3	45 6 3	48 15 0	—	119 18 9	121 6 3	13 1 3	14 6 3	14 7 6	13 1/16	13 1/16	85 0¾
9	44 15 0	44 15 0	48 5 0	46 6 3	117 0 0	118 7 6	13 2 6	14 8 9	14 7 6	13 1/16	13 1/16	85 0

Antimony.—At the close of December English regulus was quoted between £36 and £46 per ton. Chinese material was quiet with spot priced around £25 5s. ex warehouse, whilst January shipment from China commanded between £23 and £24 c.i.f.

Arsenic.—Mexican arsenic is the predominating factor at the moment at £18 per ton c.i.f. Liverpool, Cornish being nominal and scarce at about £18 10s. to £19 per ton f.o.r. mines.

Bismuth.—There is a moderate demand at the unchanged official price of 5s. per lb. for merchant quantities.

Cadmium.—A fair business has been passing at around 1s. 9½d. to 1s. 10½d. per lb., according to quantity.

Cobalt Metal.—There is very little doing in this market, but the official price is unchanged at 10s. per lb.

Cobalt Oxides.—Leading interests continue to quote 8s. per lb. for black and 8s. 10d. for grey.

Chromium Metal.—Platers still purchase fair quantities at about 2s. 7d. per lb.

Tantalum.—Business is negligible and prices nominal at between £40 and £50 per lb.

Platinum.—Demand has not been keen, and competition between sellers has resulted in prices being adjusted to £6 10s. to £6 15s. per oz. for refined metal.

Palladium.—Quite a fair business has been done in this metal, and quotations are rather firmer at £3 15s. to £4 5s. per oz.

Iridium.—Sales are small and prices easier at £33 to £36 per oz. for sponge and powder.

Osmium.—This market wears quite a sound appearance at the unchanged prices of £16 to £16 10s. per oz.

Tellurium.—Hardly any call is received for this metal, and quotations can only be called nominal at 10s. to 12s. 6d. per lb.

Selenium.—There is a steady demand at about 7s. 8d. to 7s. 9d. per lb. ex warehouse Liverpool.

Manganese Ore.—In the absence of any appreciable business the feature of this market has been the continued willingness of Russia to sell at low prices. Washed Caucasian ore to-day could probably be bought at 11d. per unit c.i.f., but other producers are asking appreciably higher figures.

Aluminium.—Very quiet conditions have ruled here during the past month or so and even at the current reduced rate of output producers are finding it difficult to market their output. Prices, however, are without change at £85, less 2%, delivered, for ingots and bars.

Sulphate of Copper.—Current quotations for British material are about £21 to £21 10s. per ton, less 5%.

Nickel.—Business is slack, but prices are upheld at £170 to £175 per ton for both home and export.

Chrome Ore.—The quieter demand now ruling for chrome ore is shown by the reduced output from Rhodesia, but prices have not varied much, good 48% ore being quoted at about 77s. 6d. to 80s. per ton c.i.f.

Quicksilver.—Producers are maintaining prices pretty steadily at £22 7s. 6d. per bottle, full terms, but business is trifling.

Tungsten Ore.—During December buyers continued a policy of inaction and sellers' ideas were reduced further. Forward shipment from China is now obtainable at between 14s. and 14s. 6d. per unit c.i.f., but even at these levels buyers are not interested.

Molybdenum Ore.—Quotations remain at around 32s. 6d. to 35s. 6d. per unit c.i.f. for 80 to 85% concentrates.

Graphite.—Demand is slow but prices are pretty steady at about £25 to £27 per ton c.i.f. for good 85 to 90% raw Madagascar flake and £24 to £26 c.i.f. for 90% Ceylon lumps.

Silver.—Distinctly easy conditions ruled in the silver market during December, for after opening at 16½d. on December 1 spot bars declined fairly steadily throughout the month. Towards the end of the month there was a check to the downward movement when some small Eastern buying was seen, but on December 31 quotations fell to the lowest level ever recorded, spot bars closing at $14\frac{7}{16}$d.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
December, 1929	813,574	37,560	851,134
January, 1930	848,245	34,556	882,801
February	783,086	35,102	818,188
March	852,089	37,281	889,370
April	831,996	36,610	868,606
May	876,893	39,320	916,213
June	847,352	40,515	887,867
July	871,468	41,184	912,652
August	878,474	42,607	921,081
September	860,311	42,865	903,176
October	884,632	41,929	926,561
November	844,038	40,715	884,753
December	867,202	41,290	908,492

TRANSVAAL GOLD OUTPUTS.

	November.		December.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	88,500	£137,892	92,800	£143,177
City Deep	95,000	25,057	89,000	24,201
Cons. Main Reef	65,000	22,501	66,000	22,935
Crown Mines	245,000	76,978	247,000	79,360
D'rb'n Roodepoort Deep	46,000	14,939	46,000	15,194
East Rand P.M.	153,000	40,903	153,000	40,860
Geduld	83,000	26,527	84,000	27,031
Geldenhuis Deep	70,000	15,589	68,500	16,062
Glynn's Lydenburg	5,700	2,161	6,200	2,296
Government G.M. Areas	196,000	£380,514	203,000	£394,866
Kleinfontein	50,600	10,973	50,700	10,999
Langlaagte Estate	78,000	£112,184	80,000	£110,857
Luipaard's Vlei	31,000	7,883	30,000	7,655
Meyer and Charlton	17,800	£17,812	18,400	£18,270
Modderfontein New	160,000	69,692	163,000	70,183
Modderfontein B	69,000	23,483	69,500	22,684
Modderfontein Deep	42,800	22,217	44,200	22,900
Modderfontein East	68,500	20,145	70,000	20,588
New State Areas	76,000	£162,277	78,000	£167,857
Nourse	66,500	19,575	64,800	19,348
Randfontein	213,000	£239,386	221,000	£248,557
Robinson Deep	97,000	27,570	96,800	27,873
Rose Deep	62,000	13,210	62,500	13,276
Simmer and Jack	77,800	21,993	76,000	22,280
Springs	66,300	£140,386	69,000	£144,749
Sub Nigel	30,900	27,668	31,000	27,784
Transvaal G.M. Estates	14,900	4,851	15,200	5,115
Van Ryn	41,000	£41,142	41,500	£42,191
Van Ryn Deep	64,000	£102,096	67,000	£104,746
West Rand Consolidated	91,500	£106,503	93,000	£106,713
West Springs	68,800	£76,542	63,100	£76,176
Witw'tersr'nd (Knights)	55,000	£50,167	55,500	£49,896
Witwatersrand Deep	39,200	12,822	40,500	12,389

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., 1929	2,530,370	28 2	19 10	8 4	1,056,839
October	2,658,100	28 1	19 8	8 5	1,115,744
November	2,559,450	28 3	19 11	8 4	1,071,199
December	2,528,000	28 3	19 11	8 4	1,058,231
January, 1930	2,618,600	28 2	19 9	8 5	1,103,718
February	2,421,100	28 5	20 0	8 5	1,019,482
March	2,663,820	28 1	19 8	8 5	1,121,216
April	2,549,250	28 7	20 1	8 6	1,084,504
May	2,741,634	28 1	19 8	8 5	1,153,549
June	2,651,970	28 2	19 7	8 7	1,141,197
July	2,706,900	28 5	19 8	8 9	1,184,107
August	2,693,100	28 3	19 6	8 9	1,174,828
September	2,653,250	28 5	19 8	8 9	1,160,430
October	2,741,080	28 5	19 7	8 10	1,212,822
November	—	—	—	—	1,145,097

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
December 31, 1929	184,280	15,326	4,811	204,417
January 31, 1930	190,663	15,288	5,889	211,840
February 28	196,752	15,495	6,584	218,831
March 31	200,134	15,350	7,002	222,316
April 30	202,434	15,109	5,565	223,108
May, 31	202,182	15,028	5,340	222,550
June 30	201,324	14,943	5,126	221,393
July 31	201,111	14,670	5,490	221,271
August 31	202,257	14,788	5,754	222,799
September 30	205,061	14,706	5,767	225,534
October 31	206,778	14,482	5,032	226,292
November 30	205,030	13,973	4,748	223,751
December 31	203,473	13,763	4,607	221,843

PRODUCTION OF GOLD IN RHODESIA.

	1927	1928	1929	1930
	oz.	oz.	oz.	oz.
January	48,731	51,356	46,231	46,121
February	46,461	46,286	44,551	43,385
March	50,407	48,017	47,388	45,511
April	48,290	48,549	48,210	45,806
May	48,992	47,323	48,189	47,645
June	52,910	51,762	48,406	45,208
July	49,116	48,960	46,369	45,810
August	47,288	50,611	46,473	46,152
September	45,838	47,716	45,025	46,151
October	46,752	43,056	46,923	45,006
November	47,435	47,705	46,219	44,351
December	49,208	44,772	46,829	—

RHODESIAN GOLD OUTPUTS.

	November.		December.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,400	10,609	24,400	10,558
Globe and Phœnix	6,013	5,031	6,026	5,393
Lonely Reef	6,200	3,650	6,400	3,675
Luiri Gold	1,547	£3,707	—	—
Rezende	6,400	2,680	6,400	2,685
Sherwood Star	4,400	£11,520	4,600	£11,081
Wanderer Consolidated	15,400	3,862	15,900	4,077

WEST AFRICAN GOLD OUTPUTS.

	November.		December.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	—	—	—	—
Ashanti Goldfields	11,388	13,534	11,620	13,958
Taquah and Abosso	10,159	£16,135	10,080	£15,921

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
December, 1929	33,650	1,459	1,636
January, 1930	25,472	952	209
February	31,307	1,354	350
March	27,946	2,562	382
April	36,652	1,812	1,081
May	32,967	3,480	580
June	41,738	812	673
July	34,174	2,327	728
August	38,579	1,864	323
September	32,034	1,992	429
October	39,687	—	—
November	33,708	—	—
December	42,097	—	—

AUSTRALASIAN GOLD OUTPUTS.

	November.		December.	
	Tons.	Value £	Tons	Value £
Associated G.M. (W.A.)	5,000	8,368	3,596	4,739
Blackwater (N.Z.)	3,450	4,766	2,860	4,730
Boulder Persev'ce (W.A.)	7,070	15,506	5,032	10,841
Grt. Boulder Pro. (W.A.)	10,213	24,133	—	—
Lake View & Star (W.A.)	7,033	20,404	—	—
Sons of Gwalia (W.A.)	12,058	15,607	8,514	12,213
South Kalgurli (W.A.)	8,261	14,994	6,042	11,351
Waihi (N.Z.)	17,654§	{ 6,148* / 32,111†	—	{ 9,034* / 83,435†

* Oz. gold. † Oz. silver. § To Nov. 15.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	November.		December.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	3,500	2,312	3,500	2,107
Champion Reef	8,465	5,858	8,760	5,863
Mysore	17,403	11,600	18,008	12,109
Nundydroog	11,502	7,049	11,540	7,667
Ooregum	12,750	5,829	12,000	6,139

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	November.		December.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	9,600	12,638	—	—
Frontino & Bolivia (C'lbia)	2,550	10,595	2,670	10,398
Lena (Siberia)	—	—	—	—
Lydenburg Plat. (Trans.)	4,000	988*p*	—	—
Marmajito (Colombia)	1,000	5,652	1,100	5,064
Fresnillo	81,651	20,539*d*	—	—
Onverwacht Platinum	—	—	—	—
Oriental Cons. (Korea)	—	86,000*d*	15,011	86,698*d*
St. John del Rey (Brazil)	—	40,000	—	43,500
Santa Gertrudis (Mexico)	42,053	82,056*d*	—	—

d Dollars. *p* Oz. platinoids.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

January, 1930	6,128	July	5,525
February	4,768	August	4,153
March	5,763	September	4,048
April	5,407	October	4,807
May	6,043	November	4,812
June	5,590	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Oct.	Nov.	Dec.
Ayer Hitam	59½	65½	119
Batu Caves	—	—	—
Changkat	50	55	60
Chanderiang	—	—	—
Gopeng	65	65½	65½
Hongkong Tin	77	63	62
Idris Hydraulic	25½	29½	38
Ipoh	40½	48½	56½
Jelapang	—	—	—
Kampar Malaya	86	80	93
Kampong Lanjut	158	110	75
Kamunting	—	—	—
Kent (F.M.S.)	39	40	44½
Kepong	38	—	—
Kinta	27	33	33
Kinta Kellas	23¾	35¾	74½
Kuala Kampar	105	100	75
Kundang	—	—	—
Lahat	—	20½	20½
Larut Tinfields	—	—	—
Malaya Consolidated	75½	53½	37¾
Malayan Tin	125	131	154¾
Meru	13	15	—
Pahang	225½	255½	255
Penawat	226½	74½	58½
Pengkalen	65½	62½	66
Petaling	234	137	145
Rahman	59½	53½	59½
Rambutan	9½	9	7½
Rantau	—	—	46
Rawang	90	100	65
Rawang Concessions	70	55	30
Renong	37	33	66
Selayang	—	—	—
Southern Malayan	—	223½	223½
Southern Perak	29¾	23¾	38¾
Southern Trouoh	59	51	34½
Sungei Besi	39	39	39
Sungei Kinta	22	31½	13½
Sungei Way	83½	107½	113
Taiping	—	—	28
Tanjong	—	—	—
Teja Malaya	29½	26¾	18½
Tekka	36	33	28
Tekka Taiping	41½	30	32
Temoh	—	—	46½
Tronoh	108	96	65¾

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Oct.	Nov.	Dec.
Amari	—	—	—
Anglo-Nigerian	55½	36½	—
Associated Tin Mines	130	200	200
Baba River	7	7	—
Batura Monguna	2½	3½	—
Bisichi	40	40	40
Daffo	16	13	—
Ex-Lands	55*	—	—
Filani	—	4½	—
Jantar	15	20	22
Jos	27½	28½	24½
Juga Valley	6	17	17
Junction	—	—	—
Kaduna Syndicate	13	13	—
Kaduna Prospectors	13	10	—
Kassa	21	12½	—
London Tin	220	75	80
Lower Bisichi	8½	9½	6½
Naraguta	—	—	—
Naraguta Durumi	—	—	—
Naraguta Extended	—	—	—
Naraguta Karama	—	—	—
Naraguta Korot	—	—	—
Nigerian Consolidated	14	14	14
Offin River	4½	3½	5
Ribon Valley	18	10½	—
South Bukeru Areas	—	—	—
Tin Fields	—	—	—
Tin Properties	6	8	1½
United Tin Areas	28	29	—
Yarde Kerri	15	10	—

* Output for 3 months.

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Oct.	Nov.	Dec.
Anglo-Burma (Burma)	38½	36¾	—
Aramayo Mines (Bolivia)	171	199	245
Bangrin (Siam)	96½	89	59½
Consolidated Tin Mines (Burma)	130	118	113
East Pool (Cornwall)	82½	37½	—
Fabulosa (Bolivia)	181	163	140
Geevor (Cornwall)	45	—	—
Jantar (Cornwall)	—	—	—
Kagera (Uganda)	28	28	28
Malaysiam Tin	20¾	20¾	23¾
Northern Tavoy	—	—	—
Patino	—	1,330	—
Polbigey (Cornwall)	18½	—	—
San Finx (Spain)	31½*	30*	—
Siamese Tin (Siam)	—	—	139½
South Croftv (Cornwall)	65	57¾	—
Tavoy Tin (Burma)	64	—	78¾
Themdaw (Burma)	—	—	—
Tongkah Harbour (Siam)	93	53	54
Toyo (Japan)	60½	86½	89½
Wheal Kitty (Cornwall)	—	—	—
Zaaiplaats	30	28	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		Nov.	Dec.
Broken Hill South	Tons lead conc.	3,570	4,949
	Tons zinc conc.	2,656	—
Burma Corporation	Tons refined lead	6,420	6,420
	Oz. refined silver	571,000	571,380
Bwana M'Kubwa	Tons copper oxide	556	452
Electrolytic Zinc	Tons zinc	4,171‡	4,190*
Indian Copper	Tons copper	321	349
Messina	Tons copper	738	800
Mount Lyell	Tons concentrates	3,922	3,476
North Broken Hill	Tons lead conc.	4,810	4,680
	Tons zinc conc.	—	—
Poderosa	Tons copper ore	628	588
Rhodesia Broken Hill	Tons lead	—	—
	Tons slab zinc	1,300	1,250
San Francisco Mexico	Tons lead conc.	4,080	4,180
	Tons zinc conc.	4,165	4,575
Sulphide Corporation	Tons lead conc.	1,995†	—
	Tons zinc conc.	2,625†	—
Tetiuhe	Tons lead conc.	1,024	—
	Tons zinc conc.	2,221	—
Trepca	Tons lead conc.	3,570	4,039
	Tons zinc conc.	2,656	2,592
Zinc Corporation	Tons lead conc.	—	5,244
	Tons zinc conc.	—	4,074

† Four weeks to Nov. 15. ‡ Four weeks to Nov. 12.
* Four weeks to Dec. 10.

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

	October.	November.
Iron Ore ..... Tons	278,637	228,862
Manganese Ore ..... Tons	11,958	17,633
Iron and Steel ..... Tons	264,480	209,769
Copper and Iron Pyrites ..... Tons	16,433	23,182
Copper Ore, Matte, and Prec. .. Tons	3,758	3,933
Copper Metal ..... Tons	19,209	13,162
Tin Concentrate ..... Tons	4,969	6,244
Tin Metal ..... Tons	320	202
Lead Pig and Sheet ..... Tons	28,041	30,939
Zinc (Spelter) ..... Tons	10,223	8,108
Zinc Sheets, etc. ..... Tons	2,631	451
Aluminium ..... Tons	855	1,472
Mercury ..... Lb.	89,622	70,691
Zinc Oxide ..... Tons	731	644
White Lead ..... Cwt.	20,479	15,179
Red and Orange Lead ..... Cwt.	3,680	3,282
Barytes, ground ..... Cwt.	57,785	31,180
Asbestos ..... Tons	1,433	873
Boron Minerals ..... Tons	803	742
Borax ..... Cwt.	25,285	13,755
Basic Slag ..... Tons	7,065	1,666
Superphosphates ..... Tons	4,112	6,214
Phosphate of Lime ..... Tons	34,672	22,285
Mica ..... Tons	165	341
Sulphur ..... Tons	6,488	7,418
Nitrate of Soda ..... Cwt.	68,873	56,234
Potash Salts ..... Cwt.	520,442	148,037
Petroleum : Crude ..... Gallons	44,398,599	23,449,026
Lamp Oil ..... Gallons	17,667,272	22,783,042
Motor Spirit ..... Gallons	79,061,204	56,681,205
Lubricating Oil .... Gallons	7,617,943	8,038,130
Gas Oil ..... Gallons	7,765,741	3,902,902
Fuel Oil ..... Gallons	44,453,279	29,873,962
Asphalt and Bitumen ..... Tons	17,169	10,503
Paraffin Wax ..... Cwt.	141,730	85,231
Turpentine ..... Cwt.	28,035	24,295

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	October.	November.	December.
Anglo-Ecuadorian	16,362	16,323	17,339
Apex Trinidad	41,820	36,850	37,280
Attock	1,805	1,815	1,680
British Burmah	4,667	4,497	4,648
British Controlled	35,814	33,990	35,074
Kern Mex	861	822	—
Kern River (Cal.)	2,732	1,751	—
Kern Romana	2,241	2,290	—
Kern Trinidad	3,836	4,389	—
Lobitos	29,257	28,164	28,401
Phœnix	37,527	50,985	70,523
St. Helen's Petroleum	6,251	6,137	—
Steaua Romana	50,550	51,310	91,250
Tampico	3,137	2,998	—
Trinidad Leaseholds	26,350	23,300	24,400
Venezuelan Consolidated	—	—	—

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	Dec. 10, 1930.			Jan. 9, 1931.		
	£	s.	d	£	s.	d.
Anglo-Ecuadorian		10	9		11	6
Anglo-Egyptian B.	1	16	9	1	17	6
Anglo-Persian 1st Pref.	1	8	6	1	8	6
,, ,, Ord.	2	17	6	2	15	0
Apex Trinidad (5s.)		11	9		12	0
Attock	1	1	3		18	9
British Burmah (8s.)		4	9		4	9
British Controlled ($5)		1	6		1	6
Burmah Oil	3	10	0	3	12	6
Kern River Cal. (10s.)		2	9		3	0
Lobitos, Peru	1	8	0	1	8	9
Mexican Eagle, Ord. (4 pesos)		7	0		8	0
,, ,, 8% Pref. (4 pesos)		8	0		9	0
Phœnix, Roumanian		7	6		6	9
Royal Dutch (100 fl.)	25	15	0	24	8	0
Shell Transport, Ord.	3	16	9	3	13	9
,, ,, 5% Pref. (£10)	10	1	3	10	1	3
Steaua Romana		6	3		5	9
Trinidad Leaseholds	1	7	6	1	8	9
United British of Trinidad (6s. 8d.)		4	3		5	6
V.O.C. Holding	1	11	9	1	10	6

PRICES OF CHEMICALS. Jan. 9.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		18	9
,, 80%	,,	1	16	3
,, Glacial	per ton	58	0	6
Alum	,,	8	10	0
Alumina, Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.			11
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate	,,	16	0	0
,, Phosphate	,,	40	0	0
,, Sulphate, 20·6% N.	,,	9	8	0
Antimony, Tartar Emetic	per lb.			11
,, Sulphide, Golden	,,			7
Arsenic, White	per ton	19	10	0
Barium, Carbonate, 94%	,,	4	10	0
,, Chloride	,,	9	10	0
,, Sulphate, 94%	,,	6	15	0
Benzol, standard motor	per gal.		1	5½
Bleaching Powder, 35% Cl.	per ton	6	15	0
Borax	,,	12	10	0
Boric Acid	,,	22	0	0
Calcium Chloride	,,	5	5	0
Carbolic Acid, crude 60%	per gal.		1	4
,, ,, crystallized, 40°	per lb.			5⅜
Carbon Disulphide	per ton	15	0	0
Citric Acid	per lb.		1	2
Copper Sulphate	per ton	21	0	0
Creosote Oil (f.o.b. in Bulk)	,,			4½
Cresylic Acid, 98-100%	per gal.		1	9
Hydrofluoric Acid	per lb.			6
Iodine	per oz.		1	0
Iron, Nitrate 80° Tw.	per ton	6	0	0
,, Sulphate	,,	2	0	0
Lead, Acetate, white	,,	34	15	0
,, Nitrate (ton lots)	,,	29	10	0
,, Oxide, Litharge	,,	31	10	0
,, White	,,	41	0	0
Lime, Acetate, brown	,,	7	5	0
,, ,, grey, 80%	,,	13	10	0
Magnesite, Calcined	,,	9	10	0
Magnesium, Chloride	,,	6	15	0
,, Sulphate, comml.	,,	3	15	0
Methylated Spirit 64° Industrial	per gal.		1	9
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	1	12	0
Phosphoric Acid. S.G. 1·500	per ton	29	15	0
Pine Oil	,,	42	10	0
Potassium Bichromate	per lb.			4½
,, Carbonate	per ton	24	10	0
,, Chlorate	,,	27	10	0
,, Chloride 80%	,,	9	10	0
,, Ethyl Xanthate	per 1,016 kilos	55	15	0
,, Hydrate (Caustic) 88/90%	per ton	28	10	0
,, Nitrate	,,	19	17	6
,, Permanganate	per lb.			5⅜
,, Prussiate, Yellow	,,			6¾
,, ,, Red	,,		1	8
,, Sulphate, 90%	per ton	11	0	0
Sodium Acetate	,,	18	0	0
,, Arsenate, 45%	,,	20	10	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			3½
,, Carbonate (Soda Ash) 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	,,	26	5	0
,, Cyanide 100% NaCN basis	per lb.			7
,, Ethyl Xanthate	per 1,016 kilos	53	5	0
,, Hydrate, 76%	per ton	14	10	0
,, Hyposulphite	,,	9	2	6
,, Nitrate (ordinary)	,,	9	18	0
,, Phosphate, comml.	per cwt.		10	0
,, Prussiate	per lb.			4¾
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	2	10	0
,, ,, (Salt-Cake)	,,	2	15	0
,, Sulphide Conc., 60/65%	,,	9	0	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	10	10	0
,, Roll	,,	10	10	0
Sulphuric Acid, 168° Tw.	,,	4	16	6
,, ,, free from Arsenic, 144° Tw. .	,,	4	0	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	9	0
Tartaric Acid	per lb.			11½
Turpentine	per ton	37	5	0
Tin Crystals	per lb.			11¾
Titanous Chloride	,,			10
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	,,	20	0	0
Zinc Oxide (White Seal)	,,	39	0	0
Zinc Sulphate	,,	9	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	Dec. 10, 1930. £ s. d.	Jan. 9, 1931. £ s. d.
SOUTH AFRICA:		
Brakpan	2 15 0	2 16 3
City Deep	4 6	4 0
Consolidated Main Reef	17 3	17 6
Crown Mines (10s.)	3 15 0	3 16 3
Daggafontein	1 4 6	1 7 0
Durban Roodepoort Deep (10s.)	11 9	11 9
East Geduld	2 2 0	2 5 0
East Rand Proprietary (10s.)	8 3	8 3
Geduld	3 12 0	3 16 3
Geldbenhuis Deep	8 6	8 6
Glynn's Lydenburg	3 9	3 9
Government Gold Mining Areas (5s.)	1 11 3	1 11 3
Langlaagte Estate	1 4 9	1 5 3
Meyer & Charlton	15 6	15 6
Modderfontein New (10s.)	3 5 6	3 6 3
Modderfontein B (5s.)	12 6	13 0
Modderfontein Deep (5s.)	1 3 9	1 3 0
Modderfontein East	1 3 9	1 5 0
New State Areas	2 2 0	2 0 9
Nourse	10 3	10 6
Randfontein	12 9	13 0
Robinson Deep A (1s.)	15 6	15 6
,, ,, B (7s. 6d.)	9 3	9 6
Rose Deep	5 3	5 9
Simmer & Jack (2s. 6d.)	2 9	2 9
Springs	3 2 0	3 2 6
Sub Nigel (10s.)	2 16 3	2 18 0
Van Ryn	8 6	7 6
Van Ryn Deep	1 8 0	1 8 0
Village Deep (14s.)	5 9	5 9
West Rand Consolidated (10s.)	7 0	7 0
West Springs	12 0	11 9
Witwatersrand (Knight's)	9 0	9 0
Witwatersrand Deep	3 9	3 9
RHODESIA:		
Cam and Motor	12 6	11 3
Gaika	4 6	2 9
Globe and Phœnix (5s.)	13 6	13 3
Lonely Reef	17 6	17 6
Mayfair	7 6	7 6
Rezende	1 2 6	1 2 6
Shamva	1 0	1 0
Sherwood Starr (5s.)	12 3	13 0
GOLD COAST.		
Ashanti (4s.)	1 16 0	2 2 0
Taquah and Abosso (5s.)	3 0	3 6
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	1 9	1 9
Great Boulder Propriet'y (2s.), W.A.	1 3	1 3
Lake View and Star (4s.), W.A.	8 3	9 6
Sons of Gwalia, W.A.	1 6	1 6
South Kalgurli (10s.), W.A.	9 6	10 9
Waihi (5s.), N.Z.	13 0	12 9
Wiluna Gold, W.A.	14 9	15 0
INDIA:		
Balaghat (10s.)	2 6	2 6
Champion Reef (10s.)	7 6	7 6
Mysore (10s.)	10 9	10 9
Nundydroog (10s.)	15 6	15 0
Ooregum (10s.)	4 0	4 0
AMERICA:		
Camp Bird (2s.), Colorado	6	6
Exploration (10s.)	3 6	3 6
Frontino and Bolivia, Colombia	7 6	8 9
Mexican Corporation, Mexico (10s.)	4 0	3 6
Mexico Mines of El Oro, Mexico	2 0	2 0
Panama Corporation	13 0	16 0
St. John del Rey, Brazil	17 0	17 0
Santa Gertrudis, Mexico	9 0	7 6
Selukwe (2s. 6d.), British Columbia	3 0	3 0
MISCELLANEOUS:		
Chosen, Korea	5 0	3 9
Lena Goldfields, Russia	6	6

COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	7 0	6 6
Esperanza Copper, Spain	1 1 6	14 0
Indian (2s.)	1 3	1 6
Loangwa (5s.), Rhodesia	2 0	2 0
Luiri (5s.), Rhodesia	3 6	3 6
Messina (5s.), Transvaal	9 0	10 9
Mount Lyell, Tasmania	12 6	17 0
Namaqua (£2), Cape Province	7 0	6 3
N'Changa, Rhodesia	1 16 3	1 15 0
Rhodesia-Katanga	17 6	17 6
Rio Tinto (£5), Spain	31 0 0	27 15 0
Roan Antelope (5s.), Rhodesia	13 9	15 0
Tanganyika, Congo and Rhodesia	1 8 0	1 6 3
Tharsis (£2), Spain	3 10 0	3 2 6

LEAD-ZINC:	Dec. 10, 1930. £ s. d.	Jan. 9, 1931. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	7 6	7 6
Broken Hill Proprietary, N.S.W.	12 6	11 6
Broken Hill, North, N.S.W.	1 15 0	1 12 6
Broken Hill South, N.S.W.	1 8 9	1 5 0
Burma Corporation (10 rupees)	9 0	8 9
Electrolytic Zinc Pref., Tasmania	17 6	13 9
Mount Isa, Queensland	16 3	15 6
Rhodesia Broken Hill (5s.)	1 6	1 6
San Francisco (10s.), Mexico	15 0	13 0
Sulphide Corporation (15s.), N.S.W.	7 0	5 6
ditto, Pref.	12 6	11 6
Zinc Corporation (10s.), N.S.W.	1 0 0	17 6
ditto, Pref.	3 1 3	2 16 3

TIN:		
Aramayo Mines (25 fr.), Bolivia	1 1 3	1 1 3
Associated Tin (5s.), Nigeria	4 0	4 6
Ayer Hitam (5s.)	11 9	12 3
Bangrin, Siam	12 6	12 6
Bisichi (10s.), Nigeria	5 3	5 9
Chenderiang, Malay	1 6	1 6
Consolidated Tin Mines of Burma	2 6	3 0
East Pool (5s.), Cornwall	3	3
Ex-Lands Nigeria (2s.), Nigeria	1 3	1 6
Geevor (10s.), Cornwall	2 3	2 3
Gopeng, Malaya	2 0 0	2 0 0
Hongkong (5s.)	16 6	16 6
Idris (5s.), Malaya	7 6	7 6
Ipoh Dredging (10s.), Malay	15 0	15 9
Kaduna Prospectors (5s.), Nigeria	4 6	4 0
Kaduna Syndicate (5s.), Nigeria	11 3	10 6
Kamunting (5s.), Malay	3 9	4 6
Kepong, Malay	10 6	10 6
Kinta, Malay (5s.)	7 6	7 6
Kinta Kellas, Malay (5s.)	5 6	6 9
Kramat Pulai, Malay	1 0 0	1 0 6
Lahat, Malay	4 0	4 0
Malayan Tin Dredging (5s.)	17 6	17 9
Naraguta, Nigeria	5 0	5 0
Nigerian Base Metals (5s.)	6	6
Pahang Consolidated (5s.), Malay	7 3	7 3
Penawat ($1), Malay	1 0	1 0
Pengkalen (5s.), Malay	11 0	10 9
Petaling (2s. 4d.), Malay	9 6	9 6
Rambutan, Malay	6 3	6 3
Renong Dredging, Malay	17 6	17 6
Siamese Tin (5s.), Siam	7 3	8 3
South Croftv (5s.), Cornwall	1 6	2 6
Southern Malayan (5s.)	11 0	12 6
Southern Perak, Malay	1 10 0	1 9 6
Southern Tronoh (5s.), Malay	6 3	6 9
Sungei Besi (5s.), Malay	7 6	7 6
Sungei Kinta, Malay	11 6	11 0
Tanjong (5s.), Malay	7 6	7 6
Tavoy (4s.), Burma	3 3	3 6
Tekka, Malay	14 3	13 9
Tekka Taiping, Malay	12 6	12 6
Temengor, Malay	1 6	1 6
Toyo (10s.), Japan	2 6	2 6
Tronoh (5s.), Malay	13 9	13 9

DIAMONDS:		
Consol. African Selection Trust (5s.)	1 0 0	1 0 0
Consolidated of S.W.A. (10s.)	4 9	3 9
De Beers Deferred (£2 10s.)	5 5 0	4 2 6
Jaggersfontein	1 2 6	1 1 3
Premier Preferred (5s.)	3 0 0	2 10 0

FINANCE, ETC.:		
Anglo-American Corporation (10s.)	13 9	12 0
Anglo-French Exploration	12 6	12 0
Anglo-Continental (10s.)	4 6	4 0
Anglo-Oriental (Ord., 5s.)	7 3	7 3
ditto, Pref.	9 3	9 6
British South Africa (15s.)	1 8 9	1 6 3
Central Mining (£8)	12 0 0	10 15 0
Consolidated Gold Fields	1 2 6	1 1 3
Consolidated Mines Selection (10s.)	9 3	7 6
Fanti Consols (8s.)	8 6	7 6
General Mining and Finance	12 6	12 0
Gold Fields Rhodesian (10s.)	5 3	5 0
Johannesburg Consolidated	1 11 9	1 6 9
London Tin Corporation (10s.)	8 3	9 3
Minerals Separation	4 10 0	3 17 6
National Mining (8s.)	6	6
Rand Mines (5s.)	2 14 3	2 10 6
Rand Selection (5s.)	6 9	6 0
Rhodesian Anglo-American (10s.)	13 3	11 3
Rhodesian Congo Border	7 7 6	7 0 0
Rhodesian Selection Trust (5s.)	16 3	18 9
South Rhodesia Base Metals	4 0	3 9
Tigon (5s.)	11 9	10 0
Union Corporation (12s. 6d.)	2 6 3	2 5 0
Venture Trust (10s.)	4 0	3 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.

ELUTRIATION IN ORE-DRESSING

The results of an investigation by A. M. Gaudin, J. O. Groh, and H. B. Henderson into the possibilities and limitations of sedimentation and elutriation as applied to the sizing of finely ground ore products are given in a paper which appears in *Industrial and Engineering Chemistry* for December. The authors state that recent developments in ore-dressing have brought about finer grinding of ore pulps. Quantitative measure of fineness of a ground material is inadequately rendered by the customary statement expressing the percentage of the material passing a 200-mesh or a 325-mesh sieve. In reference to flotation products for instance, it is no more informative to state that 72% of the pulp is minus 200 mesh than it is to describe a gravel as 72% minus 1 cm. The size of particles finer than 37 microns (equivalent to the aperture of the finest sieve cloth made: that of the 400-mesh screen) has to be determined by a method other than screening.

The experiments that were undertaken at the Montana School of Mines during the past year were designed to find out the effect of particle size on flotation. It was desired to segregate particles of different sizes in order to study further each size group as to chemical composition, state of liberation of the various minerals, etc. This automatically excluded all methods of size estimation on particles finer than 37 microns except methods based on settling of the material in fluid media.

Two methods of sizing by settling in viscous fluids were used side by side. One method consisted in allowing the suspended solids to settle in a still fluid, the other in allowing them to settle against a rising current of fluid. Sizing by the first method is commonly termed "sedimentation"; by the second, "elutriation." Air and water are the common elutriation media. In sizing fine flotation products air cannot be used as the elutriation medium, because the products are wet and they contain enough extremely fine material to cake on drying. Dispersion in air of caked material is, of course, practically impossible. Besides water, several organic liquids were tested as prospective elutriating media. Highly satisfactory results were obtained with acetone, which is much superior to water in certain fields of work.

SIZING BY SEDIMENTATION.—When a quick analysis is desired, sizing by settling in beakers may be employed. Manipulation is as follows: The sample is placed in beakers of 800 to 1000 cc. capacity (about 50 grams to a beaker); the beakers are filled with liquid to a predetermined depth (10 cm. is convenient); the pulp is stirred thoroughly and allowed to settle for a given time; the suspension is decanted from the sediment. The settling time depends on the depth of settling and the settling rate corresponding to the largest particles desired in the overflow. The settling rate is determined by application of Stokes' law. If all particles started on their settling journey from the top of the beaker, one sedimentation would suffice; but as they start from any point between the lip of the beaker and the bottom, repetition of the operation is necessary. In practice from eight to twenty washings are necessary for the supernatant liquid to become substantially clear at the end of the sedimentation period. The solids in the combined decanted suspensions make up the finest grade. After flocculating, this grade is dried and weighed. The next coarser size in the sample may be removed by repeating the decanting operations with a correctly shortened settling time. Repetition of the sedimentation operation is again necessary to insure fairly clean sorting. If water is the settling liquid, a deflocculating agent, such as sodium silicate, is frequently necessary to disperse the pulp. Sodium silicate was required in varying amounts, rarely in excess of 1 part in 4000 parts of liquid.

All grades but the finest may be separated from the associated fluid by settling, decanting, and drying. The finest product usually requires either the addition of a flocculating agent or a tremendous amount of evaporation. In the case of organic liquids evaporation is necessary to recover the valuable fluid. In the case of water flocculation by the joint addition of sodium hydroxide (about 1 gram in 20 litres) and calcium chloride (about 1 gram in 20 litres) was found satisfactory. Flocculation was followed by decantation of the clear liquid and drying on a hot plate.

Sedimentation in beakers with water as the liquid medium is not satisfactory for size-splits coarser than 400 mesh (37 microns) owing to the short time required for settling, nor for size-splits finer than 1120 mesh (11·3 microns) because of the loose character of the sediment formed by very fine material, and the consequence that the sediment is disturbed by decanting the suspended material from the beaker. For sizing below 1120 mesh settling in buckets and siphoning the suspension are more satisfactory. The thinner pulp obtainable in the buckets is also advantageous because it lessens the tendency to flocculate. In bucket sedimentation the siphons are placed in position just before it is time to remove the suspension. It should be noted that in sizing by this method the suspension is first removed from the region adjoining the sediment, therefore preventing particles still in suspension from settling beyond the point from which the water is being drawn, once the operation is started. Three siphons to a bucket are a convenient number.

When it is desired to use a minimum amount of fluid and still have a deep settling column, a sedimentor is satisfactory. This is also useful in cleaning size fractions of a previously sized sample which appear to be in error. The apparatus consists of a glass tube 5 to 8 cm. in diameter and 40 cm. long with a solid base; it is conveniently made by removing the top portion of a 1000-cc. graduated cylinder. The sample and liquid are added as described for sedimentation in beakers. A rubber stopper is then placed in the mouth of the tube and

the apparatus and contents are thoroughly mixed by shaking. The stopper is removed and, when sufficient time has elapsed, a siphon is placed in the tube and the suspension is drawn off. This is repeated until the liquid in the tube is clear. As described above, the time of settling is shortened and the next size removed.

Sizing by Elutriation.—Elutriation is a more accurate sizing method than sedimentation. It is based on the fact that a particle will just be sustained in an upward-rising current of water if the velocity of that current is equal to that which the particle itself would attain if falling in still water. An elutriator is a tubular vessel in which a liquid holding solid particles in suspension is rising at a controlled velocity which may be so adjusted that all particles finer than a given size are carried

Fig. 1.—Cross Section of Elutriator.

upward to the overflow while the rest of the material sinks or stays in suspension.

The most important factors in elutriator design are as follows :—

(1) The apparatus should insure as far as possible a constant velocity and uniform stream lines in the fluid as it passes through the separating chamber.

(2) The fluid should not be appreciably retarded by the resistance of the material under examination or by constrictions or obstructions in that part of the apparatus beyond the separating chamber, unless the amount of such retardation can be determined by pressure gauges or compensated by special devices.

(3) All particles of the material should be completely and continuously exposed to the action of the fluid, so that any which are capable of passing through the separating chamber may have every opportunity to do so.

(4) The separating chamber should have no places of lodgment for material.

(5) The apparatus should be capable of separating fair-sized samples, preferably 25 grams or more. Thus representative samples are more nearly insured and the percentage error in the calculations is reduced.

The Nipissing, Thompson, and Nobel elutriators have no separating columns. The rise of liquid in the cones therefore takes place with rapidly diminishing speed and uniform stream lines do not exist. As a result the sizes of separation are less sharply defined than it is desirable to have them. The Schultze type elutriator used by Weigel is better. It consists of cylindrical copper cans fitted with conical bottoms. The cylindrical portion is 18 cm. high. The diameters of the successive cans increase, which means a decrease in the velocity of flow and consequently a decrease in the size of solid particles in the successive overflow products. It is quite evident that the existence of a stream-lined flow in the elutriators depends largely on the ratio of the height to the diameter of the vessels.

The elutriator designed by Gross, Zimmerley, and Probert at the Salt Lake station of the U.S. Bureau of Mines is of a greatly improved design. That elutriator was adopted by the writers for their work with two modifications deriving from their need for a larger capacity and from having to cover a greater range of sizes than was covered in the work at Salt Lake. This elutriator is shown in Figure 1. The apparatus consists of a glass sorting tube, *A*, with a launder, *B*, attached to the upper end to catch the overflow. A funnel, *C*, is fastened to the lower end of *A*. Fastening of *B* and *C* to *A* is obtained with paraffin, or better still, with deKhotinsky cement. A rubber tube connects the funnel to a 3-hole bottle, *D*. Water is fed to the 3-hole bottle from a constant-level tank, the flow being controlled by clamp, *F*. The temperature of the water is read on the thermometer, *E*. Launder *B* can be made of thin galvanized iron or of heavy manila paper (such as filing folders) soaked in and coated with paraffin. The inside of the launder should be well coated with paraffin so as to provide a smooth surface to prevent lodging of particles from the overflowing material.

Table I

Volume of Water Required for Various Elutriators for Various Size Splits Using Water at 13·5° C.

Size of Split		Elutriator A (2·25 cm. dia.)	Elutriator B (4·7 cm. dia.)	Elutriator C (12·2 cm. dia.)
Mesh	*Microns*	*Cc. per min.*	*Cc. per min.*	*Cc. per min.*
28	589	1780		
35	417	1360		
48	295	1040		
65	208	775		
100	147	485	2120	
150	104	242	1060	
200	74		530	
280	52		265	
400	37		132	894
560	26		66	447
800	18·5			224
1120	13			112
1600	9·2			56

The diameter of the tube depends upon the size of the product desired. Three tube sizes were used : a 12-cm. diameter tube for the separation at 560 to 1120 mesh (when water was the liquid used), a 5-cm. diameter tube for separation at 150 to

400 mesh, and a 2-cm. diameter tube for separations above 100 mesh. The ratio of the length of the tube to the diameter should be at least 6 to 1, but 10 to 1 is preferable. The capacities of the three elutriators, as determined by extensive operation, were found to be about 500, 250, and 75 grams of flotation pulp, respectively.

Rising-current velocities are adjusted by regulating the volume of liquid overflowing the elutriator per unit time—e.g., per minute. This involves an accurate determination of the cross section of the elutriator. Corrections for viscosity changes with temperature variations and for changes in the liquid used are also necessary. Table I correlates the size at which sorting is conducted for particles having the specific gravity and shape habit of quartz with the volume of water required to overflow from the elutriators at 13·5° C. Table II shows the corrections to be applied for water at other temperatures and when using acetone at various temperatures.

TABLE II

CORRECTION FACTORS BY WHICH TO MULTIPLY RATES OF FLOW GIVEN IN TABLE I FOR TEMPERATURES OTHER THAN 13·5° C., AND WHEN USING ACETONE IN PLACE OF WATER

TEMPERATURE ° C.	WATER	ACETONE
11·0	0·933	3·59
12·0	0·959	3·63
13·0	0·988	3·66
14·0	1·011	3·69
15·0	1·043	3·74
16·0	1·071	3·77
17·0	1·100	3·80
18·0	1·128	3·84
19·0	1·154	3·87
20·0	1·178	3·91

In starting an elutriation, sufficient fluid is admitted to the sorting tube so that it stands 2 or 3 in. above the top of the funnel. Clamp *F* is left open just enough so that the rising current in the stem, *J*, of the funnel, *C*, is sufficient to maintain in suspension the coarsest particles of the sample to be introduced. The weighed sample, previously wetted with the fluid, is introduced in tube *A*. The flow is then increased by opening clamp *F* until the correct velocity is obtained. In the elutriators used the ratio of the cross sections of *A* and *J* was about 100 to 1. For particles following Stokes' law a ratio in diameters of 10 to 1 results in a ratio in ascending velocities of the liquid of 100 to 1, so that particles ten times coarser than the largest particles in the overflow are the only particles liable to settle in tube *J* during the charging and operation of the elutriator. As neither elutriator was used over a size range in excess of 5 to 1, no difficulty was encountered under proper operating conditions.

When, after a sufficiently long operation, the elutriator overflow carries substantially no solids (this is generally equivalent to a fluid displacement of twelve to fifteen times the capacity of the elutriator), the collected material is set aside and the current is increased to the speed necessary to overflow the next larger size. When the coarsest separation for which the elutriator is designed has been finished, the oversize may be removed by closing clamp *F* and allowing the material to settle into bottle *D*. If clamp *H* is closed first, and clamp *F* directly afterwards, stopper *I* may be removed from the bottle and clamp *H* again opened to drain the sediment directly into a pan. This material is then placed in the next elutriator and the elutriation is continued.

In the separation of the finer sizes (below 800 mesh), it is desirable to have the pulp very thin, as this lessens the flocculation. When making a separation at a fine size it is best to add a dispersing agent, such as sodium silicate, even though the pulp may not be visibly flocculated. Microscopical examination of the products obtained shows readily whether there has been any flocculation.

Flocculation of relatively coarse particles (15 to 75 microns) of magnetic minerals (magnetite and pyrrhotite) has been observed. This phenomenon

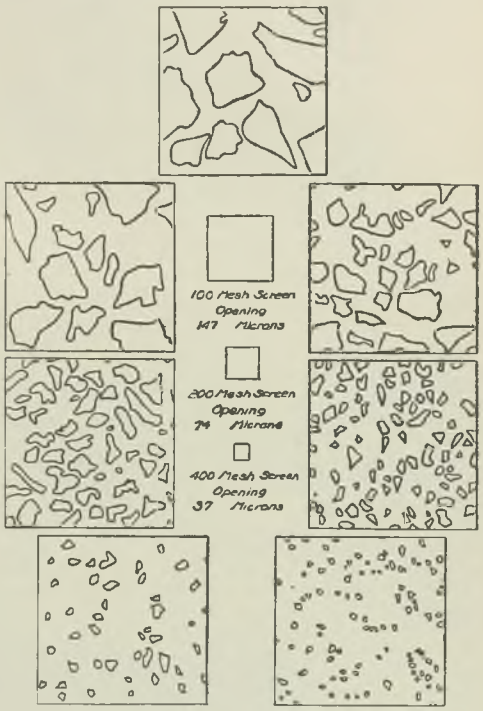


FIG. 2.—ELUTRIATED PRODUCTS OF ZINC CONCENTRATE.

appears different from the ordinary flocculation of fine solids. No way of dispersing these magnetic aggregates has been found.

ELUTRIATOR FLUIDS.—Water is the most convenient of all fluids because it is available in quantity and need not be recovered after use. Most tap water contains dissolved gases which are partly retained even though it is heated and cooled before use. When water containing gases in solution comes in contact with material being elutriated, the gas precipitates out of solution as small bubbles adhering to the walls of the elutriator. If flotable particles are present, they adhere to the bubble boundaries and are carried to the surface, thus "salting" the various size fractions. Distilled water is far better than tap water, as it is not saturated with air and therefore does not exhibit the flotative effect observed with tap water. Flocculation is more easily prevented in distilled water than in tap water.

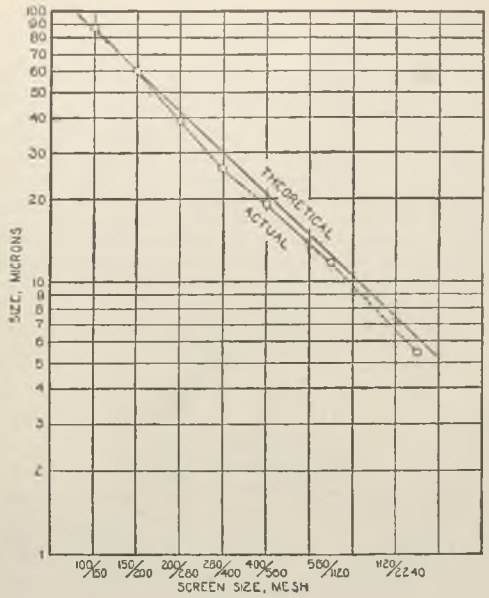


FIG. 3.—COMPARISON OF SIZES OF ELUTRIATED FRACTIONS AS IN TABLE III.

With material composed mainly of metallic sulphides or other non-polar substances or non-polarly filmed substances, such as flotation concentrates, it is often impossible to effect reliable sizing if water is the liquid medium. This derives from the great tendency towards flocculation and flotation exhibited by non-polar substances. To obtain reliable size fractions from flotation concentrates or other non-polar substances it is necessary to use another liquid medium than water. Several non-polar liquids were tried in place of water. Contrary to expectations, strictly non-polar organic liquids, such as gasoline, kerosene, benzene, and toluene, were not satisfactory, as they led to flocculation of flotation concentrates. Alcohols, ketones, and ethers, which are heteropolar substances, caused flocculation of fine silicates but not of sulphides. Acetone proved to be the best of the few substances that were investigated.

Acetone has several advantages over water, among which are its lower specific gravity and lower viscosity, which reduce the settling time of mineral products to about one-fourth that required in water. On the other hand, acetone is too valuable to discard—it has to be recovered by distillation after use. In the elutriation of sulphides by the use of acetone it is usually convenient to first make the fine splits (560 mesh and finer) by sedimentation, and to make the coarser splits by elutriation, preferably in the smallest elutriator described above.

QUALITY OF SIZING OBTAINED BY ELUTRIATION.—Figure 2 shows, magnification ($\times$ 68), the various grades made by acetone elutriation from the zinc concentrate of the Morning mill of the Federal Mining and Smelting Company. The close sizing obtained is apparent. Microscopic measurement has confirmed the visual result presented in Figure 2. Microscopic measurement was carried out as follows: The sized material was sprinkled on a glass slide and the grains occurring along a random diameter of a random field were all measured along that diameter with a micrometer eyepiece. Averaging of a sufficient number of these grains by the $\left[\frac{\Sigma nd^3}{\Sigma n}\right]^{1/3}$ method of Weigel resulted in a measure of the average of the two dimensions of the grains visible under the microscope. These two dimensions are the two largest dimensions of the grains. The average obtained was found to be approximately half again as large as the average of the two smallest dimensions, which is actually measured by screening. Table III and Figure 3 present the results obtained in one extensive count.

TABLE III

COMPARISON OF ACTUAL AND THEORETICAL SIZES OF ELUTRIATED FRACTIONS OF ZINC CONCENTRATE FROM MORNING MILL OF FEDERAL MINING AND SMELTING COMPANY

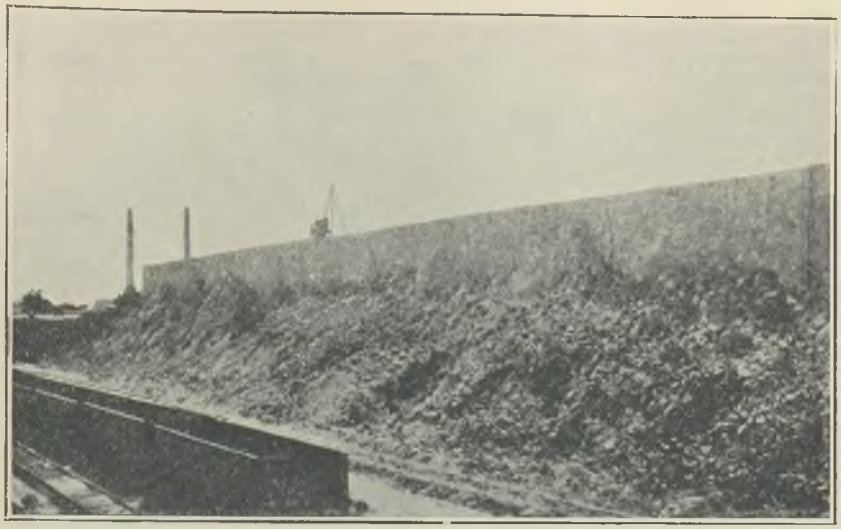
SIZE RANGE *Mesh*	THEORETICAL AVERAGE *Microns*	ACTUAL AVERAGE *Microns*
100–150	86	87
150–200	60	60
200–280	43	39
280–400	30	26
400–560	21·5	19·0
560–1120	12·4	11·8
1120–2240	6·2	5·4

SULPHUR PRODUCTION IN TEXAS

The production of sulphur at Newgulf, Texas, is described by George H. Reid in *Chemical and Metallurgical Engineering* for November last. The author says that between Gulf and Houston, Texas, the town of Newgulf has been constructed by the Texas Gulf Sulphur Company, and here the company has recently begun mining the Boling dome and Long Point dome. Both of these areas are leased from the Gulf Oil Corporation. At the rate of production of 1,403,640 long tons of sulphur in 1929, reserves are estimated to be sufficient for 40 years.

Texas Gulf Sulphur Company is the world's largest producer of sulphur. Freeport Texas Company, owner of Bryanmound (which has a present estimated life of 3 years) and lessor of Hoskins Mound from the Texas Corporation (12 years' estimated life), and with other reserves, is the second largest producing company, having mined last year a total of 916,260 long tons. These two companies, which operate their properties similarly, produced over 95% of the total United States production of 2,363,389 long tons last year, and nearly 80% of the total world production. Stocks as at January 1, 1930, were 1,900,000 long tons. Exports for 1929 were 855,500 long tons.

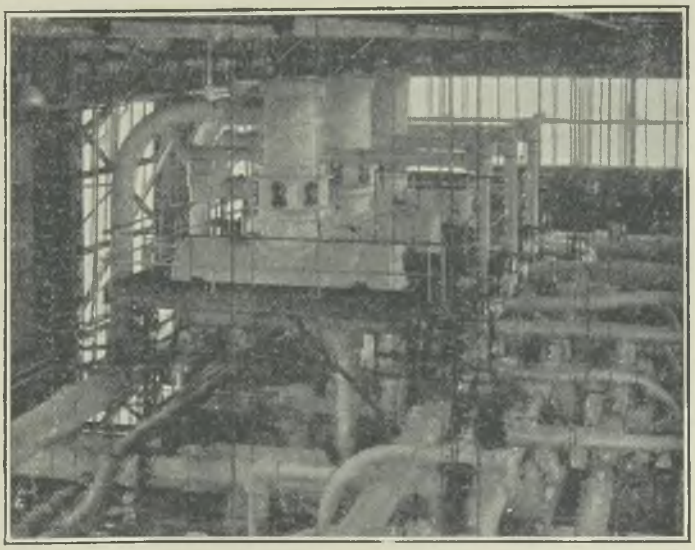
Superheated water, injected through 6-in. casings at approximately 100 lb. pressure into wells ranging in depth from 500 to 1,500 ft., melts the rhombic sulphur deposited above a stratum of gypsum. The water settles to the gypsum, but its pressure forces the liquefied sulphur upward through a 3-in. line of tubing strung inside of the larger casing. Compressed air at 500 lb. pressure is injected through a 1-in. pipe placed inside the 3-in. line, jetting hot liquid sulphur (melting



VAT OF SULPHUR WITH SIDE BOARDS REMOVED.

point, 239° F.) out of the well to relay stations or sumps, and ultimately to storage vats. This is the application of the famous Frasch process (on which the patents have now expired) at the sulphur mining operations of the Texas Gulf Sulphur Company at Boling dome, near Wharton, Texas. Similar operations prevail at Freeport Texas Company's Bryanmound and Hoskins Mound, near Freeport, Texas.

To provide sufficient heat for large-scale mining, enormous quantities of water, heated under pressure to a temperature considerably above the melting point of sulphur, must be pumped into the sulphur-bearing formation. The quantity varies from 10 to 50 tons of water per ton of sulphur mined, depending upon the nature of the sulphur deposit at the point of penetration. The primary requisites for successful operations of this type are, therefore, a suitable water supply and an efficient power plant for the heating of this water. Taken over a long period it is estimated that Boling dome operations may require an average of 5,000,000 gal. of water per day, which finds its way into the project through such uses as steam generation for operating drilling rigs, for heating miles of liquid-sulphur transfer pipe lines which must be maintained hot, and for the operation of steam turbines used to drive generators, blowers, fans, and pumps. Its principal use is that of a heating medium for melting crystalline sulphur at the bottom of the



THREE 75,000 GAL. PER HOUR COCHRANE JET HEATERS.

wells or mines; but it also cools compressors and is distributed through the fields, where it is used in drilling, maintaining drilling mud consistencies, and filling other needs.

Water is taken both from wells and from the San Bernard River. The supply of river water varies with the season, and a reservoir covering 262 acres, with a capacity of a billion gallons, has been constructed to tide over the low-water periods. Water from the river contains permanent hardness, and often suspended matter; while that from the wells contains sodium carbonate alkalinity. Hence, in the subsequent hot-process softening, the treatment of the river water with the well water suffices to precipitate the permanent hardness with little or no additional sodium carbonate. It is necessary only to add lime and sufficient ferrous sulphate to coagulate the suspended matter.

Although steam is employed for the operation of compressor and pumping equipment in the main plant building, electricity is required for power purposes at outlying stations and for lighting purposes in the plant, field, and in the company's town of Newgulf. The electric generating plant, housed in the same building with steam plant, compressor units, pumping equipment, and mine water heaters, consists of three turbo-generators, two of which are of 750 kw., and the third of 1,500 kw. capacity, all designed to operate at 3,600 r.p.m. and 100 lb. steam pressure. The turbines which are employed here and the 20 turbines used for operation of centrifugal pumps, as well as the turbines operating fans and blowers in the same building, are all of the non-condensing type.

Exhaust steam from these turbines is conducted to a large water-treating plant built by the Cochrane

Top of a Vat of Solid Sulphur.

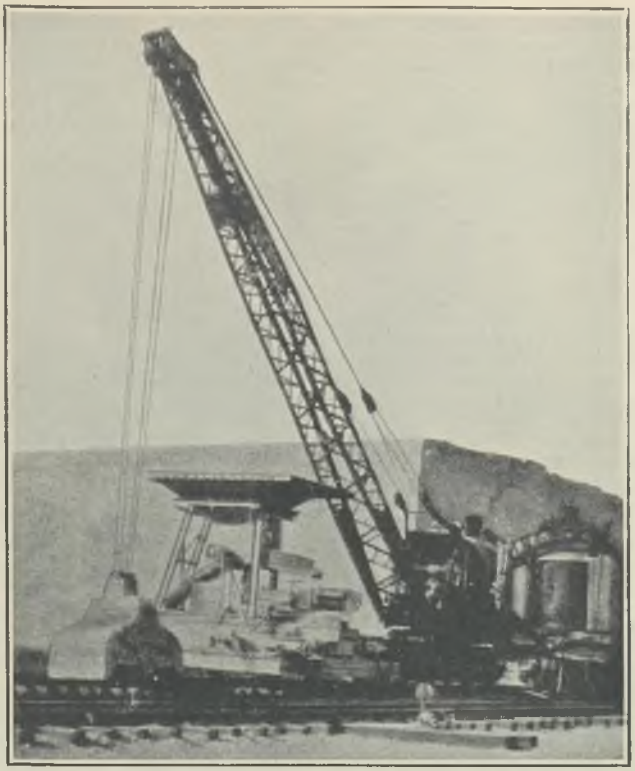
At the power plant two water circuits are maintained. The first raw-water system passes through the treating or softening plant and into the boilers. The second circuit passes through a separate treating system, into the high-pressure mine-water heaters, and to the mines through a heavily insulated 16-in. distributing main. The usual third circuit of cooling water for compressor and engine jackets is, of course, maintained.

The power house is of modern construction and design, consisting of ten 1,500 h.p. Stirling type water-tube boilers set in two batteries of five each. Separate brick stacks, 38 ft. bottom inside diameter, 18 ft. top inside diameter, and 330 ft. in height are provided, one for each battery. Furnace walls are air-cooled. Boiler feed water is supplied through four turbine-driven centrifugal pumps, operating under automatic control. It is measured to the power plant by recording orifice meters, at a feed temperature of 220° F. Gas burners are used for firing, with auxiliary or stand-by equipment for oil burning provided at each burner for almost instant use in event of gas failure.

Operating at low pressure, the boilers provide steam at about 100 lb., discharging into a common header system from which live steam is taken for superheating the mine water used in the wells for melting sulphur and for operation of the turbine-driven centrifugal pumps and electric generators. Large quantities of live steam are also taken to the field for operating and heating purposes.

Corporation, of Philadelphia, where it is employed in the hot-softening process to heat the incoming raw water to slightly over 212° F. This steam is condensed and reclaimed for further evaporation or injection into the mines (wells). Six 70,000-gal. sedimentation tanks are installed in the water-treating system. Adjacent to this battery of treaters is a building housing supplies of treating chemicals and six agitated chemical mixing tanks and their accompanying machinery for automatically proportioning chemical feed to the raw water. Feed water from the boiler-water softener is given an additional treatment before passing to the boilers. By means of the controlled addition of sodium sulphate and mono-sodium phosphate, the sulphate—carbonate ratio is adjusted to avoid caustic embrittlement as well as scale formation.

The principal need for live steam generated by the boilers is for superheating the so-called mine water which is injected into the sulphur deposit. After raw water has first been passed through the chemical treating plant, where it is preheated by exhaust steam, it passes through a battery of five turbine-driven centrifugal pumps to five high-pressure mine-water heaters, each of 75,000 gal. per hour capacity. These heaters are of the jet type, into which steam is introduced at boiler pressure. Water and steam enter separately and mix in the dome of the heater, bringing the temperature to above 300° F. (usually 325° F.), at which temperature the mine water is discharged



SULPHUR LOADING EQUIPMENT.

through a second battery of five pumps into the insulated 16-in. main. From this main it is distributed to the wells and pumped into the sulphur deposit. This volume of water is likewise measured by recording orifice meters, which type of instrument is also employed to measure steam to the field. Temperature recorders give permanent records of the various temperatures of fresh water, boiler feed water, and mine water. The use of recording thermometers, pressure gauges, and water, steam, and gas meters gives complete data from which the engineers in charge may check the performance of the various units and regulate operating efficiency.

Three steam-operated, two-stage compressors supply the air used in jetting the liquid sulphur from the wells. Air pressure of 500 lb. is maintained in the 6-in. field distributing line which is of sufficient capacity to eliminate the use of the usual air-surge or storage tank.

An interesting commercial-scale experimental plant for purifying spent mine water is now in partial operation. The customary practice is followed in this field, wherein the mine water is removed from the sulphur body through drainage or " bleeder " wells which are drilled to a deeper level in the surrounding area, solely for this purpose. Mine water returns to the surface at a temperature of about 180° F. and carries a large quantity of hydrogen sulphide in solution. Former practice has been to aerate this water in an open ditch some 20 miles in length, thus purifying it before it is returned to the river, and such will be the practice until the success of the new purifying system is certain. Boiler flue gases are used for stripping the H_2S in the new process. Gases are withdrawn from the breeching just ahead of the stack. This is done by means of turbine-driven blowers which force the flue gases through several hundred feet of metal piping about 3 ft. in diameter. When delivered at the purification plant, the gases contain about 8% carbon dioxide.

Purification towers consist of eight redwood water tanks, inverted, closed at the top, placed over concrete basins, and filled with yellow pine baffles. The locally termed " poisoned " water is circulated in counter-current flow by motor-driven centrifugal pumps against the stream of water combustion gases to effect the removal of the H_2S. It is said that CO_2, being the more acidic, will effect purification of the water through the removal of the lesser acidic H_2S. The mixture of cooled flue gases and the H_2S extracted from the water is taken back to the stack through an inclosed concrete duct. Here it enters the base of the stack through a rectangular aluminum flue gas duct. This becomes a false stack erected inside of the main stack, and extends upward to a point just above the flue gas breeching, through which the principal stream of furnace gases enter the stack. It has not been necessary to blow the gases back to the stack from the purification plant, since sufficient draught prevails to effect their delivery there. Fans for this purpose, however, are installed at the purification plant.

Liquid sulphur jetted from the producing wells, or mines, is conveyed through steam-heated, insulated transfer lines to a near-by relay station,

where sumps are provided for its collection. These sumps are equipped with steam coils on the sides and bottom to keep the sulphur liquid. The lining may be of any suitable material, but cast iron has been found to be the most satisfactory. When the sumps are full, the sulphur is removed by means of centrifugal pumps, either steam or motor-driven, through sulphur pipe lines to the vats. The pumps are especially designed for this purpose, and the moving parts are either submerged in liquid sulphur or steam jacketed, so that they may have no cooling effect upon the material being handled.

Actual mining operations are controlled at the pumping stations. Valves regulating hot water as well as steam and air lines, and sulphur discharge lines are grouped for the convenience of the operator. Best conditions for each well are determined by experiment and are controlled by conveniently placed meters and gauges on air and water lines.

Sulphur from the relay stations is delivered to the vats through well insulated pipe lines in which is a small live-steam pipe for preventing solidification of the sulphur. These lines discharge directly into the vats, which are formed by the solidification of the liquid sulphur in a wooden bin. A few inches each day is added to the vats, until they reach a height of some 40 ft. Then the wooden sides are torn away, for the sulphur in the solid state requires no support.

Sulphur for shipment is blasted from the face of the vat as required, a vertical block from 12 to 20 ft. deep being removed at one time. Holes drilled back from the face of the vat at intervals are charged with powder and exploded, and the sulphur is broken into pieces of a size suitable for loading. Locomotive cranes with 2-yd. clam-shell buckets load the sulphur into box cars or gondolas. Box cars are loaded by means of hopper-conveyors, while the gondolas are loaded directly by the cranes. Before leaving the plant, each car is weighed and more sulphur added, or some removed, as the case may be, to meet proper weight requirements. Cranes and conveyors are installed for this purpose at the weighing station.

MINE TIMBER PRESERVATION

The use of zinc meta-arsenite (ZMA) as a wood preservative is discussed by C. Marshall Taylor in the *Canadian Mining Journal* for November 28 last. The author says that some investigators, in studying the action of wood-destroying fungi, had noted a certain acid formation in fungus cultures, and it was ascertained definitely that this acidic reaction invariably existed in the activities of all wood-destroying fungi. In some cases it was stronger than others, but invariably it did exist. This gave the investigators the thought that it might no longer be necessary to follow the supposed axiom of the wood preserving industry—that in order to be toxic the preservative must be water soluble—and, since then, it has become generally believed that it is not necessary to have a water soluble preservative, but rather one that is soluble in the acid body juices of the fungi.

This led to the thought that if some substance could be injected into the wood in a soluble condition and certain chemical changes there made to take place, an insoluble material could then develop which would be permanent in the wood for all practical purposes, but which would be dissolved by and thereby become toxic to the wood-destroying fungi if they came in contact with it.

There were several materials which could be injected into the wood in a soluble form which, upon evaporation of the solvent, would react to form insoluble compounds. The vast majority of these materials were too expensive for commercial application, but two groups were developed which were relatively cheap and abundant and which would answer the requirements, namely, combinations of copper and zinc with arsenic. As it would be unwise to use copper compounds in steel treating cylinders, the substance chosen finally was zinc meta-arsenite.

$$Zn(CH_3COO)_2 + 2HAsO_2 \rightleftarrows Zn(AsO_2)_2 + 2CH_3COOH$$

(Zinc Acetate) (Meta-Arsenous Acid) (Zinc Meta-Arsenite) (Acetic Acid)

The reaction proceeds slowly from the outside of the timber and the zinc and the arsenic combine to form zinc meta-arsenite.

To ascertain its toxic value, standard toxicity values were determined using one of the most important fungi as a basis for comparison—*Fomes annosus*. The relative values of various commercial wood preservatives are given below :—

Substance.	Killing Point.
Zinc chloride . .	0·35
Copper sulphate . .	0·15
Mercuric chloride . .	0·015
Zinc meta-arsenite . .	0·050

The solubility of zinc meta-arsenite in water is about twenty-five parts per million, but it is readily soluble in the body juices of any of the commercial wood-destroying fungi, and its effectiveness as a wood preservative is due to this fact.

Since its introduction, ZMA, which is the trade marked name for zinc meta-arsenite, has enjoyed splendid support from the wood-preserving interests in the United States. At present there are fifteen wood preserving plants using this process in the United States. Its wide acceptance by those who are desirous of obtaining the best results in wood preservation indicates the thoroughness with which the original research was carried on by the Western Union Telegraph Company. Ordinarily it takes a wood preservative many years to establish itself in engineering circles, but ZMA has been tried out by so many different companies in so many different conditions with complete success that it is now being accepted as a standard.

To prove the value of ZMA, the results which the United States Forest Service is obtaining in the tests now being conducted at the Panama Canal, are most reassuring. The locality where the tests are being conducted has a rainfall of approximately one hundred and forty inches, and practically every known species of termite or white ant prevails on this territory ; yet ZMA continues to equal creosote after approximately two years in accelerated tests, whereas the water soluble salts show the

effects of the high moisture conditions and are failing slowly but surely.

To many mine operators, the question of subjecting their timbers to some sort of preservative treatment is no doubt new. However, the economy of operation through the use of wood preservation should appeal to most of them. Unfortunately, very few operators maintain sufficiently accurate records of installations of timbers to enable them to give definite cost figures. This lack of specific knowledge makes it difficult for the manager to prepare figures to prove the wisdom of utilizing wood preserving methods. Atmospheric conditions in various mines differ widely. It may be said that there are definite ratios of temperature and humidity which are most conducive to rapid deterioration of timber in mines. If these conditions were maintained always on the same basis, it would render the problem simpler, but unfortunately certain good conditions which may obtain in one portion of the mine may be changed through a shift in operating conditions.

The first question to be decided in making a survey as to the advisability of utilizing timber preservation in any mine, is to determine the life of timbers used untreated. Strange as it may seem and easy as it appears, definite conclusions covering the life of wood in any single operation are likely to vary greatly, even amongst individual timbers on the same operation. Furthermore, widely diverging estimates are met with in trying to arrive at the proper figure, where mines are subject to squeeze. In certain anthracite mines, a 20% figure is used to estimate the quantity of timber which, as a result of squeeze, would not have any increased life due to preservative treatment. If different species of wood have been used, undoubtedly different life averages will be determined for each species used and for the various locations under the varying mine conditions.

With this life history data in hand, it is then a matter of determining just what prices prevail at this time, in order to figure just what economies are possible. Some companies are fortunate enough to have the larger part of their timber requirements on their own property, relieving them of paying freight, and also allowing them the lowest possible stumpage value. In such instances, it is much more difficult to sell the idea of wood preservation to mine managers. However, the fact remains that there are very few cases where it pays to use untreated timbers in mines, and in the vast majority of cases, wood preservation pays its user handsome economy dividends.

A. D. A. Crawford, of Lee Higginson & Company, New York, has developed a formula for determining the annual charges per cu. ft. of timber, which gives a basis for making determinations. It is as follows :—

Average Life Untreated : three years.

Average Life Treated : eight to ten years.

Permanent and semi-permanent timber destroyed by crush : 20%.

$$\text{Annual charge formula} = \frac{PR(1+R)^N}{(1+R)^{N-1}}$$

in which A = annual charge including interest and amortization.

P = original cost

R = rate of interest expressed decimally = 0·06 in this case.

N = life in years.

Annual Charge.

Life in Years.	Untreated.	Treated.
3	0·2375	0·3300
4	·1835	·2550
5	·1505	·2090
6	·1290	·1790
7	—	·1580
8	—	·1421
9	—	·1300
10	—	·1200

Annual Charges Allowing for Crush or Squeeze.

Untreated	Treated	
$0·2375	* 20% × 0·3300	80% × 0·1421 = $0·1797
·2375	** 20% × 0·3300	80% × 0·1200 = $0·1620

* Based on a life of 8 years for treated timber not destroyed by crush.

** Based on a life of 10 years for treated timber not destroyed by crush.

From the records obtained by the railways and mine companies, it is evident that the estimate of eight to ten years as the life of treated mine props is extremely conservative, and that a life of twenty to thirty years is much more likely to result with consequently much greater savings.

As to where and how to procure mine timbers treated with preservative, this is a different subject for consideration and has to be viewed from several angles. Mining is both an art and a science, and so is wood preservation, and any attempt to consider preserving wood on any other basis is certain to be fraught with difficulties, the majority of which have already been met by those concerns who thought that treating mine props was a simple, easy matter and something that any company could do without much previous experience. It is true that the technical detail required for the proper treatment of wood is not so highly specialized as that met with in mining operations. Yet, due to its apparent ease of operation, wood preservation has several pitfalls for the uninitiated ; and usually as a result of one of these, wood preservation itself may be blamed, whereas in reality the art was never properly practised. For instance, open tank treatments, even with the very best preservatives, do not penetrate the wood sufficiently and are bound to give poor results.

The question of whether a mining company shall build its own treating plant or should buy treated timbers from commercial wood preserving companies is to be answered only after a study of each case. Where a mine has an abundance of timber adjacent to its operations, and its annual consumption runs to at least a million board feet per month, it would possibly pay to install a private plant. Some mining companies using half that quantity per month have found it economical to treat their own timbers, but local conditions as to timber supply, freight rates, etc., were the deciding issues.

Commercial plants are usually available to mines in most localities where they should be able to contract for the timbers or treatment, or both, on a reasonable basis. These treating concerns have large treating facilities which enable them to cut down their overhead through quantity production. Furthermore, they are managed by technical men well versed in wood preservation. Peak demands for any individual company are easily handled. None of the large pole consuming

companies operate their own plants. They find it more economical to purchase their poles already treated.

Mine timber preservation has several angles, too, in the selection of the preservative. As a general basis for consideration, however, most engineers and operators have decided that any preservative that is used for the treatment should be something that will not increase the inflammability of the timbers, and yet will be permanent. Creosote, which has a long and enviable record as a preservative for cross-ties, is usually enjoined from consideration for mine timbers because of its inflammability, its odor, and the objection that the timbermen in the mines have to handling creosoted material. Mine timber preservation would have been much further advanced had creosote not been subject to these objections.

The leading wood preserving companies of the United States are using ZMA for the treatment of mine props, ties, poles, cross-arms, fences, piling, house timbers and for the many miscellaneous uses where treated timber is advisable and economical. This treatment leaves the wood odorless, colorless, paintable and permanent, and timber treated with it burns less readily than untreated timber. On account of these several very desirable attributes, its use for the treatment of mine timbers is growing rapidly.

Several salt preservatives for mines have been on the market for years but none of them have developed any great consumption, largely because all of them were soluble in water and consequently were not permanent in the damp locations of the mines. Zinc chloride, sodium fluoride, Ac-Zol, Wolman Salts, Minolith, mercuric chloride, copper sulphate and other miscellaneous chemicals have been tried to some extent but no general or wide use has been made of any of them by the different operators in various parts of the country, many of whom have almost identical wood-preserving problems.

In a study of mine timber preservation, consideration should not be given exclusively to underground structures; wherever wood is used around mines, studies should be made as to the possible economies to be obtained by its treatment. Such structures as tipples, concentration buildings, warehouses, bins, wharves, track structures, poles for power and telephone lines, piling for foundations —all should be analysed to determine the advisability of preservative treatment.

THE ALDERMAC MINE, QUEBEC

The Aldermac mine in Temiskaming County, Quebec, is situated on the Nipissing Central Railway, 10 miles west of Noranda. The mine is described in the *Canadian Mining Journal* of December 12 by W. P. Anderson and A. A. MacKay, who state that the company owns four two-hundred acre claims in a square block. The known ore is located at approximately the centre of the block. Exploration work has been confined to a comparatively small area containing the known ore-bodies. The article also contains a description of the Freeman pyrite furnace and acid system.

Geology.—The Aldermac ore-bodies are enclosed in volcanic rocks of Keewatin age near the southern margin of a large intrusive mass of porphyry, which outcrops for three miles to the north. Studies of the ore in place and of thin sections show that it has been deposited by the replacement of certain highly acid lava beds that were evidently more susceptible to solution than the other rocks in the solvent that brought in the sulphides. As for the genetic relationship of the ore, the present evidence points strongly to the conclusion that it was originally diffused through the magma that gave rise to the porphyry batholith, that this diffused material was concentrated into a fluid residue as the rock cooled, and that two differentiates of this residue furnished, first the material for the small porphyry dykes that abound in the locality, and, a little later, the sulphide material that constitutes the ore-bodies.

Type of Ore-Bodies.—The ore-bodies so far discovered are of the replacement type, sulphides having replaced rhyolite and breccia flows. In Nos. 1 and 2 ore-bodies, which lie approximately 1,000 ft. south of the shaft, the replacement is only partial, while in Nos. 3, 4, 5 and 6 ore-bodies, located near the shaft, the replacement is practically complete, at least 90% of the rock being replaced by sulphides. The portions of the ore-bodies developed at present contain approximately 260 lb. to the cu. ft., or 7·5 cu. ft. to the ton. It is estimated that 70% of the total sulphides is iron pyrites. The other sulphides are pyrrhotite, chalcopyrite and a small amount of sphalerite. The sulphur content of Nos. 3, 4 and 6 bodies is approximately 40%.

The three bodies last mentioned above are somewhat similar in shape, but vary greatly in size, the length on a horizontal plane being approximately three to four times the width, while the vertical axis is much longer than either of the horizontal axes. A more complete description of the three most important bodies follows:—

Grade and Dimensions of Ore-Bodies.—No. 3 ore-body has been developed on the 125 ft. and 250 ft. levels, and partially developed on the 500 ft. level. The average width is approximately 35 ft. and the length approximately 200 ft. It has a vertical extent of at least 500 ft. The dip averages about 65° south. The body is almost entirely massive sulphides, pyrite predominating, the average sulphur content being about 35%. The average copper content of this body, taken from all the later work and drilling, is 2·6% and the precious metal content approximately 90 cents per ton. The body is very regular in shape and has a generally clean-cut contact between sulphides and rock. The wall rock, which is hard and stands up well, should lend itself to cheap mining.

No. 4 ore-body has been developed on the 500 ft. level, and explored by bore-holes on the 250 ft. and 750 ft. levels. Angle bore-holes have also been drilled through the body at 375 and 600 ft. from the surface, and from the 250 and 500 ft. levels. At 250 ft. the body appears to be approximately 60 ft. wide. Drilling indicates a width of 100 ft. at 375 ft. in depth. Where opened up on the 500 ft. level the maximum width is 140 ft. On the 750 ft. level the outlines have only been partially delimited by drilling. The drilling indicates that the body will be at least as wide, if not wider, than on the 500 ft. level. The greatest length on the 500 ft. level is approximately 300 ft.

The vertical limits above 250 ft. and below the 750 ft. levels are not known. This deposit is approximately 90% sulphides, pyrite predominating. The average sulphur content is approximately 40%. The approximate average copper content, taken from development work and bore-holes, is 2% and the precious metal content approximately 60 cents. The body shows sharp contacts between the sulphide and wall-rock. The wall-rock is very hard and massive. Since No. 4 ore-body is very large and compact, and has such hard walls, it should lend itself to very cheap mining.

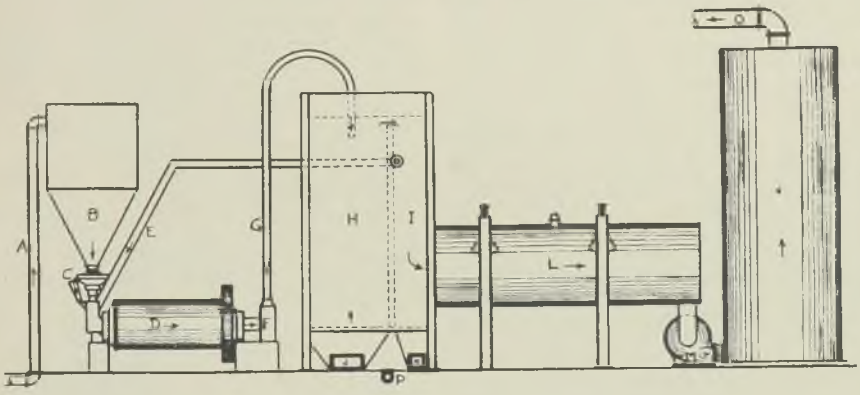
No. 5 is a small body between Nos. 3 and 4 on the 500 ft. level. Angle bore-holes have cut it at 70 ft. and 140 ft. below the 500 ft. level. The width is about 10 ft. and the copper content about 2·4%. Nothing is known about the other dimensions.

The estimated probable tonnage above the 750 ft. level in Nos. 3 and 4 ore-bodies is 1,500,000 tons, containing approximately 2% copper, 70 cents in precious metals and 40% sulphur. Metallurgical tests of the ore have shown that 50% to 60% of the total tonnage can be recovered as an iron pyrite concentrate containing 50% sulphur. Iron pyrite concentrates containing as high as 52% sulphur have been obtained in some of these tests. From this material practically all the impurities have been eliminated and the residue, after roasting, makes a very high-grade iron ore. The arsenic content of the ore is very low.

No. 6 ore-body has been opened up on the 1,125 ft. level only. It is approximately 90% sulphides, pyrite predominating. 60 to 70% of the sulphides are pyrite. The widest cross-section of the body so far determined is 185 ft., and the greatest length on the same horizontal plane is 300 ft. The depth in a vertical plane has not been determined. Where opened up by drives and cross-cuts the indicated grade is similar to No. 4 ore-body. If this body has as great a vertical extent as the ones above, the tonnage in it would be greater than that stated above as occurring above the 750 ft. level. There is enough ore above the 750 ft. level to keep a 500 ton mill running for ten years.

Large scale metallurgical tests have shown that 90% of the copper can be recovered in a 20% copper concentrate, and that 50% to 60% of the ore can be recovered in a 50% sulphur concentrate.

These pyritic ore-bodies constitute a reserve from which the pulp and paper and sulphuric acid industries can draw for the sulphur content, since the pyrite concentrate makes an ideal product for use in the Freeman burner, which is now working smoothly on a commercial scale. Ever since the market for pyrite in Canada was lost to the imported sulphur, Canadian mining men and chemists have endeavoured to find a cheaper and more economical way of producing sulphurous and sulphuric acid from pyrite. The large bodies of massive pyrite at Aldermac mine were the means of bringing the authors in touch with Mr. H. Freeman, who had been experimenting in the burning of sulphides for some time previous. The Sulphide Research Corporation Limited was then formed, which enabled Mr. Freeman to carry on his experiments on pyrite burning for the production of sulphur dioxide gas for use in the pulp and paper industry and the manufacture of sulphuric acid. The first work was carried on in a fifteen-ton capacity furnace at Shawinigan Falls. Later a twenty-ton furnace was installed in the St. Maurice mill of the Canadian Power and Paper Corporation at Cap de la Madeleine, near Three Rivers, Que. This furnace is now supplying that mill with their total acid requirements, and is running smoothly on a commercial basis.



The Freeman Pyrite Furnace and Acid System.

The Freeman Pyrite Burner.—The commercial plant now in operation at the Three Rivers mill is best described in the words of Mr. Freeman himself, as given in a paper before the Canadian Institute of Mining and Metallurgy in Toronto last March. The accompanying diagram will elucidate this description.

"The concentrate descends from a hopper, B, on to a rotating feed regulator, C, which supplies a 6 ft. by 3 ft. air-swept ball mill, D. Air, preheated in the combustion chamber, H, is led into the feed end of the mill and serves to take up the moisture in the pyrite as it passes through the mill. This air, as well as the air-floated pyrite, is drawn through the mill by a special fan, F, and delivered by six inch pipe to the combustion chamber. The suspended pyrite is caused to fall down a vertical combustion chamber, H, lined with firebrick and well heat-insulated. At commencement, this chamber is heated with oil for about one hour. Only part of the air for combustion is used to convey the pyrite, the remainder being caused to flow upwards from the bottom of the chamber. The particles are thus kept in suspension long

enough to attain substantially complete combustion. They then fall onto a conveyor, which carries them from the furnace in the form of sintered iron oxide.

"The entire combustion chamber is filled with the flame, and the temperature rapidly rises after starting and attains 1,150° C. This temperature is higher than is developed in sulphur burners and is an important factor in preventing the formation of sulphur trioxide. It also causes rapid fusion of the sulphide particles as they enter the furnace. They rapidly evolve elemental sulphur, and in doing so become puffed up, assuming the form of broken minute hollow balls, thus presenting a large surface for oxidation as they fall downwardly into the uprising air current. These particles rapidly become iron oxide in a state of incipient fusion, and exhibit a tendency to agglomerate; consequently, the oxide product is not an objectionable dust.

"The gases, consisting of sulphur dioxide, air, and the distilled sulphur, pass from the first combustion chamber to a second, I, in which they mingle and where final combustion of the sulphur is effected. They are then immediately passed into a fire-tube boiler, L, and are rapidly cooled from over 1,000° to 2,500°, passing so quickly through the temperature range for the formation of sulphur trioxide (500° to 800° C.) that only traces are formed. In the boiler, capacity 125 h.p., steam is generated at 165 lb. pressure. This is connected into the main steam system of the mill. Our experience, to date, is that 1 lb. of steam is recovered per lb. of pyrite consumed, and this covers the cost of operating.

"The gases are drawn through a regulating damper by a volume exhauster, M, and are delivered into the bottom of a large cooling and washing tower, N. They rise, through a charge of acid-proof spiral tile packing which mixes them effectively with the counter-flow of shower water. The gases become saturated with vapour at about two hundred degrees Fahrenheit, at which temperature they carry 30 lb. water per 1,000 cu. ft. In the upper part of the tower they are cooled to the temperature of the entering water and deposit the greater part of the absorbed water on the dust particles, which, owing to the slow progression of the gas through the chamber, are able to settle. The cooled moist gas, freed from dust and traces of sulphur trioxide, is then led to the absorption system. The gases contain 11 to 12% sulphur dioxide. The effluent from the bottom of the tower being kept at 80° C. dissolves very little sulphur dioxide. The residue of iron oxide, as already stated, is in the form of minute hollow shells, which have been fused and partly agglomerated."

The plant installed at the St. Maurice mill, as described above, has a capacity of 1,500 lb. pyrite per hour, requires a floor space of 900 sq. ft. and has a maximum motor load of 25 h.p.

The iron oxide residue constitutes a very important by-product, especially when using a high-grade pyrite concentrate. The chemical composition of pure iron pyrites is: Iron 46·6%, Sulphur 53·4% = 100%. The analysis of an iron pyrites concentrate from Aldermac mine is: Iron 46·0%, Sulphur 50·2% = 96·2%, leaving only 3·8% of foreign matter which is chiefly silica. After burning in the Freeman burner, this material makes an ideal product for the blast-furnace when sintered or briquetted. The copper, zinc and arsenic contents are very low.

An analysis of a sample of Aldermac pyrite burned was as follows:—

Before Roasting.	%	*After Roasting.*	%
Sulphur	50·20	Sulphur	0·214
Iron	46·03	Fe_2O_3	96·37
Insoluble	1·88	Silica	2·87
		Lime	0·12
		Alumina	0·07
		Magnesia	0·034
		Manganese	0·100
		Copper	0·139
		Zinc	0·240

Dressing of "Bideford Black."—In the *Bulletin* of the Institution of Mining and Metallurgy for November, H. M. Morgans describes a dressing plant for Bideford Black, which is a black ochre or earth occurring as a seam in the culm measures of North Devon. This ochre has long been used as a pigment and dressing plant has recently been erected near Bideford to prepare it for the market in larger quantities and of superior quality.

The ochre is brought from underground in wagons up an incline to the dressing plant, which is erected on the slope of a hill, so that the movement of the material is by gravity. The raw ochre is associated in the seam with shale, sandstone, and culm, but is kept as free from these as possible when mining. The raw ochre is delivered at a regular rate to a Hardinge mill (4 ft. 6 in. by 16 in., 31 r.p.m.), where it is ground wet to 40 mesh. The pulp is delivered to a Dorr classifier (3 ft. by 14 ft. 8 in.), which separates the coarse solids and returns them to the mill feed.

The fine material, mixed with about ten of water to one of solids, passes to a 16-cell flotation unit. The first 10 cells treat the pulp in series, and the float from these cells passes to the last 6 cells for further concentration. The flotation cells are 2 ft. 9 in. square by 4 ft. deep, of the positive-flow type with the vertical agitator spindles driven by quarter-twist belts at 390 r.p.m. from a countershaft running at the same speed.

The reagents used are creosote, cresylic acid, pine oil, and xanthate. The proportions of reagents as found in the tuning-up process are, per long ton of dry material:—

	Primary Float.
Creosote	0·90 lb. — 1·10 lb./2240 lb.
Cresylic acid	1·50 ,, — 1·75 ,, ,, ,,
Xanthate	0·20 ,, — 0·27 ,, ,, ,,
	Re-treatment.
Pine oil	0·09 lb. — 0·135 lb./2240 lb.

From the flotation plant, the concentrates flow to a Dorr thickener with a redwood tank 26 ft. in diam. by 9 ft. 9 in. deep, internal dimensions. The thickened pulp, drawn from the bottom of this tank by a diaphragm pump with variable stroke, contains one of solids to two of water. This pulp flows by wooden launder (slope 1 in 4½) to Oliver filters, of which there are two units with a drum 8 ft. in diam. by 8 ft. long. The vacuum pump and air compressor for the filters are horizontal, single-cylinder, belt-driven. The vacuum pump has a piston displacement of 400 cu. ft. per min. at 300 r.p.m. The low-pressure air compressor has a displacement of 75 cu. ft. per min. at 400 r.p.m.

The cake made on the Oliver filters consists of about two of solids to one of water, and is delivered to a rubber belt conveyor (12 in. wide, 30 ft. per min.) which carries it to a cylindrical dryer. This consists of a cylindrical steel tube 5 ft. 6 in. in diam. by 35 ft. long, having fixed around it two circular rails running on rollers and at the inlet end a heavy worm wheel, gearing with a worm. This cylinder turns at about 2 r.p.m. It is heated by a coal fire, whose products of combustion pass around the exterior of the tube. On their way from the fire to the tube enclosure, the gases pass through a nest of small tubes around which a secondary current of fresh air is passed and sent as hot air through the inside of the revolving large tube. Any dust picked up by this air current is separated out in a large cyclone and is re-fed to the dryer with the wet feed.

The dryer tube is set with a slight fall (1 in 90) towards the delivery end and is designed to deliver concentrated ochre, or "Bideford Black," containing not more than 0·5% of moisture, to an enclosed scraper conveyor that takes the black to the feed hopper of a Hardinge mill 8 ft. in diam. by 5 ft. This mill is lined with silex stone, and Danish pebbles are used for grinding.

Attached to the mill is an air separation plant for withdrawing material fine enough and returning coarse material to the mill. There is a closed circuit with a fan in it for circulating air. A current of air enters the Hardinge mill through a pipe in the centre of the outlet, reverses within the mill and passes away with the ground black in suspension through the mill outlet in the annular space around the air inlet pipe referred to. The dust-laden air passes upwards spirally between two inverted cones. On reaching the open top of the inner cone, the air velocity slows and any oversize material falls into the inner cone and gets into the current of air that passes it again into the Hardinge mill. The dust that is fine enough passes upwards to the top of a large cyclone and settles to the spigot where there is an air-lock discharge into paper-lined sacks or close-jointed barrels. There is a small access of air to the system through the feed inlet of the Hardinge mill. This excess is discharged to the atmosphere through a bunch of canvas bags which catch whatever dust there may be in the air. The dust caught in these bags is the finest.

In the dry grinder plant there are suitable adjustments for varying the rate of discharge and the degree of fineness. The plant is completely roofed in, whilst the dry grinder section is totally enclosed. The stanchions and principals are of steel sections and the roof and sides are of galvanized corrugated sheets. Glazed roof lights are fitted. The main roof faces north.

The duty of the plant is to produce 25 cwt. per hour of finished "Bideford Black," of a fineness of 300 mesh. The ratio of concentration, allowing for no loss, is 2·33 to one.

A supply of water is drawn from old workings by a vertical-spindle centrifugal pump and also from the mine by a ram pump, and water separated from the tailings is returned by a centrifugal pump to the head of the plant. The amount of water used measured at the head of the plant is roughly 120 gals. per min.

The plant is driven by electric motors. A supply of power being provided by the local electric supply company by overhead line, with a transformer yielding 415-volt 3-phase, 50-cycle current. The actual powers taken from the motors driving the more important units are :—

Primary grinding and classifier	20 h.p.
Flotation plant (with Dorr thickener, diaphragm pump and centrifugal pump for return of clear water)	50 ,,
Oliver filter plant :	
2 filters about 2 h.p.	
Centrifugal water pump 1 h.p.	5 h.p.
Vacuum pump	
Compressor	22 ,,
Dryer (cylinder, feeder, induced draught fan and secondary air fan)	23 ,,
8 ft. by 5 ft. Hardinge mill	70 ,,
Fan for air separation plant	21 ,,

The motors drive by direct connexion or belt. The large motor driving the 8 ft. Hardinge mill drives by inverted tooth chain and wheels with cut teeth. The motor driving the flotation plan (51 h.p.) drives by 5 Tex "ropes."

Magnetic Purification of Ground Felspar.—The application of magnetic methods for the purification of ground felspar is described in *Chemical and Metallurgical Engineering* for November last. It is said that an adaptation of a recently developed electro-magnetic induction separator to the processing of ground felspar has lately been made in the plant of the Tennessee Mineral Products Corporation, at Spruce Pine, N.C., to obtain a granular product specially suitable for the glass industry. This new process had been in operation for about two months and produced a ground felspar having the same maximum particle size as is standard in the manufacture of glass, but practically all of the dust and fine particles are also eliminated. The result is a free-flowing product such as the glassmaker has desired since felspar was first used in this industry.

The induction separator which is used almost completely removes from the raw felspar all contaminating materials. Metallic iron, garnet, pyrite, tourmaline, hæmatite, biotite, and even muscovite are taken from the material. The net result is an almost chemically pure felspar in a form best suited for blending with the sand, quartz, and other raw materials of the glass industry. While the new process gives a material that is practically dustless, previous methods of grinding have resulted in a high percentage of the product passing a 200-mesh screen.

In the new process, crushing rolls are used instead of pebble mills. The felspar is first broken to about ½-in. maximum size in a jaw crusher before it is fed to the first set of rolls. The output of this set of rolls is elevated to a double-deck screen, the lower deck of which produces a product of the required maximum size. The oversize on the top deck is returned to the first set of rolls. The ground material between the two decks of the screen goes to a second set of rolls. This process is repeated through two more sets of rolls, except that on the last set the top-deck screen scalps off mica, and the material between the two decks is returned to the last set of rolls. All rolls are 14 by 20-in. Sturtevant full-balanced type. Double-deck 4 by 5-ft. Tyler Hum-mer screens also are used straight through the line.

Ground felspar, as it comes from the final rolls, will all pass through the required maximum-size screen. It contains a minimum percentage of fine particles, since the screens remove the product

from the circuit as soon as it is reduced to 20 mesh. No raw material may be granulated, however, without the production of some fine particles. To remove these the output of the rolls is elevated to a Gayco centrifugal separator. The fines from this separator are delivered to a separate storage bin and blended with similar products for other industries that are produced by fine grinding units in the plant. The oversize from the separator is elevated to screens which classify it in two sizes to facilitate feeding to the induction separator.

Two 50-ton bins take the surge between the rolls and the induction separator units. The separator has two large coils, the upper one having three and the lower two arms or polepieces on each end. A laminated rotor 30 in. long revolves under each of these polepieces, making five on each side, or ten in all. Special feeding devices consisting of sloping pans between the rotors deliver a thin uniform stream of the ground material over the length of each rotor. As the material passes from one rotor to the next the magnetized particles are pulled out of the stream by the rotor and fall into a tailings receptacle. The gradually cleaned felspar thus continues on through five successive magnetic separations. At each stage a portion of the contaminating materials is removed. Minerals more highly susceptible to magnetism come out at the upper rotors and those feebly magnetic at the lower rotors.

Belt conveyors and elevators take the output of the magnetic separator to intermediate storage or mixing bins. Various grades of raw material are handled through each roll-separator unit, stored in the mixing bins and then blended to consumers' specifications. An automatic sampling device between the last roll and the storage bin secures frequent samples.

After the granular product has been blended it is put over check screens to catch any oversize which might in any way get into the product prior to shipment. From this check screen the product goes directly to the cars.

SHORT NOTICES

Shaft Sinking at Texas Salt Mine.—The application of the Francois cementation process to sinking in fissured cap rock over a salt dome at Grand Saline, Texas, is described by M. Taylor in *Mining and Metallurgy* for December.

Lead Zinc Flotation.—The flotation of lead-zinc at Tybo, Nevada, is dealt with by H. M. Lewers in *Engineering and Mining World* for December.

Volatilization of Zinc.—K. R. Goehre describes volatilization processes for low-grade zinc material in *Engineering and Mining World* for December.

Alluvial Gold in Korea.—A Japanese gold-dredging enterprise near Kintei, Province of Zeurahudo, Korea, is described by H. S. Little in *Engineering and Mining World* for December.

Ventilation and Dust.—*Chemical Engineering and Mining Review* of Melbourne for November 5 contains an article by A. J. Moore on ventilation and dust in metal mining.

Tables for Ventilation.—C. W. B. Jeppe discusses the control of high temperatures in deep level mining and compiles psychrometric tables in the *Journal* of the Chemical, Metallurgical and Mining Society of South Africa for October last.

Drill Sampling.—The drill sampling and interpretation of sampling results in the copper fields of Northern Rhodesia are dealt with by H. T. Matson and G. A. Wallis in Technical Publication No. 373 of the American Institute of Mining and Metallurgical Engineers.

Correlation of Katanga-Rhodesia Sediments.—Anton Gray discusses the correlation of the ore-bearing Sediments of the Katanga and Rhodesian copper belt in *Economic Geology* for December.

Gas-Lift Method of Flowing Oil Wells.—Under this title H. C. Miller describes California practice in Bulletin 323 of the United States Bureau of Mines.

Effect of Vacuum on Oil Wells.—B. E. Lindsly and W. B. Berwald treat of the effect of vacuum on oil wells in Bulletin 322 of the United States Bureau of Mines.

Hydrogenation of Petroleum.—R. T. Haslam and R. P. Russell review progress in the hydrogenation of petroleum in *Industrial and Engineering Chemistry* for October 1.

RECENT PATENTS PUBLISHED

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

13,885 of 1929 (310,972). G. Jakova-Merturi, Gagny, France. A plant for the distillation of sulphur, adapted for the production of carbon disulphide or sulphur oxides.

19,401 of 1929 (314,987). R. J. Frost, Clayton, Australia. White lead is produced by electro-chemical action by subjecting lead anodes to the action of direct current while immersed in a dilute aqueous solution of commercial sodium bicarbonate.

19,833 of 1929 (335,609). Soc. Anon. la Nouvelle Montagne, Engis, Belgium. Improvements in the sintering roasting of zinc blende.

21,197 of 1929 (316,969). Hirsch, Kupfer- und Messingwerke A.-G., Messingwerk, Germany. The electrolysis of fused electrolytes is carried out by heating the electrolyte bath through conducting heat transferring bodies, which are heated by eddy currents induced in them, thereby avoiding the very strong currents of low tension usually employed.

22,283 of 1929 (336,670). E. J. Kohlmeyer, Berlin-Charlottenburg, Germany. Metals such as zinc, tin, lead, bismuth, cadmium, antimony and arsenic are recovered from sulphide ores or secondary products by blast-roasting in a rotating furnace of such a design that the flame is compelled to enter and leave the furnace on the same side, lime being added to a limited extent.

29,585 of 1929 (336,770). Meyer Mineral Separation Co., Pittsburg, United States of America. Roasting processes for converting the metallic values of sulphide ores or other metalliferous materials to forms susceptible to ready extraction and recovery, particularly sulphating and chloridizing processes.

22,488 of 1929 (336,970). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Chromium ores are heated above 800° C., with or without the addition of a small quantity of oxidizing substance, for the purpose of rendering them readily amenable to chemical attack.

23,270 of 1929 (337,395). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Agents which will absorb the impurities in sulphur prepared by

the ammonium polysulphide process, vastly improve the colour of the product.

24,189 of 1929 (337,792). I. G. FARBENINDUSTRIE A.-G., Frankfort-on-Main, Germany. Finely divided zinc oxide is prepared from basic zinc carbonate by drying and grinding the carbonate and then calcining at a temperature below red heat.

36,467 of 1929 (337,636). A. FOLLIET and N. SAINDERICHIN, Paris. A furnace of improved design for the volatilization of zinc ores and mixtures of ores.

NEW BOOKS, PAMPHLETS, Etc.

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

The Mineral Industry of the British Empire and Foreign Countries; Imperial Institute Memoirs—Statistical Summary, 1927–1929. Paper backs, 371 pages. Price 5s. 6d. London: H.M. Stationery Office.

Zinc. Imperial Institute Memoirs on the Mineral Industry of the British Empire and Foreign Countries. Second Edition, 1920–1929. Paper backs, 193 pages. Price 3s. London: H.M. Stationery Office.

Safety in Mines Research Board. Subject Index to Vol. V, 1929. Paper backs, 10 pages. Price 2d. London: H.M. Stationery Office.

Mines Department: Report of H.M. Electrical Inspector of Mines, 1929. Paper backs, 40 pages, illustrated. Price 9d. London: H.M. Stationery Office.

Prospecting in Canada. Geological Survey of Canada, Economic Geology Series No. 7. Paper backs, 288 pages, illustrated. Price 50 cents. Ottawa: Department of Mines.

United States Bureau of Mines; Annual Report of the Director for year ended June 30, 1930. Paper backs, 54 pages. Price 10 cents. Washington: Superintendent of Documents.

Permissible Electric Mine Lamps. By L. C. ILSLEY and A. B. HOOKER. Bulletin 332, U.S. Bureau of Mines. Paper backs, 39 pages, illustrated. Price 15 cents. Washington: Superintendent of Documents.

Economic Relations of Silver to Other Metals in Argentiferous Ores. By C. W. MERRILL and others. Economic Paper 10, U.S. Bureau of Mines. Paper backs, 29 pages. Price 10 cents. Washington: Superintendent of Documents.

Metal Mining in California; Historical Summary of Gold, Silver, Copper, Lead, and Zinc produced in California, 1848 to 1926. By J. M. HILL. Economic Paper 3, U.S. Bureau of Mines. Paper backs, 22 pages. Price 5 cents. Washington: Superintendent of Documents.

Explosives in the United States; Production during 1929. By W. W. ADAMS and L. S. GERRY. Technical Paper 478, U.S. Bureau of Mines. Paper backs, 51 pages. Price 10 cents. Washington: Superintendent of Documents.

Mineral Resources of the United States, 1929. Part I, pp. 5–44, Iron Ore, Pig Iron and Steel, by H. W. DAVIS; pp. 45–56, Antimony, by P. M. TYLER; pp. 57–71, Platinum and Allied Metals, by H. W. DAVIS. Part II, pp. 65–81, Abrasive Materials, by O. BOWLES; pp. 83–93, Felspar, by O. BOWLES and J. MIDDLETON; pp. 95–104, Clay, by J. MIDDLETON; pp. 105–118, Gypsum, by R. M. SANTMYERS and J. MIDDLETON; pp. 119–138, Magnesium and its Compounds, by P. M. TYLER. Each part in paper backs. Washington: Superintendent of Documents.

Canada. The Manufacturing Industries of the British Empire, Part I. Folio size, 45 pages. London: Erlangers, Ltd.

Whitaker's Almanac. Cloth, clix + 960 pages. Price 6s. London: J. Whitaker and Sons.

Mathieson's Mining Highest and Lowest, for Mid-December, 1930, annual supplement to the Monthly Mining Handbook. Paper cover, 112 pages. Price 2s. London: J. C. Mathieson and Sons.

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

Asbestos in the Union of South Africa.—By DR. A. L. HALL. Second Edition. Paper covers, 324 pages, illustrated, with sections and map. Price 7s. 6d. Memoir No. 12 of the Geological Survey of the Union of South Africa.

Uganda. Annual Report of the Geological Survey Department, 1929. Paper. folio, 44 pages, with map. Price 3s. Entebbe: Geological Survey Department.

COMPANY REPORTS

Sulphide Corporation.—This company was formed in 1895 to work the Central lead-zinc-silver mine at Broken Hill, New South Wales. It also operates the Cockle Creek works in New South Wales, a zinc works at Seaton Carew, and has a controlling interest in the Nantymwyn lead-zinc mine in Wales. The report for the year ended June 30 last shows that at the Central mine operations were continuous throughout the year, 135,797 tons of ore being extracted, of which 2,459 tons were raised from Block 10 mine, as compared with 134,086 tons in the previous year. The ore milled totalled 266,844 tons, including, in addition to the Central mine ore, 97,113 tons of Broken Hill Proprietary mine ore and 33,906 tons of Block 14 mine ore. Lead concentrates produced totalled 24,907 tons, assaying 65·9% lead, 8·0% zinc and 48·9 oz. silver per ton. Zinc concentrates totalled 32,593 tons, assaying 50·2% zinc, 3·3% lead, and 5·7 oz. silver per ton. At the acid plant 531 tons of sulphur was consumed for a production of 1,449 tons of acid. At the Cockle Creek works the acid produced shows a decrease mainly owing to the effect of the coal strike on the Newcastle industries, and the 34,351 tons of superphosphates produced also shows a decrease when compared with the previous year. At the Seaton Carew works 7,863 tons of spelter, 69·83 tons of lead and 10,297 tons of retort residues was produced. The operations for the year resulted in a net profit of £72,593 as compared with £213,228 in the previous year.

Lake View and Star.—This company was formed in 1910 to work gold mines in the Kalgoorlie district of Western Australia. The report for the year ended June 30 last shows that 151,049 tons of ore, including 64,979 tons purchased from tributers, was treated for a yield of £494,629. In addition 138,508 tons of Ivanhoe residues was retreated which gave a profit of £1,896. The net profit for the year was £38,991 and, after adding the credit balance brought forward and making allowances for depreciation, etc., there remained a credit balance of £8,447 to be carried forward. The ore reserves at the end of the year were estimated to be 1,067,650 tons, averaging 31·66s. per ton,

although this only includes a portion of the rich ore proved in the Chaffers lease. The first unit of the flotation plant was completed in July last and is working satisfactorily.

Associated Gold Mines of Western Australia.—This company was formed in 1925 and owns gold mining leases in the Coolgardie field, Western Australia. The report for the year ended March 31 last shows that 56,388 tons of ore was treated at a profit of 3s. 5d. per ton. The tonnage treated is less by 2,888 tons than in the year before and this was caused by an accident to supply company's electric power plant. The year's operation resulted in a net profit of £4,659, from which was deducted the debit balance brought in leaving a credit balance of £3,573 to be carried forward.

Griqualand Exploration and Finance.—This company, first formed in 1895 as the African Saltpetre Company, changed to its present name in 1927. The company is working asbestos properties in Griqualand West, Cape Colony. The report for the year ended May 31 last shows that the production of asbestos was continued throughout the year, a policy of making forward sales of a substantial part of the company's output being maintained. The year's operations resulted in a profit of £4,856 and dividends absorbed £3,776, equal to 20%. Increased power plant was erected during 1930 and has been brought into successful operation in the current financial year.

Naraguta Korot Areas.—This company was formed in 1925 to acquire alluvial tin properties on the Bauchi plateau, Northern Nigeria. The report for the year ended December 31 last shows that 198 tons of tin concentrates was recovered as compared with 135 tons in 1928, the price realized, however, being only £105 10s. 7d. per ton, against £133 19s. 11d. The year's working showed a loss of £10,069 and, in view of the present depressed conditions, the properties in Nigeria are being run by a skeleton staff which has effected material economies.

Nigerian Consolidated Mines.—This company was formed in 1920 and works alluvial tin properties on the Bauchi plateau, Northern Nigeria. The report for the year ended March 31 last shows that 238 tons of tin concentrates was recovered as compared with 264 tons in the previous year. The year's operations resulted in a profit of £603 which was carried forward.

Offin River Gold Estates.—The report for 1929 shows that 86½ tons of tin concentrates was recovered during the year which realized £11,561, the profit for the year being £788.

Consolidated Tin Mines of Burma.—This company was formed in 1928 and works alluvial tin properties in the Tavoy district. The report for the year ended June 30 shows that 1,366 tons of tin concentrates was recovered, as compared with 700 tons in the previous year. The working profit for the year was £11,109 and, after making allowances for depreciation and other items, there remained a balance of £929, which was carried forward. The company has made strong efforts to enable it to face the present depression and substantial reductions have been made in salaries and fees. The board is endeavouring to keep the properties in good shape while curtailing development and restricting production.

Chosen Corporation.—This company, formed as the Chosen Syndicate in 1923, holds all the shares in three Japanese companies which have been formed to operate a concession in Korea. The report for the year ended June 30 last shows that at the Great Nurupi mine 112,500 tons of ore was treated for total yield of £139,826. The working profit was £26,000. The ore-reserves of this mine were estimated to be at June 30 last, 114,800 tons, averaging 6·62 dwt.

DIVIDENDS DECLARED

Apex Mines.—6d., less tax, payable February 7.
Ashanti Goldfields Corporation.—65%.
Burma Corporation.—3 annas, free of tax, payable February 14.
Cam and Motor Gold.—1s. 6d., less tax, payable February 13.
Charterland and General Exploration and Finance.—Pref. 3%, less tax, payable January 14.
Clydesdale (Transvaal) Collieries.—9d., less tax, payable February 12.
Consolidated African Selection Trust.—9d., payable February 4.
De Beers.—Pref. 10s., less tax, payable Jan. 9.
Fanti Consolidated.—6d., less tax, payable January 16.
Frontino and Bolivia.—Pref. 6d., less tax, payable December 31.
Gopeng Consolidated.—4d., less tax, payable January 7.
Kramat Tin Dredging.—6d., less tax, payable January 10.
Malayan Tin Dredging.—9d., less tax, payable December 18.
Messina (Transvaal).—3d., less tax, payable January 5.
Natal Navigation Collieries.—9d., less tax, payable February 13.
Rezende Mines.—2s. 6d., less tax, payable February.
San Francisco Mines of Mexico.—1s., less tax, payable January 8.
Sherwood Starr Gold.—9d., less tax, payable February.
Sinai Mining.—Pref. 1s. 2⅔d., less tax, Ord. 6d., free of tax, payable December 31.
South Kalgurli.—1s., less tax, payable Feb. 2.
Southern Malayan Tin Dredging.—4½d., less tax, payable December 18.
Southern Perak Dredging.—6d., less tax, payable December 18.
Sulphide Corporation.—Pref. 1s., less tax, payable January 17.
Transvaal Consolidated Lands.—1s., less tax, payable February 3.
Wankie Colliery.—6d., less tax, payable Jan. 22.

NEW COMPANIES REGISTERED

Britannia Lead.—Registered as a private company December 4. Nominal Capital: £100,000 in £1 shares. Objects: To acquire concessions and to prospect for lead, tin, wolfram, iron and other minerals or metals, etc.

French Fluor Spar.—Registered December 3. Nominal Capital: £60,000 in 40,000 Six per Cent. £1 Preference and 400,000 1s. Ordinary. Objects: To acquire a mining concession granted by the Mayor of Tanneron, Department of Var, France, to P. Tibaud, to adopt an agreement with the Continental and British Mining and Financial Trust, and to carry on the business of miners, etc. Directors: H. C. Woolmer, A. F. De Reya and D. D. Chaffey.