The Mining Magazine

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CONTENTS

EDITORIAL

IT is difficult to estimate the results of the Ottawa Conference, since the inter-Empire agreements are not valid until they have been ratified by the respective Governments. The only matter in which mining men might be considered to be directly interested was the proposal to place a duty equivalent to 2d. per pound on copper imported from any country outside the British Commonwealth.

A CHELSEA Polytechnic Old Students' Association is to be inaugurated at a meeting to be held on November 4, on the occasion of the opening of the polytechnic extension by the Parliamentary Secretary to the Board of Education. It is hoped that there will be a good attendance of old students, those desiring further particulars being asked to communicate with the honorary secretary of the new association at the polytechnic.

DURING 1931 the work done in the mining research laboratory at Birmingham University was, as usual, mainly concerned with the coal mining industry, the report just issued containing full details of the investigations completed or in hand. Mining companies and miners in this country are now fully aware of the dangers of silicosis and research on rock dusts as well as konimeter tests of mine air are deservedly treated as of importance.

THE use of aircraft as an aid to mining and prospecting is becoming increasingly common. Following reference last month to their successful employment in New Guinea for the transport of dredge parts and the announcement of the intention to conduct an aerial survey of the Rand comes the news from Australia of a survey flight over a wide area in the north which it is hoped will be helpful in mapping rugged oil-bearing country.

THE annual meeting of the British Association was held for the fifth time at York—the place of its inception—from August 31 to September 7. Sir Alfred Ewing, in his presidential address, surveyed the field of scientific progress from the point of view of the engineer and was disposed to regard the mechanization of industry as a mixed blessing, as it results in the disappearance of craftsmanship and reduces the necessity for toil. Professor Rankine, in his address as president of the section of mathematical and physical sciences, dealt with the progress of geophysical methods of mineral finding.

A LETTER in a recent issue of *Nature* recalls a discussion in 1928 on the effect of moonlight on timber begun in the Institution and commented on in the MAGAZINE. Dr. Semmens propounded the theory in our July issue that the light of the moon during its early phases had a hydrolysing effect. The same investigator now advances proof of this contention as the outcome of her experiments with leaves, which go to show that the starch is hydrolysed by the moonlight, thus causing sugary essences to enter the sap, the presence of which renders the timber more attractive to insects.

South African Mining

With the output from the gold-mining industry during 1931 constituting a record and with every prospect of yet another record being established in 1932, the task of the Union Government Mining Engineer in preparing his annual report [1] must have been pleasanter than he probably anticipated, having regard to the poor conditions prevailing in other branches of the mining industry. The only other metalliferous product shipped in larger quantity last year was manganese ore, the output increasing from 58,572 tons to 115,889 tons, although the value only rose from £91,858 to £127,884, but as shipments from Postmasburg were suspended in October last the figures for the current year may be expected to show a severe set-back. All other mining products registered decreased outputs and conditions as regards employment generally deteriorated. The stimulus given to operations on the Rand mines by the world-wide demand for gold was, however, sufficient to ensure that salaries and wages for the year and money spent on stores would be maintained and it is satisfactory to note that the

[1] Union of South Africa—Department of Mines and Industries, Annual Report of the Government Mining Engineer, 1931. Price 10s. 6d.

latter item showed a slight increase over the figures for 1930. Mining in the Union is, therefore, in an enviable position and nothing perhaps indicates this better than the improved labour returns, the monthly statements having shown a continuous increase, in spite of the fact that employment on the diamond mines has all but ceased, while a continued decline is recorded in the numbers employed by the coal mines. From this it will be seen that the gold-mining industry is fortunately in a position to absorb much of the labour no longer required in other branches of industry.

It is gratifying to note from the report the continued decrease in the accident rate on the Witwatersrand gold mines during the year, the figure having fallen from 2·56 to 2·35 per 1,000, this improvement being mainly due to the fact that there were no abnormal accidents. It is clear, however, that the problem created by increasing pressures due to the depth of working must involve continued changes in the methods and amount of support if the accident rate is to be kept down, for experience in the shallower workings cannot be expected to be altogether applicable to conditions at depth. Deaths due to explosives accidents show a continued decrease, as might be expected, but those in connexion with trucks and tramways again show an increase, mainly due to mishaps with runaway trucks in mines on the Far East Rand, and the Government engineer has considered it wise to warn the managements on those mines that unless they can succeed in reducing the accident rate from these causes further legislation may be necessary. Altogether it may be deduced from the report that the good effects of the Safety First Campaign, which was energetically carried on during the year, are being continued. Turning to the mechanization of the industry, it is recorded that on the gold mines the rock mined during the year by means of rock-drills amounted to 95·48% of the total tonnage hoisted, as compared with 96·34% in 1930 and 59·59% in 1921, while 75% of the drills employed are now hand-held jack-hammers, against 30% for 1921. Again, it is noted how the method of sludging has changed during the past 10 years, all drills employed on the Rand to-day being classed as passing water only through the steel. The total number of drills on the Rand now number 9,390 against 8,768 a year ago, and the fact that British manufacturers continue to more than hold their own in this field is indeed gratifying. As regards phthisis conditions, it is recorded that, on the whole, these were found to be measurably satisfactory and that the regulations have been generally complied with, whilst it is important to note that the liability to contract the disease had undergone a marked decline during the past decade. It is evident that working conditions on the Rand continue to improve, in spite of the increased depth of operations, and this is mainly due to the general high level of efficiency which is maintained by the managements.

Reviewing conditions in South Africa generally, it must be admitted that the importance of the Rand is so great that it is difficult to form a correct estimate of the relative values to the Union of the gold-mining and other industries. It is certain, however, that the Rand can continue to carry the Union when all other primary commodities are in the doldrums and it is difficult not to feel that the Union Government is, to some extent, jealous of the industry, although realization of how easy it would be to allow the political views of the industry to prevail doubtless explains to some extent the attitude of conscious rectitude preserved by the Union Administration. Returning to the report, it is regrettable, perhaps, that it is somewhat out of date, as the inquiries in progress during the year were not concluded in time to be recorded, so that the work of the Low Grade Ore Commission, for example, which has already been reviewed in these columns, may be regarded as providing a less biased view of the problems confronting the Rand. As to that part of the industry concerned with metals other than gold, conditions can only improve as world conditions improve, a state of affairs which all hope may be near at hand.

Secondary Metals in the United States

The continued decline in the prices of primary metals which prevailed during the greater part of 1931 naturally affected the collection of scrap for the production of secondary metals. Prices for scrap metals, alloys, and residues declined so rapidly that the operations of dealers were at times seriously hampered and, in consequence, many furnaces active during 1930 became idle or worked on a much reduced scale. It is not surprising, therefore, that the latest returns from the United States, dealing with

the recovery of metals from secondary sources during 1931, should show a further falling off in value and quantity. The value of the non-ferrous metals included in the returns recovered from these sources is estimated to have been $110,674,600, which is $82,580,500, or 43%, less than in 1930, while the total quantity was down by 21%. The decrease in value was largely due to the much lower average prices prevailing for all the primary metals, but the main decrease in quantity of secondary metals treated was in copper and brass, the output of these being reduced by 27%, the value declining by nearly 50%. The table given below summarizes the production in short tons of secondary metals in the United States for 1931 and the figures for 1930 are added for comparison :—

	1930	1931
Copper, including that in alloys other than brass	332,800	261,000
Brass scrap remelted	192,000	122,800
Lead as metal	129,000	128,800
Lead in alloys	126,800	105,900
Zinc as metal	49,300	34,800
Zinc in alloys other than brass	7,700	7,400
Tin as metal	5,600	5,500
Tin in alloys and chemical compounds	20,600	14,300
Antimony as metal and in alloys	8,082	7,900
Aluminium as metal	19,700	15,200
Aluminium in alloys	18,900	15,100
Nickel as metal	500	270
Nickel in non-ferrous alloys and salts	2,400	1,800

With the reduction of primary supplies coming on the market and the increase of stocks, it is evident that the quantities of metal produced from secondary sources still amount to a significant total.

Examining in some detail the figures given in the report, it may be noted that, while the shipments of scrap copper to Europe were double those of 1930, the shipments of scrap brass declined. The quantity of secondary copper produced by smelters and refineries in the United States treating mainly primary metal decreased from 140,270 tons in 1930 to 78,064 tons in 1931, the total production of secondary copper metal last year amounting to 188,300 tons, against 244,800 tons in 1930, while the copper content of secondary brass and other alloys was 158,700 tons, as compared with 222,400 tons in 1930. Thus the total amount of secondary copper recovered in 1931 was 347,000 tons, as compared with 467,200 tons in 1930. In the case of lead the secondary metal recovered by smelters whose main business is the treatment of ore was 43,774 tons, that coming from smelters treating only scrap and drosses being 85,026 tons, the total of 128,800 tons comparing with 129,000 tons in 1930. These quantities, however, make no allowance for secondary lead recovered in remelted alloys, which in 1931 totalled 105,900 tons, against 126,800 tons in the previous year. The total production of secondary lead in the United States for 1931 was, therefore, 234,700 tons, as compared with a production of the primary metal amounting to 442,764 tons, figures which emphasize the importance of the secondary metal industry. Turning to zinc, it may be noted that the production of unalloyed secondary metal fell from 49,300 tons in 1930 to 34,800 tons in 1931, while the zinc recovered in alloys, including brass, was 37,400 tons, against 50,000 tons. In the case of zinc dust produced from dross a slight gain was recorded, the output for 1931 from this source amounting to 7,478 tons, as compared with 6,394 tons in the previous year, while 8,700 tons of zinc dross was used for zinc dust, as against 7,450 tons in 1930. The zinc content of zinc salts made from skimmings showed little change when compared with 1930, the figures being 35,969 tons against 37,013 tons, but the secondary zinc content of lithopone increased to 15,111 tons from the 14,679 tons recorded for 1930. The figures for tin show that secondary pig tin amounted to 5,500 tons in 1930, against 5,600 tons in the previous year, the tin recovered in alloys and chemical compounds declining from 20,600 tons to 14,300 tons. The other important metals covered by the returns are, as will be seen from the table, aluminium, antimony, and nickel, and in each of these the 1931 output of secondary metal showed a decline, although each remains an important item.

Mining in British Columbia

The recent arrival in this country of the annual report of the Minister of Mines of British Columbia for 1931 was followed almost immediately by the statistical summary and review of the mineral industry of the same Province covering the first six months of the current year, so that, in reviewing the two publications simultaneously, it is possible to obtain a better conception of business trends in Western Canada. The key metal at times like the present is, naturally enough, gold and, while the 1931 output of this metal from both placer

and lode sources showed a decline as compared with the previous year, it is already evident that the output for the current year will be much larger. Indeed, as the Provincial Mineralogist remarks, the search for gold has become the paramount feature of British Columbian mining activities in 1932 and, while actual production has increased in a satisfactory manner, the finding of new gold properties and the development of others already known may be taken as an augury of an even greater expansion in the future. As regards lode mining, pride of place seems about to be yielded by the Premier company to the Pioneer, while the output of the Reno and Lorne properties is also expanding. As regards placer mining, a comparison is a little more difficult. Placer gold is mainly produced during the second half of the year, the major clean-ups at most properties being made in the autumn, so that, while it is estimated that $70,000 in placer gold was produced up to the end of June in the current year, it is felt that this figure is no guide as to what the year's total production will be, the figure for 1931 being $291,992. One of the most important features during the present year has been the large number of inexperienced people who have gone out into the backwoods in an attempt to make a living by mining work. Many of these newcomers to the profession have not persisted long in their efforts, it is true; nevertheless, a number of these new men may become useful prospectors and their discoveries may prove of benefit to the industry.

In British Columbia gold mining has never been of the same importance as has that for other metals and yet at the present time it is only in gold that any expansion of activities is being witnessed. It is encouraging to note, however, that the major mining properties in the Province have managed to remain open during the period of hard times, efficiency of operation having prevented a complete shut down. It is evident, therefore, that conditions are likely to improve rapidly as soon as general business trends upwards. During the first half of the present year the silver output shows a considerable decline when compared with the corresponding period of 1931, the decrease being mainly due to the curtailment of operations at the Sullivan mine, which is also responsible for heavy declines in the Provincial output of lead and zinc, these metals being almost entirely produced by the Consolidated company from that mine. The copper output of the Province also shows a sharp decrease during the first half of the current year and here again the drop is mainly due to the curtailment of operations by one company. Nearly the whole of the copper output of British Columbia is produced jointly by the Granby company's mine at Anyox and by the Britannia and the decreased output at the latter enterprise is responsible for most of the decline in the 1932 figures for the Province. It should be noted here that the incidence of the United States latest tariff on copper has hit these producers very badly, for most of the copper used to cross the border. Other markets are being sought for the British Columbian output, but the future is at the moment regarded as somewhat obscure. As regards coal, the value of the output has also declined in the present year, but coal, perhaps, will be the first mineral to respond to any improvement in general conditions, so that there is some consolation in the fact that, although the value of the output to June 30 last was $3,636,900 against $3,968,000 for the first half of 1931, the output had actually risen from 793,600 long tons to 806,200 long tons. Structural materials and miscellaneous minerals are also being produced on a diminished scale during the present year, but here again the output is likely to show a ready response to any improvement in trade.

The activity with which the search for gold is now being carried on in the Province brings with it its attendant danger. The Provincial Mineralogist, in his introduction to the summary for the first half of the current year, has, therefore, thought it wise to issue a warning to investors against undue optimism or a too easy belief in the exaggerated statements of unscrupulous promoters. In this respect the reports of the resident engineers, which accompany the summary, should prove valuable, for information is given which should enable those interested to appraise all such promotions. The work of the Mineral Survey of British Columbia has always been beyond reproach and it is unfortunate that the present financial state of the Province should have meant a curtailment of its activities. A return to normal conditions in the mining industry, however, should enable this important department to resume its valuable pioneer work on the same scale as hitherto, with equal benefit to the profession and the community.

REVIEW OF MINING

Introduction. — The most important feature of the past month has been the steady rise in the prices of commodities, the improvement in the non-ferrous metals having been of a substantial nature. In Australia, in the course of the introduction of the new budget, it was announced that the gold bounty was to be suspended as from September 13, probably not to be restored until gold falls to £5 per oz. at Melbourne.

Transvaal.—The output of gold on the Rand for August was 943,174 oz. and in outside districts 48,148 oz., making a total of 991,322 oz., as compared with 981,160 oz. in July, the August total being another new monthly record. The number of natives employed on the gold mines at the end of the month totalled 217,658, as compared with 217,525 at the end of July.

It was announced last month that in the sinking of No. 17a sub-vertical shaft on the Crown Mines the South Reef was encountered at 5,240 ft., the average value being 7·7 dwt. over a width of 25 in. At 5,360 ft. the Main Reef Leader was intersected, the value at this point being 20·3 dwt. over 15 in. of reef. The dip of the reefs being 4° less than at the nearest operating section 4,000 ft. away, they have been cut much earlier than had been anticipated.

Interesting disclosures at depth are also announced by the Luipaard's Vlei, the West Rand Consolidated, and the West Springs companies. On the Luipaard's Vlei driving towards the new Midas shaft is being accelerated with a view to the early intersection of the Midas shoot area, while on the West Rand property the main reef has been struck in the west sub-incline shaft at the 31st level, the value of the first 50 ft. sampled being 14·6 dwt. over a reef width of 68 in. At West Springs the bore-hole in No. 2 south-east haulage intersected the reef 200 ft. below, the core assaying 18·7 dwt. over a true width of 34 in.

Shareholders of the Meyer and Charlton company were informed last month that extraordinary meetings are to be held in Johannesburg in October at which the requisite proposals for the liquidation of the company will be considered. A complete clean-up of the plant is now in progress and arrangements are in hand for the realization of the remainder of the company's assets.

In a circular to shareholders of the New Kleinfontein company it is stated that the finance necessary to enable operations to be conducted on a larger scale has been arranged. In return for an option up to December 31, 1933, to take over 100,000 ex-enemy shares at 8s. 6d. per share, certain of the larger shareholders have guaranteed the provision of £40,000 in South African currency as and when it is required.

At the extraordinary meeting of Witpoort Gold Areas, held this month, the resolution for winding up the company was approved.

The accounts of Oceana Consolidated for the year to June 30 last show an adverse balance of £74,731, mainly arising from losses on investments, deferred land payments, and farms.

Favourable developments on the property of the Messina (Transvaal) Development Company are recorded in a cable issued by the company last month. It is stated that on the K lode work on the 11th level has exposed a total of 179 ft. of ore assaying 3·74% copper, while on the west end of the same lode at the 13th level a new ore shoot has been exposed, which over 342 ft. sampled gives very promising results. Other bodies discovered between the 11th and 13th levels are now proved to be continuous and the development results being obtained are said to be very satisfactory.

Southern Rhodesia.—The output of gold from Southern Rhodesia during July was 47,331 oz., as compared with 48,441 oz. for the previous month and 44,765 oz. for July, 1931. Other outputs for July last were : Silver, 12,350 oz. ; coal, 39,030 tons ; chrome ore, 515 tons ; asbestos, 822 tons ; tin, 1 ton.

The report of the Lonely Reef company for the three months to June 30 last states that in May a commencement was made on the transport of a small tonnage of ore from the Peter Pan claims to the Lonely mill, 976 tons from that source being milled during the quarter. The ore coming up to expectations, the claims have now been purchased outright at what is stated to be a reasonable figure. Some alterations are to be made to the Lonely plant in order to enable it to deal with an increased tonnage from the Peter Pan section and a light railway is being put down to connect the properties.

In the report of the Cam and Motor company for the quarter ended June 30 last it is stated that a Crowe-Merrill precipitation plant has now been installed in place of the

zinc extractor boxes and that it is operating satisfactorily. A crushing plant has been erected at the Petrol shaft to prepare oxidized ore for treatment in the residue retreatment plant.

The results of exploration on the Caliph claims are given in the report of Rezende mines covering the three months to June 30 last. It is stated that No. 1 bore-hole passed through reef formation at a depth of 317 ft., the core assaying 6·7 dwt. over 29 in. No. 2 bore-hole was put down to 498 ft., but no ore has been encountered, owing to faulting.

Northern Rhodesia.—As a precautionary measure, the Roan Antelope company has made arrangements enabling it to place 7% convertible debenture stock during the course of the next year in order to obtain approximately £200,000 as additional working capital. It is stated that the company does not anticipate having to issue any of this debenture stock, unless there is a severe set-back in the price of copper.

It was announced last month that the Rhodesia Broken Hill Development Company had decided to offer to the holders of options expiring at August 31 the right to extend their options at 5s. per share up to August 31, 1934, on payment of a further 3d. per share. This would leave 4s. 3d. per share to be paid.

Shareholders of the North Charterland Exploration Company were informed last month that the directors were on the whole satisfied with the report of Mr. Justice Maugham, the commissioner at the recent inquiry into the company's concession in Northern Rhodesia, believing that their claim for compensation has been in a large measure upheld.

Nigeria.—At meetings of shareholders of the London Tin Corporation, held last month, it was unanimously approved that the unissued preference shares of the corporation should be cancelled and that ordinary shares should be created in their place.

During the year ended March 31 last the Yarde Kerri Group Tin Mines, Ltd., made a working profit of £408. After allowing for debenture interest and the debit balance of £794 brought in from the previous account, however, there was a deficit of £1,161 to be carried forward. In consequence of restriction arrangements the company's output for the year amounted to only 65 tons, as compared with 149 tons in the previous year, the price per ton realized being £78 12s. 4d., against £84 3s. 7d. The proved ore reserves at the end of the period under review were estimated to be 1,361 tons. It is stated that a considerable decrease has been effected in running expenses, a factor which should have greater effect on the accounts for the current year.

The report of Tin Properties, Ltd., for the year to September 30, 1931, shows a loss of £8,981. Operations on the company's property were discontinued at the end of December, 1930, its quota being disposed of in March last.

The accounts of the London Nigerian Power Company covering the year ended February 29, 1932, show a profit of £6,603. After allowing for debenture interest, however, there was a debit balance of £1,293, which, after deducting the sum of £214 brought in, left a deficit of £1,079 to be carried forward.

Gold Coast.—Shareholders of the Ashanti Goldfields Corporation were informed last month that the reef had been cut in the main cross-cut on the No. 27 level at 528 ft. from the main shaft and later advices show the ore at the point of intersection to have a width of 4 ft. and an average assay value of 36·8 dwt. The corporation has declared a second interim dividend of 25% in respect of the year ending September 30, payable on or after that date. It will be remembered that this year's dividend is on a larger capital, a scrip bonus of 33⅓% being issued at the end of the last financial year.

Australia.—Advices from Australia received this month are to the effect that the New South Wales basic wage rate has been reduced from £4 2s. 6d. to £3 10s. A two months' notice has been given by the Union to end their present agreement and to enter into negotiations for a fixed wage rate at Broken Hill.

Last month a dividend of 1s. per share was declared by the North Broken Hill company. It is stated that this, like the dividend in June last, will be paid primarily out of accumulated funds.

In the return for the month of August shareholders of Boulder Perseverance, Ltd., have been informed of the results achieved by the new plant. During the period from August 15 to 31 2,621 tons of ore was treated at a cost of 16s. 9d. per ton, the gold recovered being valued at £4,057, while in addition it is estimated that bullion to the value of £750 has been absorbed in the plant. The extraction is estimated at 95% and it is thought that operating expenses will soon be reduced to 12s. per ton. Until certain modifications

making for smoother running and increased capacity have been effected it is considered advisable to continue the running of the old plant.

New Guinea.—Shareholders of New Guinea Goldfields were informed last month that the Golden Ridges mill started treating ore on August 16. At the same time the announcement was made of a new discovery of ore some 2,500 ft. from and 600 ft. above the Golden Ridges ore-body.

India.—The report of the Indian Copper Corporation for the half-year to June 30 last states that the mill treated 90,737 short tons of ore, averaging 3·04% copper, with a recovery of 97·58%, as against 79,089, averaging 3·258% copper, for the same period of 1931. The output of the smelter was also higher, at 2,160 long tons of refined copper, while the output of the rolling mill rose to 2,408 long tons of yellow metal sheet.

Nundydroog Mines, Ltd., has announced an interim distribution of 20%, equal to 2s. per share, this representing the largest interim payment since the company was reconstructed in 1920.

Balaghât Gold Mines, Ltd., which, in pursuance of the authority conferred by the special resolution approved on July 11, intends to pay the preference dividend for the six months ended June 30 last, equal to 6d. per share, will also pay a dividend of 2s. 3d. per share to holders of both ordinary and preference shares.

A circular to shareholders of the Balaghât company states that as all formalities with respect to handing over the mine to the Nundydroog company have been concluded, an extraordinary meeting is to be held on October 3 at which it will be proposed that the company should go into voluntary liquidation.

Burma.—Further work on the Mwedaw ore-body, now being opened up by the Kafue Copper Development Company, has shown the average width to be 24 ft., averaging 16 dwt. in value.

Malaya.—The report of the Raub Australian Gold Mining Company for the year ended February 29 last shows a profit of £71,647, against £41,008 in the previous year. The tonnage milled was 36,130, an increase of 4,510 tons on the previous year's total, while the total yield of gold from all sources amounted to 24,452 fine oz., against 22,304 fine oz. The ore reserves at the end of the year were estimated to be 46,800 tons, as compared with 33,400 tons at the end of the previous year, 28,200 tons of the present reserve averaging more than 10 dwt. Work at the Silensing mine is still in hand, but so far it is impossible to give an opinion of its value.

Canada.—Shareholders of the Mining Corporation of Canada were informed last month that the Ashley mill had started on August 25 and that it was running smoothly at half capacity, treating 75 tons daily.

Mexico.—The report of the Mexican Corporation, Ltd., for the three months to June 30 last states that 14,807 ft. of development was completed during the period, mostly in the oxide area near the surface, with, it is stated, very satisfactory results. In addition 1,370 ft. of diamond drilling was completed, principally in the sulphide section, as a guide to development and to test the walls of the veins. Milling results for the period were normal and the pre-treatment plant for rebellious manganese-silver ores has now been put into service.

During the three months ended June 30 the Santa Gertrudis Company, Ltd., treated 74,048 short tons of ore, the revenue being estimated at $159,653. The ore treated all came from the properties of the Compañia Dos Carlos and milling results were normal and satisfactory.

Panama.—Debenture and share holders of Panama Corporation have been informed by the liquidator that he will shortly be in a position to arrange for the exchange of certificates in the old company for those of the new.

Spain.—An offer of £3,984 of debenture stock has been made by San Finx Tin in order to make up the £10,000 offered in October, 1931. The company is at present in the hands of a receiver, but a successful result of the present appeal would enable the company to go to the Court to obtain sanction for new proposals.

Metals.—The statistics for tin available at the end of August indicated a decrease of 2,051 tons in the visible supplies, in addition to which there was a decline of 1,020 tons in the Straits unshipped surplus, making a total decrease of 3,071 tons, an amount considerably in excess of expectations. Figures for lead and zinc production, issued last month, showed an estimated production of lead during July of 87,109 tons, 28,487 tons less than the average monthly output of 1931, while the zinc output was estimated at 61,403 tons, 22,780 tons less than the 1931 monthly average.

GOLD MINING IN THE SUDAN

By K. S. TWITCHELL, B.Sc.

The author describes past activities on the Red Sea coast of the Sudan and deals with present-day operations and potentialities.

When a mining engineer visits the Egyptian Museum at Cairo and looks at the amazing exhibits from the tomb of King Tutankamen, he naturally thinks of the mines that produced the gold for the wonderful ornaments and coffin. The author personally had a feeling of great pity and wondered how many lives had been taken in obtaining the gold for the coffin alone, for the winning of gold in those far-off days was carried out under conditions sometimes awful beyond description. In Cyprus, the early mining was done by heating each face with fires, water then being dashed on the hot rock to cause cracks to develop, excavations being then made with moils and picks. The charcoal, ashes, dumps of broken pottery water jars, and marks of the moils and picks are the basis for the above statement.

In the Sudan the following method of operations is described by Diodorus about 100 B.C., and the author takes the liberty of quoting from a bulletin prepared by Stanley C. Dunn [1] :—

The kings of Egypt condemned vast multitudes to the mines who were notorious criminals, prisoners of war, and persons convicted by false accusation—the victims of resentment. And not only the individuals themselves, but even whole families are doomed to this labour, with the view of punishing the guilty and profiting by their toil. The vast numbers employed are bound in fetters and compelled to work by day and night without intermission, and without hope of escape ; for they lay over them barbarian soldiers who speak a foreign language, so that there is no possibility of conciliating them by persuasion or through familiar intercourse. No attention is paid to their persons, they have not even a piece of rag to cover themselves ; and so wretched is their condition that all who witness it deplore the excessive misery they endure. No rest, no intermission from toil is given either to the sick or maimed ; neither the weakness of age nor woman's infirmities are regarded ; all are driven to their work with the lash, till at last, overcome with the intolerable weight of their afflictions, they die in the midst of their toil. So these unhappy creatures always expect worse to come than they endure at the present, and long for death as preferable to life.

The following is a free translation from Muller's text of Agatharchides' description written about the same time :—The metal-bearing rocks which are called gold-bearing are intensely black, but among them is produced a stone than which nothing is whiter. Of these mountains, those which are rugged and have an altogether hard nature they burn with wood ; and when they are softened by fire they experiment on them, and cut the loosened stones into small pieces with an iron chisel.

But the principal work is that of the artificer who is skilled in stones. This man shows to the diggers the track of the metal, and apportions the whole work to the needs of the wretched men in the following manner :—Those whole in strength and age break the places where shines the white stone with iron-cutting hammers. They use not skill but brute force, and thus they drive in the rock many galleries, not straight but branching in all directions like the roots of a tree, wherever the stone pregnant with gold may diverge.

These men thus, with candles bound on their foreheads, cut the rock, the white stone showing the direction for their labours. Placing their bodies in every conceivable position, they throw the fragments to the ground—not each one according to his strength, but under the eye of the overseer, who never ceases from blows. Then boys, creeping into the galleries dug by the men, collect with great labour the stones which have been broken off, and carry them out to the mouth of the mine.

Next, from these a crowd of old and sickly men take the stone and lay it before the pounders. These are strong men of some thirty years of age and they strenuously pound the rock with an iron pestle in mortars cut out in stone, and reduce it until the largest piece is no bigger than a pea. Then they measure out to others the pounded stone in the same quantity as they have received it.

The next task is performed by women, who, alone or with their husbands or relations, are placed in enclosures. Several mills are placed together in a line, and standing three together at one handle, filthy and almost naked, the women lay to at the mills until the measure handed to them is completely reduced. And to every one of those who bear this lot death is preferable to life.

Others, called *Selangeus* (workers at the table or *Serangex*), take from the women the powder thus produced. These are the artificers, in whom lies the power of carrying to the end this work of royal utility. They pour the stone already milled on a table rather broad and polished with a smooth surface, which, however, does not lie flat but has a slight inclination. On this table they rub with their hands the dust mixed with water, first lightly and then with greater pressure. By this means the earthy particles are dissolved and flow down the slope of the table, but that which is heavy and worth anything remains on the wood. And when the Selangeus has frequently rinsed the matter out with water, he handles the dust lightly, with soft thick sponges, and pressing lightly from time to time he absorbs from the table and throws away that which is soft and light, entangled in the web of the sponge.

There remains to the Selangeus separated on the table that which is heavy and shines, and which on account of its weight is not easily movable. This he transmits to the cooks, who, immediately they

[1] Stanley C. Dunn. "Notes on the Mineral Deposits of the Anglo-Egyptian Sudan." Bulletin No. 2. Sudan Government.

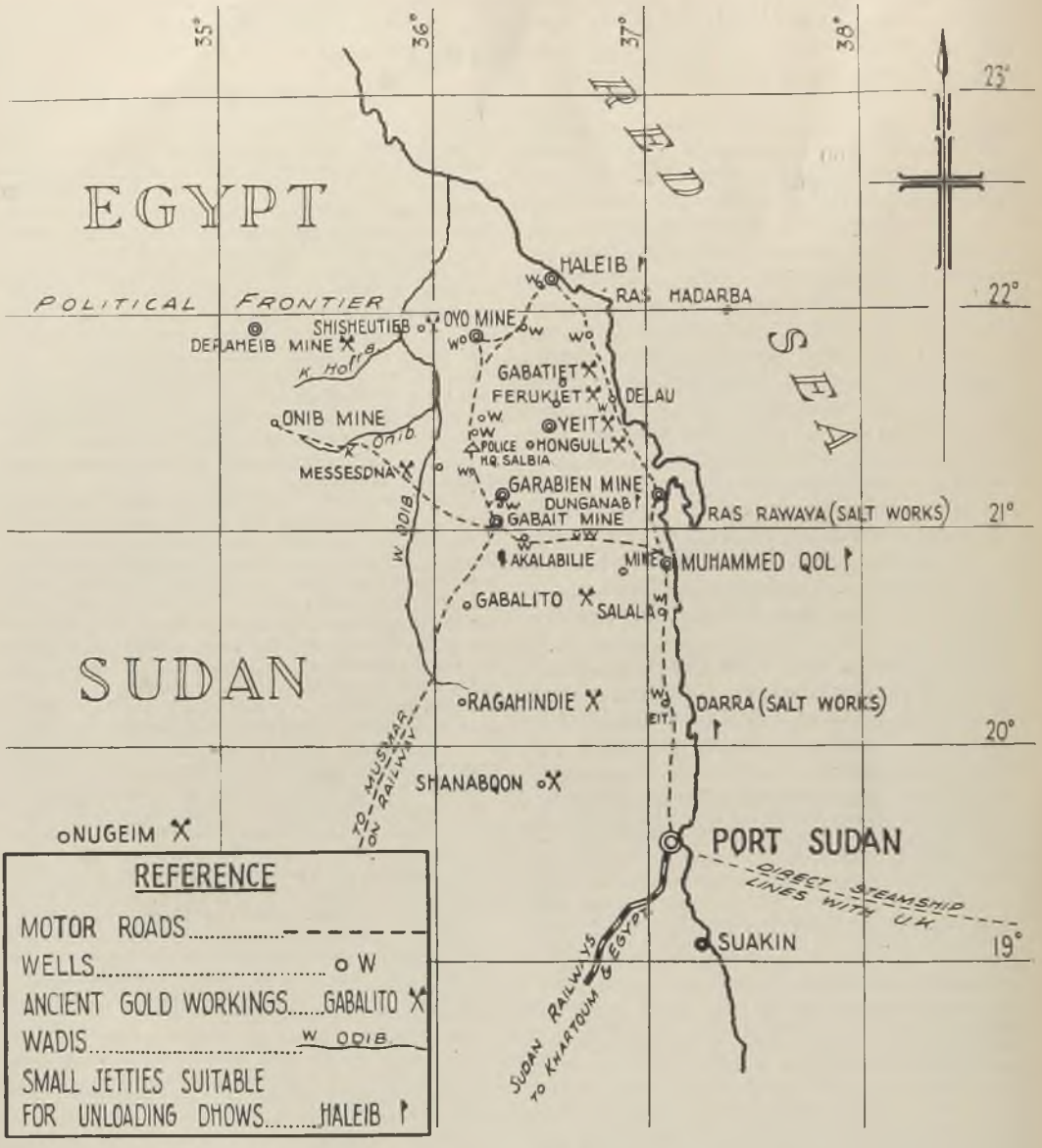


FIG. 1.—SKETCH MAP OF THE COUNTRY NORTH OF PORT SUDAN.

receive it by weight, put it into a clay pot, and in proportion to its quantity they add a lump of lead, some grains of salt, a little alloy of silver and lead, and barley bran. The pot's mouth being carefully covered and looted round, they cook it five days and five nights consecutively. On the following day, when the burnt materials are cooled, they pour them into another vase. They find none of the things which were put in together, but only a mass of molten gold, little less by weight than the original matter.

Judging by the number of the ancient mines so far known in that portion of the Sudan lying north of Port Sudan to the Egyptian frontier and westwards towards the Nile, it seems logical that much of Egypt's gold came from this district. As the ancients used prisoners of war and other slave labour for most of their mining, the cost was only for food. Therefore the grade of ore did not have to be high and mining was done on practically all outcrops containing appreciable amounts of free gold.

The first record of gold being mined was

in the era of Menes, about 3,800 B.C., and the first record written was in 2,500 B.C. It is recorded that in 1,500 B.C. Thutmosis III received an annual tribute of 2,400 pounds of gold (about £132,000 value at par), but in 1,440 B.C. the amount of gold had decreased to between 600 and 800 pounds. The descriptions previously quoted and those by Strabo bring the history of gold mining up to the first of the Christian Era. At this time all mining seems to have been stopped during a period of nearly 900 years. There was another period of activity during the tenth century A.D. as recorded by Cufic inscriptions on rocks ; the author has seen some of these in Nejd and Hedjaz, Arabia, and he was informed that they were made in the time of Haroun Rachid, about A.D. 960.

FIG. 2.—MILL AND HEADFRAME AT THE GARABIEN MINE.

There is no doubt that great quantities of gold were extracted in ancient times, but that it was not all taken out is proved by the fact that the Om Nabardi mine is stated to have produced £250,000 sterling, and in the area visited, the Gabait mine produced 60,000 tons of ore averaging 28 pennyweights or £5 7s. per ton, making a total of £320,051 during the period of 1914–31. From 1902 to 1905 there was a considerable amount of prospecting in the above area, which lies between the latitudes 20° and 22° North and meridians 36° and 37° 15′ East.

Within the past year several ancient mines have been discovered by the use of intelligent gifts to natives working in the mines now in operation. Now that these men realize that they and their families gain money and food by mines being worked, they are willing to act as guides to find others. Formerly only mines near well-travelled caravan routes were known. The very just and humane treatment by the present operators has allayed fear and distrust in the native inhabitants and greatly facilitated the recruiting of labour as well as the prospecting for other ancient workings. In view of what has been found during the past year, it seems reasonable to expect several additional discoveries during the next year or two.

The author was the guest of three partners, who are operating the Garabien mine. They also own the Wadi Oyo mine and have taken out a prospecting licence on the Yeit ancient workings. These men, who might be said to be defeating the present world depression, as well as developing a part of the Empire, are T. M. Foley, M. J. Bishop, and T. A. Clarke.

The Garabien mine is 70 miles from the Red Sea harbour of Muhammed Qol and 173 miles northerly from Port Sudan by road and eight miles from the Gabait mine. The country rocks are highly metamorphosed, the workings lying entirely in a schist. The ancients stoped to the surface for about 500 ft. As the partners have had years of mining experience in the Sudan, they immediately commenced sinking to determine the value of the ore under the old workings. The sites of their operations are shown by the accompanying map (Fig. 1).

These workers commenced operations on January 20, 1931. At the beginning of August, work was stopped by flooding due to heavy rains. During that period they

FIG. 3.—GARABIEN MINE. VIEW SHOWS EXCAVATION FOR No. 3 SHAFT HOIST, WITH No. 1 SHAFT HEADFRAME IN THE BACKGROUND.

had sunk and driven a total of 447 ft. at a cost of 65½ P.T., or 13s. 8d. per foot, exclusive of administration charges. During this time stoping was carried on and, with the development work, produced a total of 833 tons, which was milled, yielding 258 oz. of fine gold, or 6·1 dwt. per ton. The operators estimate the tailings to be 3 dwt., which gives an average value per ton of 9·1 dwt.

The milling is done by a one 750-lb. stamp mill and a 30-in. Straub ball-mill, crushing to 30 mesh, and amalgamating on a 1-ft. by 2-ft. plate. The average daily output amounts to eight tons. The tonnage of ore mined exceeds the above amount as it is all hand-sorted before milling. The tailings are impounded for subsequent retreatment. Fig. 2 shows the mill and the tailings that were left with the main shaft headframe at the right. Fig. 3 is a more distant view showing excavating being done for the No. 3 shaft hoist, as well as the surface plant. In Fig. 4 a most efficient sheet-iron wheelbarrow is shown, suitable for narrow drives. It makes use of a conveyor belt roller, which is superior to the usual wheel, as it is much more stable.

Work at Garabien has been delayed for six months on account of the inflow of water. Although this is but 25 gallons per minute, the makeshift pumps have repeatedly broken down, allowing the mine to fill up to the No. 1 level. It was only by the end of June, 1932, that the new electrical installation finally began to function, so that driving, sinking, and stoping from No. 2 level could be resumed. The manner in which lack of adequate capital causes increased costs, is well shown in this case, for it has resulted in such delay owing to the absence of suitable equipment on hand to deal with emergencies such as water. If amply financed each one of the three partners could be operating a similar

FIG. 4.—WHEELBARROW AT GARABIEN.

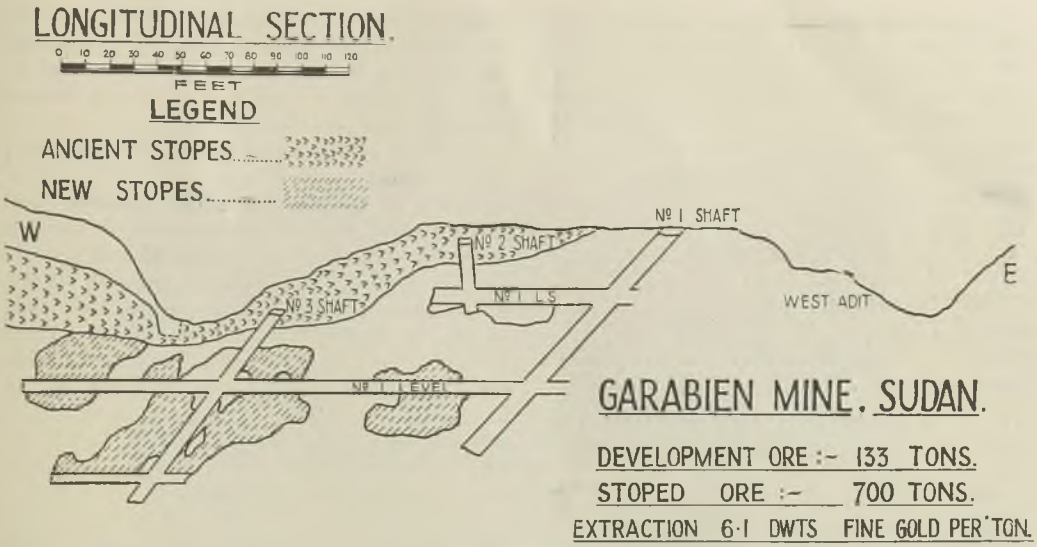


Fig. 5.

mine instead of all three remaining at the one place until enough gold is obtained to equip the other properties. Although the inflow of water has caused such delay it is a natural asset, as 35 tons per day would be ample for a large increase in milling capacity, if the water were reasonably conserved and reused.

The size of the vein at Garabien varies from 18 in. to 4 ft. From what the writer saw it would average under 2 ft., but this would yield a considerable tonnage if the ore shoots extend the full length of the ancient workings. A longitudinal section through the mine is shown in Fig. 5.

The present total costs at Garabien, exclusive of administration, are 8 dwt. of ore per mill. That treated to-day averages 9 dwt. (tailings assayed 3 dwt.). The sample taken by the author in the lowest workings and at the water level gave 1 oz. 8 dwt. value and the vein was 22 in. wide. From 35 tons of ore milled in July since the water has been under control, an extraction averaging 15·4 dwt. has been attained. The partners stated they expect to mill an average of 15 dwt. heads. With efficient equipment all costs should decrease, also the tailings, but there will be an administrative cost to be added.

After a few days at Garabien the writer visited some ancient workings discovered last March. These are called the Yeit mine, and are situated 49 miles (by car) northerly

Fig. 6.—On the Road to the Wadi Oyo Mine

from Garabien and about 20 miles west from Mersa (harbour) Dalwin on the Red Sea coast, where dhows and light draft vessels can land supplies from Port Sudan. The party travelled by car, although there were no roads, to this property. A little work with a road grader and drags would make this place easily accessible by car and light lorry.

At Yeit, the workings are stopes in the surface on seven veins cutting at 90° across a ridge of diabase, which is schistose in places. The apex of this ridge lies at an elevation of 2,180 ft. (by aneroid). The slopes average 29° down both sides from the summit. There are excellent adit sites at an elevation of 1,910 ft. On only three other veins are the stopes over 100 ft. long, as far as could be seen. Nothing has yet been done here, but the partners wish to commence operations as soon as there are funds available. Although the author's grab samples of broken quartz along the surface show no values, there may be a mine of considerable importance beneath the ancient workings if the same conditions hold as at Garabien, Wadi Oyo, and Gabait. On the previous visit Mr. T. A. Clarke took several samples during his three days' stay. All of these showed gold when panned. He estimated the values to be from 3 dwt. to 8 dwt. Water for milling should be drilled for in the gulch at the adits; there is undoubtedly ground water in the larger Wadi bed about half a mile to the east.

After returning to Garabien mine the party proceeded by car to visit the Wadi Oyo mine, 80 miles north-westerly. It is 55 miles south-west of Haleib, a harbour on the Red Sea and lies at an elevation of 1,350 ft. Fig. 6 shows Mr. T. N. Foley *en route* with the author.

At Wadi Oyo considerable ore has been extracted from the one vein worked. Fig. 7 shows in the background the tailings from the mill, and just behind these are the ancient and modern workings; in the left-hand foreground, near the top of the hill, dumps from ancient operations on a parallel vein are seen. No modern work has been done here, so that there is scope for a possible additional tonnage. The appearance of the ancient stopes at the surface is shown at the right-hand of Fig. 8, the three-stamp mill and tailings dump can also be seen at the left of this picture. The headframe at the main shaft with a Ford rigged up to drive a hoist, is shown in Fig. 9.

FIG. 7.—WADI OYO MINE. ANCIENT WORKINGS ARE SHOWN ON THE LEFT AND ON THE RIGHT THE MODERN WORK BEING DONE BELOW THEM.

The vein at Wadi Oyo is of hard, white quartz and varies from 6 in. to 4 ft. in width, averaging about 24 in. as far as could be judged from the stopes seen. The workings at the surface are 675 ft. in length. Dykes of basalt cut and fault the vein in places. Ore has been found on both sides of the dykes, so that it is reasonable to expect that the ore will be encountered again in the south-east winze which was stopped at a dyke.

Ancient workings extend farther south than any of the modern drives, so that additional tonnage may be obtained in that section. The writer took a sample at the lowest part of the workings at the

FIG. 8.—MILL TAILINGS AND PLANT AT THE WADI OYO MINE.

water level. This was 50 ft. below No. 2 level, and about 240 ft. below the collar of the shaft. This sample assayed 1 oz. 1 dwt. in gold. If this value is maintained, or approximated, there should be a profitable tonnage in depth.

According to the owner's report, they operated this mine in 1930 and 1931, milling 1,217 tons of ore which yielded 1,854 oz. of gold with a value of £6,972, or 30·4 dwt. per ton. With tailings at 3 dwt. this gives an average value of 33·4 dwt., but it must be remembered that all ore was hand-sorted at the surface before milling. The mining cost was 16s. 8d. and milling 7s. 3d., or a total cost of £1 3s. 11d. With tailings at 12s. the total cost was £1 15s. 11d., or 9 dwt., which would give an average profit of 24·4 dwt. per ton.

The partners suspended operations at this property on account of an abnormal shortage of water. The fact that water is now coming in at the deepest workings (where the author took a sample) encourages the hope that sufficient may be found on developing in depth to provide enough for milling without depending on the rains and wells. Very limited time prevented more detailed examination and sampling. The flow-sheet in Fig. 10 shows how the ore was treated.

Mining timber is available near all the workings visible. Natives bring it in at a price of 4 P.T. or 10d. per piece of over 6 in. diameter and 6 ft. to 9 ft. long. At present only underhand stoping is practised (the natives drill down holes much better than uppers). Stulls are used to support the walls, when wood becomes more scarce and expensive, pack walls, waste filling, or shrinkage stoping may be adopted. Miners earn from 10 P.T. or 2s. to 20 P.T. or 4s. per eight-hour day. The pay being

FIG. 9.—MAIN SHAFT HOIST AND HEADFRAME AT WADI OYO. THE HOIST IS A MODEL T FORD MOUNTED ON CONCRETE BLOCKS.

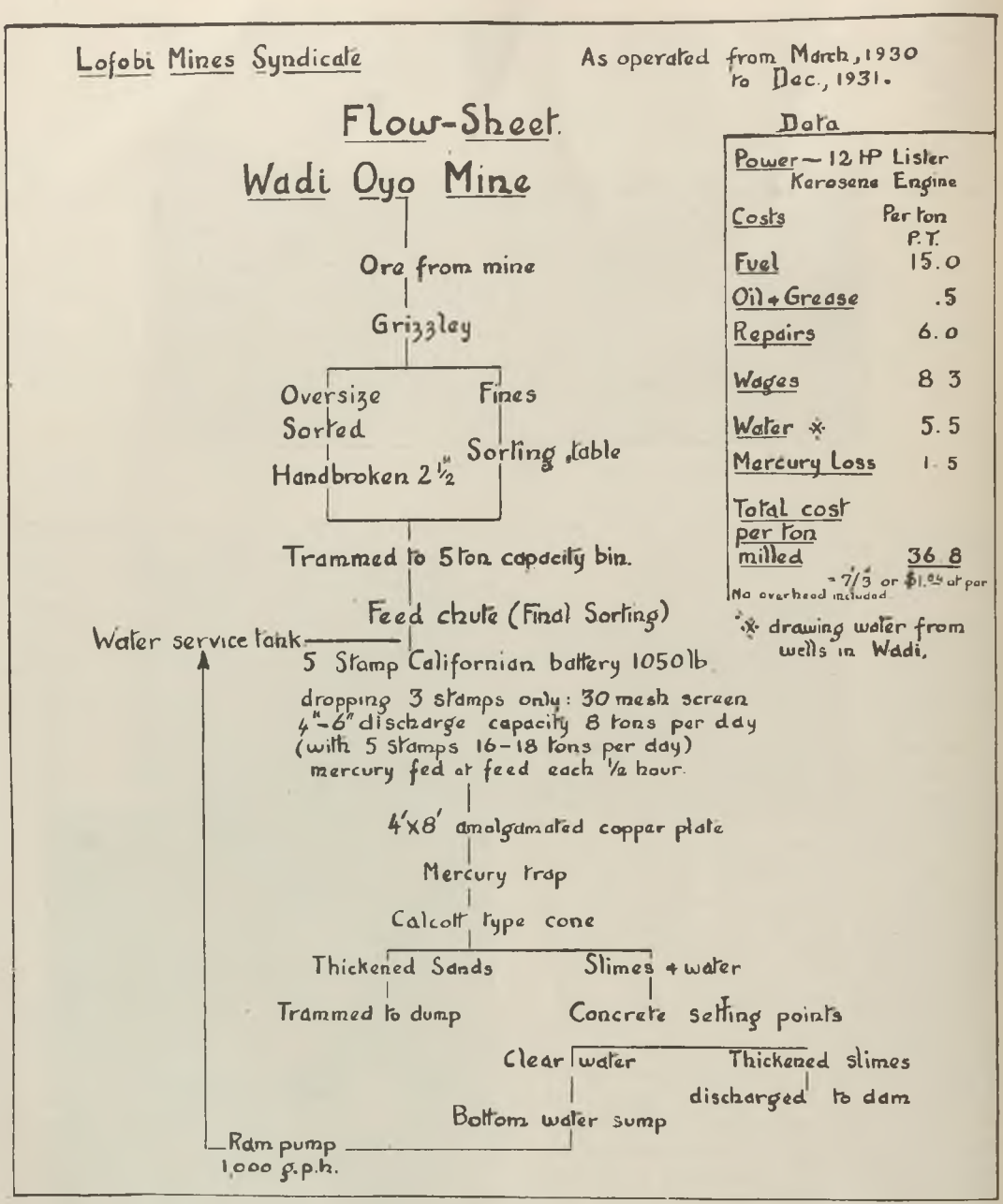


FIG. 10.

based on 2 P.T. or 5d. per foot of hole drilled. In addition every man is given weekly rations which are valued at 2 P.T. or 5d. per day in addition to his cash payment. All supplies have to be obtained from Port Sudan.

The Sudan Government recognizes the value to the country of the mining industry so that their laws are very just and favourable. The cost of a mining prospecting licence is £25 per year, and when mining, a royalty of but two per cent of the value of the bullion is required.

From what he has seen during his 600 miles of travelling in this section of the Sudan, the author believes that there will be no

large tonnage mines developed, but he can see no reason why groups of small mines under a competent central management could not yield a good profit if the ore maintains the values obtained so far, and if the ore persists to, say, 600 ft. in depth. Efficient, standardized, and semi-portable equipment would reduce the loss in tailings and decrease capital outlay. Such plant would be 80% salvable and so could be moved to another property when the first one was exhausted. The owners intend to follow such a plan when funds are available. They have good grounds for believing that many ancient mines similar to those they now control exist in the area described.

STOPE-FILLING

By W. E. SINCLAIR, A.I.M.M.

The author gives his observations on some methods of stope-filling on different mines in South and West Africa.

Stope-filling, or the replacement of the ore by other material in underground excavations, is an essential side-line to the successful recovery of the ore and, in this respect, may be likened to ventilation, in some mines. The process of filling is done, generally, to support heavy or broken ground, with the primary object of ensuring the safety of the mining operations and to attain the maximum possible recovery of the ore. Filling of underground excavations, however, not only solves the immediate problem of ground support, but also produces the following general advantages in the processes of exploitation :—

1.—General improvement in ventilation conditions by the reduction of voids underground, less air being consequently required and better currents of air passed along the stope faces.

2.—Where parallel reefs or lodes overlie each other mining of the lode is simplified, and the danger of breaking through from one to the other is eliminated. Such an example of parallel reefs which have stoped out without filling are shown in Fig. 1, a photograph which illustrates the difficulties and dangers of mining without filling, despite the large pillar of ore which has been left in the upper reef, and the waste pack underneath it in the lower stope.

3.—In the same manner, as illustrated above, filling simplifies the mining of wide lodes or reefs, by stoping the lower half and, after filling this section, mining the upper part, while using the filled area as the floor.

4.—The prevention of surface subsidence and the consequent movement and damage to buildings and plant.

5.—Avoidance of local crushing effect of the country rocks in a mine, which will at a later date eliminate severe rock pressures, when working at a deeper horizon.

6.—Elimination of the danger of fire.

The advantages of filling are further justified, although perhaps not always appreciated, by the comparatively low cost, as compared with other methods of ground support, despite the fact that timbering and other auxiliary supports are sometimes necessary in conjunction with the filling of stopes in heavy ground, an example of which is described in the following notes. The initial outlay necessary to inaugurate a system of filling is insignificant when the importance of the work, where such is necessary, is taken into consideration. The above points have occurred to the author and have suggested to him the following comparisons of various methods of filling as applied on several mines in different parts of Africa, where the only factor common to each example is the human one, or that of labour employed, which consists in each case of white supervision of natives. The material used for filling in the various examples outlined, consists of sand or tailings from cyanide plants, and waste rock. The

Fig. 1.

Fig. 2.

sand is used in one case mixed with water to form a pulp and, in such a form, is conveyed by gravity, for the most part, to the stopes which require to be filled. This method of filling—by mixing sand or other fine material with water—is sometimes called "hydraulic stowing," or "flushing" in American coal mines, where the method originated. In South Africa this method is simply called sand-filling, and in these notes, to distinguish this method from that in which the sand is filled in a dry state, it is referred to as the "wet method of filling."

Wet Method of Sand-Filling.—The application of this method of stope-filling, as is commonly practised on the Rand, under suitable conditions, is probably the cheapest and most satisfactory method employed. Suitable conditions in this instance means the method of mining and the class of ground being mined. Much has been written giving the detailed application of this system of filling, as practised on certain mines,[1] but, for the purposes of comparison of this method and others, under different conditions, a brief general description of the class of ground, method of mining and filling the stoped areas (where filling is practised at all) may not be amiss.

The banket reef is bedded regularly between hard, tenacious, and compact quartzite and slate walls, at a dip which varies from steeply inclined to flat, but usually averages from 30° to 50° in those mines where sand-filling is practised. The displacement of the reef by faults or dykes, which is no uncommon occurrence, offers no difficulties to the wet method of sand-filling. The strike of the banket is regular and the width of the reef never excessive.

The common method of working the steeply inclined stopes consists of open stoping in all its variations, opening out and away from the connecting winze and rise. The hard and compact nature of the walls has allowed the practice of open stoping and in most cases of leaving the stopes open, and it is only the result of mining at great depths that rock pressures have been the indirect cause of rockbursts and falls of ground, aggravated no doubt by stopes being left open and allowed to cave in the upper levels. Fig. 2 illustrates heavy ground supported by waste packs or pig-styes in a stope at depth. This photograph also illustrates the flatter angle of inclination of the reef at this horizon and the possible difficulty in gravitating sand in the wet method of filling in flat stopes.

Stopes are with few exceptions left open, the hanging-wall being supported, where this is necessary during exploitation, by stulls, pig-styes, pillars, or reef-packs; the two latter means of temporary support being recovered before the worked out stope is filled. Pillars of ore are sometimes reclaimed after the stope is filled. When the hanging-wall shows signs of pressure or is intersected by slips or cleavage planes, and so liable to fall, stopes are filled in sections from level to level as shown in Fig. 3, which is a sketch-plan on the plane

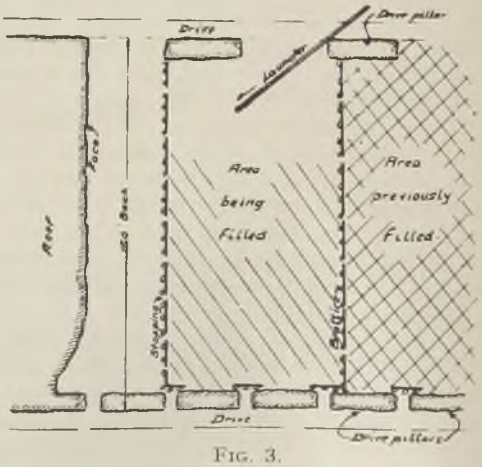


Fig. 3.

[1] F. Dunning. Assoc. of Mine Managers, 1924. A. G. Barrat. *Trans.* Chem. Met. & Min. Soc. of S.A., 1928. R. E. Sawyer. *Trans.* Inst. M.M., 1912. Messrs E. Pam, W. A. Caldecott, O. P. Powell, and others.

FIG. 4.

of the reef of a typical working stope in process of filling.

The means of conducting sand underground to the filling section of the mine is (1) through pipes down shafts, (2) in launders through outcrop openings, and (3) in the case of the deep-level mines, which have no outcrop openings to the surface, through bore-holes which are specially shot-driven for the purpose. Fig. 4 indicates in cross-section the usual bore-hole method of delivering the sand in depth. Before delivery underground, the sand is cleaned and rid of its cyanide content by washing in a solution of potassium permanganate at its source of supply, which may be a tailing dump, or from the current treatment plant. From here it is usually pumped to the pipes or launders leading underground and, in the case of bore-hole delivery, it is pumped to cone classifiers, which are erected over the bore-holes.

From the point of delivery underground, the flowing sand is directed in launders, or sand lines, to the points where filling is required, by a system of branch distributing launders. Wooden launders are in general use, and these may be open or closed, depending on the grade of the launder. The ideal and correct grade for varying consistency of pulp is indicated in the graph by W. A. Caldecott, shown in Fig. 5. In general practice, the consistency of pulp solution varies from time to time, and it is therefore better to maintain launders at steeply inclined grades and never flatter than 6 or 7 degrees.

No shovelling problems present themselves in wet sand filling, unless it is necessary to shovel the sand out of the workings after an accident, caused by the breaking of a launder or brattice stopping, a mishap which is often responsible for much damage and loss of time, by the flooding of working stopes. The extent of the damage resulting from such accidents is often measured by the efficiency of the signalling system necessary to stop the flow of the solution when required. Great importance attaches to the building or erection of brattice stoppings to hold the weight of the sand in the filled areas. Such barricades are made of stulls, waste walls, packs, and drive pillars (the latter are shown in Fig. 3 and are afterwards reclaimed).

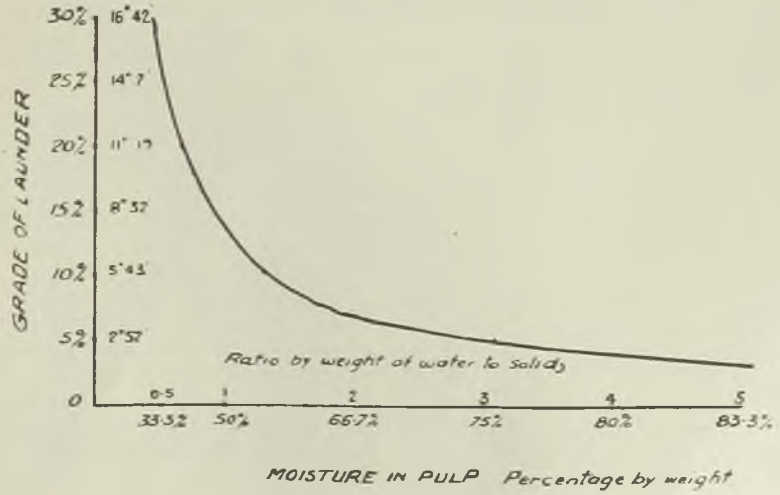


FIG. 5.

In order to allow the water content of the pulp mixture to drain out of the filled void and also to prevent the washing out of fine sand or slime, coco-nut matting is usually fixed on the inside or filling side of the stopping. The water in the mixture percolates through the matting and is led off in drains or gutters. Owing, however, to the importance of draining the filling, special drainage launders are sometimes arranged on the foot-wall of the stope being filled, which collect and drain the water from the filled area.

Sand is sometimes pumped up to fill overhand or back-stopes, which have no opening or outlet to the level above. The process of filling under such circumstances naturally cannot be executed simultaneously with stoping operations.

By the fact that the sand, in this wet method of filling, flows by gravity to every open space or void, an ideal replacement is effected, and, after the water has drained from the filling, a comparatively hard cake-like cement is the result, which can easily and cheaply be driven and risen through, when this procedure is necessary, as in the case of reclamation work after filling. The wet method of filling also lends itself to the filling of old workings which may be partly caved and thereby inaccessible or unapproachable for filling, or other reasons.

The average all-in cost of this method of filling on various mines varies from 6·6 to 9·9 pence per ton filled, and, in the case of mines which are filling from current treatment plants, the cost of tailings disposal, as part of the sand-filling charge, is put to a remunerative purpose.

Dry Method of Sand-Filling.—Under certain conditions, on a small scale, the application of the dry method of sand-filling, while probably more costly than the wet method, is more satisfactory in practice. It has the advantage that it does not add to drainage problems, nor does it cause seepage in ground which is soft, porous, or "heavy," such as, for example, the typical fissure-zones, filled with auriferous brecciated graphitic schists and quartz veins, that are being mined in West Africa.

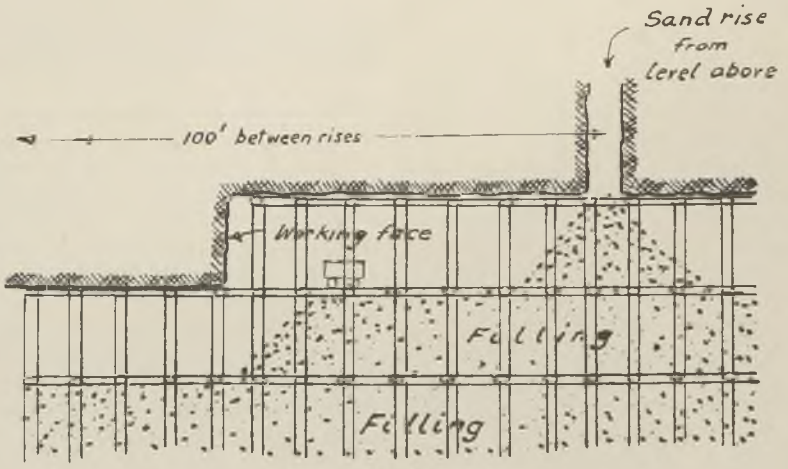


Fig. 6.

The mining of one such lode, which is enclosed between extremely weak graphitic walls, presents a difficult mining problem. The width of this lode varies from 5 ft. to 50 ft., and it dips at an average angle of 80°. To mine the ore, a system of overhand bottom slicing in a series of horizontal lifts, is practised, together with a form of square-set timbering and close sand-filling to support the back. A typical longitudinal section in a stope under these conditions is shown in Fig. 6. Sand is delivered to the stope from the level above by way of the sand rise depicted, whence it is loaded into end-tipping trucks, which are used to tram the sand to the filling position in the stoped-out lift, when this point is out of reach of shovelling distance of the rise. Filling, under these conditions, is carried out simultaneously with stoping, and the process can be stopped at any time and at any point; decided advantages over the wet method of filling.

The work is slow and costly, however, and with a view to analysing the inefficiency of the work, under the cramped conditions in such a stope, a number of tests were made under varying conditions, and measurements taken to determine the actual amount of sand being handled per shift. Table 1 gives the results of these observations and the comparative rate of the work deduced in terms of tons handled per 100 ft. haul.

TABLE 1

Stope.	Average haul.	No. in Gang.	Tons loaded per shift.	Time taken loading, tramming, tipping 1 ton, 100 ft. min.	Remarks.
1	75 ft.	6	23	17 min.	Difficult tramming.
2	50 ft.	9	29	12 min.	,,
3	75 ft.	6	20	17 min.	sand wet.

Difficult tramming conditions may be due to cramped conditions, involving space for only one shoveller, and only one truck in action at once, or delays in trucking due to transport of timber, timbering operations, or blasting in the stope. Wet sand is due to seepage of mine water through the lode or country, causing the sand to become sticky and to clog on the tracks and truck wheels. Such unfavourable conditions, including that of hot, humid, or bad air, increase shovelling costs underground by 20%, besides, and not because of, the decrease of shovelling efficiency, resulting from the physical exertion of the work. In no other work underground is the output of effort so constant and continuous, and while the average output of a white shoveller in most parts of the world is from 25 to 30 tons per shift, the rate of the native shoveller in Africa rarely exceeds 5 tons per shift, which figure is checked in the test described. It is evident also, therefore, that to load a large tonnage with the aid of native shovellers, six natives are necessary as compared with the effort of one white shoveller, and the cost per ton therefore, all things being equal, is about the same, despite the difference in labour strength.

Certain arrangements are devised to improve the handling of sand and waste under these conditions, such as, the introduction of chutes at the bottom of the sand rise, in order to eliminate shovelling, or, where sand only is being dealt with, it is possible that the use of sand blowing tanks [1] would dispense with both shovelling and tramming in the stope. Attended by one man, such a contrivance draws the sand

[1] Sand Blowing Tanks, Champion mine (F. W. Denton). Peele's "Handbook," 1927, p. 645.

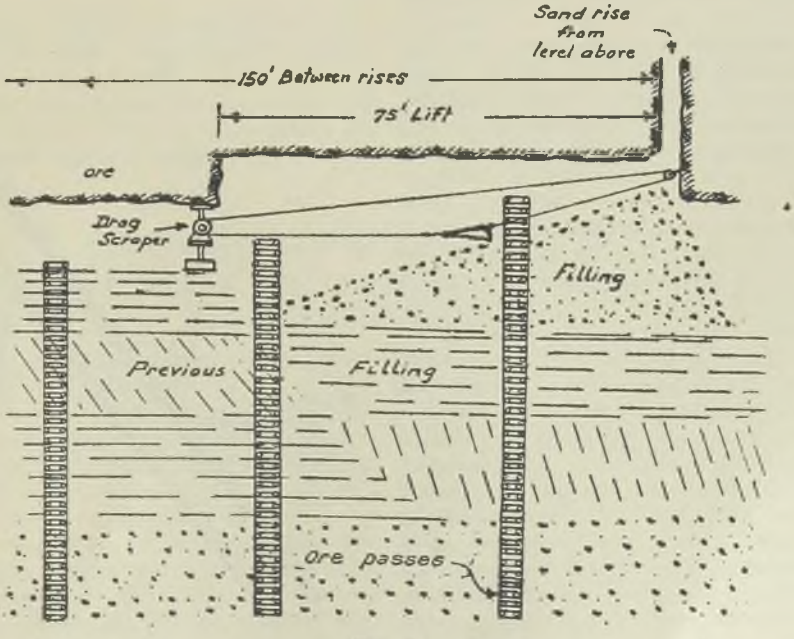


FIG. 7.

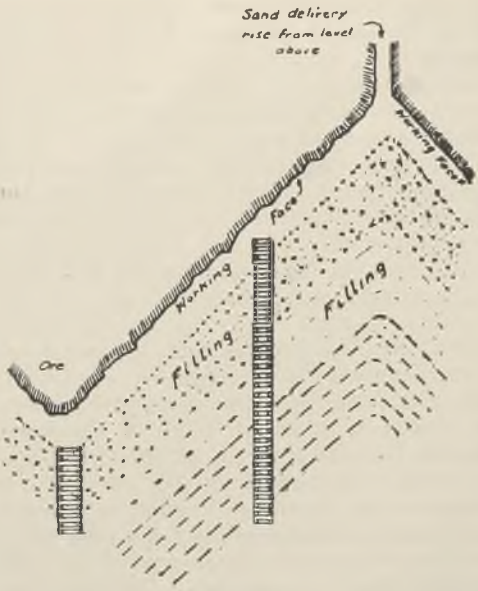


Fig. 8.

from the rise, and, operated by compressed air, the sand is delivered through flexible pipes to the part of the stope which needs filling.

Another example of handling dry sand in horizontal bottom slice stopes is illustrated in Fig. 7, which is a longitudinal section of a typical stope working the same lode described above, except that in this case the rock structure is not so weak, and the lode itself needs little or no timbering during the process of mining. Weak graphitic walls are supported, however, by sand, which is introduced in layers, equivalent to the depth of each alternate half lift between sand rises, as shown in the section. Sand and waste rock is delivered to the stope, as in the previous example, by way of the sand rise, and from this point is dragged and spread throughout the area by the drag-scraper; the set-up of which allows the rig to be reversed, so as to deal with filling from the opposite rise. The rate of filling a stope in this manner, under suitable conditions, is far in excess of any other method, and for that matter, under normal working conditions, the scraper is able to handle more sand than can be delivered to it from the level above, when the sand rises are 150 ft. apart. Under these circumstances the capacity of the scraper is limited and measured by the rate of the trucking and delivery of sand to the sand rise from the level above. A point against the use of scrapers, under these conditions, in narrow stopes, is the difficulty of manipulation of scraper buckets around the built-up ore-passes, without fouling the cribbing, and the fact that a system of flood lighting of the stope is necessary; also, the process of stoping and filling cannot be undertaken simultaneously.

Stoping the same lode in narrow widths, where less filling was required over a given area, a system of rill stoping was instituted, primarily with a view to assisting the handling of ore by gravity, and secondly, to simplify the process of filling, by means of dry sand and waste rock. Fig. 8 is a longitudinal section on the plane of the reef (which dips at 70°), of a typical rill stope, showing layers of filling, which is gravitated down the stope from the delivery rise and spread into place with the minimum of shovelling.

Delivery of Filling Material.—In all these examples the sand is delivered to each level underground by means of a pass or winze from the surface, and delivered to various stopes and rises by trucking the sand along levels from the main delivery pass. Chutes[1] are arranged in the main sand-pass at each level for the drawing off of requirements, or other delivery devices are installed, such as platforms or shedding chutes, which

[1] "Description and Method of Working the Obuasi Reef," G. W. Eaton Turner. *Trans.* I.M. & M., Nov., 1928.

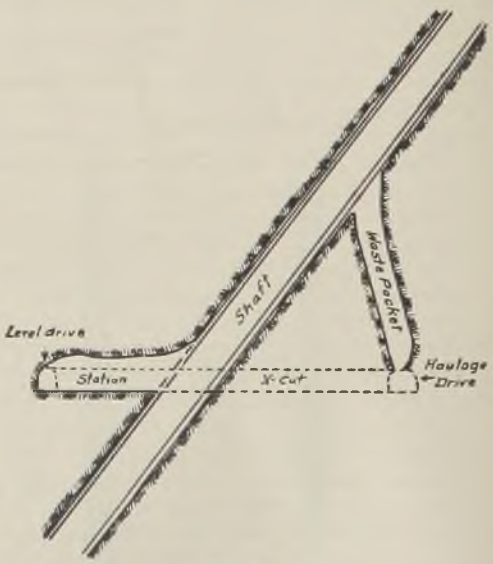


Fig. 9.

allow of the drawing of a certain proportion of the sand, while the remainder slides over and down to the next level.

Where, however, arrangements such as these are not in use, an additional cost, that of shovelling, is added to the cost of trucking the sand, and loading the trucks at the point of delivery or source of supply. There is a close relation between shovelling and trucking, as the two operations so often go together or even overlap, so that in timing the actual work of delivering sand from a main sand-pass to stope sand rises, as shown in the examples in Table 2, no attempt was made to distinguish these operations one from another.

TABLE 2

Operation.	*Level.*	*Length of haul.*	*Trucks in use.*	*No. in gang.*	*Rate loading, trucking, tipping 1 ton sand 100 ft. haul.*
Loading, trucking from main pass to stope rises.	1	750 ft.	2	6	12 minutes.
	2	400 ft.	5	6	6 ,,
	3	200 ft.	6	5	9 ,,

No strict comparison can be made of the work executed on the three levels shown, owing to the length of hauls, the different number of trucks in use on each level, and the varying strength of the gangs in each case.

Many factors appear as a handicap to the handling of the sand for filling in these examples, the more important of which are included in the following :—

1.—The general lack of double tracks, or convenient sidings, to allow the passing of opposite traffic without delay.

2.—In some instances, the necessity for trucking sand loads against the grade of the track.

3.—Necessity for strict supervision of quantities of sand handled, owing to the difficulty of checking truck tallies.

4.—The trucking of ore, timber, and drills is considered of more importance than the filling, and the handling of the latter is consequently delayed.

The cost of sand-filling as described in these examples varies from 1s. 7d. to 2s. 5d. per ton of sand filled.

WASTE ROCK-FILLING.—On those mines where the bulk of the development is carried out in the country rock, owing to the heavy nature of the lode or for other reasons, the waste rock from development ends is generally used for stope-filling. On one mine, where all development waste is made use of in this manner, a waste-pocket or bin has been excavated in the foot-wall of the main inclined shaft, as is shown in Fig. 9, which is a transverse section through the shaft, at a station and tramming level, at a horizon commanding all the filling stopes in the mine. A tipping arrangement in the shaft at this point above the pocket opening, allows all waste hoisted from the lower levels to be dumped from the skip into the waste-pocket, from which it is drawn off into trucks and trammed to the stope-filling rises by means of a main and tail haulage.

In this example the filling costs consist merely of the handling of the waste in the stopes, since the hoisting and haulage of the rock from the development places would have to be undertaken in any case.

DERBYSHIRE MINING

By LESLIE B. WILLIAMS, B.E. (*Sydney*), M.I.M.M.

(*Continued from the August issue, p. 94*)

LAWS AND CUSTOMS.—The period from the Roman occupation to that of the Normans, however, is generally looked upon as having been responsible for a set of customs (which were codified and became law in 1851) which governed the terms and conditions under which lead ore could be won from the soil. Those interested in this point may obtain two opposite opinions from Tapping and Hoover. The former thinks they were of Roman origin, the latter that they were purely Anglo-Saxon and represented, after the Norman conquest, the only Anglo-Saxon institutions adopted without change by the Normans. Bainbridge says it would be difficult and unprofitable to attempt to find their source. Tapping bases his argument on certain points of resemblance to the section of the Justinian Code dealing with mines. Hoover's contention seems to ignore the fact that the laws governing Derbyshire at the time of Norman William's adventure were what is called "Danelege" as distinct from the

"Saxonlege," which controlled other sections of England. At any rate, the holding of land for mineral purposes by the payment of "Balluca" in the time of the Romans or of "Lot" in feudal times is an identical process.

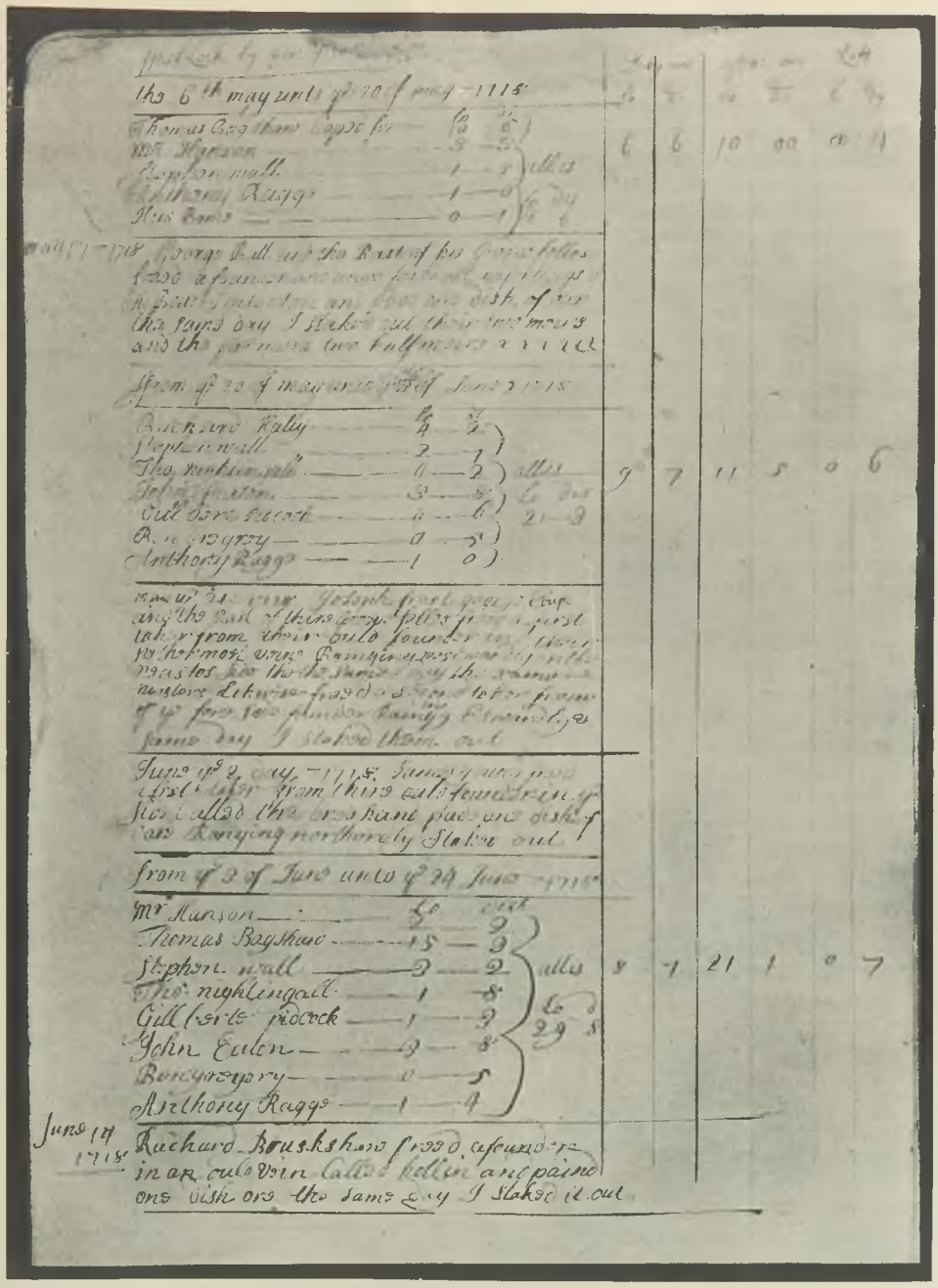
It is impossible to believe that any custom which gave the common man a right to mine could have existed under a régime so essentially aristocratic as that of the Anglo-Saxons. In fact the evidence given by Dugdale, meagre as it is, but taken from the monastery records, shows that the mines could be given away by the Lord of the Soil whether king or noble, and this is the direct antithesis of any rights that have been claimed by the commoner since, at any rate, the reign of Edward I. The conqueror nation could use its slaves (as it did) for anything it pleased in the way of forcing production of anything of value, and the Norman idea does not appear to have differed from that of the Saxons or the Romans or any other usurper. The kingdom of Mercia, too, which included the lead-bearing portion of Derbyshire, was in the occupation of the Danes for a considerable period before the Norman conquest. Edward I gave away mines in the wapentake of Wirksworth. There was only one form of ownership after the conquest and no one could hold anything from the Lord of the Soil without payment of some kind.

Without labouring the point, the suggestion is made that the conditions which gave rise to a later conception of the existence of customs were purely accidental. A great deal of misinformation on the subject exists because the historical side has never been closely studied and, in addition, authenticity has been attributed to printed material which has no historical basis of truth. From the date of the defeat of Simon de Montfort at Evesham in 1265, to the accession of Edward I in 1272, the consolidation of the king's position was the main effort made by Prince Edward. Shortly after being crowned he passed his famous statute of Quo Warranto (1278), under which he instituted inquiries into practically every aspect of land tenure by the barons for the purpose of determining and stabilizing the kingly prerogatives which had been encroached upon, filched, or assumed by the barons in all parts of the kingdom during the reign of his father, or, as the barons themselves thought, for the purpose of taking their rights and possessions from them.

> Le Roi cuvayte nos deneres
> E la Rayne nos beaus maners
> E la Quo Warranto
> Sal mak us all to do.

This song was chanted in the presence of Edward himself on one occasion by the sons of some of the barons.

The form of inquiry was a commission and there were thousands of them. Amongst them, and in the third year of Edward's absence in France (1288), was one held at Ashbourne in Staffordshire to inquire, *inter alia*, concerning the rights which the miners of the Peak claimed to have in those parts, etc., concerning the getting of lead ore. This commission consisted of men of birth and estate. Its findings referred to the king's estate in the Peak, but what it laid down appears to have applied to every manor, and to have been the custom of those manors. It was in fact a definite reply to his Quo Warranto because it claimed customs, affecting mining, for the king, and by so doing, assured identical customs for the manors which were not the king's, and so tended to establish the rights of the Mesne Lords themselves. This point will be discussed later, but it may be remarked here that just as in Roman times (and probably earlier) and certainly right throughout the period from Roman to Norman, the main features of the so-called customs did not alter. These were—the incentive to the baseborn to search for ore, the reward for finding it, and above all and the most important feature of all, the form of tenure by which the lord got his share, without risk, of those minerals which were of value and which were undoubtedly vested in him as Mesne Lord. Upon the findings of that commission, however, there appears to have been gradually built up a set of customs that were to come later into direct conflict with the law of England. It is quite possible that Edward determined to hold the particular land referred to because of its mineral wealth, and that the commission was included in the long list because the Crown just then was interested in metals. Just a few years subsequently he sent from Derbyshire over 300 men to the Combe Martin mine in Devonshire to work on the lead-silver ores there. This mine had been very productive of silver. Watson, quoting Hollinshed, states that it had produced 1,600 lb. of silver in the space of three years.



A Page of a Barmaster's Book, Liberty of Matlock (1718).

The lands in Derbyshire at that time formed part of the Duchy of Lancaster. The commission was not a legal body and whatever its findings it was open to the king to reject them if he thought fit. There was nothing in them however that would be repellent to him since his prerogative was not only not denied, but actually confirmed by the finding. As with many other commissions Quo Warranto, nothing was done one way or the other.

It is stated by Bryan ("History of Matlock,"

1903) that a similar commission had been held at the instance of Henry III, and that the finding was for the king, and that the mines were the prerogative of the king. In fact the ownership of minerals in lands held from the king was likely then to be as it has always been, a fairly contentious subject. William the Conqueror was considered to have acquired by right of conquest the right to all minerals, but he did occasionally give away lands " up to heaven and down to hell." Besides this there were barons, the descendants of those who came over as partners of William and received their share as such when the country was cut up. Whosoever owned the minerals, however, one fact remained : There had to be men to work them and a form of tenure or right by which the worker could find and hold, and the findings of the commission set this down in its simplest form. In this sense the so-called customs are at least Roman, but the control of mines by the lords was almost certainly based on customs brought from Normandy and corresponding wholly with those affecting the base tenure of land.

The vital point about the findings was that if ore were found the finder should go to the bailiff, who would allot him two lengths of ground of four perches each, which he could work by giving a share of the gross production to the lord, who got the next measure as well. Looked at as a bargain it was a one-sided business. There was, however, no bargain in it. The evidence points to its being merely a form of tenure, based identically on that under which husbandry or forestry was carried on and existing between the lord and his bondmen (villeins).

Unfortunately, no critical inquiry has ever been made into the history of the customs since 1288. When in 1760 a case of appeal was heard before the House of Lords (Duke of Devonshire v. Wall and Others) it was stated for the Duke :—

> His Majesty's royal predecessors being seized as lords and owners of the soil of the district called the King's Field or King's Fee in the hundred of the High Peak had of common right all the minerals within it and must be presumed to have granted the privilege of searching for and getting the minerals under certain regulations and on payment of certain mineral duties. The commencement of this privilege from its great antiquity is not capable of being actually proved, but the evidence arising from the inquisition in the reign of King Edward the First, which finds that his then Majesty was entitled to a thirteenth dish of the ore gained at the mines ought to have been adjudged sufficient to establish and ascertain His Majesty's right . . . the inquisition produced being a record of great authority and the best evidence which the case after such a length of time will permit.

The reply to this was :—

> As to the inquisition . . . it appears to have been taken by two persons named who seem to have been appointed by the crown by some commission, but such commission does not appear, nor does it appear that two such persons were officers of the mine, or of the crown except *pro hac vice*, nor does it appear that any evidence was given thereon, or that any defence or opposition was made thereto, so that the whole proceeding seems questionable in respect of its authority, and indisputably was no more than an inquiry *ex parte*.

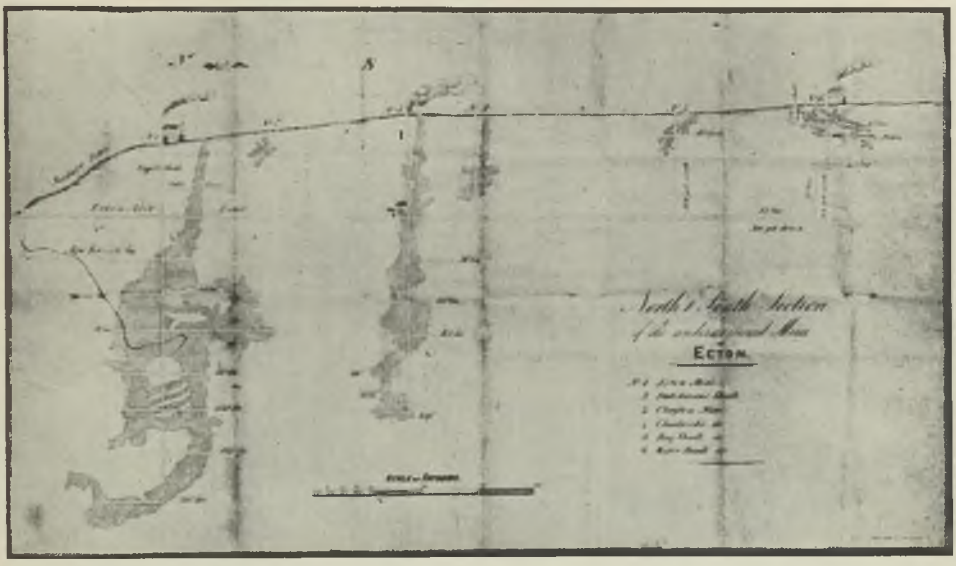
That reply seems to state the case fairly. It is significant that no other authority than this document has ever been quoted to prove the actual existence of customs at that time, but this proves nothing beyond the fact already stated that there has been no critical inquiry into the subject. It is therefore very much to be regretted that the promise made by Hoover to examine the matter from the historical side could not have been fulfilled. The reasons for this are of course well known. The field is still open, but it is very much to be doubted if it will ever be explored because there are few men so equipped with the mining knowledge necessary in addition to the historical sense and critical habit of mind. Those who have written at length on the subject appear to have seized on some very doubtful material of the seventeenth century and without further inquiry to have used it as if it had represented an inspired summary of all knowledge available on this wide subject. All that has been written is simply a muddled hash of popular tradition in which the same story is told over and over again.[1] To give an idea of the lack of research the following may be cited : After Camden wrote in 1586 and was translated in 1610, nothing was printed until 1645, when a small volume " The Laws and Customs," printed by R. A. (Richard Atkins ?) appeared. This gave a translation of the original writ of Edward I, together with the findings of the commission at Ashbourne in 1288. There are errors in both. The findings are so phrased in the translation as to make it appear that the so-called customs had actually been in

[1] This does not refer to the Victoria County History.

operation from some dim past—"In the beginning"—whereas the first section of the findings merely sets out the procedure which in the opinion of the jurors should be followed when ore happened to be found. The words are "*In principio*"—in the first place. They meant in effect that nothing should be done without the authority of the lord by his barmaster. The translation, together with a set of customs which had nothing to do with Edward I's time, was lifted bodily by Sir John Pettus, and incorporated in his book ("Fodinae Regales," 1670). He is generally referred to as the first authority on the subject, but where alone anything of value could be found (and still remains to be found) added little except a few errors and some bad Latin. As history none of it is worth anything. Hoover saw the material at hand in the public records and marked it down, but the High Gods willed otherwise.

The laws as they exist to-day did not come into the code until 1851. Up to that date mining was carried on religiously under the customs. Mining law was administered by the Barmote Courts through the stewards, barmasters, and juries (the "Body of the Mine").

In England a custom is not a custom until



SECTION OF THE FAMOUS ECTON MINES, STAFFORDSHIRE.

his borrowings are disclosed by the fact that the errors are identical in each case. In 1713 Moses Stringer, of the Company of the Mines Royal, with which Sir John had been connected some 40 years before, had something to say on the subject *ex parte* from the standpoint of the company in its fight for its prerogatives with Sir Humphrey Mackworth, whom Stringer regarded as a pirate. Much of what he had to say apropos Derbyshire was borrowed from Sir John.

Pilkington and Farey add nothing to the previous writings. Stephen Glover ("History of Derby") writes at great length, but all his material in relation to this particular aspect is Stringer. Tapping fell into the error of accepting Sir John as his authority and Hunt, in spite of having access to the public records, it fulfils the condition necessary to establish it as such, viz., that it goeth back beyond the memory of man to the contrary. The first written record of any such is that document which gives the findings of the commission of Lords of the Manor in 1288. In the course of time, these were to be added to, revised, and affirmed and to persist, always growing in number and scope, for six hundred years until they came ultimately into conflict with the civil law of England itself. The miners, that is—those whose names were recorded as such in the books of record of the barmasters, were asked in the middle of the nineteenth century if they would agree to their customs being brought into the code, or lose them altogether. They chose the former. Those which were *ultra vires*

or repugnant to the civil law were omitted. The balance were embodied in Special Acts—1851 for the High Peak, and 1854 for the Low Peak. Their spirit was preserved along with the vital rights. They are maintained to-day with all ceremony and with all that solemnity which their antiquity calls up in the responsive minds of those who administer them. There is little doubt that the Australian laws were founded on them and they, or a paraphrase of them were offered to the King and Parliament in 1693–4, as a basis on which might rest a set of laws for the "governance of Mines in His Majesty's possessions of Africa and America"—(Houghton, "Royal Institutions," 1693–4). Whatever rights were conferred on the prospector he has shouldered through all those years the burden of setting aside at the least a thirteenth of his gross production for the Lord of the Soil. In many cases, too, but not in all, the Church, which exhorted him to do his duty in that state of life to which it should please God to call him, has called on him for a little bit more. He seems always to have paid his duty cheerfully to the Temporal Lord, because he got something for it, such as his right of entry, water, fuel, etc., but the Church he regarded in all ages as a sort of income tax collector.

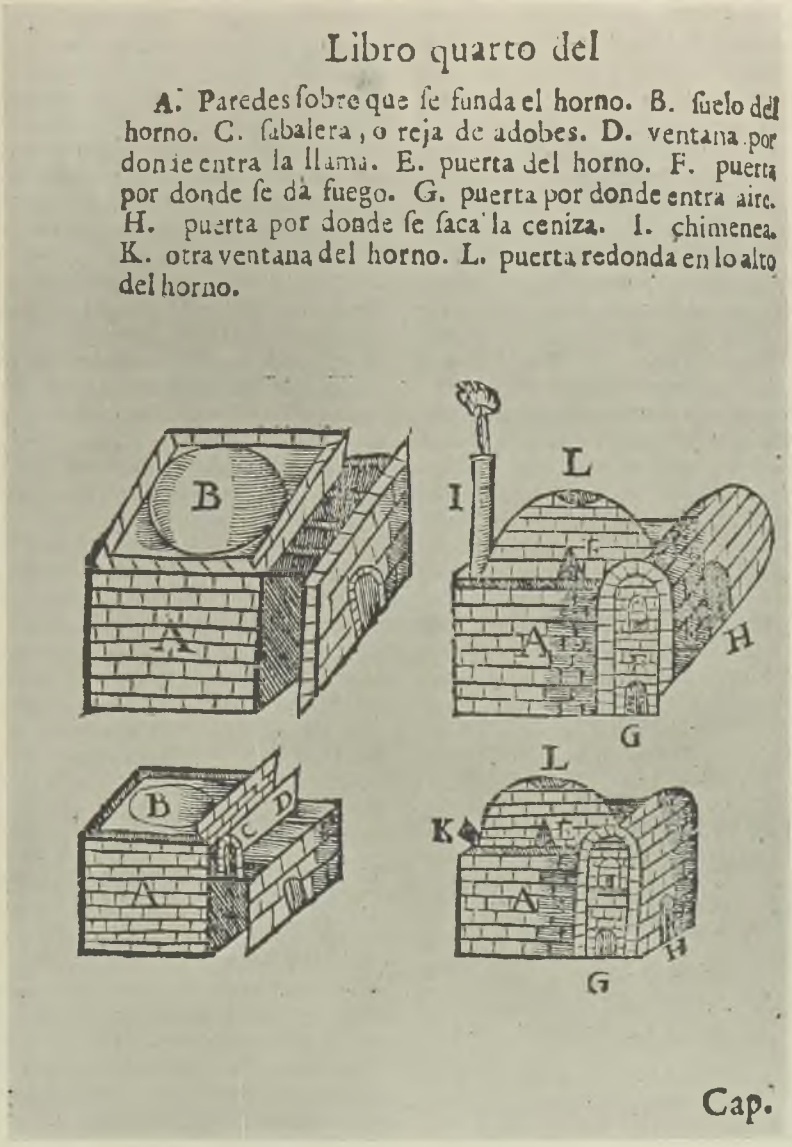
He could lose his mine if he did not pay his duty of Lot, but his immortal soul could be damned if he did not pay his tithe, and where death from "damp" or by falls of earth was a common occurrence it took a brave man to evade it. But he did so, or tried to, continuously and rancorously. All the writers who championed the causes of the miners had something to say on the subject of the iniquity of the imposition, declaring that it should be a tenth of the profit and not of the gross; 8% for the lord and 10% for the Church was a shocking load. He compromised at times by pretending that what he could not avoid giving was a voluntary gift. Sometimes the representative of the vicar was made to hang round the spot where the ore was being measured to be beckoned down from his seat on some dump or hillock, whenever the miner thought he could spare him a dish. Sometimes, too, the miner was let off with $2\frac{1}{2}$%, but not often. Generally speaking, his load would seem to have always been heavy enough to have broken a bigger man physically. He was probably kept going as all true prospectors are by the hope that his luck would turn, that the elfin knocker would lead him on one day to a store of riches. Sometimes it did, and some families of note in later times owed their aristocracy to a bonanza.

LANGUAGE.—The "Miners' Terms of Art," as they are usually called in the writings, include a number of words which are strictly local and which to the newcomer are quite incomprehensible. The reason for this is that they are almost wholly Middle English. In spite of the Norman and Latin influences of the overlord, whether Spiritual or Temporal, these words have their roots in the Anglo-Saxon tongue. This is no argument that a mining community persisted through Anglo-Saxon times, but is simply a reflection of the fact that no foreign influences have had any appreciable effect on the population of Derbyshire, and the dialect of the village born, not only in its vocabulary, but in its pronunciation, is to-day as near as one can picture to the Middle English of the 13th century.

MINING. — The laws and customs previously referred to operate in the two Hundreds of the High and Low Peaks of Derbyshire. The latter of these is generally known as the Soke and Wapentake of Wirksworth. A full description of them is given in Tapping's critical "Survey of the Act of 1851," etc., and no further reference is necessary here. With several exceptions they apply to the whole of the area included in these two Hundreds which themselves form part of the Duchy of Lancaster, and are known as the King's Field.

Under these customs, mining has been carried on according as the means to do so were suitable to the conditions, or whenever the price of lead was high enough to induce men to undertake the work. From the time of Edward I to the end of Elizabeth's reign, it is fairly certain that very little indeed was done. No improvement in the means for getting ore had been devised beyond what the Roman had. Fire setting, the hammer and gad, and the plug and feathers were the only tools at the disposal of the miner.

There were seven mines at work at the time of the compilation of Domesday Book. In Camden's time there were two Sir John Pettus mentions one that was working when he was a boy, i.e., about 1630. Some of the lead work on Haddon Hall dates back to the 16th century (Cox).



A.A. Barba's "Arte de los Metales" (1640), showing the Peruvian forerunner of the Derbyshire smelting furnace.

It can be safely assumed that there was little demand for lead by itself. The search for silver would ensure that all needs would be met so far as the base metal was concerned, and the West of England was prolific of both. The best argument perhaps is that such enormous quantities of its ores were left practically on the surface to be available when the need for the metal made itself felt in much later times. It has been said that Camden noted two mines only in his account of 1586. Elizabeth herself may have been responsible for this. Side by side with her desire to provide the kingdom with the materials of war her need for silver and gold urged her in a direction which had the effect of stifling all prospecting. Her grants to the foreign metallurgists which

were later passed on to the Company of Mines Royal and the Mineral and Battery Works, together with the active exercise of her prerogative as regards so-called "Royal Mines" led to the almost entire cessation of prospecting work. No adventurer could engage in mining so long as he was sure to lose his mine if it proved to contain enough silver to cause it to be classed as a royal mine, and once she had won her case against the Earl of Northumberland in the famous Keswick litigation, no man of lesser degree was likely to interest himself even if ore were found. So far as Derbyshire lead was concerned her Company of Mines Royal appears to have interested itself very little. It must be remembered, however, that the King's Field in Derbyshire was her own property since she had no heir, and it is on record that the mines were worked during her reign in accordance with the customs then in vogue as provided for in her grants previously referred to. Quite a number of lawsuits are recorded in her reign which fact indicates that she made use of the customs to assure to herself such revenue as might be forthcoming from the workings of lead mines, but she made no effort to foster the work itself: The ore had no silver.

It was really not till the 17th century that the group of customs which formed the basis of the modern law became important. In fact Queen Elizabeth's charter to Humphrey and Schutz expressly covenanted that "none of the subjects of her Highness, or any other person whatsoever other than such as from time to time shall be set to work therein by the said W.A. and C.S., shall be suffered to dig, open, or work at any time after the date of the said Letters Patent . . . for any of the said ewers or mines of gold, silver, copper, tin, or lead." Also that her Majesty would "overthrow, deface, and utterly destroy, or cause to be overthrown, defaced, and utterly destroyed, all and every such tool and tools, instrument, etc., engine and building staff and other thing and things whatsoever which shall be brought, etc., contrary or prejudicial to the said privilege." (See Stringer.)

There was very little room left by the Letters Patent for any common right to mine and it would be of interest to know under what conditions mining in Derbyshire was carried on during this period. It may be noted, however, that in the third year of Edward VI., a great barmote court had been held at Wirksworth.

(To be continued.)

The I.M.M. Benevolent Fund

The following further subscriptions to the Benevolent Fund of the Institution have been received during the past month:—

	£	s.	d.
Mining Trust, Ltd.	20	0	0
Cyanamid Products, Ltd.	10	10	0
Fraser & Chalmers Engineering Works	10	10	0
Sir Robert Kotzé	10	0	0
R. S. Mackilligin	5	5	0
H. M. White	5	5	0
Anonymous	5	0	0
R. Hamilton	5	0	0
E. G. Lawford	5	0	0
E. R. Woakes	3	3	0
R. F. D. Allen	2	2	0
R. Allen	2	2	0
N. R. Junner	2	2	0
L. Kessler	2	2	0
G. Trestrail	2	2	0
N. A. Veitch	2	2	0
A. L. J. Wyly	2	2	0
A. J. W. Legge	2	0	0
V. H. M. Barrett	1	1	0
N. H. Monro	1	1	0
R. G. K. Morrison	1	1	0
T. L. Robb	1	1	0
A. C. Skerl	1	1	0
E. H. Tregoning	1	1	0
Previously acknowledged	£570	10	0
Total	£673	3	0

BOOK REVIEWS

Bauxite and Aluminous Laterite. By Cyril S. Fox. Cloth, octavo, 312 pages, illustrated. Price 30s. London: Crosby, Lockwood, & Son.

This volume is described as a second edition of the author's "Bauxite" (1927), partly rewritten and enlarged. New matter is found in the Introduction and in Chapter x, while Chapter xi on "Supplementary Information" takes the place of a chapter in the earlier volume on "Statistical Information." New photographs and text-figures are included. The supplementary information concerns occurrences of bauxite in Austria, France, Germany, Hungary, Italy, Roumania, Russia, and Yugo-Slavia. For the general reader the chapters on the uses, mining, and preparation of bauxite, and on the aluminium industry will still prove the most valuable and interesting. The scientist, on the other hand, will find interesting reading and food for thought in the author's Preface and Introduction to the new edition.

The author now wishes to use the name "bauxite" for the French or European type only, and "aluminous laterite" for that of true lateritic origin, such as the Indian type. Primary bauxite he now regards as a sediment that was originally grey, often pyritic, and not derived from "*terra rossa*." He states that there appears to be a preponderance of monohydrate of alumina in bauxite and a preponderance of trihydrate of alumina in laterite. On p. xvi the author says that he uses the term "*terra rossa*" for weathered red clays of limestone and dolomitic rocks found on such rocks; "*roterde*" for the red clay of basaltic or basic igneous rocks; whereas "red clay" should be applied in general to material of uncertain origin. With regard to the last it might be objected that "red clay" is commonly used for a widespread deep-sea deposit.

The reviewer must confess that after reading the Introduction he is not convinced of the necessity for calling the material with which this book deals bauxite in some cases, and aluminous laterite in others and suggests that if the former contains a preponderance of aluminium monohydrate and the latter a preponderance of aluminium trihydrate, we might advantageously name them diaspore and gibbsite, rather than make confusion worse confounded by adopting the author's newly proposed divisions of bauxite and aluminous laterite, which in his memoir on "The Bauxite and Aluminous Occurrences of India" were differently used to designate varieties of laterite rich enough and not rich enough for use as aluminium ores (Memoirs Geol. Sur. India, vol. xliv, pt. 1, 1923, p. 5). The use of the term "laterite" is so perplexing now that we should aim at simplicity instead of new divisions, which those who are commercially concerned with bauxite will almost certainly disregard.

Although described as a second edition, it is clear that by far the greater part of this book (to be exact, Chapters i to ix and the Bibliography) is a second impression of the earlier volume with the old errors uncorrected except for a slip containing two *errata*, one of which is not clear. On p. 54 the incomplete title of the author's Geological Survey of India Memoir remains incomplete; elsewhere names are still incorrectly spelt. "*Terra-rosa*" persists instead of "*terra rossa*" but is corrected in the Introduction. The Bibliography has not been brought up to date. In this connexion attention is invited to a paper on "Laterite and Laterite Soils" published this year by the Imperial Bureau of Soil Science (Rothamsted) in which there is a Bibliography. Even in the Index the author has not been able to correct old mistakes, although it has been enlarged to embrace the new matter in the volume. Thus we still have "Xenthosiderite" for Xanthosiderite, "ZrO_3" for ZrO_2, "Bunka" for Banka; and regardless of the repetition we must protest that not even Wegener would agree that Borneo was at any time in East Africa.

In spite of these defects, which were perhaps beyond the author's control, this book has much additional and welcome information. Since 1927, the author tells us, most of the world's production of bauxite has still come from France and Arkansas, but Hungary has become a great producer and Yugoslavia has now an important position in the trade.

J. B. SCRIVENOR.

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1. **Geophysics, 1931.** *Transactions* of the Society of Petroleum Geophysicists. Vol. I. Paper covers, 113 pages, illustrated. Price $2·50. Tulsa, Okla., U.S.A.: The American Association of Petroleum Geologists.

2. **Geophysical Prospecting, 1932.** *Transactions* of the American Institute of Mining and Metallurgical Engineers. Cloth, octavo, 510 pages, illustrated. Price $5. New York: Published by the Institute.

3. **Traité Pratique de Prospection Géophysique**. By C. L. ALEXANIAN. Cloth, octavo, 268 pages, illustrated. Price 62 francs. Paris and Liège: Librairie Polytechnique Ch. Béranger.

The extensive developments which have recently occurred in the science of applied geophysics have produced a wider appreciation of this subject by geologists and mining engineers, who now fully realize that applied geophysics is not an entirely separate field, but an important branch of geological investigation, providing new means of mapping structures, both for their own geological significance and for the control they exert over the occurrence of ore and oil.

The early secrecy and reticence with which this science was formerly surrounded, is now fortunately giving place to the presentation of technical papers and a freedom of discussion, which will do much to stimulate still further development by the interchange of ideas and information. It is gratifying therefore to be able to draw attention to these three publications, all of which are welcomed as contributing to the advancement of this important subject.

1.—This volume contains seven papers which were presented at a symposium of geophysics in March, 1931, before the newly-formed Society of Petroleum Geophysicists, during the annual convention of the American Association of Petroleum Geologists. These papers are reprinted from the *Bulletin* of the Association, Vol. 15, Nos. 11 and 12, Nov. and Dec., 1931, and form Vol. 1 of the *Transactions* of the Society of Petroleum Geophysicists. Two of the papers relate to the gravity method, two to the seismic method, and the remaining three to the magnetic, there being no paper included on the electrical method. Some of the papers describe actual field surveys and give a critical discussion of the results obtained, while in others new and unorthodox ideas are presented which subsequently led to interesting and useful discussions. Other papers are devoted to theoretical aspects of different branches of the subject, and to a description of a new instrument. This book is recommended as presenting " a fair cross-section of the present development of petroleum geophysics," and is of particular interest to those who desire to keep in close touch with recent developments.

2.—This volume is the second of a series devoted entirely to geophysical prospecting, and contains papers and discussions presented at the New York meetings of the American Institute of Mining and Metallurgical Engineers from 1929 to 1932. Since the appearance of the first volume in 1929 many papers on the problems connected with this subject have been submitted to the Institute, and twenty-four of these have been selected for inclusion in the present volume. No claim is made either for continuity or completeness, and no objection can be taken to the varied nature of the subjects dealt with. The electrical methods have received the greatest consideration, thirteen papers being devoted to the resistivity and electromagnetic methods and to theoretical studies of an electrical nature. The magnetic and seismic methods each claim three papers, while two are devoted to gravity. This volume is not intended as a textbook, but as a selected series of papers representative of varying aspects of current geophysical practice. As in the earlier publication, the papers abound with interesting information and valuable data, and doubtless everyone interested in geophysics will find this book a source of useful and reliable information.

3.—As its title indicates this volume is intended as a textbook for geologists and mining engineers who desire to acquire some knowledge of the basic principles governing the practical application of the various geophysical methods. It is an elementary manual giving a clear and concise account of the subject, without the advanced mathematical treatment which is so often disliked by the geologist.

The first part of the book is devoted to the fundamental principles upon which the methods are based, and to a description of the different instruments employed, the various corrections to be introduced, and the procedure adopted in plotting the results of field surveys. Each method is treated individually in a separate chapter, at the end of which a short but useful bibliography enables specialized information to be obtained on any particular aspect of the subject.

The second part of the book deals with the practical application of the methods and the geological interpretation of the results. Maps and plans from a considerable number of surveys are reproduced, and these are discussed in detail, with a view to arriving at a satisfactory interpretation. A novel feature introduced at the end of the book is a list of the principal manufacturers of applied geophysical instruments in Europe, and one giving the most important prospecting companies employing geophysical methods.

As an introduction to applied geophysics, the book will most certainly prove of considerable value to the mining engineer or geologist who desires to acquire a general knowledge of this interesting subject.

H. SHAW.

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

NEWS LETTERS

BRISBANE

July 19.

Mount Isa Activities.—Lead production at Mount Isa has, according to official reports, continued to proceed smoothly during June, and latest figures available indicate a substantial improvement in output. The new blast furnace is practically complete, the second Dwight-Lloyd sintering furnace has been given a trial run, and good progress has been made with the erection of the third sintering furnace, which, when complete, will finish that portion of the new plant. The alterations being made to the Cottrell plant will be finished by the first week in August and the whole of the reorganized smelter plant will then be brought into operation. On the opening of the works last year some new metallurgical problems had to be worked out in connexion with the sintering plant and furnaces. The Cloncurry mining warden (Mr. S. Wilson) states that a mixture of sulphide and carbonate concentrates, containing considerably more carbonates than sulphides, had to be treated at the smelter—an innovation in treatment methods. The problems set by this innovation, Mr. Wilson says, have now been solved.

Underground Work and Output.—In the Black Star section at Mount Isa development work is in full swing, and driving has begun off the main haulage level, preparatory to the further development that is to follow. At Davidson's shaft, on this lode, an electric winder is being installed in order to facilitate the handling of materials in that part of the mine, which in future will be a busy centre. Larger scraper equipment has been installed to handle the ore from the H40 north stope in the Black Rock section. The diamond drilling plant, having finished the Crystal No. 1 bore-hole, at 632 ft., has been closed down for an indefinite period. The bullion produced at the mine during June contained 3,921 tons of lead, worth £38,066 and 191,902 oz. of silver, valued at £14,392. The quantity of ore treated at the mill was 49,039 tons, and the concentrates therefrom 8,406 tons. The furnaces were started on June 8, 1931. Official returns show that since that date 493,252 tons has been treated, for a yield of 38,633 tons of lead and 2,065,361 oz. of silver. The value of the total production, at average monthly prices, amounted to £650,200. The General Superintendent (Mr. G. J. Gray) has resigned his position, and is leaving Mount Isa.

Mount Wandoo Goldfield.—The official report for June from the Mount Wandoo gold mine, North Queensland, states that no development work was done during the month in the Hardman (or main) and the Wendy shafts. Surface construction has been continued, and the ore bins at the battery and Hardman shafts are nearing completion. Mr. Alexander Macdonald, the holder of the Mount Wandoo lease, is now on the return voyage from his latest visit to Great Britain, and is expected on the field about the beginning of August. Advice from a private source is to the effect that he has been successful in his efforts to raise capital abroad to finance the development of the mine, and that work on a comprehensive scale will commence shortly after his return. In some progress notes on the Mount Wandoo field, dated June 7 and written by Mr. J. H. Reid, one of the Government geologists, who is now stationed in the north, it is reported that 40 ft. of driving and 5 ft. of cross-cutting on the Wandoo lease done since Mr. Reid's first visit sustains the view that the country rock is much shattered, and that certain intersections of fissures may be important economically. The geologists samplings show that the 6-in. end of an arsenical ore-body of unknown extent above the southern cross-cut carries 7 dwt. of gold per ton, and that the 6 in. of ore showing underfoot at the end of the eastern drive contains more than 2 oz. of gold to the ton, together with 14½ oz. of silver.

Another Goldfield.—Some stir has been caused during the past week or so by very optimistic, if not sensational, reports of discoveries of gold on the Cracow field, on the Dawson River, in the Wide Bay or Burnett district of that State. The field is 240 miles north-west of Brisbane, and about 35 miles south of the railhead at Theodore, which is some 150 miles south-westerly from Rockhampton. The field was discovered 15 or 16 years ago, but only last year, thanks to the intense prospecting throughout the State, did the area come into prominence. A large number of claims have now been pegged out, several options have been obtained, and companies have been, and are being, formed with substantial nominal capital, to acquire and develop

the areas included in these options. The auriferous ground already partially tested is reported to be extensive and sufficiently rich to be operated on a payable basis. A statement emanating from the Mines Department, based on particulars so far available supplied by Government geologists, gives an impartial view of the potentialities of the new disclosures. From these data the Minister for Mines (Mr. J. Stopford) is convinced that the field is characterized by very large low-grade formations, very richly auriferous and in well separated patches. The development work to date is inconsiderable, the greatest depth as yet being only 52 ft. In one shaft at that depth values as high as 17 oz. of gold to the ton, over a width of 27 in., have been indicated by assay, while the adjoining 29 in. showed 3 oz. per ton. Only one of the formations had been open to inspection by the geologist who visited the field, and the sampling of this gave an average gold content (over a width of 60 ft.) of about 2 dwt. per ton.

Mount Coolon.—After several weeks of suspended operations at the mine in Queensland, of the British company, Mount Coolon Gold Mines, Ltd., the matter in dispute between the workmen and the company was referred to the arbitration of the district Inspector of Mines, and, following on a conference, work has been resumed. Large quantities of material and heavy machinery are still going forward to the field, and, the local mining warden states, everything is progressing satisfactorily. This official adds that it will probably be well on in the year before all is ready to start crushing. Mount Coolon Extended, Ltd., with a nominal capital of £250,000, has been registered in Melbourne. The objects of this company are to work what is believed to be a continuation of the auriferous lode to the north-west of Barclay's Native Bear mine, which is one of the properties now being opened up on a large scale by the Mount Coolon Gold Mines, Ltd. It is expected that the new company will take over its properties at the end of this month. Those to be acquired are the Dig Again and two other leases.

Expedition to Central Australia.—A gold prospecting expedition on a large scale, organized and led by Mr. C. H. Chapman, of Roma, Queensland, to operate in Central Australia, left Brisbane last week. The party, when it sets off from Camooweal, on the north-western border of this State, will be equipped with several motor vehicles carrying men, materials, stores, etc., a complete boring plant, and probably a wireless receiving and dispatching set, and later with an aeroplane. Mr. Chapman is connected with a well-boring company, and is taking with him about 20 men, including experienced miners, a metallurgist, and an assayer. The expedition will explore areas north, north-west, and south-west of Tennant's Creek, in the Northern Territory—an extent of country which totals an area larger than Queensland, or over 670,500 square miles.

Coal Mining.—The coal miners in New Zealand who have been out on strike have accepted terms offered by the colliery owners, and have resumed work after a stoppage of five weeks. Another State-owned coal mine has been closed, following a decision of the Government of New South Wales to suspend operations at its Lithgow mine. It is estimated that by this action a saving of £80,000 a year will be effected.

Port Pirie Smelting Works.—In the half-year period ended January 10, 1931, the ore deliveries to the Broken Hill Associated Smelters, Ltd., at Port Pirie, South Australia, were restricted to the output from three mines, and smelting operations confined to a maximum of four blast furnaces, as compared with an average of five and a half for some years previously and prior to the collapse in metal prices. The company is controlled by North Broken Hill, Ltd., Broken Hill South, Ltd., and the Zinc Corporation, Ltd., which supply almost the whole of the raw material, in the shape of lead concentrates, for conversion into lead and silver. At the works considerable improvements have been effected during the past seven years. To minimize the risk of lead poisoning, the smelting company undertook an extentive plan of reconstruction of its blast furnaces and refinery. Seven years ago the works employed about 2,800 men, of whom some 260 were afflicted with the dread disease. Last year, when 1,400 were engaged, those who contracted the malady numbered only seven. Thanks to the enterprise of the three share-holding companies, the improvement in working conditions combined with the high efficiency attained in the refinery processes, has made the Port Pirie smelting plant one of the best of its kind in the world.

Mount Lyell Company.—Last week the price of copper reached the lowest level on record. According to Mr. R. M. Murray, the general manager of the Mount Lyell, Tasmania, this is causing the company serious concern. The continued fall, he said, was making it difficult for the company to carry on, and the strictest economy was necessary. Mr. Murray, however, added that in spite of the slump the same quantity of ore as formerly is being treated.

JOHANNESBURG

August 4.

Heidelberg.—It is recalled that in 1919 considerable work was done in the neighbourhood of the Heidelberg town lands, and in some old reports of that time reference is made to a bore-hole which had been sunk some years previously, which encountered a reef lying on shale at a depth of 1,943 ft., assaying 11 dwt. over 3 in. In the same bore-hole a reef was stated to have been intersected at 435·5 ft., showing a value of 28 dwt. 12 gr. over 12 in. Since then, the work of the Geological Survey, has been published together with a geological map covering this area of the Far South-East Rand. According to the findings of the survey, the Kimberley Slates, dipping in a north-easterly direction, run more or less along the line of railway upon the farm Langlaagte, upon which the town of Heidelberg is situated. The reefs which outcrop upon the town lands in the vicinity of the two bore-holes marked thereon are, therefore, labelled Kimberley Series. A thousand feet or more below the Nigel Reef horizon should be encountered according to the data given.

Meyer and Charlton Closed Down.—The Meyer and Charlton gold mine—one of the " plums " of the Witwatersrand fields—has been closed down after over 44 years of active operations and the clean-up of the plant is now in progress. During the period mentioned the company has distributed no less than £3,855,309 in dividends. The last dividend, 15% was declared in 1927. Since then profits have accumulated and it is expected that, with the liquidation distribution, the amount finally returned to shareholders will exceed £4,000,000. The issued capital of the company nominally stands at only £200,000, but, owing to the successful nature of its operations, a large portion of this was issued from time to time at fairly high premiums, resulting in further receipts on capital account of £322,019, the new capital, together with the premiums being used mainly in the acquisition of additional mining areas.

Solar Development Company.—According to advices from Windhoek, the Solar Development Company, a Canadian mining concern, which has been carrying on extensive development work in South-West Africa on mineral deposits, has now found it necessary to curtail operations as a result of which many white men have been retrenched or are returning to Canada. Only a few men are being retained to supervise the work already done. This concern has up to the present been obtaining options over various mining areas.

New Chief of Geological Survey.—Dr. Leo Krige will be appointed to succeed Dr. A. W. Rogers as Chief of the Department of Geological Survey. Dr. Krige, who is one of the senior geologists in the department since the retirement on superannuation of Dr. Rogers and Dr. A. L. Hall (the late Assistant Director), has had a long and distinguished career in the public service.

Chrome in Zululand.—A promising occurrence of chrome is being developed on the Isitilo Range, about nine miles from Middle Drift on the Tugela River, in the Zululand native reserve. It is stated that chrome ore railed in bulk from Eshowe can be placed on ship for about 8s. 6d. per ton of 2,000 lb. This low rate is made possible by the specially cheap shipping and wharfage charges at the Port of Durban, and includes intermediate handling and haulage services at the port; in addition, one month's free storage in the open is allowed. It is estimated that Transvaal chrome ore costs from 15s. to 16s. a ton loaded at Lourenço Marques, and Southern Rhodesian chrome about 27s. 6d. a ton loaded at Beira. Samples of the Zululand chrome have been sent to Barclays Bank, Johannesburg, for assay, and results range from 52% to 59·2% chromic acid content. The higher assay was obtained from a sample of oxidized ore. A sample representative of the ore mined during prospecting operations has been analysed by Barclays Bank at Johannesburg with the following results: Chromic acid, 51·05%; iron, 13·2%; magnesia, 15·5%; silica, 8·6%; phosphorous, traces.

Rhodesian Mineral Rights.—The question of the ownership of mineral rights

in Southern Rhodesia has suddenly been brought to a head by the refusal of Sir Hugh Williams, of the Elf Mine, Hartley district, to pay royalties on his output. His intention is to make a test case, as he contends that Section 3 of Ordinance 19 of 1903, declaring the mineral rights vested in the Chartered Company, is not a valid vesting section, and that Section 13 of Ordinance 10 of 1907, prescribing royalties payable to the Chartered Company, is invalid. This action ultimately involves the whole title of the Chartered Company to the mineral royalties of Southern Rhodesia, amounting to over £100,000 per annum.

Alluvial Gold Discovery.—Reports from the Shabani and Fort Victoria districts, Southern Rhodesia, indicate that the rush to the recently discovered alluvial deposits on the Ngesi and Lundi Rivers is assuming important dimensions. The number of prospectors camped at the junction of the two rivers, some 32 miles from Shabani, is stated to be now over 100, and claims have been pegged on the Ngesi for a distance of 12 miles. The chief centre of activity is from a point at the junction of the two rivers to a spot some miles along the Ngesi. Gold has also been won from the Lundi, but this has been difficult to recover by sluicing. The Ngesi gold, on the other hand, is coarser, and most of the diggers are concentrated along this river.

Unemployed Men as Prospectors.—The Governor of Southern Rhodesia has decided to adopt on a small scale the proposal of the Unemployment Committee to employ workless men in prospecting parties. Provision is to be made to send parties of ten men, each of whom are experienced prospectors, to areas north-east of Shamva selected by the Government Mining Engineer. Equipment and rations will be provided, and the men will receive two shillings each daily. In the event of payable reef being found, the discovery will be transferred to the names of the party jointly. Ten youths are also to be attached to the parties as prospector learners.

TORONTO

August 18

Porcupine.—During July the producing mines of this area yielded bullion to the value of $1,608,025, from the treatment of 276,270 tons of ore, as compared with $1,861,913 from 275,075 tons in June. The mill of Hollinger Consolidated is operating at the rate of about 5,000 tons a day, the ore being of an average grade of $7 gold to the ton. The ore reserves are being steadily increased and a big programme of development is under way in various sections of the mine. During the first six months of the year, the mine showed fair improvement on the tonnage of 842,819 handled by the mill, the net recovery exclusive of exchange amounting to $4,828,556. The Dome Mines reports net profits for the second quarter of the year at $743,090, as compared with $539,028 for the first three months. Tons milled for the first half of the year totalled 267,000, as compared with 269,500 tons for the corresponding period of last year, the average recovery being $7·86, against $6·55. Costs showed a slight increase, being $3·72 per ton, as against $3·52. McIntyre Porcupine, in the report covering the first quarter of its fiscal year ending June 30 shows a net income, after depreciation, of $557,737, as compared with $408,530 for the previous quarter. The gross income for the quarter was $1,450,844, as compared with $1,124,651 for the preceding three months. The Canusa has been re-financed and is preparing to carry out an active development programme. The shaft will be put down from the 300 to the 600-ft. level, with two new levels established at 450 and 600 ft. Special attention will be given to the opening up of the downward continuation of the vein system found on the 100 and 300-ft. horizons. During the seven months ending July 31, the output from the Coniarium Mines was approximately $515,000, an average of $73,000 per month, with an average recovery of from $6·15 to $6·20 per ton. The company has declared an initial interim dividend of 3 cents per share.

Kirkland Lake. — The bullion output of the gold mines of the Kirkland Lake field during July was valued at $1,879,871, from 149,230 tons of ore milled, as compared with $2,152,718 in June, when the mills handled 147,781 tons of ore. The Lake Shore during June established a new high record with an output of $1,170,000 with mill-heads running close to $18 per ton. The new equipment installed to reduce tailing loss is working satisfactory and actual recovery per ton averages higher than it did a year ago. The company is proceeding with its programme of opening up new levels and what work has already been accomplished has proved ore to extend downward without lowering its grade, and the ore reserves are

being steadily increased. Teck-Hughes is continuing its proposed deep development programme. The winze has been put down to the 37th level, where cross-cutting and driving are in progress. An interim statement for the nine months ending May 31 shows an estimated surplus of $2,628,838, as compared with $2,448,361 for the corresponding period of 1931. The gross income amounted to $4,942,565, operating costs to $1,777,761, and the net earnings to $3,164,822. Production is being maintained at a high rate and mill-heads are more than $15 per ton. At the Wright-Hargreaves new finds of importance have been made on the five new levels from 2,250 to 3,000 ft., while on the bottom workings the average grade is stated to be about $20 per ton. The mill is treating about 800 tons of ore a day, and a substantial increase in the tonnage will follow the improvement in mining and hoisting facilities now under way. The Kirkland Lake gold mine, the deepest gold producer in Canada, is preparing to maintain its lead in depth development, the winze will be put down from the 4,950-ft. level to 5,600 ft. with new levels to be established at intervals of 125 ft. The success met with on the lower levels, which prove to be the best in the mine, gives good grounds for the expectation that good ore will be found below the present bottom horizon. Sylvanite Gold Mines continues to meet with success in its development campaign on the bottom levels at 2,500 and 3,000 ft., where new sections opened up reveal the best grade of ore so far found in the mine. The mill is keeping up its former high rate of operations, with a gross recovery averaging approximately $18·50 per week.

Other Ontario Gold Fields.—At the Ashley mine in the Matachewan area good progress is being made in the construction of a mill which will have a capacity of 150 tons of ore per day and this is expected to be ready for operation in a few weeks. Stoping operations are proceeding on the four levels down to 500 ft. and there is enough ore in sight to keep the mill in operation for several months. Prospecting is being actively carried on in this field and some encouraging discoveries are reported. On the Micmac property a shaft is being put down on a strong vein system. Attention has been directed to the Michipicoten area by the finding of a $5,000 nugget in the Parkhill mine and the Hon. Charles McCrea, Ontario Minister of Mines, recently paid a visit to the camp. The output of the Howey gold mine in the Red Lake area of Patricia district for the first seven months of the year is valued at about $700,000. Despite the low grade of the ore, the company realized a profit of around $1·40 per ton. Two new levels below the 1,000 ft. horizon are being opened up.

Sudbury.—Operations of the International Nickel Company were further curtailed by 30% at the beginning of August. The electrolytic department at Port Colbourne has been closed down for three months. Operations at the Garson and Creighton mines, which have for some time been conducted on a very limited scale, have also been discontinued and work at the Coniston smelter has been suspended. No change has been made in the output of the Frood mine or the Copper Cliff plants. The company's operations will remain on a very substantial basis with over 2,000 men on part or full time. The Falconbridge Nickel is steadily maintaining production, the output for the three months ending June comprising 1,482,240 lb. of nickel, and 605,975 lb. of copper both in matte, as compared with 1,480,562 lb. of nickel and 619,857 lb. of copper for the preceding three months, the gross operating profits were $167,423, as compared with $113,511. The company is assured of a market for its output during the remainder of the year under contracts secured in the United States and is now negotiating with Japanese interests, with a view of obtaining extensive contracts for nickel.

North-Western Quebec.—The Noranda Mines, Ltd., in its estimated statement for the six months ending June report the production of 29,529,873 lb. of anodes, and recovery of copper and precious metals valued at $6,203,363. Operating expenses were shown at $3,237,143, and, after all deductions, there remained a net profit of $2,040,807. President Murdoch recently stated that the company was maintaining copper production at its old rate and had no intention of further curtailment, as all the copper produced was being sold and there were no surplus stocks on hand. The Siscoe Gold mine reports production during July to the value of $89,055, from a tonnage of 5,550 tons, with a recovery of $16·25. This brings the total output for the first seven months of the year up to $661,856. Shaft sinking is progressing at 884 ft., on its way to its objective of 1,000 ft. High-grade ore has been opened up on the 600-ft. level. At the Granada the new cyanide mill is working satisfactorily and success is attending development on the lower

levels, where a find of importance has been made on the 925 ft. level. The Stadaconna Rouyn mines, which has been closed down for some time, will shortly be reopened as the company is being re-financed. The new mill on the O'Brien-Cadillac property is nearing completion and is expected to go into operation about the end of August. It will have a capacity of 100 tons per day. The Treadwell Yukon, operating in the Pascalis gold area, will shortly begin production with 150 ton mill. Dome Mines, Ltd., has taken an option on the Jowsey claims in the Pascalis district, a campaign of exploration work having indicated good values.

Great Bear Lake.—The active exploration work carried on by several companies in this area has been followed by new discoveries, the most important recent find being the discovery of high-grade gold ore at about 20 miles south of the Echo Bay section. This has been followed by a staking rush to the locality. The Eldorado Gold Mines has erected new buildings for housing the power plant now on its way north and store rooms for mining equipment and supplies.

VANCOUVER

August 10.

Mineral Production.—Production for the six months ended June 30, 1932, is set out in the recently-published Summary and Review of the Mineral Industry for the Province, as follows:—

Product.	*Quantity.*	*Value,* $
Gold, placer and lode, oz.	91,000	1,881,137
Silver, oz.	3,700,000	1,214,969
Copper, lb.	28,700,000	1,899,108
Lead, lb.	128,000,000	2,904,320
Zinc, lb.	68,500,000	1,607,010
Coal, tons of 2,240 lb.	808,200	3,636,900
Structural Materials	—	900,000
Miscellaneous Metals and Minerals	—	292,616
Total		$14,336,060

These figures indicate a general decline of 23·4% as compared with the returns from the same period in 1931. An increase of 25%, however, is recorded in the case of gold production, due in some measure to placer-mining activity, but mainly in respect to the growing returns from the lode-gold operations in the Bridge River area. In former years, no attempt has been made to record placer-gold returns for the first six months of the year, but in view of the existing interest in this branch of the industry, the estimate of $70,000 is submitted as representing encouragement resulting from the "placer rush." It is estimated that Pioneer Gold Mines will assume the leadership among lode-gold producers in 1933 with a production of about $2,000,000. Emphasis is laid upon the fact that the normal output from Premier Gold Mines is maintained, in proof that a good mine dies hard. The search for gold is described as being the paramount feature of the industry and it is forecast that as a result of the present era of activity the record production of $6,137,190 in 1913 will be eclipsed in the next two or three years. It is estimated that over 5,000 prospectors were engaged in placer mining during the period under review, although many persisted in their efforts for a short time only. Copper, lead, and zinc production was affected by curtailment at Britannia, Anyox, and Sullivan mines, the continuance of operations at the two first-named copper producers being threatened by the imposition of the 4% tax on the metal entering the United States in the form of concentrate. Both of these companies are seeking other markets for their products, but the future of copper mining in the province is obscure.

Portland Canal.—J. T. Mandy, Resident Mining Engineer for the North-Western Mineral Survey District, reports resumption of development on the Kenneth group by the Argentine Syndicate. This property has been described as being decidedly worthy of intensive exploration. It is conveniently situated to transport facilities on the south side of Glacier Creek at an elevation of about 4,000 ft. The mineral occurrence consists of lead, zinc, and iron sulphides in brecciated shear zones from 2 to 15 ft. wide, from which shipments of ore have been made carrying high silver values with an appreciable gold content.

Porcher Island.—A new discovery of high-grade gold-bearing pyrite has been made on the Eddy Pass group, and the outcrop has been stripped over a distance of about 200 ft. There is a system of quartz veins in a quartz-diorite formation, ranging from 4 in. to 3 ft. wide.

Taku River.—Exploratory work on the Whitewater group situated on the Tulsequah River has been resumed by Noah Timmins Inc. During 1931 some 5,300 ft. of diamond drilling work and a large amount of open-cutting was done on shear zones carrying good gold values associated with antimony. The

results of this work were inconclusive, but of sufficient encouragement to warrant the continuance of investigations.

Atlin.—It is reported that an attempt is to be made to resume operations at the Engineer mine, in connexion with the opening up of another property in Idaho. For this purpose it is proposed that outstanding liabilities shall be settled by the issue of treasury stock, in addition to the provision of working capital. It appears that there are 765,000 shares out of the 1,000,000 share capitalization that are available for this scheme. The Engineer mine has had a varied career; there are large bodies of quartz, and about 25 veins in which bonanza ore-shoots are found, but at no time has it been found possible to establish reserves in any amount. During the year 1925 1,700 tons of ore were milled with a production of 1,814 oz. gold. The Idaho property in question is said to be a low-grade prospect.

Bridge River.—Lorne Gold Mines, Ltd. has been absorbed by Bralorne Mines, Ltd., the former company being wound up on the basis of a settlement of outstanding liabilities, and the distribution of approximately 400,000 shares in the Bralorne company among shareholders at the rate of about 8 Lorne shares to one of the operating company. In a letter addressed to the shareholders, F. W. Rouncefell, chairman of Lorne Gold Mines, states that there is no immediate prospect of an increase in the capitalization of Bralorne Mines. It is reported that since the commencement of milling operations on February 8 last, until May 31, an amount of 11,119 tons of ore from the King vein was treated at a net profit of $90,000. With nearly 200 men on the payroll, Pioneer Gold Mines, Ltd. is rapidly approaching completion of the new development and milling stage of its operations. The new mill is expected to be tuned in some time in September. It is reported that a 30-in. vein has been encountered in cross-cutting work on the Why Not property, which is held under option by Bridge River Consolidated, and is being developed by Bridge River Exploration Company, Ltd. Referring to the holdings of the company, J. D. Galloway states in a note appended to the report of the Resident Engineer that the properties are prospects with but little indicated ore disclosed anywhere, and that over-optimistic statements that have appeared recently in the daily press should be discounted. The work of exploration is being continued on both the Why Not and Forty Thieves claims.

Lillooet. — Interesting placer-mining undertakings are described by G. A. Clothier, Resident Mining Engineer for the Coast and Lillooet districts on Bridge River and its tributaries, and on the Fraser River. Among these, the operation of chief importance is the hydraulic work of Lower Bridge River Placers on the benches situated about 14 miles above the junction of the Bridge and Fraser Rivers at Lillooet. The company has installed equipment including three monitors and 2,100 ft. of pipe line, after carrying out exhaustive testing operations by drilling during the past two seasons. The results of this work are said to indicate values of about $1·00 per cubic yard.

Coast. — Conditions of mineralization similar to those of the Bridge River district are said to exist around the head of the San Juan and Leech Rivers and prospectors are working in the area. Placer gold is found along the lower reaches of Leech River and in one operation a very promising channel is said to have been exposed from which fairly coarse gold has been recovered. Development work is being continued on the El Capitan property at the head of Cottonwood Creek, which flows into Cowichan Lake. There are two attractive veins on either side of a 10-ft. dyke traversing an andesitic rock, in which lenses and pockets of chalcopyrite carrying some high gold values are found. The vein matter, in two tunnels that have been driven, is considerably oxidized and there are said to be good prospects of developing sulphide ore at greater depth. Other promising prospects mentioned by the Resident Engineer, are the Leora gold claims on Kennedy Lake upon which some new work is being started; the You group on Bedwell River where arrangements are being made to resume operations on a gold-quartz vein; and a group of claims on Marble creek in the Alice Lake area, on which there are showings of bornite and chalcopyrite in a basalt formation.

Cariboo.—As a result of work that has been carried out since the date of his last report, Douglas Lay, Resident Engineer for the North-Eastern District is enabled to give a highly satisfactory account of the operations of Cariboo Gold Quartz Mining Co., near Barkerville. It is stated that six additional veins have been penetrated by the main cross-cut tunnel which has been extended to a distance of over 1,200 ft. from the portal. Five of these veins were encountered in the last 150 ft. that was driven. The width varies from 2 to 6 feet, and it is

stated that sampling by the management has shown that all veins have been found to disclose commercial values. The mineralization is composed principally of pyrite. The principal activity in this district has been naturally in connexion with placer mining and the Resident Engineer reports that the inexperienced are inevitably finding difficulty in securing sufficient gold to cover the cost of living.

Sheep Creek.—The balance sheet of Reno Gold Mines, Ltd. shows a net profit after depreciation and depletion of $24,443 for the fiscal year ended April 30, 1932, representing less than 11 months of actual operations. The average of the 10,634 tons treated was $17·93 per ton ; mining costs were $3·97 per ton and milling costs $3·34.

Osoyoos.—It is reported that United States interests have acquired the Nickel Plate property together with adjoining claims in the Hedley district and resumption of operations at this famous camp are expected at an early date.

East Kootenay.—Continuance of the drilling operations for oil in the Flathead valley by Crow's Nest and Glacier Oil Company is recommended by Dr. Victor Dolmage in a report that has been laid before the shareholders in the company. Dr. Dolmage's recommendation is based upon the possibility of oil-bearing formations occurring below the great Lewis overthrust, which is believed to extend below this area. The depth to which drilling will have to be continued is not known, and further geological work is required before any pronouncement upon this score can be made.

IPOH

August 18.

Reorganization of the Industry.—Since the beginning of the present quota period the local price of tin has advanced about $10 per pikul to date and there is a distinct tendency to look forward with growing confidence to the future. But while anyone closely concerned recognizes the tendency of the metal to appreciate in value, the situation with regards to stocks is far from being entirely clear. In any case the present is a good time for the reorganization and consolidation of holdings. There are many parts of the Kinta mining field in which minute subdivision and small detached holdings, so situated that they could not be economically worked except in conjunction with adjoining ground, have been frequent causes of disputes and difficulties. The difficulties are much aggregated when, as is often the case, the actual producer holds the land on a third or fourth sub-lease ; for each of the parties who hold prior sub-leases, and possibly the original lessee from the State, have legally grounds of complaint if as the result of grouping or a policy of restricted working the part of the ground in which they are interested is not being worked for production and no tribute is being paid. The excessive subdivision of mining land in Kinta has been previously noticed in the MAGAZINE. The actual holder of an original mining lease from government may never have spent or intended to spend any labour or money on the land, and very often holds his right for the purpose only of exacting tribute. Mining leases have commonly been granted for 21 years and if the land is being mined by any sub-lessee according to the regulations the actual miner may find, on expiration of the original lease, that it will be renewed to the original holder. While it is true that rights in property must be protected it seems this is a type of case in which the rights under the original or any mining lease should be cancelled if it is proved that the holder has not himself during any period of three years expended a minimum amount on the land in labour or equipment, or been a subscriber or partner to a sufficient amount in the mining operations of a sub-lessee.

Gold.—There is still active prospecting for gold, chiefly in Pahang and Kelantan, on the east side of the main range ; but no very important discoveries have yet been reported to the public. The wide distribution of gold there has long been known, and the most promising objectives for systematic prospecting are probably the alluvial deposits on the present and former river channels in which some degree of concentration of values must have occurred. It will be remembered that the Duff Development Co. had four dredges working on the main stream of the Kelantan River, which above Kuala Krai is known as the S. Galas, for a number of years. Gold has also long been known to occur widely up the branches of this river system above Kuala Pergau—both on the Sungei Pergau and on the Sungei Nengiri. In 1921–24 a local company with its headquarters in Singapore attempted to work occurrences of gold-bearing veins in the hills above Kg. Batu Melintang on the head waters of the streams

which form the S. Pergau. At Bukit Birching and at Chinong, especially at the latter, money was freely spent on prospecting and driving on quartz veins, with very poor results.

PERSONAL

W. H. Beak is returning from Sumatra.
Alfred Boyes has left for Western Australia.
S. Gordon Cullen is returning to the Gold Coast.
W. Hope Henderson has left for California.
C. E. Jobling has left for Burma.
Malcolm Maclaren has left for Venezuela.
J. D. Mead is returning to Malaya.
Frank Oates is returning to Tanganyika.
R. E. Palmer has returned from South America.
A. B. Watson is returning to Nigeria.

Gordon Henry Jenkinson died in Panama on July 21 at the age of 28. He graduated from the Royal School of Mines in Metallurgy in 1927 and spent three years in Bolivia in tin and later silver mining, proceeding to Panama towards the end of 1931.

Alfred Ernest Oakes died recently at the age of 85. After early experience in civil engineering in this country and in West Africa, Mr. Oakes became a mining engineer. He was first engaged in hydraulic mining in California and then went to Colombia, where he was one of the pioneers of alluvial gold mining as practised there so extensively since.

Edwin Edser died after a long and painful illness on August 17 at the age of 66. Professor Edser was an associate of the Royal College of Science and a former professor of physics at the Goldsmiths' College. Subsequently he became associated with Minerals Separation and was a recognized authority on molecular attraction and the physical properties of liquids. He was the author of several text-books of physics and mathematics, as well as of many papers presented to learned societies.

TRADE PARAGRAPHS

Askania-Werke, A.G., of Kaiserallee, 87/88, Berlin-Friedenau, publish a catalogue of their magnetic instruments for use in the observatory and in the field. This includes field balances such as have been described from time to time in connexion with geophysical investigations.

General Electric Co., Ltd., of Magnet House, Kingsway, London, W.C. 2, in their *G.E.C. Journal* for August have an article by two of their executives at Fraser and Chalmers Engineering Works describing the handling of ore for export. This treats of various systems of conveyors, tipping gear, and overhead gantries.

Davey, Paxman and Co., Ltd., of Colchester, the well-known manufacturers of oil engines, steam engines, boilers, etc., announce the reorganization of their company. Lord Goschen has been appointed chairman and the active management of the business is in the hands of Mr. P. A. Sanders and Mr. E. P. Paxman, for long associated with the original company.

E. G. Acheson, Ltd., of 40, Wood Street, London, S.W. 1, describe the advantages of their colloidal graphite, which is specially prepared to yield a grit-free product of extreme fineness for incorporation with a high-grade lubricating oil to make a substance that has commercially been known for some time as "oildag" and is a suitable lubricant for engine parts, particularly for new or rebuilt engines.

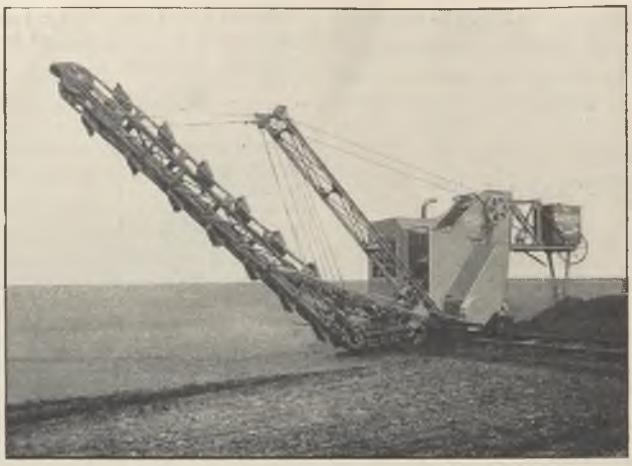
J. Rolland and Co., of 2, Victoria Street, London, S.W. 1, issue a catalogue prepared by **Fried. Krupp Grusonwerk, A.G.,** of Magdeburg-Buckau, devoted to the universal vibratory screen which was described in the Magazine for October, 1931. This is fully illustrated and as well as describing the construction of the machine indicates the variety of sizes in which it is manufactured and examples of its application.

Adam Hilger, Ltd., of 98, Kings Road, Camden Road, London, N.W. 1, are sending out literature describing their "Specpure" products, which are substances that have been highly purified and especially prepared for use in the method of quantitative spectrographic analysis such as has been described by Dr. S. Judd Lewis in *Chemistry and Industry*, vol. 51, pages 271–4. These substances are salts and solutions of metals, of which over fifty are listed, and are used for purposes of comparison in the spectrograph.

Ruston and Hornsby, Ltd., of Lincoln, announce that they have been awarded a contract for the installation of five of their oil engines at a new power station for the Port of Basrah, Iraq. Two of these engines will be 8-cylinder units of 440 b.h.p., each direct coupled to a 250-k.w. laternator, two will be 4-cylinder units of the same range, each direct coupled to a 125-k.w. alternator, and the remaining engine a 4-cylinder unit of 120 b.h.p. direct coupled to a 65-k.w. alternator, the whole being arranged to deal with a load up to 815 k.w.

Filtrators, Ltd., of Hazlitt House, Southampton Buildings, London, E.C. 2, publish a booklet describing their "Filtrator" non-chemical system of feed-water treatment applicable to boilers, economizers, evaporators, condensers, and all water-circulating systems, the purpose of which is the prevention of scale. The underlying principle of its operation consists in the use of a colloid obtained from ordinary uncrushed commercial linseed by extraction with saturated steam. The plant is charged every 24 hours with the required quantity of linseed, the colloidal carbohydrate content of which is then extracted by steam to give a solution which is introduced to the feed tank. The colloid mixes freely with hot or cold water and circulates throughout the system, so that wherever there is any deposition of scale-forming matter the scale crystals become immediately filmed over with colloidal starches, whereby crystalline growth is effectively prevented. The filming action is a mechanical process and will therefore operate irrespective of the chemical composition of the scale-forming matter.

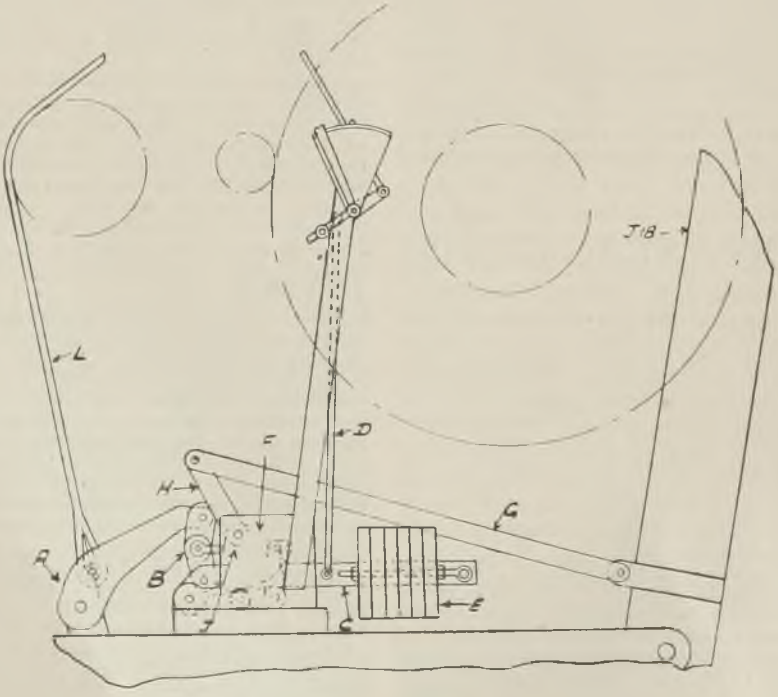
Frederick Parker, Ltd., of Viaduct Works, Catherine Street, Leicester, publish particulars of their all-British multi-bucket excavator. As can be seen in the illustration this is a continuous type of machine analogous in its operation to a dredge and has been designed more particularly for sand and gravel pit excavating and similar work. The cost of winning sand or gravel is stated to



PARKER MULTI-BUCKET EXCAVATOR.

approximate to 2d. per cu. yd., a figure allowing for all normal overhead charges. The machine will dig to a height or depth of 25 ft. and is capable of excavating 25–30 cu. yds. per hour. The power unit is an 8 h.p. Petter airless-injection crude-oil engine. The machine is described as being adaptable for removing overburden and excavating horizontal strata from below the working face when the machine is at the top of the pit. The jib is built up in sections so that the length can be altered readily and additional joints introduced if required. The buckets are carried on a chain which moves round a lattice steel jib and the machine is mounted on rails parallel to the face to run backwards and forwards along the track, giving a series of wide thin cuts.

Thos. Smith and Sons (Rodley), Ltd., of Rodley, Leeds, have perfected a safe-load indicator which is being installed on cranes and like machinery of their manufacture. It is well-known that a number of accidents have been caused by the overloading of travelling cranes, and this device is similar to others which have been lately designed for the purpose of warning the operator when he is



SMITH LOAD INDICATOR.

exceeding the safe limit. The method of operation is indicated by reference to the accompanying drawing. The load on the luffing rope L is transmitted by means of a lever A to the links B. These links are connected to a weighted lever C to which the push-rod D—for the indicator pointer—is pivoted. The weight E is so adjusted that the lever C will rise and move the pointer towards "danger" when the maximum safe load at any radius is being moved. Should an overload be moved, the lever will rise still further, with a corresponding movement of the pointer to "danger," when a whistle or an electric bell will be sounded. In order to compensate for variation in the maximum safe loading with variation in the working radius of the jib, a cam F is connected through an arm H and a coupling-rod G to the jib. This cam operates on one arm of a bell-crank lever, the other arm of which is coupled at J to the links B, the object being to vary the angle of the links B by means of the operating face of the cam F. Any variation in the angle of the links has a cumulative effect on the leverage of the system.

Holman Bros., Ltd., of Camborne, have fitted up a demonstration van which carries what is probably the most comprehensive collection of pneumatic plant ever taken on tour, for there is something to interest all users of compressed air. The compressor that supplies air to operate the various tools and appliances is an 80 cu. ft. "H.S.B." (rotary-piston) type driven by a Morris industrial petrol engine. For mining engineers, quarry managers, and others engaged in rock excavation there is a range of "S.L." Handrils (hand-held hammer drills) and drill sharpening equipment. This consists of a small oil-fired furnace and a Newgrip sharpener. The latter, which is attracting considerable attention wherever it is demonstrated, was designed particularly for those rock-drill users who have only a few steels in commission, but is capable of dealing with all types of bits up to 2¼ in. diameter, as well as the usual shanks on steel up to a maximum of 1¼ in. For hoisting and similar work, there is an air winch—a light, portable device driven by an "H.S.B." air motor. The van is in charge of two competent demonstrators, and arrangements will be made for it to call at any undertaking in this country on application being made to the head office at Camborne, or any branch in Great Britain.

METAL MARKETS

Copper.—Standard values in London experienced a very substantial advance during August in sympathy with the general strength of commodity and stock markets. Electrolytic copper also hardened from 4·40 cents per lb. f.a.s. New York to about 5·75 cents. The rise has been so sharp as to create doubts as to whether it has not been too fast, but of course prices were previously at an absurdly non-economic level. The proposal, as a result of the Ottawa Agreement, that Great Britain shall impose a duty of 2d. per lb. on foreign copper has naturally created great interest as it would profoundly affect the general copper position.

Average price of Cash Standard Copper : August, 1932, £31 9s. 1d. ; July, 1932, £26 2s. 5d. ; August, 1931, £32 12s. 3d. ; July, 1931, £34 9s. 1d.

Tin.—In this market the previous upward trend was carried still further and by the end of August the cash price had risen to around £150, thus drawing within an appreciable distance of the initial release price of the International Tin Pool which is fixed at £165 per ton. Consumers seem at last to be following the rise and considerable American and Continental buying was witnessed late in August. The parties to the restriction agreement seem to have got the position under a fair amount of control now, thanks to the drastic measures taken and even if the statistical situation does not improve as quickly as they anticipate they are likely to continue to give the market support. The August statistics were favourable, reflecting a decline in the total supplies in sight of about 3,000 tons.

Average price of Cash Standard Tin : August, 1932, £142 2s. 4d. ; July, 1932, £125 19s. 5d. ; August, 1931, £114 19s. 1d. ; July, 1931, £111 11s. 1d.

Lead.—Values underwent a marked improvement last month and considerable buying was witnessed on the part of consumers. Stocks remain heavy, but the leading interests seem to have the market under control at present. Output has been very severely curtailed in America and this fact and the general improvement in sentiment over there has resulted in the New York price rising from 2·95 cents to 3·60 cents per lb.

Average mean price of soft foreign lead : August, 1932, £11 9s. 4d. ; July, 1932, £9 19s. 8d. ; August, 1931, £11 19s. 4d. ; July, 1931, £12 16s. 3d.

Spelter.—This market has shared in the general strength of non-ferrous metals, although consuming demand has not yet expanded very markedly. Sentiment, however, has been supported by the steady reduction in the Cartel stocks. For some time past the statistical position of this metal has been regarded as less unfavourable than that of certain others, and it was generally expected that any improvement in commercial conditions would be promptly followed by a rise to higher price-levels ; this advance has now taken place.

Average mean price of spelter : August, 1932, £13 14s. 4d. ; July, 1932, £11 15s. 6d. ; August, 1931, £11 14s. 7d. ; July, 1931, £12 10s. 9d.

Iron and Steel.—In view of the fact that August is a holiday month it was not surprising that demand for British iron and steel should have been subdued during the major part of last month, but towards the close a better enquiry materialized for pig-iron, semis, and finished steel, and it looks as if the usual autumnal seasonal revival of trade is likely to eventuate earlier than usual. A number of engineering contracts have been secured by this country and of course the Admiralty's cruiser orders will help the steel industry. British steelmasters recently reaffirmed their stabilized prices. Continental steel has become distinctly firmer, works there being tired of the low prices at which their material has been selling.

Iron Ore.—Business has been to all intents and purposes at a standstill during August and prices can only be considered nominal at about 14s. 6d. per ton c.i.f. for best Bilbao rubio.

Antimony.—Buying interest in Chinese regulus revived in the early part of August and prices advanced sharply to about £21 15s. c.i.f. for forward shipment. Subsequently, however, quieter conditions prevailed, although values kept up fairly

LONDON DAILY METAL PRICES.

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

	COPPER.				TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD
	STANDARD.		ELECTRO-LYTIC.	BEST SELECTED.				SOFT FOREIGN.	ENGLISH.			
	Cash.	3 Months.			Cash.	3 Months.				Cash.	For-ward.	
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
Aug.	30 8 9	30 11 3	35 0 0	—	142 2 6	143 12 6	13 2 6	10 13 9	12 15 0	18 1/16	19	118 0
11	30 11 3	30 15 9	35 5 0	33 0 0	142 12 6	144 2 6	13 5 0	11 0 0	13 0 0	18 1/4	18 5/16	118 7
15	30 8 9	30 9 4 1/2	35 5 0	—	142 7 6	144 1 3	13 11 3	11 2 6	13 0 0	18 3/8	18 1/4	118 5
16	30 18 9	31 0 7 1/2	35 5 0	33 0 0	143 8 9	145 1 5	13 16 3	11 5 0	13 0 0	18 3/8	18 1/4	118 0
17	31 4 4 1/2	31 5 7 1/2	35 5 0	—	142 16 3	144 6 3	13 17 6	11 12 6	13 10 0	18 1/16	18 5/16	118 7
18	30 18 9	30 18 9	35 0 0	—	140 13 9	142 12 6	13 17 6	11 5 0	13 5 0	17 15/16	18	118 7
19	31 2 6	31 1 10 1/2	35 0 0	33 0 0	142 2 6	143 12 6	14 1 3	11 13 9	13 15 0	18 1/4	18 5/16	118 10
22	31 13 1 1/2	31 11 10 1/2	35 5 0	—	141 13 9	143 6 3	13 17 6	11 13 9	13 15 0	17 15/16	18 1/16	119 1
23	33 8 1/2 9	33 3 1 1/2	36 0 0	34 10 0	143 11 3	145 2 6	14 1 3	11 17 6	13 15 0	18 1/4	18 1/4	118 11
24	34 7 6	33 17 6	37 0 0	—	142 16 3	144 11 3	14 2 6	11 15 0	13 15 0	18 1/16	18 3/16	118 11
25	34 1 3	33 13 9	36 15 0	—	145 17 6	147 6 3	14 2 6	11 17 6	13 15 0	18 5/8	18 1/4	119 1
26	34 5 0	33 18 9	36 17 6	35 5 0	147 17 6	148 17 6	14 2 6	12 0 0	13 15 0	18 1/16	18 3/16	119 0
29	34 16 10 1/2	34 11 10 1/2	37 0 0	—	149 16 3	151 1 3	14 7 6	12 7 6	14 5 0	18 1/2	18 5/8	118 10
30	35 15 7 1/2	35 11 3	37 5 0	36 10 0	149 17 6	150 17 6	14 10 0	13 2 6	15 0 0	18 5/16	18 11/16	118 8
31	35 16 3	35 11 10 1/2	37 15 0	—	148 1 3	149 2 6	15 1 3	13 8 9	15 5 0	18 1/16	18 1/2	118 10
Sept.												
1	35 5 10 1/2	35 5 10 1/2	37 15 0	—	147 17 6	149 2 6	15 0 0	12 17 6	15 0 0	18 1/16	18 1/2	118 11
2	35 14 4 1/2	35 16 10 1/2	38 7 6	37 5 0	153 17 6	155 1 3	15 7 6	13 7 6	15 10 0	18 1/2	18 5/8	118 9
5	37 8 1 1/2	37 9 4 1/2	39 10 0	—	154 17 6	156 7 6	15 18 9	13 16 3	15 15 0	18 5/8	18 3/4	118 4
6	37 18 9	38 1 3	40 7 6	39 5 0	157 7 6	158 17 6	16 5 0	14 0 0	16 0 0	18 11/16	18 11/16	118 6
7	37 15 0	37 15 0	40 5 0	—	157 13 9	159 7 6	16 10 0	14 7 6	16 5 0	18 1/16	18 1/16	118 3
8	38 1 3	38 1 10 1/2	40 5 0	—	157 16 3	159 6 3	16 6 3	14 1 3	16 0 0	18 3/8	18 1/4	117 11
9	35 16 3	35 16 3	39 10 0	37 15 0	155 17 6	157 7 6	15 11 3	13 2 6	15 5 0	18 1/16	18 3/16	118 2

well, the current level being about £21 5s. to £21 10s. c.i.f.

ARSENIC.—Consumption continues limited, but prices are pretty steady at about £24 10s. to £25 f.o.r. mines for 99% Cornish white, Mexican high grade advancing to £23 to £23 10s. c.i.f. on account of the easier tendency of sterling.

BISMUTH.—The official price is steadily maintained at 4s. 6d. per lb. for 5 cwt. lots and over.

CADMIUM.—Prices have again eased slightly, about 1s. 8½d. to 1s. 9d. per lb. being the present value, but at the lower level more demand has been forthcoming.

COBALT.—The official price of metal has been further reduced to 7s. per lb.

COBALT OXIDES.—There has not been a great deal of enquiry recently and prices have eased in sympathy with metal, black being priced at about 4s. to 4s. 2d. per lb., and grey at 4s. 10d. to 5s.

CHROMIUM.—About 2s. 9d. per lb. delivered is named.

TANTALUM.—Only limited quantities are changing hands at the unaltered price of £15 to £20 per lb.

PLATINUM.—Buying interest has remained very much restricted, but prices are steady at about £9 9s. to £9 15s. per oz. for refined metal.

PALLADIUM.—There is nothing much moving, but prices are quotably unchanged at £4 to £4 5s. per oz.

IRIDIUM.—The market remains quiet but steady at about £12 to £14 per oz. for sponge and powder.

OSMIUM.—Quotations are nominally unchanged at £11 10s. to £12 10s. per oz., but demand is slow.

TELLURIUM.—Only trifling quantities change hands, prices being around 20s. per lb.

SELENIUM.—High grade black powder is in steady request at the unaltered quotation of 7s. 8d. to 7s. 9d. per lb. (gold).

MANGANESE ORE.—No developments of interest have been seen in this market recently, buying by consumers remaining on an extremely small scale. Prices are inclined to be nominal at about 9d. to 9½d. per unit c.i.f. for best Indian ore and 8½d. to 9d. c.i.f. for good 48% Indian and minimum 50% washed Caucasian.

ALUMINIUM.—Raw metal has not been in much demand, but a little better demand is reported here for semi-finished material. Prices are without change at £95 less 2% delivered for ingots and bars, and £97 for rolling billets.

SULPHATE OF COPPER.—English material is now quoted at about £18 to £18 10s. f.o.r., less 5%, prices having naturally risen in sympathy with standard copper.

NICKEL.—On exchange account, quotations have been raised to £240 to £245 per ton, but demand is slow.

CHROME ORE.—Business remains at a low ebb, the Rhodesian shipments being a good indicator of the quietness of the market. Prices, however, are without change at 80s. to 85s. per ton c.i.f. for good 48% Rhodesian ore, and 100s. to 110s. c.i.f. for 55 to 57% New Caledonian.

QUICKSILVER.—This has been an irregular market. It is now reported that Italy will remain in the Cartel, and with spot supplies here scarce prices rose at one time to £10 5s. per bottle, net. Subsequently, however, quotations eased to about £9 15s.

TUNGSTEN ORE.—There is practically no change to report, prices being steady at 11s. to 11s. 3d. per unit c.i.f. for forward shipment from China, although actual sales are few and far between.

MOLYBDENUM ORE.—Supplies are very scarce and prices are firm and rather nominal at about 42s. 6d. per unit c.i.f.

GRAPHITE.—Current quotations stand at about £17 to £19 per ton c.i.f. for good 85 to 90% raw Madagascar flake, and £15 to £17 c.i.f. for 90% Ceylon lumps.

SILVER.—In the early part of August the market was quiet but fully steady, spot bars, after being 17¼d. on August 2 advancing slowly. Some brisk Indian buying then developed and on August 15 spot bars stood at 18⅛d. After a temporary reaction sentiment again became rather more bullish and although the market is a sensitive one, prices closed higher at 18 5/16d. on August 31.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
August, 1931	870,822	45,603	916,425
September	872,053	43,971	916,024
October	900,353	44,760	945,113
November	855,102	45,408	900,510
December	877,178	46,175	923,353
January, 1932	890,688	46,096	936,784
February	869,711	44,301	914,012
March	914,017	46,018	960,035
April	901,894	47,902	949,796
May	919,223	46,421	965,644
June	913,297	45,714	959,011
July	933,947	47,213	981,160
August	943,174	48,148	991,322

TRANSVAAL GOLD OUTPUTS.

	July.		August.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	107,500	£159,489	115,000	£168,146
City Deep	85,000	21,899	86,500	22,173
Cons. Main Reef	74,000	24,210	73,000	24,303
Crown Mines	284,000	88,064	285,000	89,408
Daggafontein	42,000	£67,715	44,000	£71,293
D'rb'n Roodepoort Deep	50,000	15,630	50,000	15,826
East Geduld	60,000	19,283	61,600	20,022
East Rand P.M.	161,500	42,522	161,500	42,607
Geduld	86,500	27,892	86,800	27,676
Geldenhuis Deep	77,000	17,164	78,100	17,627
Glynn's Lydenburg	7,200	2,555	7,100	2,525
Government G.M. Areas	207,000	£406,036	212,000	£420,404
Kleinfontein	53,800	10,953	54,000	10,984
Langlaagte Estate	82,000	£108,996	82,000	£109,674
Luipaard's Vlei	34,600	8,689	34,700	8,673
Meyer and Charlton	12,600	£18,199	—	—
Modderfontein New	171,000	64,144	175,000	64,223
Modderfontein B	77,500	21,805	77,500	21,960
Modderfontein Deep	44,400	21,507	46,100	22,321
Modderfontein East	74,500	21,721	77,500	22,605
New State Areas	88,000	£180,453	92,000	£187,770
Nourse	72,000	21,201	72,000	21,511
Randfontein	249,000	£300,276	250,000	£302,205
Robinson Deep	100,000	28,502	100,000	28,629
Rose Deep	64,500	13,150	65,700	13,302
Simmer and Jack	82,100	21,857	79,900	22,164
Springs	76,200	£164,738	81,000	£169,053
Sub Nigel	37,000	33,022	37,200	33,232
Transvaal G.M. Estates	19,100	5,637	19,100	5,744
Van Ryn	51,000	£46,508	51,500	£46,707
Van Ryn Deep	71,000	£92,153	74,000	£94,127
West Rand Consolidated	96,500	£106,372	96,500	£108,331
West Springs	77,100	£79,159	81,500	£82,310
Witw'tersr'nd (Knights)	69,000	£56,034	70,000	£56,143
Witwatersrand Deep	49,000	14,939	49,900	15,888

Values in S.A. currency.

COST AND PROFIT ON THE RAND, Etc.

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

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
May, 1931	2,751,400	27 10	19 6	8 4	1,149,105
June	2,698,100	28 0	19 7	8 5	1,140,399
July	2,771,400	27 10	19 6	8 4	1,155,466
August	2,799,800	27 10	19 5	8 5	1,159,382
September	2,765,400	27 10	19 5	8 5	1,162,355
October	2,870,800	27 8	19 3	8 5	1,210,743
November	2,726,720	27 10	19 5	8 5	1,144,208
December	2,793,900	27 10	19 5	8 5	1,173,732
January, 1932	2,880,500	27 5	19 4	8 1	1,163,434
February	2,775,400	27 8	19 6	8 2	1,133,212
March	2,901,300	27 10	19 7	8 3	1,200,278
April	2,883,500	27 9	19 5	8 4	1,196,011
May	2,964,100	27 6	19 2	8 4	1,228,198
June	2,927,200	27 9	19 3	8 6	1,241,392
July	—	—	—	—	1,260,744

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
August 31, 1931	209,409	13,563	1,705	224,677
September 30	209,424	13,276	1,626	224,326
October 31	208,987	13,061	1,517	223,565
November 30	209,270	12,882	1,429	223,581
December 31	211,552	12,260	1,402	225,214
January 31, 1932	215,752	12,394	1,598	229,744
February 29	216,171	12,177	1,363	229,711
March 31	214,024	12,009	—	226,033
April 30	214,334	11,943	—	226,277
May 31	215,926	11,972	—	227,898
June 30	217,077	11,833	—	228,910
July 31	217,525	12,056	—	229,581
August 31	217,658	11,727	—	229,385

PRODUCTION OF GOLD IN RHODESIA.

	1929	1930	1931	1932
	oz.	oz.	oz.	oz.
January	46,231	46,121	45,677	42,706
February	44,551	43,385	42,818	45,032
March	47,388	45,511	42,278	47,239
April	48,210	45,806	43,776	46,487
May	48,189	47,645	43,731	46,854
June	48,406	45,208	44,118	48,441
July	46,369	45,810	44,765	47,331
August	46,473	46,152	43,292	—
September	45,025	46,151	42,846	—
October	46,923	45,006	44,260	—
November	46,219	44,351	44,516	—
December	46,829	46,485	50,034	—

RHODESIAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	25,200	9,648	25,200	9,622
Globe and Phœnix	6,222	6,281	6,208	6,376
Lonely Reef	8,500	2,443	8,600	2,328
Luiri Gold	—	—	—	—
Rezende	6,500	2,551	6,500	2,553
Sherwood Star	4,800	£8,367	4,800	£7,907
Wanderer Consolidated	15,600	3,231	15,300	3,400

WEST AFRICAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	5,273	£15,549	6,150	£17,085
Ashanti Goldfields	13,430	14,605	13,430	14,629
Taquah and Abosso	10,528	3,479	10,100	3,312

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland
	Oz.	Oz.	Oz.
August, 1931	52,501	3,020	610
September	38,173	—	638
October	52,741	7,838*	1,031
November	53,869	4,758	1,428
December	49,215	4,700	1,224
January, 1932	44,037	—	916
February	44,672	—	981
March	47,108	9,735†	769
April	48,936	3,912	1,216
May	53,928	2,782	692
June	50,079	—	920
July	53,585	—	—
August	51,536	—	—

* Sept. and Oct. † Jan., Feb., and March.

AUSTRALASIAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,067	6,324	5,377	5,944
Blackwater (N.Z.)	3,582	11,523	3,602	2,126
Boulder Persev'ce (W.A.)	7,266	14,814	8,359	14,531
Grt. Boulder Pro. (W.A.)	7,662	20,846	7,400	23,990
Lake View & Star (W.A.)	30,007	38,143	—	—
Sons of Gwalia (W.A.)	13,088	15,554	12,692	16,464
South Kalgurli (W.A.)	9,751	16,186	9,628	17,157
Waihi (N.Z.)	18,981	6,110* / 40,028†	18,864	6,602* / 37,688†
Wiluna	28,433	48,965	—	—

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	July.		August.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	—	1,485	—	1,749
Champion Reef	9,350	5,575	9,360	5,628
Mysore	14,420	7,562	14,650	7,390
Nundydroog	14,970	9,329*	13,967	9,470†
Ooregum	11,750	4,352	11,750	4,199

*1,939 oz. from 1,870 tons Balaghat ore. †2,070 oz. from 1,661 tons Balaghat ore.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	July.		August.	
	Tons	Value £	Tons	Value £
Bulolo Gold	—	—	—	—
Chosen Corp. (Korea)	10,400	16,197	10,200	14,033
Frontino Gold (C'lbia)	3,890	19,219	3,750	15,821
Fresnillo	79,036	7,598*d‡*	—	—
New Goldfields of Venezuela	7,886	2,228*	8,589	2,727*
Oriental Cons. (Korea)	—	69,744*d*	—	70,056*d*
St. John del Rey (Brazil)	—	42,500	—	44,000
Santa Gertrudis (Mexico)	24,471	37,634*d*	—	—
Viborita	—	1,564	—	—
West Mexican Mines	1,270	20,000*d*	—	—

d Dollars. * Oz. gold. ‡ Loss.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

January, 1932	3,014	July, 1932	1,437
February	2,132	August	1,164
March	3,064	September	—
April	3,333	October	—
May	2,276	November	—
June	2,491	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	June.	July.	August.
Ayer Hitam	38½	—	—
Batu Caves	—	—	—
Changkat	—	—	—
Gopeng	27	—	—
Hongkong Tin	35½	—	—
Idris Hydraulic	13½	—	—
Ipoh	34¾	—	—
Kampar Malaya	—	—	—
Kampong Lanjut	42	35	25
Kamunting	117	—	—
Kent (F.M.S.)	—	—	—
Killinghall	46	32¼	33½
Kinta	12½	—	—
Kinta Kellas	—	—	—
Kramat Tin	60	70	75
Kuala Kampar	42	—	—
Kundang	—	—	—
Labat	14½	11½	—
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	71½	59½	48
Malim Nawar	22	20	28
Pahang	105	78	78
Penawat	42½	—	—
Pengkalen	25	—	—
Petaling	100	—	—
Rahman	25	25	—
Rambutan	4½	—	—
Rantau	—	—	—
Rawang	38	30	30
Rawang Concessions	21	35	60
Renong	20¾	—	—
Selayang	9½	—	—
Southern Kampar	60	—	—
Southern Malayan	70	59½	46
Southern Perak	25½	38¼	—
Southern Tronoh	19½	—	—
Sungei Besi	27	—	—
Sungei Kinta	32½	—	—
Sungei Way	41½	—	—
Taiping	—	—	—
Tanjong	12½	—	—
Tekka	18	—	—
Tekka Taiping	24½	—	—
Temoh	—	—	—
Tronoh	43½	—	—
Ulu Klang	—	—	—

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	June.	July.	August.
Anglo-Nigerian	15½	12½	12⅝
Associated Tin Mines	145¾	108	108¾
Baba River	—	—	—
Batura Monguna	1	—	—
Bisichi	25	—	—
Daffo	—	—	—
Ex-Lands	32	23	—
Filani	—	—	—
Jantar	10	10	10
Jos	10½	7¾	—
Juga Valley	8	5	5
Kaduna Syndicate	13	13	—
Kaduna Prospectors	6	7	—
Kassa	7	8	8
London Tin	102	75	77
Lower Bisichi	¾	8½	—
Naraguta Extended	—	—	—
Nigerian Consolidated	7	5	5
Offin River	—	—	—
Ribon Valley	18	10	10
Tin Fields	—	—	—
United Tin Areas	17	11	12
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	June.	July.	August.
Anglo-Burma (Burma)	25¾	43½	48
Aramayo Mines (Bolivia)	84	119	—
Bangrin (Siam)	61¼	—	38¾
Beralt	26½*	26½*	—
Consolidated Tin Mines (Burma)	83	120	150
East Pool (Cornwall)	48½	46¾	—
Fabulosa (Bolivia)	41†	—	—
Kagera (Uganda)	25	25	—
Kamra	—	—	—
Malaysiam Tin	13	13½	14½
Mawchi	208*	193*	—
Patino	—	—	—
Pattani	—	—	—
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	79	—	152½
South Crofty	52¾	52	55½
Tavoy Tin (Burma)	91	73	97¾
Tongkah Harbour (Siam)	30	30	40
Toyo (Japan)	70	72	75
Zaaiplaats	15½	—	—

* Tin and Wolfram. † Tons fine tin.

COPPER, LEAD, AND ZINC OUTPUTS.

		July.	August.
Britannia Lead	Tons refined lead	4,249	4,058
	Oz. refined silver	280,728	82,002
Broken Hill South	Tons lead conc.	7,492	5,044
	Tons zinc conc.	8,059	5,573
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	463,542	475,032
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	370	380
Messina	Tons copper	883	739
Mount Isa	Tons lead bullion	3,455	3,771
Mount Lyell	Tons concentrates	2,81–†	3,305*
North Broken Hill	Tons lead conc.	5,760	4,980
	Tons zinc conc.	5,440	4,800
Rhodesia Broken Hill	Tons V_2O_5	30	32½
	Tons V_2O_5 conc.	100	100
Roan Antelope	Tons concentrates	—	—
	Tons blister copper	2,178	2,166
Sulphide Corporation	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Trepca	Tons lead conc.	4,984	4,892
	Tons zinc conc.	6,691	7,323
Villemagne	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Zinc Corporation	Tons lead conc.	8,204	—
	Tons zinc conc.	6,185	—

* To August 10. † To July 13.

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

		June.	July.
Iron Ore	Tons	164,617	134,162
Manganese Ore	Tons	11,891	5,162
Iron and Steel	Tons	126,079	118,740
Copper and Iron Pyrites	Tons	23,284	13,564
Copper Ore, Matte, and Prec.	Tons	2,056	805
Copper Metal	Tons	10,598	10,402
Tin Concentrate	Tons	5,294	2,260
Tin Metal	Tons	100	170
Lead Pig and Sheet	Tons	24,765	17,118
Zinc (Spelter)	Tons	6,287	6,360
Zinc Sheets, etc.	Tons	1,367	1,743
Zinc Oxide	Tons	11	11
Zinc Ore	Tons	7,638	15,800
Aluminium	Tons	554	177
Mercury	Lb.	87,085	95,553
White Lead	Cwt.	3,479	4,703
Barytes, ground	Cwt.	21,000	24,874
Asbestos	Tons	1,725	1,334
Boron Minerals	Tons	1,117	814
Borax	Cwt.	10,107	11,400
Basic Slag	Tons	100	1,054
Superphosphates	Tons	1,140	1,345
Phosphate of Lime	Tons	10,478	46,971
Mica	Tons	194	112
Tungsten Ores	Tons	474	308
Sulphur	Tons	5,264	3,067
Nitrate of Soda	Cwt.	8	7
Potash Salts	Cwt.	51,277	294,411
Petroleum : Crude	Gallons	34,046,642	43,857,257
Lamp Oil	Gallons	14,218,997	9,293,690
Motor Spirit	Gallons	99,200,744	83,839,798
Lubricating Oil	Gallons	7,254,847	5,691,640
Gas Oil	Gallons	11,593,696	4,281,893
Fuel Oil	Gallons	48,843,402	43,030,277
Asphalt and Bitumen	Tons	14,124	9,817
Paraffin Wax	Cwt.	62,029	58,715

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	June.	July.	August
Anglo-Ecuadorian	16,608	16,926	16,226
Apex Trinidad	47,140	51,260	48,230
Attock	2,056	1,998	1,543
British Burmah	3,767	3,875	3,798
British Controlled	40,318	42,263	—
Kern Mex	980	830	853
Kern River (Cal.)	1,999	2,067	2,518
Kern Romana	164	76	93
Kern Trinidad	1,863	1,766	1,703
Lobitos	24,134	25,260	25,013
Phœnix	65,286	80,434	97,900
St. Helen's Petroleum	4,675	4,903	4,770
Steaua Romana	84,604	98,968	—
Tampico	2,596	2,294	2,391
Tocuyo	1,056	1,253	1,161
Trinidad Leaseholds	28,950	28,600	27,600

QUOTATIONS OF OIL COMPANIES' SHARES

Denomination of Shares £1 unless otherwise noted

	Aug. 10, 1932			Sept. 9, 1932.		
	£	s.	d	£	s.	d
Anglo-Ecuadorian		9	3		11	3
Anglo-Egyptian B.	1	7	6	1	13	0
Anglo-Persian 1st Pref.	1	8	0	1	8	0
,, Ord.	2	2	6	2	5	0
Apex Trinidad (5s.)		13	3		16	0
Attock		10	0		12	6
British Burmah (8s.)		3	9		5	0
British Controlled ($5)		1	6		2	6
Burmah Oil	2	18	0	3	3	9
Kern River Cal. (10s.)		2	0		3	0
Lobitos, Peru	1	15	0	2	3	9
Mexican Eagle, Ord. (4 pesos)		6	3		8	6
,, 8% Pref. (4 pesos)		6	0		8	3
Phœnix, Roumanian		8	0		10	9
Royal Dutch (100 fl.)	17	12	6	19	15	0
Shell Transport, Ord	2	5	0	2	10	9
,, 5% Pref (£10)	11	0	0	11	2	6
Steaua Romana		7	6		10	0
Trinidad Leaseholds	1	9	3	1	16	9
United British of Trinidad (6s. 8d.)		3	0		4	3
V.O.C. Holding	1	8	0	1	13	9

PRICES OF CHEMICALS. Sept. 12.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		19	9
,, 80%	,,	1	16	5
,, Glacial	per ton	59	0	0
Alum	,,	8	7	6
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.		1	0
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate, comml.	,,	40	0	0
,, Sulphate, 20·6% N.	,,	5	5	0
Antimony, Tartar Emetic, 43·44%	per lb.			10
,, Sulphide, golden	,,			9
Arsenic, White (foreign)	per ton	24	0	0
Barium, Carbonate (native), 94%	,,	4	10	0
,, Chloride	,,	10	10	0
Barytes	,,	8	5	0
Benzol, standard motor	per gal.		1	4
Bleaching Powder, 35% Cl.	per ton	8	15	0
Borax	,,	16	10	0
Boric Acid	,,	26	10	0
Calcium Chloride, solid, 70/75%	,,	5	15	0
Carbolic Acid, crude 60's	per gal.		1	7
,, ,, crystallized, 40°	per lb.			6
Carbon Disulphide	per ton	30	0	0
Citric Acid	per lb.			10½
Copper Sulphate	per ton	17	0	0
Creosote Oil (f.o.b. in Bulk)	per gal.			4½
Cresylic Acid, 98–100%	,,		1	4
Hydrofluoric Acid, 59/60%	per lb			6
Iodine	per lb.	1	0	11
Iron, Nitrate 80° Tw.	per ton	6	0	0
,, Sulphate	,,	1	15	0
Lead, Acetate, white	,,	31	10	0
,, Nitrate (ton lots)	,,	27	10	0
,, Oxide, Litharge	,,	28	10	0
,, White	,,	38	10	0
Lime, Acetate, brown	,,	8	10	0
,, ,, grey, 80%	,,	11	0	0
Magnesite, Calcined	,,	8	5	0
Magnesium Chloride	,,	5	10	0
,, Sulphate, comml.	,,	4	10	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	0
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	2	5	6
Phosphoric Acid. (Conc. 1 750)	per lb.			10
Pine Oil	per cwt.	2	7	6
Potassium Bichromate	per lb			5
,, Carbonate, 96/98%	per ton	29	10	0
,, Chlorate	per lb.			4
,, Chloride 80%	per ton	12	10	0
,, Ethyl Xanthate	per 100 kilos	7	0	0
,, Hydrate (Caustic) 88/90%	per ton	39	0	0
,, Nitrate	,,	30	0	0
,, Permanganate	per lb.			8½
,, Prussiate, Yellow	,,			8
,, ,, Red	,,		2	0
,, Sulphate, 90%	per ton	12	10	0
Sodium Acetate	,,	19	10	0
,, Arsenate, 45%	,,	23	0	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			4
,, Carbonate (Soda Ash) 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	,,	28	10	0
,, Cyanide 100% NaCN basis	per lb			8
,, Ethyl Xanthate	per 100 kilos	6	12	6
,, Hydrate, 76%	per ton	14	0	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (ordinary)	,,	8	8	0
,, Phosphate, comml.	,,	12	0	0
,, Prussiate	per lb.			5
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	2	15	0
,, ,, (Salt-Cake)	,,	3	1	0
,, Sulphide Conc., 60/65%	,,	10	15	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	10	10	0
,, Roll	,,	10	0	0
Sulphuric Acid, 168° Tw.	,,	4	5	0
,, ,, free from Arsenic, 140° Tw.	,,	3	0	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	0	0
Tartaric Acid	per lb.			10½
Turpentine	per ton	63	0	0
Tin Crystals	per lb.		1	0
Titanous Chloride	,,			10½
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	,,	20	0	0
Zinc Oxide (White Seal)	,,	35	0	0
Zinc Sulphate	,,	8	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

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

COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	3 3	4 9
Esperanza Copper	13 9	13 9
Indian (2s.)	1 3	1 6
Loangwa (5s.), Rhodesia	1 9	2 0
Messina (5s.), Transvaal	5 0	7 6
Mount Lyell, Tasmania	16 6	19 0
Namaqua (£2), Cape Province	3 6	3 6
Rhodesia-Katanga	10 0	12 6
Rio Tinto (£5), Spain	16 5 0	20 0 0
Roan Antelope (5s.), Rhodesia	8 3	11 6
Tanganyika Con.	1 0 6	1 2 6
Tharsis (£2), Spain	3 2 6	3 11 3

LEAD-ZINC:	Aug. 10, 1932. £ s. d.	Sept. 9, 1932. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	7 6	7 6
Broken Hill Proprietary, N.S.W.	14 6	16 9
Broken Hill, North, N.S.W.	2 12 6	3 0 0
Broken Hill South, N.S.W.	1 16 3	2 2 6
Burma Corporation (10 rupees)	9 6	11 6
Electrolytic Zinc Pref., Tasmania	18 9	18 9
Mount Isa, Queensland	8 9	13 6
Rhodesia Broken Hill (5s.)	1 1	1 9
San Francisco (10s.), Mexico	7 3	11 0
Sulphide Corporation (15s.), N.S.W.	7 9	8 9
ditto, Pref.	9 6	12 0
Zinc Corporation (10s.), N.S.W.	1 1 3	1 3 9
ditto, Pref.	2 16 3	3 7 6

TIN:		
Aramayo Mines (25 fr.), Bolivia	12 6	17 6
Associated Tin (5s.), Nigeria	4 9	6 0
Ayer Hitam (5s.)	12 0	13 0
Bangrin, Siam	9 0	16 3
Bisichi (10s.), Nigeria	6 0	6 3
Chenderiang, Malay	9	9
Consolidated Tin Mines of Burma	2 3	5 0
East Pool (5s.), Cornwall	6	1 0
Ex-Lands Nigeria (2s.), Nigeria	1 3	1 9
Geevor (10s.), Cornwall	1 6	4 0
Gopeng, Malaya	1 12 6	1 12 6
Hongkong (5s.)	13 3	14 0
Idris (5s.), Malaya	5 6	7 0
Ipoh Dredging (16s.), Malay	12 6	16 3
Kaduna Prospectors (5s.), Nigeria	3 9	3 9
Kaduna Syndicate (5s.), Nigeria	10 0	12 6
Kamunting (5s.), Malay	4 6	6 9
Kepong, Malay	5 0	7 6
Kinta, Malay (5s.)	5 3	6 3
Kinta Kellas, Malay (5s.)	5 0	5 3
Kramat Pulai, Malay	19 6	19 3
Kramat Tin	—	1 10 0
Lahat, Malay	3 0	3 0
Malayan Tin Dredging (5s.)	17 3	1 0 0
Naraguta, Nigeria	7 6	8 9
Nigerian Base Metals (5s.)	6	6
Pahang Consolidated (5s.), Malay	4 9	6 6
Penawat ($1), Malay	9	1 6
Pengkalen (5s.), Malay	9 6	10 0
Petaling (2s. 4d.), Malay	9 6	10 6
Rambutan, Malay	5 0	5 0
Renong Dredging, Malay	12 6	16 3
Siamese Tin (5s.), Siam	8 6	9 6
South Crofty (5s.), Cornwall	2 3	3 0
Southern Malayan (5s.)	10 0	11 3
Southern Perak, Malay	1 5 0	1 5 0
Southern Tronoh (5s.), Malay	5 6	6 0
Sungei Besi (5s.), Malay	7 0	8 0
Sungei Kinta, Malay	10 3	13 0
Tanjong (5s.), Malay	5 6	7 0
Tavoy (4s.), Burma	5 6	5 9
Tekka, Malay	11 3	12 6
Tekka Taiping, Malay	10 0	13 0
Toyo (10s.), Japan	1 0	2 6
Tronoh (5s.), Malay	14 6	16 3

DIAMONDS:		
Consol. African Selection Trust (5s.)	7 0	11 3
Consolidated of S.W.A. (10s.)	2 9	5 0
De Beers Deferred (£2 10s.)	3 12 6	5 2 6
Jagersfontein	1 1 3	1 8 9
Premier Preferred (5s.)	1 0 0	1 12 6

FINANCE, ETC.:		
Anglo-American Corporation (10s.)	8 9	12 6
Anglo-French Exploration	10 6	16 6
Anglo-Continental (10s.)	2 9	4 3
Anglo-Oriental (Ord., 5s.)	6 6	6 6
ditto, Pref.	9 6	11 0
British South Africa (15s.)	19 9	1 1 3
Central Mining (£8)	10 15 0	12 0 0
Consolidated Gold Fields	1 5 9	1 12 6
Consolidated Mines Selection (10s.)	7 6	11 3
Fanti Consols (8s.)	6 6	7 6
General Mining and Finance	1 0 6	1 8 6
Gold Fields Rhodesian (10s.)	3 0	4 6
Johannesburg Consolidated	1 6 6	1 13 3
London Tin Corporation (10s.)	11 3	12 3
Minerals Separation	2 10 0	3 7 6
National Mining (8s.)	3	3
Rand Mines (5s.)	3 13 9	4 1 3
Rand Selection (5s.)	9 0	12 3
Rhodesian Anglo-American (10s.)	10 6	13 6
Rhokana Corp.	3 18 9	5 7 6
Rhodesian Selection Trust (5s.)	4 9	6 6
South Rhodesia Base Metals	2 0	2 6
Tigon (5s.)	2 6	2 3
Union Corporation (12s. 6d.)	2 11 3	3 2 6
Venture Trust (10s.)	5 0	5 9

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, 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.

RESIDUAL GOLD AFTER CYANIDATION

A description of research carried out by the metallurgical staff of the Central Mining group on the location and constitution of residual gold after cyanidation is described by J. R. Thurlow in the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for June. Full extracts from this paper are given here, the author opening by a consideration of the importance of the genesis of the gold to the metallurgist. He says that much has been written about the origin of the gold in the Witwatersrand "banket" ore, the two most important speculations advanced being the "placer theory" and the "infiltration theory." The interest of the metallurgist in its origin and subsequent modifications in situ lies in the manner of the final distribution of the gold in the rock sent to the mills. Any evidence or information regarding its deposition in situ is of importance, inasmuch as it may indicate a line of research leading to the best method for its most economical recovery.

The important constituents of the "banket" are gold, pyrite and quartz, the last forming the predominating bulk of the deposit and the pyrite approximately three per cent. While there are sufficient geological data available to justify the conclusion that the origin of the gold has a bearing on its association with the pyrite and quartz, and observed phenomena definitely establishes metasomatic activities, evidence is still required as to the processes involved and their chronological sequences.

While there may be an inadequacy of information concerning the association of gold with the other components of the rock in situ, much is known regarding the distribution of the gold in the ore constituents of the various products of the reduction works circuit. For example, Wartenweiler has ably demonstrated the association of gold and pyrite in milling circuits, a summary of this work appearing in the issue of the MAGAZINE for September, 1921. This consortment, however, is not necessarily due to any intimate physical connexion between the gold and pyrite other than the accidental alliance due to the relatively high specific gravity of each and the use of water classification. Graham and Wartenweiler have shown that, in crushing coarsely, a certain proportion of the gold content of the ore is freed from the matrix without being subjected to comminution. They also demonstrated the necessity for fine grinding of the free gold particle for maximum extraction by cyaniding per unit of time.

Intimate knowledge of the association between the gold, pyrite and quartz in the ore to be treated is not, however, of such great importance as the knowledge of the manner in which the gold is associated in the residue after complete treatment. A study of the results on record can be summarized by the simple statement that additional gold can only be recovered by decreasing the amount normally locked up in the residue. It is probable, of course, that the proportion in which the gold is encased in the pyrite and quartz in the residue would indicate approximately the distribution of the gold in the ore before treatment.

In view of the ever-present urge to explore the ways and means whereby an improved economic recovery from the ore might be obtained, the present research work has been carried out. A factor of prime importance was to determine whether the bulk of the residual gold was associated with the pyrite or the quartz, and thus to elucidate whether selective grinding of one or the other or whether bulk grinding of both together would give the most economic improvement in total extraction. The crux of the matter was to discover the form in which the gold existed, which, if accomplished, would throw light on the reason of its presence in the residues after complete treatment.

In reduction plants treating sand and slime separately the scope for improved gold extraction lies most frequently in an attack on the sand. For example, at Modderfontein B plant, where, in 1930, 61·6% of the ore milled was treated as slime, the sand residue averaged 0·446 dwt. per ton, whereas the slime residue averaged only 0·200 dwt. per ton. The combined residue was 0·294 dwt. per ton. For the foregoing reason, and the fact that the sand normally carries the heavier portion of the pyrite, this research work was carried out on sand residues from several mines of the Central Mining–Rand Mines Group. For the purpose of this paper, the author quotes results obtained from sand residues from Modderfontein B and the New Modderfontein "South" plant.

The preliminary line of attack to disclose the location of the residual gold after cyaniding was to grade a representative sand residue into four sized products, namely, + 48, — 48 + 100, — 100 + 200 and — 200. In the case of Modderfontein B the + 48, amounting to only 0·7% by weight, and the — 40 + 100 products were combined owing to an insufficient quantity of the former. Each resulting product was assayed and then subjected to an intensive cyanide treatment. It was assumed that the latter treatment would dissolve all accessible gold and leave only completely encased gold, whether enclosed in pyrite or quartz.

After cyanide treatment, portions of the washed residues were assayed and the remainder were treated with aqua regia and then washed and assayed. It was considered that the aqua regia would expose and dissolve the gold encased in pyrite, and that the residual gold would represent that enclosed in the quartz.

The results obtained indicated that intensive cyanide treatment reduced the Modderfontein B and

New Modderfontein residues from 0·465 dwt. and 0·705 dwt. per ton to 0·295 dwt. and 0·430 dwt. per ton respectively. The latter amounts are presumed to be entirely encased in pyrite and quartz. The aqua regia tests indicated that of this encased gold, 89·5% at Modderfontein B and 77·2% at New Modderfontein was encased in the pyrite. In each case the pyrite content by weight is only 1·949% and 1·952% of the original residues. If it were feasible to grind only all of the + 200 pyrite to — 200, then it may be deduced that the assay value of the residual pyrite at Modderfontein B would be reduced from 13·55 dwt. per ton to 5·9 dwt. per ton, and at New Modderfontein from 17·01 dwt. to 6·3 dwt. per ton. By deduction the sand residues would, under such circumstances, be reduced from 0·295 dwt. to 0·145 dwt. per ton at Modderfontein B and from 0·430 dwt. to 0·219 dwt. per ton at New Modderfontein "South." Thus a theoretical recovery of 47·5% at Modderfontein B and 49·0% at New Modderfontein of the gold remaining in the cyanide-treated sand residue is indicated, provided that the + 200 pyrite, amounting to 0·89% and 1·10% by weight of the total residue, could be ground to — 200. It appears also, by similar deduction, that if in each case the whole of the sand residue was reground to — 200, the respective residues would become 0·125 dwt. and 0·133 dwt. per ton. Thus bulk grinding as compared with selective grinding would, at Modderfontein B, give an additional extraction of only 0·02 dwt. per ton (0·145 — 0·125) and at New Modderfontein an additional extraction of 0·086 dwt. per ton of sand.

The fact that the gold content per ton of pyrite in the various grades diminishes as the pyrite becomes finer is further evidence that gold is encased in pyrite. With further grinding of the pyrite, the gold is freed and removed by cyanide treatment, leaving that grade of pyrite in the finest state of division the most impoverished. It is interesting to note that in both cases the gold encased in the — 200 quartz is negligible.

On completion of the preliminary tests, which seemed to confirm the accuracy of oft-stated opinions suggesting closer association between the gold and the pyrite, other tests were carried out to obtain further elucidation of this interesting problem. In one test some of the — 200 portion of the residue from the New Modderfontein "South" Plant was heated in a combustion tube in a current of hydrogen, the temperature being about 1,000° C., in an endeavour to decompose the pyrite in a reducing atmosphere. Sulphuretted hydrogen was evolved copiously, but when the combustion tube was emptied, it was noticed that the pyrite was not all decomposed. In consequence the sample was roasted to complete the decomposition. It was then treated with hydrochloric acid and the insoluble residue given an intensive cyanide treatment. The residue was washed and assayed. In a second test another portion of the — 200 product was roasted direct, treated with hydrochloric acid and then given the same treatment as in the preceding test.

In both tests the gold content was reduced from 1·0 dwt. to 0·05 dwt., indicating that only 0·05 dwt. of the gold per ton of — 200 residue was encased in quartz. The breaking up of the pyrite rendered the gold encased therein amenable to attack by solvents.

The investigation was carried further by dressing a large quantity of Modderfontein B sand residue on a reciprocating table and collecting the pyritic product therefrom. This product assayed 4·6 dwt. per ton and 51·5% FeS_2. On being exhaustively treated with cyanide, the value was reduced to 4·0 dwt. per ton. After grinding the product wet to — 200 mesh and then subjecting it to intensive cyanide treatment, the washed residue was reduced to 1·0 dwt. per ton. These tests indicated that in sand residues the bulk of the gold is encased in pyrite, but it is nevertheless possible that free gold was present in the sample in a rusty form insoluble in cyanide solution, but which, on regrinding and consequent cleaning, became readily soluble. However, careful reconcentration and microscopic examination entirely failed to show the presence of any rusty gold.

An attempt was then made to isolate the gold in this pyritic product for microscopic examination. Solution of the pyrite in nitric acid did not render the gold mechanically recoverable. This was to be expected owing to probable chemical action on the gold by the powerful combination of oxides of nitrogen, free nitric acid and sulphuric acid, formed by oxidation of the pyrite.

The method finally adopted for separating the gold from the pyrite was as follows :—The sample is roasted at a low temperature and then treated with a strong solution of stannous chloride in hydrochloric acid ; heat is generated and the iron-oxide is converted to ferrous chloride, which does not dissolve gold. Stannous chloride crystals are added as necessary to prevent the formation of any ferric chloride. The action is complete in a few minutes and the residue, after washing with a little warm strong hydrochloric acid and subsequently with water, consists of clean quartz and the liberated gold, which can be separated by panning.

The gold thus separated was found, on microscopic examination, to exist principally as minute crystals of gold, but a few gold particles had an open lace-like structure, which had possibly formed a skeleton on which the pyrite had deposited and so concealed the gold. It is possible, however, that this lace-like structure was caused by decrepitation, freeing and annealing of the gold by the roasting, which would decompose any sulphide of gold or double sulphide of gold and iron. Sufficient nuggety gold was seen to justify the deduction that the precious metal content of the sulphides exists simply as normal but minute metallic grains, and that the sulphides must be very finely crushed to expose the gold to the action of solvents.

In summarizing the evidence, it would appear that the quartz grains in sand residues encase a very small amount of the total undissolved gold. The highest assay for the + 100 silica is 0·12 dwt. per ton and for the — 200 portion the assay is 0·01 dwt. per ton. With the pyrite, however, the case is very different, and the data submitted indicate a gold content descending from 131·6 dwt. per ton in the + 48 pyrite to 5·87 dwt. per ton in the — 200 product.

These tests lead one to the conclusion that if improved recovery is to be obtained from sand, it is unnecessary finally to grind the whole bulk of the residue, provided it is feasible to remove the mineralized portion and subject that only to intensive grinding.

Selective grinding of the pyritic-gold portion of the "banket" ore has been advocated by Wartenweiler, Johnson, and Willey and Ewing, and attention has been drawn to the benefit

obtained when applying selective grinding on account of the accidental consortment of free gold and pyrite due to the system of water classification in general use on the Rand. In the Central Mining-Rand Group selective grinding, through the agency of the Johnson concentrators, has been adopted beneficially on three reduction plants.

Selective grinding has also been achieved at several others of the mines of the Central Mining-Rand Mines Group by the adoption of multiple stage classification and closed circuit stage grinding. In this way one or more tube-mills are set aside to grind a mixture of relatively fine quartz and pyrite. Thus the coarse quartz is confined to the primary tube-mills and is not present in the secondary grinding mills to hinder the effective grinding of the finer mixture of quartz and pyrite. It appears to the author that when operating a regrinding mill in closed circuit with a classifier, the effect of the grinding on the particles of quartz and pyrite is such that a selective concentration of the pyrite, greater than indicated theoretically, takes place in the classifier, resulting in a relatively high pyritic product circulating through the tube-mill continuously. This is illustrated in the flow-sheet of Modderfontein East, where stage grinding, through the agency of two 20-ft. bowl classifiers was adopted in March, 1930. Here although the original feed carried only 2·37% FeS_2, the raked product from the bowl averages 5·23% FeS_2 and that from the straight Dorr classifiers in closed circuit with the regrinding mills averages 11·50% FeS_2. At Modderfontein East, the nine months following the adoption of stage grinding gave a total residue of 0·361 dwt. per ton compared with 0·448 dwt. for the corresponding nine months of the previous year. However, this benefit must be largely due to the fact that during these two periods the percentage of −200 in the final pulp improved from 69·1% to 77·5%.

At the Durban Roodepoort Deep in September, 1930, one of the six tube-mills was converted into a regrinder, leaving only five to operate as primary tube-mills. The sand, normally passing to the sand collectors, is now reclassified in a hydraulic V-shaped box, the underflow constituting the original feed to the regrinding mill. The outflow from the regrinder, after passing over corduroy, is pumped to a hydraulic cone in closed circuit with the mill, the underflow returning thereto. The overflow from the cone gravitates to the bowl classifier to be reseparated into sand and slime. In view of the fact that the bowl classifier was brought into commission only six months before the adoption of regrinding, a comparison can only be made between the results from those six months and the half year immediately following the adoption of regrinding. Such a comparison shows that, on account of increased tonnage milled, the percentage −100 in the cyanide pulp dropped from 80·0% to 79·4%, but that the percentage −200 improved slightly, from 58·3% to 58·6%. Notwithstanding a very similar ore value, the residue improved from 0·337 dwt. per ton to 0·297 dwt. An appreciable improvement in the recovery by corduroy is disclosed, causing a reduction in the cyanide pulp value. It is submitted that this reduction in residue, without any significant improvement in the fineness of grinding, emphasises the benefit to be obtained from stage tube-milling and selective grinding of the pyrite.

The foregoing information has confirmed the desirability of selectively grinding the pyrite. It adds another milestone to the path leading to improvement in economic extraction by revealing the nature of the valuable particle remaining after treatment. It confirms that further grinding renders the residual gold available for removal by cyanide treatment and points to the conclusion that, whereas bulk regrinding would be uneconomical, the application of selective grinding to the mineralized portion, often less than 3% of the whole, might be made profitable. During the course of the work, extending well back over the past two years, the line led to many by-paths and other useful data were obtained. In this connexion, the possibility of the application of reagents tending to increase the solvent action of cyanide, or, alternatively, disrupt the pyrite to expose the gold, has not been lost sight of.

MILLING AT BRITANNIA

In the *Canadian Mining and Metallurgical Bulletin* for August W. G. Hatch discusses the effects of recent changes in the milling practice at Britannia, which changes have resulted in marked improvements in efficiency and costs. The practice in 1927 was fully described by H. A. Pearse in a paper appearing in the same bulletin and full extracts of that article were given in the issue of the MAGAZINE for December of that year. Returning to the present paper, Mr. Hatch says that during the past few years two major changes have been made in plant equipment. The first of these was the elimination of an intermediate crushing stage by discarding two gyratory crushers in favour of two Symons cone crushers. The latter installation now effects in one stage a greater reduction than was formerly accomplished in two, that is, by the gyratories together with a set of rolls. The second important change in equipment took place when the original M.S. flotation machines were replaced by six Forrester pneumatic machines, so that now the flotation department consists entirely of machines of this type. A number of minor changes and some further additions to equipment have also been effective in raising plant capacity and concentrate grade, while making noticeable reductions in tailing losses and costs of ore treatment.

CRUSHING.—Early in the history of the present mill, the segregation of the slime portion of the original ore was put into effect. The ore, reduced to 6 in. by a jaw crusher situated at the mine, is passed over Hum-mer screens, and high-pressure water sprays placed above these screens wash the slimes and soluble salts from the coarser portion of the ore. Until the summer of 1930, the initial crushing was accomplished by two gyratories operating in parallel and delivering a 2 in. product. This material, together with the oversize from the washing screens, passed first to a set of 72 in. by 20 in. rolls and then to four sets of 54 in. by 18 in. rolls, the final crushing resulting in a ball-mill feed of $\frac{1}{4}$ in. The capacity of the crushing plant averaged 200 tons an hour during the year 1927. This rate has since been raised to well over 300 tons

an hour, although the size of the ore from the primary jaw crushing has remained the same.

At the present time, the ore from the receiving bins is fed by roll feeders to a conveyor which discharges to grizzlies of the rigid-grid type with openings of $\frac{3}{4}$ in. The oversize passes to two $5\frac{1}{2}$ ft. Symons cone crushers, which deliver a $\frac{3}{4}$ in. product. The former installation of gyratories and 72 in. by 20 in. rolls effected a reduction in ore size from 6 in. to 1 in., plus a considerable amount of tramp oversize. The undersize from the grizzlies passes to a bucket elevator and thence to launders, in which are baffles for a more thorough separation of the slimes and soluble salts from the coarse portion of the ore. The washing screens on which this separation takes place now consist of two 15 ft.

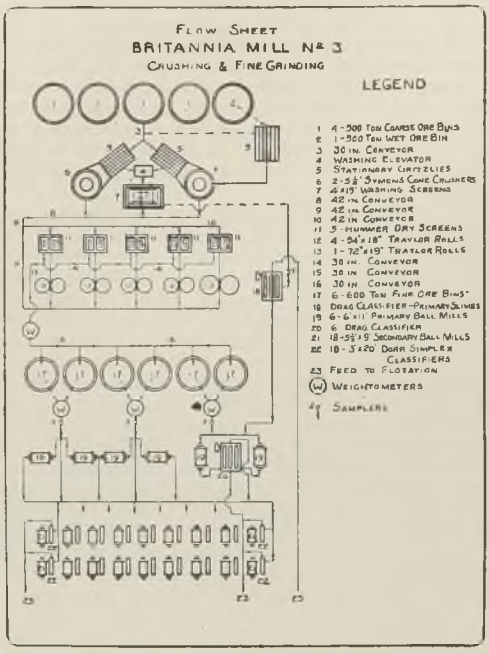


FIG. 1.

by 4 ft. screens, having openings of $\frac{3}{16}$ in. This gives twice as much wet screening surface as was available formerly

The set of 72 in. by 20 in. rolls is now used in final crushing, together with the four sets of 54 in. by 18 in. rolls, the five sets of rolls being in closed circuit with Hum-mer screens which deliver a $\frac{5}{32}$ in. product to the fine-ore bins. In order to take care of the larger circulating load, the three conveyor belts which handle this load were speeded-up from 250 ft. a minute in 1927 to 400 ft. a minute at the present time.

The crushing plant is at the disadvantage during the rainy season of having to treat wet, soupy ore, with consequent added expense both in labour and maintenance. To cope with this condition, one bin, reserved for storage of this ore, discharges into a surge tank holding about twenty tons, from which the ore, after partial removal of slimes by screening, passes to a conveyor and thence to the grizzlies and cone crushers. Air gates on the outlets of the bin and surge tank enable the operator to control the flow of ore and guard against spills.

Roll shells were formerly imported, but are now manufactured at the local foundry. These shells contain 0·5% carbon, 0·7% manganese, and 0·6% chromium, and they last fully as long as the imported shells at a saving of more than 65% of the former costs. Liners of manganese steel for the Symons cone crushers, containing 12 to 14% manganese and 1·2% carbon, are also made locally at a fraction of the cost of the imported manganese liner castings. Latheing of roll shells and grinding of cone-crusher linings are done on the roll floor by the repair-men during slack hours. These factors all contribute to a very important saving in the cost of maintenance.

FINE GRINDING.—In 1927 the fine-grinding plant consisted of four primary and 18 secondary ball-mills in parallel, each of the latter operating in closed circuit with a Dorr simplex classifier. In addition, there was one mill which was used for regrinding of concentrates from the flotation roughers. During the last four years, two primary ball-mills have been added and the concentrate regrinding plant has been enlarged by the addition of another mill, a drag classifier, and a bowl classifier. A tailings regrinding plant was constructed, but is not in operation at present, as the finer ball-mill feed makes regrinding of the tailings uneconomical at present low copper prices. This plant consists of a hydraulic classifier, which separates the coarse material (plus 35 mesh) from the mill tailings, and a drag classifier in closed circuit with a ball-mill. When this plant was operating, the reground material or drag classifier overflow was returned to the flotation circuit.

The grinding medium consists of steel balls, manufactured locally from scrap rail. In the primary and secondary mills, $3\frac{1}{2}$ in. balls are used, while rejects from the upper mills are used in the two concentrate regrinding mills. The total steel consumption in grinding averaged 2·50 lb. per ton of ore milled during 1930. The ball plant consists of two oil furnaces, three stands of forming rolls, with conveying idlers and ball-forming machine. The scrap rails, cut to 10 ft. lengths, are heated in the furnaces to a white heat. A rod, actuated by air pressure, pushes the heated rail to the forming rolls where it is drawn through and shaped into cylindrical billets. The billet then passes to the ball-forming machine. The capacity of this plant is over 30 tons per eight-hour shift. The cost of production of the steel balls is considerably below that recorded elsewhere for steel grinding media.

FLOTATION.—The main principles of flotation practice, as applied in 1927, have been retained. These include the separate treatment of primary slimes and the floating of a bulk rougher concentrate, which is de-watered or thickened, then reground and subjected to differential flotation in three stages—first, a high-grade copper concentrate is made; second, the remaining copper is floated in a middling product, which passes to the head of the cleaning circuit; and, finally, a pyrite concentrate is recovered. Former flotation equipment consisted of two 21-cell and three 14-cell standard Spitz-type M.S. roughers, a 14-cell M.S. cleaner, and auxiliary Forrester machines. The auxiliary installation included a 160 ft. middling machine, the pyrite plant consisting of two 30 ft. roughers and a 12 ft. cleaner, and a 70 ft. scavenging machine, which gave a final treatment to one-half of the mill tailings.

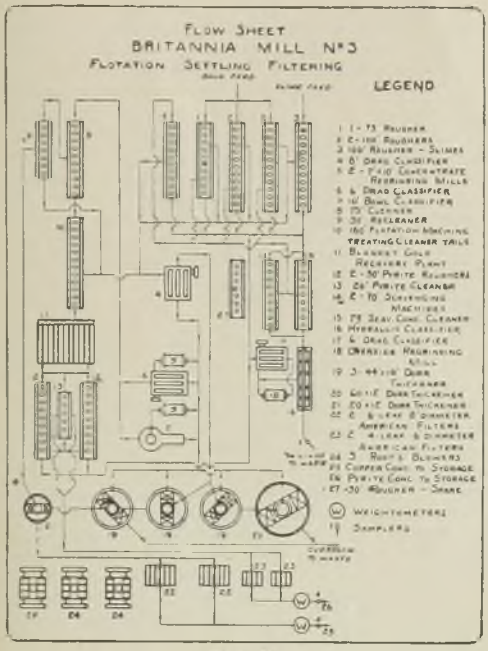


FIG. 2.

At the present time, flotation equipment consists entirely of Forrester pneumatic machines, the total length of which is close to 1,000 ft. In place of the M.S. equipment, six new Forrester machines were constructed and installed last March, of which three are 75 ft. long and three 100 ft. long. The roughers consist of one 100 ft. machine for treatment of primary slimes, and two 100 ft. and one 75 ft. machine which receive the ground pulp from the classifier overflows. A longer treatment of the ore is made possible by the greater capacity of the present installation, resulting in marked improvements in tailings on both the primary slimes and ground portions. It is estimated that the present capacity is 7,500 tons daily, or 1,500 tons greater than that of the M.S. equipment, and this increase was effected by utilizing exactly the same floor space.

Total scavenging of mill tailings is now carried out in two 70 ft. machines. The low-grade concentrates from this operation, together with the concentrates from the tail ends of the roughers, are treated in one of the new 75 ft. Forresters to remove excess gangue before they unite with the higher-grade rougher concentrates. These rougher concentrates now pass to a drag classifier, the overflow from which is de-watered in a series of Dorr thickeners. The settled material from the thickeners uniting with the oversize from the drag classifier, is ground in two ball-mills, one of which is in closed circuit with a second drag classifier, the other in closed circuit with a bowl classifier. The reground material is pumped to a 75-ft. cleaner. Here a high-grade copper product is floated, the tailings passing in turn to a 160-ft. middling machine, where the remaining copper is floated, thence to the pyrite plant, which, as in 1927, consists of two 30-ft. roughers and a 20-ft. cleaner for recovery of the iron concentrate.

A second stage has been added to the copper cleaning operation. The concentrates from the 75-ft. machine are now re-cleaned in a 30-ft. Forrester, which has resulted in an increase in grade of approximately 2%. Tailings from this machine, in common with all other middling products, unite with the rougher concentrates entering the thickeners. Air is supplied at a pressure of 2 lb. per sq. in. at the source by two Connersville blowers, each having a capacity of 20,000 cu. ft. per minute. A spare blower is occasionally used to augment pressure and volume.

The oils and reagents, in general, are the same as formerly, except that the use of a number of auxiliary reagents has been discontinued. Lime is added to the ore at the grinding mills to maintain a slight alkalinity in the roughing circuit and also to the rougher concentrates prior to regrinding, in order to retard flotation of the pyrite in cleaning. About 1 lb. of lime is used per ton of ore treated. The frother is steam-distilled pine oil, of which a total of 0·13 lb. per ton of ore is used. The collector is potassium xanthate, which is also used to reactivate the pyrite, consumption averaging 0·04 lb. per ton. Aerofloat to the amount of 0·01 lb. per ton is also used as a collector.

A short description of the change from M.S. to Forrester equipment is given. The former machines, which had been in use since the present mill started operations, were arranged in two rows, each of which contained one 21-cell and two 14-cell machines. It was proposed to use the same floor-space for six new Forrester machines and these were to be placed in three rows, each row consisting of one 75-ft. and one 100-ft. machine. The new machines were constructed at the shops in sections of 15 and 20 ft. Advantage was taken of a two-day shut-down on March 16–17 to dismantle and remove one of the 21-cell M.S. roughers, and instal a 75-ft. Forrester machine in its place. By the morning

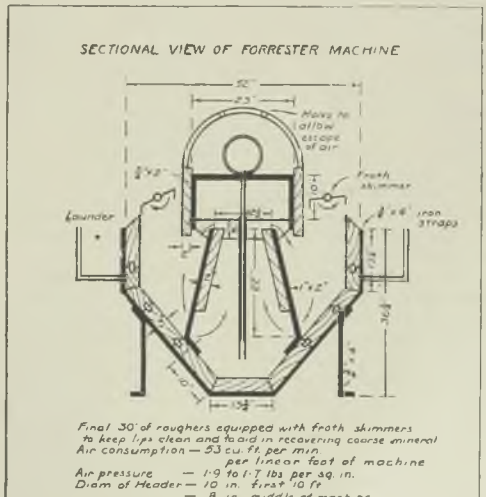


FIG. 3.

of March 18 this machine was in operation as a rougher. During the following days, the other M.S. machines were removed, one by one, and each replaced by a Forrester. The last was removed on April 2, and a few days later the entire Forrester plant was installed and operating. Thus the change-over was completed in just slightly over two weeks, and was effected without any drop in tonnage or interruption of regular operation.

THICKENING.—The original Dorr thickeners were three in number, each having a diameter of 44 ft. Two other thickeners have been added in recent years, one 60 ft. and the other 20 ft. in diameter. All thickeners, excepting the smallest, are used to de-water the rough concentrates prior to regrinding and make a clear overflow to waste. The 20-ft. tank thickens the final re-cleaned copper concentrate, which is filtered by two 6-leaf American filters and thence passes to concentrate storage.

FORRESTER *versus* M.S. OPERATION. — The Forrester flotation machine has shown several advantages over the M.S. machine in the treatment of Britannia ores. It is simpler in operation, requiring only one adjustment, that of water level, as compared with a similar adjustment on the M.S. machine together with a separate adjustment on the tail gate of each cell. The Forrester machine, requiring fewer adjustments, or being more automatic in operation than the M.S. machine, needs less labour from an operating standpoint. The pine-oil consumption has dropped considerably since the change to Forrester operation. During the year 1930 and for the first three months of 1931, with M.S. operation, an average of 0·23 lb. of pine oil was used per ton of ore milled. This figure compares with a consumption of 0·13 lb. per ton for recent months with the Forrester installation, representing an annual saving of approximately $13,000. A saving in power has also been effected. Approximately 700 h.p. were formerly consumed for the M.S. machines and auxiliary Forresters, while 500 h.p. are now required to drive the three blowers, which serve all flotation machines. The annual saving from this source amounts to approximately $5,000, while the lower maintenance and repair cost, averaging about 0·3 cents per ton, will account for an additional economy of at least $6,000 yearly.

A steady improvement in concentrate grade has been obtained during the last two or three years. Additional concentrate regrinding equipment in 1929 made possible the finer grinding and more thorough conditioning of the rougher concentrate prior to making a separation of the copper from the pyrite. This resulted in a substantial increase in grade, followed in 1930 by a further increase to approximately 26% which was promoted by the re-cleaning of the primary copper concentrate. Since the Forresters have been installed, the grade has again risen to an average of approximately 27·5%, so that this installation can be credited with an improvement in concentrate grade of about 1½% over that obtainable by means of M.S. machines.

DRILL STEEL

The efficiency of hollow drill steel is discussed by R. H. Davis in the *Canadian Mining Journal* for August. The author refers to the economic importance of hollow drill steel and the improvement in rock drill design and goes on to say that the efficiency of such steel depends upon the depth cut per bit and its ability to withstand reforging and re-hardening. The design of the bit and the efficiency of the heating and hardening have a direct bearing on the drilling performance. This is brought about by the intelligent supervision in the blacksmith shop, but obviously as a first requirement the steel used must have the necessary quality and the shanks and bits designed to best meet the drilling conditions.

The question of efficiency of hollow drill steel has received much study and there is a considerable amount of information available based on work carried out by different investigators. The efficient use of hollow drill steel depends on several factors and their inter-relationship. The first consideration is the type of rock to be drilled—then the machine to be used. The hollow drill bar ready for use incorporates several factors directly influencing its efficiency. First there is the question of size and section of steel to be used, also the type and design of the shank and the bit. All of these are most important, and anyone wrongly adapted to the conditions existing may have a detrimental effect on results obtained.

Constant efforts are directed towards the reduction of the size of the steel. The transverse section of hollow drill steel may be round or polygonal. Drill steel of a polygonal section has, however, proved itself stronger than steel of a round section. The use of the anvil block or tappet machine necessitates the use of polygonal steel and experience from mines all over the world points distinctly towards the polygonal section as being far superior to the round section from the strength point of view. Another distinct advantage of the polygonal section over the round is noted in the shank end of the steel. Much attention has been devoted to the problem of finding a completely satisfactory unforged shank as it has been conclusively proved that the long life of a shank is more due to the absence of forging than to the design of the shank.

Modern shanks now used at large mines have the following advantages :—

1. No forging.
2. Simple and cheap to make and maintain.
3. Good alignment in the chuck.

A machined or unforged shank must be made of polygonal steel (hexagon, quarter octagon, or square). A hexagonal section allows the use of the smallest bit and the size of the bit is of the greatest importance, because obviously—other things being equal—the drilling speed increases as the size of the bit decreases. The smaller the size of the steel used, the smaller the bit possible which directly affects machine maintenance.

It is, of course, necessary to take hardness of rock in consideration when reducing the size of the steel used. If steel of too small a cross section is used, the bar will break more freely and thus cause unnecessary delays. Results under these conditions are sometimes ascribed to the fact that the drill is not rigid enough and the blow of the

piston is lost in the "whip" of the steel. As the quality of hollow drill steel is improved, the rigidity of the drill of smaller size is improved. The use of smaller sectional steel of course means a considerable saving of labour and time in the shaft, and distribution under ground is easier because of the smaller weight handled. There is also a considerable saving in the forging of a smaller sized bit, as it requires less fuel with a greater number of bits forged and heat treated per shift.

Shanks.—There are three types of shanks in common use to-day—the lugged shank, the collar shank, and the lugless or collarless shank used with anvil or tappet block machine. With all types it is necessary to keep the diameter within close limits so that the shank will slip into the chuck bushing freely with a minimum of clearance. The length of the shank has a direct bearing on both the drilling speed and the over-all efficiency as well as on its life. Tests have been made to prove this, the longer shank, having a better fit in the chuck and therefore being less liable to wobble, gives better guidance, and transmits the blow of the piston more directly to the bit end of the drill. The use of the long shank seems to indicate increased drilling speed and it also decreases the machine maintenance cost. This decrease is no doubt due to better alignment, resulting in longer life of pistons, bushings, rotation sleeves, guide nuts, pawls—and generally all the parts that go to make up the rotation gear.

Records kept of all drill steel breakages, giving not only the total number broken as compared with the number sharpened, but also the locations of the breaks, show that a large number of the breakages take place in the forged part of the bar. Efforts have been made to reduce the number of breakages by subsequent heat treatment in an attempt to restore the steel to the "as rolled" condition; but this is an expensive operation, and is therefore not very practical. The proper way to obtain longer shank life is by directing efforts towards proper practice in the forging. Great effort has been made to improve the life of the forged shank steel, but the possibilities of using unforged shanks have been receiving more and more attention. Extended tests have been carried out, and different types of unforged shanks have actually been adopted as standard by several large mines with highly encouraging results.

The lugless or collarless shank used on hexagonal or quarter octagon steel with an anvil block (tappet) machine undoubtedly reduces the shank breakages under ordinary working conditions. The drilling speed with this type of shank, however, is five to ten per cent slower than with collared shank steel. This decrease is mainly due to the anvil block absorbing a portion of the blow of the piston.

Bits.—The design of the bit to suit rock conditions is most important. The shape of the cutting edges can be modified in a number of ways, and the degree of penetration can be regulated by changing the angle of the cutting edge. This has a direct bearing on the cutting speed of the bit. A cutting edge of 90° appears to be the best angle for the great majority of rock conditions, although in very soft rock a 120° cutting edge has proved more effective.

The depth of penetration can be regulated by varying the length of the cutting edges. A chisel bit will have half the length of cutting edge of a cross bit of the same gauge. A chisel bit, of course, must dissipate more energy per unit length than the cross bit, and for this reason the chisel has a higher rate of penetration in some classes of rock, but other factors make it less desirable for general use than a cross bit. A six-point bit, on the other hand, has fifty per cent greater cutting edge than a cross bit, and consequently a similar percentage of reduction in energy absorbed per unit of length. This type of bit is particularly suitable for softer rocks and for hand rotated rock drills. The six-point bit, however, has poorer cleaning qualities than the cross bit.

Because the length of the cutting edge has a marked influence on the degree of penetration, the size of the bit is of the greatest importance as, obviously—other things being equal—the drilling speed increases as the size of the bit decreases. Increases in drilling speed will be obtained by reducing the size of the bit. Actual test results from changing the size of the bits on $\frac{7}{8}$ in. round jackhammer steel from $1\frac{1}{2}$ in., $1\frac{3}{8}$ in., $1\frac{3}{16}$ in. to $1\frac{1}{8}$ in., $1\frac{1}{4}$ in., and $1\frac{1}{8}$ in., show the reduction in the volume of the hole being drilled to be 15%. A comparison of the average drilling speeds before and after the alteration shows that the actual drilling speed of the machine on running time was increased by 49%, and on the over-all time by 31%.

The facts and figures given in the previous paragraph above are considered to be important, and it is believed they indicate the real problem to be solved by the detachable bit. The design of the detachable bit must not require an increase in the diameter of the bit because we know that increased diameters mean greatly increased losses in efficiency.

Forging and Treating.—The better the bit stands up and keeps sharp the greater the cushioning effect on the hammer blow, the less breakage of drill steel, as well as machine parts; less delay, fewer lost holes and greater output per man and machine. The proper forging and hardening of bits and shanks is therefore a point of the utmost importance, and throws indirectly a vivid light on the importance of using a drill steel that is easy to forge and harden. The dominant influence of the human element on the forging and hardening makes it especially desirable that the steel may be forged and heat treated within as wide a temperature range as possible above the critical point without coarsening the structure. The extent of this range denotes the "fool-proof" character of the steel. The fact that a drill steel has often to spend a longer time in the furnace for re-sharpening purposes than the time it is used in actual drilling, is worth taking into consideration. The steel is subjected to fatigue not only from repeated blows of the machine, but also from repeated heatings. In order to facilitate the difficult and delicate task of the blacksmith a high-grade drill steel should be required to withstand a great number of re-sharpenings without losing its "body." It should be easy to forge and to have a wide hardening range.

When heating to forging-heat it is of the utmost importance to proceed uniformly and slowly in order to avoid strains and cracks in the material. A uniform temperature on the surface of the bit or shank is no guarantee of the full penetration of heat straight through, and the steel should, therefore, always be allowed to remain for a certain time at full forging heat, to make sure the bit and shank are thoroughly heated. Should the heating not be thorough, the plasticity of the surface and core

may vary so much that the material may crack in forging, or, at least, set up serious internal strains.

The proper temperature to which the steel should be heated for forging depends to a great extent upon the speed of the sharpener, and the skill of the operator. The forging should be completed as close as possible to the critical temperature. A low finishing temperature produces a fine-grained structure suitable for hardening. If the mechanical working is stopped at any temperature above the critical point, the crystal growth will proceed from that point until the critical point is reached. It is, therefore, poor practice to heat the steel to the highest temperature possible, then complete the forging while the steel is still very hot and thereafter allow the steel to cool over a considerable temperature range before the critical range is reached. Such a steel shows a very coarse structure, and is unsuitable for the following hardening process. Mechanical working of the steel below its critical temperature deforms the grain structure and imparts to the steel undesirable qualities of brittleness.

It will be apparent, therefore, that drill steel must be completely forged before the lower limit of the critical temperature is reached. Completing the forging at too high a temperature, as well as completing the forging below the critical temperature, will invariably increase the amount of bit or shank breakage, due to the coarse structure existing at the forging temperature not being sufficiently refined or else to internal strains and brittleness caused by cold working.

Fatigue.—When a steel has broken once in service there remains relatively little useful life in it. A test to prove this might be quoted. Three series of steels were used. The drilling was continued with the steel after it had failed in service due to fatigue and footage drilled until the first, second, and third failure was recorded and plotted. From this test and from observations at mines all over the world, the indications are that steel is, after the occurrence of the first failure due to fatigue, not fit for service. Therefore, if a drill steel has failed in service due to fatigue it is doubtful if it is good economy to re-shank or re-bit this piece and put it into further service. Of course, steel may break because of causes other than fatigue and such steels possess further usefulness.

In view of what is said above, it is also very doubtful if it will pay to weld up broken drill steel, which is a practice carried out at some mines. Tests have been carried out in order to ascertain the life of welded steel (welded in electric butt welder) as compared with its original life (before the first break). In these tests care was taken to weld together the same pieces as were originally together in the unbroken steel, so that every portion of each steel had performed the same amount of work. In passing it might be mentioned that in actual working practice broken steel is almost invariably mixed up, so that steel broken the first time may be welded to steel which may have been broken many times. The figures obtained in test are therefore probably much better than those obtained under actual working conditions. The results of the tests show that the life of welded steel is very short when compared with its original life (prior to the first break), and it is not good economy to weld and re-weld broken steel. The loss of life of welded steel is mainly due to the fact that the whole length of the pieces of steel to be welded are fatigued. The indicated life of welded steels therefore agrees fairly well with the average "second life" obtained in the fatigue test on drill steel. The loss of life through welding itself is found to be about 60 to 70%.

Record of Steel Breakages.—There is no doubt that most mines keep a record of steel breakages. However, the breakages, as a rule, are not expressed in a standard measure, and the results are therefore not directly comparable. Furthermore, it appears to be frequently and erroneously assumed that the steel breakages expressed as a percentage of the steel used—i.e. sharpened daily, can be used as a measure of the relative merits of various brands of steel. There seems, however, to be one "correct" rate of breakages, namely, the same ratio as daily footage drilled bears to the "steel life." For example, if the average daily footage drilled per steel and the average life per steel are 2 ft. and 100 ft. respectively, the daily breakages must be 2% if the average condition of the steel is being maintained at a fixed level as outlined above. If the breakage figure is persistently above or below the "correct" figure it shows that the assumed life per steel is greater or smaller than the true life respectively.

SMELTING ANTIMONY IN NEW SOUTH WALES

In the August issue of the Magazine full extracts of an article describing antimony smelting practice in California by W. Brazenall, which appeared in the *Chemical Engineering and Mining Review* of Melbourne for June 6 were given. In the same paper for July 5 Mr. Brazenall goes on to describe practice in New South Wales. He says that in 1925 the Hillgrove, Metz Gold Mining and Smelting Co. was formed to work the deposits of antimony in the Hillgrove district of N.S.W. for the production of star antimony, the price at the time being in the vicinity of £100 per ton. The writer obtained a lease of the Freehold mine at Hillgrove, on which were two reverberatory furnaces and flues and smoke-stack. The furnaces were repaired and a new oxidizing unit added, 3 ft. by 5 ft. by 10 ft., and all connected to condensing chambers and flues, at the end of which was an exhaust fan driven by a 6-h.p. super-Diesel engine.

A bag-house holding 20 woollen bags was built to recover the oxide from the oxidizing furnace. The bags, 13 ft. long by 20 in. diameter, were made of woollen cloth woven 20 threads to an inch. The fume containing SO_2 and antimony trioxide was drawn from the top of the burning charge by the exhaust fan and then discharged into the chambers below the woollen bags. Each of the chambers was fitted with a valve. The bags when being shaken were deflated by first shutting the valve and then gently shaking them by oscillating the beam which was hung on three links from the cross beams fixed on the wall plates to carry the bags. The bags were connected to the chambers by pipes at the top of the chambers, and hung from a beam that extended 3 ft. outside the building, and to which a handle secured on the end extended down to within reach of the operator, so that he could shut the valve, and after about a minute, shake the bags

and so remove the coating of oxide inside them which fell into the chamber below. In order to cool the gases before reaching the bags, cold air was drawn into the flues, and the temperature kept about 100° to 150° F.

The ore was chiefly sulphide of antimony and was weighed and mixed with coke. The furnace, having been filled with fuel and brought to a bright red heat, was then charged. The charges consisted of 2½ cwt. of ore mixed with sufficient fuel and were charged evenly over the furnace every half-hour. As the clinker was formed from the residue of the coke and ore, it was removed through portholes placed for the purpose. After a week's constant run, the chambers and flues were cleaned out, and the oxide stored and reduced in the reverberatories.

The reverberatory furnace for reducing the oxide was 7 ft. by 5 ft. hearth measurement and was fitted with a charging door on the side and a door on the end for slagging and working the bath in the furnace. The oxide was weighed into half-ton charges and mixed with carbon and soda and charged on to the hearth, after it had been brought to a bright red heat. The furnace was fitted with a grate for burning 5-ft. wood, the flame passing over the charge and being drawn through the flues to the bag-house. After several charges were smelted the metal was skimmed off and a clean flux added to remove any impurities. The metal was then brought to the proper temperature to star.

The flux furnace was 4 ft. by 3 ft. ; it was heated by wood fuel, and kept at a low temperature. It was tapped into a large slag pot and ladled out by small ladles into the metal ladles just before pouring. The metal ladles were placed under the tap hole of the metal furnace, one on the floor and the other on bars above it, close to the spout of the furnace. Then the bar was drawn, allowing the metal to flow into the ladles, into which enough flux had been poured to cover two bars.

The moulds, 10 in. by 10 in. by 3 in., were placed in rows adjoining each other and a gate of iron was placed above them with a hole at each end reaching to the centre of the moulds, so that both moulds were poured simultaneously. The flux floating on top of the molten metal flowed into the mould with the metal, thus completely covering it. This is essential for starring the metal as it excludes the air from it. This method of pouring the metal was devised by the writer at the works of the Western Metal Co., Harbor City, California, after a great deal of experimenting, in order to avoid ladling from the furnace with iron ladles, as they soon wear out and burn away, the iron then going into the metal.

In 1926 the Hillgrove, Metz Gold Mining and Smelting Co. went into liquidation. The writer bought the concern and the Brazenall Mining and Smelting Co. was formed with the object of purchasing the Mathews mine at Burrapine, the ores being brought around by rail to Armidale and then on to Hillgrove to be smelted. After operating some two years it was decided, as Hillgrove ore supplies were of no importance, to remove the plant to Burrapine. The writer designed the plant and it was completed in November, 1928. The plant consists of an oxidizing furnace 3 ft. by 4 ft. by 10 ft. with a capacity of 24 tons per week. The reverberatory is 10 ft. by 7 ft. on the hearth, and is fitted with a grate for 5-ft. firewood. The flux furnace is 4 ft. by 3 ft. and fitted with 5-ft. grate for burning wood fuel. The bag-house contains 25 bags and is fitted with large chambers enabling the plant to run two weeks, if necessary, before cleaning up. A large shed adjoins to store the oxide before and whilst reducing it to metal. Gas coke is used in the oxidizing furnace.

The mine is situated about 2 miles away on Purgatory creek, so that the ore is brought direct from mine to smelter, the vein varying from 3 in. to 3 ft. At the time of writing there is a very large body of ore supplying the furnaces, besides which four other mines contribute to the ore supply. The ore is a very clean high-grade sulphide, free from impurities and the metal produced is equal to the best English.

SHRINKAGE STOPING

The evolution of shrinkage stoping and its place among modern mining methods are discussed by R. K. Warner in the *Canadian Mining Journal* for July. The author says that shrinkage stoping together with its synonyms, "battery stoping," the "lay system," "magazine mining," once had a rather definite meaning, but modern modifications have made it difficult to say what shrinkage stoping is, and where it ends and caving begins. This confusion is well illustrated by Information Circular 6293 of the United States Bureau of Mines, which includes at least five distinct mining systems under its title "Shrinkage Stoping." Basically, shrinkage stoping means a system of mining where a large part of the ore is left as broken until the stope is finished, this reserved ore being used to support the miner and his equipment while he is drilling the back. The fundamental reason for leaving the broken ore in the stope then is to obviate the need for the introduction of other means, such as stulls, square-sets or filling, for getting the miner up to the back. So used, the system requires rather rigid conditions. The walls must be strong or else they will spall off as the ore is drawn, and dilute the ore to a point where the method must be abandoned. (Cf. present trend in the Ontario Gold Mines.) The ore itself must be strong since the miner works under it and there is little or no opportunity to furnish support other than that of the broken ore. The cost of support of the miners by broken ore (interest loss, metallurgical loss due to dilution, oxidation, etc.) must be less than alternate systems. The ore must be of uniform grade, as there is no opportunity for sorting in the stope. The ore-body must not contain waste horses unless they can be left unbroken. The foot-wall should be regular and preferably steep so that the ore will flow to the level below without the need for ore passes through rock. The ore must not pack or oxidize unduly while being stored in the stope. Some of these requirements still persist for the modern variations, but others have ceased to be important. Shrinkage stopes often require subsequent filling if they are to remain open for a long period after drawing.

There are now at least nine variations of mining systems starting with typical shrinkage stoping, in which all the ore is broken by the use of explosives,

and ending with undercut caving, where explosives are used to take off one slice only and the remainder of the ore caves into this undercut slice. The change in passing from one of these systems to the next is slight. In order these are as follows :—

1.—Straight shrinkage stoping as practised in veins narrow enough not to require transverse vertical pillars. All the ore is broken by explosives, and the requirements for successful use are as above. The system is adaptable to ore-bodies of any tenor.

2.—Same as (1) except that some or much of the ore is broken by caving. At Alaska Gatineau (Peele, p. 674) most of the ore is allowed to cave from the back after a narrow shrinkage stope has been carried up the foot-wall. In some other mines cheap breaking in shrinkage stopes is obtained by driving the sides or ends of a stope more rapidly than the central portion, thus creating a belly of ore which eventually falls under its own weight, and which may then be attacked from above.

3.—The miners are removed from the broken ore under the back end placed either in horizontal openings (Sub-level Stoping, Peele, pp. 587–588) or in the belled-out portions of rises (Beatson System, Peele, pp. 669–672). This change of drilling points permits safer work in softer ore than is possible with straight shrinkage stoping and these variations are better suited to ore-bodies that are not uniformly strong throughout. The removal of the miners from the top of the broken ore also obviates any difficulties due to the fact that irregular drawing of the stopes might, and frequently does, leave parts of the back temporarily inaccessible to the drillers. The fact that the drawing of the stopes is practically independent of the mining also makes it easier to vary, and regulate, the rate of production. If it is desired to take advantage of the breaking effect of fall, the broken ore level can be drawn down and the ore dropped.

4.—System used at Alaska Juneau (*Mining and Metallurgy*, Dec., 1929). After usual stope preparation much of the ore is broken by caving. Explosives are used as needed, being fired in powder drives run from rises in the back. In this variation as in the one last mentioned, weaker parts of the ore-body prove an asset rather than a source of danger.

5.—A combination of ordinary shrinkage stoping between pillars, with subsequent caving and drawing of the pillars. Before these stopes are drawn, enough work is done under or in the pillars so that they will cave and come down with the shrinkage ore. At one extreme is the system used at the Creighton mine (Peele, p. 668), where the stopes range in width from 50 to 60 ft. The transverse pillars between these stopes are 15 to 25 ft. wide. These pillars are at times over 300 ft. long and require considerable work inside them throughout their height and length before they are weakened and broken enough to draw freely. At the other extreme of this variation is the old Ray system in which the stope width is kept to the economic minimum, and the pillars made as large as they can be and still assure their caving as the broken ore is drawn and the weight of the capping comes on them. The amount of ore won by the caving method of stoping varies greatly in these methods. In the Creighton system the hanging stays up so that the method must be classed as an open stope system. Since the capping is allowed or forced to cave in the Ray and other allied systems these are caving systems.

6.—The modification of the Ray system used in softer ore (G. J. Young, *Engineering and Mining Journal*, 121, p. 482). Here after the undercutting, and the division of the ore-body into blocks by isolating shrinkage stopes carried almost to capping, shrinkage stopes are carried only a short distance (25 ft.) up in the back on 25 ft. centres. As these are drawn the rest of the back caves.

7.—Caving systems in which after the undercut is made and one or more edges of the mass are freed by a shrinkage stope, the remainder is won by caving. This system was used at Alaska Gatineau in slate and at Ray in soft ground.

8.—No shrinkage stopes are put in even to divide the ore into blocks, but, at vertical intervals along the edges of the blocks, sections of ore are broken so as to create planes of weakness. Cf. Miami new system.

9.—Straight undercut caving where no work at all is done in the block above the undercut. The preparation of the stope bottom and the arrangements for loading the ore after it is broken are, or may be, identical in each of these systems. If the ore has a tendency to come down to the level in pieces too large to pass the chute gates, opportunity for block holding must be provided.

After breaking in a stope is completed and before it is drawn it would be difficult to tell by observation alone by which of the nine systems the mining was done. If we classify as open stope mining systems those in which no artificial materials are brought in and systematically used to support walls and ore, and classify as caving systems of mining those in which, not only is nothing done to support the back, but in which caving of the back is an integral part of the mining method, we can then draw our line of distinction easily after the stope is drawn. If there is a hole after the drawing, the method is shrinkage stoping, and vice versa. This results in classifying as shrinkage stoping two systems, sub-level stoping and the Beatson system, in which there is no use of the broken ore to support men, that is, in which the stope can be run full or empty as desired. These methods are in reality but two variations of the same system. The breaking is done by drill-holes fanned out from the ends of horizontal or vertical openings in the back, a method called "roundabout stoping" or "mass stoping" by the writer elsewhere. They differ from an ordinary shrinkage stope in two features only, the method of breaking ground and the fact that they may be run empty, though they seldom are. In the formal classification of mining systems if we have a segregated group of "shrinkage stopes" in parallel with "open stopes," "filled stopes," etc., these two systems fall in between "shrinkage" and "open" stopes and this offers, the writer feels, an added reason for dropping the term shrinkage stopes from any formal classification. What we have been calling shrinkage stopes (cf. Peele, p. 655, et. seq.) are but open stopes with broken ore left in them during mining to support the men, and under this heading we include the Beatson method, where the storage of ore is not essential, and omit sub-level stoping where the ore is often stored. It would be better to classify all such mining systems as open stopes run empty or run full, or, if you must, run "shrinkage."

DIAMONDS IN THE BELGIAN CONGO

In *Mining and Metallurgy* for August A. E. Brugger describes activities on the Kasai diamond fields of the Belgian Congo. After describing something of modern conditions in the Congo the author goes on to say that courageous exploration coupled with a considerable element of chance marks the story of the discovery of these diamonds. The parent company, the Société Internationale Forestière et Minière du Congo, was founded in the Congo Free State days by Leopold II with the aid of French and American capital. Among its purposes was the search for gold in areas where prospecting rights had been granted. Two American geologists headed a group entering at the mouth of the Congo and working east. Exploitable auriferous gravels were located in the Aruwimi district and are still being worked. In Kasai concession only traces of gold were found, but a Belgian prospector noticed in his pan a brilliant stone the size of a pinhead. In the field this was suspected of being a diamond and in Europe some months later proved to be such. Then, a party was despatched to the Kasai to examine the concession for diamonds. The task which then presented itself, to delimit the best of the diamondiferous area in the limited time which the prospecting concession had still to run, was remarkably well accomplished.

Hardly less interesting was the discovery of diamonds in the large mineral concession granted to the Chemin de Fer Bas Congo au Katanga, years after geological expeditions had been through the country. This discovery is to the credit of an experienced Forminière prospector who chanced to be crossing the concession on his way home on furlough. It led eventually to the location and development of one of the largest and richest deposits in the Congo, on the Bushimaie in the Sankuru drainage, of which, however, only a small percentage is of gem quality.

The original source of the Kasai diamonds is still not known. There have probably been many sources because little evidence exists of the stones having travelled a long distance. So far as exploitation operations are concerned the immediate origin is in the basal conglomerates of the Lubilashi sandstone series laid down unconformably on the granites and gneisses which form the igneous basement of the Congo basin. Wherever the streams of the present drainage system have eroded their beds down through the conglomerates and sufficient concentration has taken place, the exploitable deposits are found, as well as occasionally in terrace and hillside deposits of older drainage systems well above present stream levels. Search for primary sources is made unbelievably difficult under the local tropical conditions, and the subject is one of academic rather than practical interest. The deposits vary in thickness from a few centimetres in the smaller creeks to several metres in the river flat and terrace deposits, and may lie at shallow depths or be covered by many metres of over-burden. The average depth of gravel over the whole field is less than 1 metre, and the average overburden-gravel ratio is about 3 to 1.

Development of a technique for the location and evaluation of the widely scattered deposits has been a process of gradual evolution over several years. Exploration is undertaken by the general prospector whose mission is roughly to map the virgin territory penetrated, with pocket compass and paced traverse, to locate areas showing concentration, and to act as an ambassador of goodwill to the native tribes, as well as to report on local resources in labour and foodstuffs. His samples are taken at the most favourable points and concentrated by panning or hand jigging in circular sieves. The diamond, due to its low coefficient of adhesion with water, concentrates much more easily than its specific gravity of about 3·5 would indicate. Careful panning or jigging will bring it down with the heavier black concentrates, such as magnetite and ilmenite. Development of potentially profitable areas is undertaken by trenching across creek valleys usually at 100 metre intervals, by pit-sinking or by drilling with 6 in. Empire drills in deep-lying deposits. In spite of the small sample and the high value of the product, excellent results have been obtained by drilling at 10 metre intervals where other methods of attaining bedrock have been impractical. In calculating estimates, abnormally high results are reduced arbitrarily, the method varying with experience and the particular conditions. At one of the first deposits to be worked out, for example, values between 5 and 10 carats per cubic metre were reduced to 5 carats, and those above 10 carats by one-half, up to a maximum of 10. Final returns from exploitation agreed with the estimate within 10% on the conservative side. As experience widened, judgment has improved and total production almost always agrees with estimates within very close limits.

To decrease the amount of initial dead work, so-called preliminary development was evolved. This consists simply of laying out the development plan normally but first completing only such parts of it as would not permit passing over an exploitable area. When valuable ground is found the detailed or final development is filled in. Hand washing and concentration of samples from development is practised. Nests of rocking screens for sizing into three sizes, oversize and undersize, and a type of Joplin jig for concentration of the fairly coarse material are employed.

Gradual evolution has characterized the processes of diamond recovery from the Kasai field. Early methods were necessarily entirely hand, using locally built equipment. Sizing into three sizes between 1 and 10 mm. was accomplished in rocking screens or small trommels, with limited capacities. Concentration took place in jigs of the Joplin or Harz type, and final sorting of the concentrates by natives in gold pans under water. First experiments with the rotary pans as used in South Africa, with pulsator jigs, and with greased tables were all unsatisfactory, but with the exception of the greased table have since been adapted to the conditions. At present transportable pan plants operated by electricity or by steam power, and varying in capacity from 3 to 7·5 cu.m. per hour are universal. A double treatment of all material passing 15 or 20 mm., depending on the gravel being washed, delivers a pan concentrate amounting to about 3% of the feed. The first pan should give upwards of 95% of the total recovery, and none but the very smallest, "sand diamonds," unprofitable to save, should be passed into the tailing. Efficient recovery depends on uniform rate of feed and proper mixture of sludge, visibly apparent to

the trained operator. Pan concentrates are sized into three or four sizes which are jigged in mechanical Harz-type jigs making a hutch product. Hutch products, consisting mainly of black concentrate containing the diamonds together with some garnets and chrysoberyl, are drawn into locked containers for transport to the diamond sorting centre for each group of mines. Here, in a double-fenced compound and under the eye of a European, final concentration and sorting takes place. These are purely precautionary measures against theft, for no illicit underground traffic in diamonds has yet been discovered in the Congo.

Through there is much variation, the average tenor of the gravels that have been mined in the Belgian Congo is such that the final product amounts to about one twelve-and-a-half millionth part by weight of the material treated. So the shipment of a quarter of a ton of diamonds to the world's markets means that some 3,000,000 tons of gravel have been excavated and washed and concentrated, and about 9,000,000 tons of overburden removed. Shipment takes place by registered and insured air mail in parcels of approximately 1 kilogram or 5,000 carats net weight.

Reserves have been developed for a long period of profitable operation. The diamonds of the Kasai are of fine gem quality, with the exception of those from the Bushimaie field, but of rather small size. They average from 12 to 15 stones to the carat with a very small percentage weighing above 5 carats.

Magnetic Concentration.—Methods and costs of concentrating magnetite iron ore at Mineville, New York, by means of magnetic separation equipment are discussed in detail by T. F. Myners in Information Circular 6624 of the United States Bureau of Mines. The ore treated is magnetite in a gangue composed essentially of gneiss and apatite. It is mined by open-stope methods, three large ore-bodies furnishing most of the tonnage. In 1930 the average tenor of the ores from these three deposits, in percentage of iron, was as follows :—

Old Bed . .	52·57%
Harmony . .	40·26%
New Bed . .	29·79%

Magnetic concentration was first applied at Mineville in 1853, but was unsuccessful. Wet-milling by means of jigs was later introduced in the district, but likewise met with failure. Dry magnetic separation with drum-type machines was instituted in 1902, and has continued in use, with modifications in flow sheets and equipment, ever since. Five mills have been built, but three were destroyed by fire ; construction of a sixth is contemplated at present. In a general way the process consists of :

(1) Breaking to 4 in. maximum size.

(2) Intermediate crushing in gyratories to 2 in.

(3) Screening, the fines going to drum separators where shipping concentrates and middlings to the dryer are made ; the oversizes are screened to three sizes—minus 1¼ in., which goes to the dryer, plus 1¼ mlnus 2 in., which goes to pulley-type separators, and plus 2 in., which is returned to intermediate crushing. Trommels and vibrating screens are used at various points in the flow sheet to distribute the feed, and to effect plus and minus 10-mesh segregation of the feed to the separators which make final shipping products.

(4) Drying of minus 1¼ in. material prior to final separation of shipping concentrates and tailings.

(5) Magnetic separation, involving three types of machines—pulley, drum, and belt. The pulley type is used primarily as a cobbing machine to make middling and clean tailing ; the drum type is employed to produce concentrate and middling ; and the belt type is used on the finer sizes for making concentrate, middling, and tailing.

(6) Fine crushing to about 10 mesh by means of rolls, operated in open circuit on middlings from various points in the flow sheet. This is the final stage in size reduction, and no fine grinding in the commonly accepted sense of the term is employed.

(7) Conveying of concentrate to shipping bins on conveyor belts.

(8) Disposal of dry tailings by means of conveyors and surge bins. Some tailings are sold for road construction, the balance being stacked in large piles or dumps.

Samples for mill control are taken at various points, quick determination of magnetic iron being made in an ingenious apparatus consisting essentially of a glass tube held between the poles of a magnet. The sample is agitated, with water flowing through the tube ; magnetite is retained in the tube by the magnet while the gangue is washed out. The cost of treating 905,405 tons of ore to produce 538,253 tons of concentrate in 1930 was $0·394 per ton, of which $0·181 was for labour and $0·213 for supplies. Power is distributed in these two general accounts.

Milling at Miami.—The milling methods recently developed to treat the low-grade Miami ore-body, which contains less than 1% of copper, are described by H. D. Hunt in Information Circular 6573 of the United States Bureau of Mines. The present Miami concentrator is of unusual interest due to the low copper content of the ore treated, the large size of operating units and the housing of these units in a small space as compared to former operations. The ore-body averages 0·87% of copper, which is mainly in the form of chalcocite with subordinate amounts of oxidized copper minerals. The chalcocite occurs chiefly as films upon pyrite particles. This combination makes a satisfactory extraction of the copper by bulk flotation methods possible, but regrinding of the bulk flotation concentrates and retreatment of the concentrates by selective flotation methods are essential for the production of high-grade concentrates. The plant has recently been remodelled and at present is capable of treating over 17,000 tons of ore per day. The mine ore, minus 12-inch size, is crushed to ⅜ or $\frac{5}{16}$ in. size by cone crushers followed by two stages of rolls ; the latter operate in closed circuit with vibrating screens.

The concentrator is divided into six sections for grinding and bulk flotation operations ; two additional grinding units are provided, one for the regrinding of bulk flotation middlings and the other for the regrinding of bulk flotation concentrates. The reground concentrates are treated by selective flotation methods and the pyrite depressed in a separate flotation circuit. In each of the six concentrator sections the ore is ground to 4% plus 48-mesh by three stages of ball-mills ; the last stage operates in closed circuit with a bowl classifier. The bowl classifier overflow pulp is treated by flotation in two stages of matless flotation cells. The rougher cell produces concentrates which are cleaned in the second cell and middlings which are reground in a separate grinding circuit and returned to the head of the rougher cell. The concentrates

produced in the cleaner cell are sent to the concentrate retreatment plant which, as previously noted, is equipped to grind and treat the concentrates by selective flotation methods. The final concentrates produced in the retreatment plant are thickened and dewatered for shipment to the Miami plant of the International Smelting Co. Flotation reagents used comprise lime, potassium ethyl xantate, and pine oil.

For the year 1930 the concentrator treated an average of 17,141 tons of ore per day which contained 0·604% of sulphide and 0·112% of oxide copper. It produced concentrates containing 34·13% of copper; the mill recovery amounted to 78·88% of the total copper and the concentration ratio was 60·4 tons into 1. The cost of milling for the year 1930 was $0·297 per ton of ore treated.

Hecla Concentrator, Gem, Idaho.— The methods of milling practised by the Hecla Mining Co. at Gem, Idaho, are described by W. L. Zeigler in Information Circular 6600 of the United States Bureau of Mines. The principal economic mineral contained in the ore treated is fine-grained galena, and this is associated with small amounts of zinc in the form of marmatite. Jigs have been retained in the Hecla mill because the ore is ideal material for jigging operations and furthermore the present smelter settlement schedule favours jig concentrates as compared to flotation concentrates. Mine ore is crushed to 5 in. size and then passed over a grizzly having 3 in. spaces. The grizzly undersize is further sized by a vibrating screen having 1¾ in. holes. The grizzly and vibrating screen oversize products fall on to a conveyor belt where smelting ore and waste are removed by hand sorting. The milling ore remaining on the belt is crushed to 1¼ in. size, and joins the vibrating screen undersize as feed to the concentrator. The concentrator utilizes jigging methods as far as possible; jig middlings and tailings are ground and further treated in separate flotation units. Ore from the sorting plant is crushed to minus 30 mm. size by rolls and then sized for jig feed by trommel screens. The sized products are treated in jigs which produce finished concentrates, middlings, and tailings. The jig tailings after grinding are treated in a machine which produces lead concentrates.

The zinc contents of the original ore concentrate in the jig middlings to a sufficient degree to warrant treating this product by selective flotation methods. The jig middlings after grinding are therefore treated in two machines operating in series; the first machine produces lead concentrates and the second zinc concentrates. A third flotation unit is provided for the treatment of primary slimes by flotation methods; this treatment results in the production of lead concentrates.

For the year 1930 the total recoveries of silver, lead, and zinc were 96·1, 97·4, and 65·0% respectively; jig concentrates accounted for 62·5, 65·8, and 40·1% of the total silver, lead, and zinc, respectively, the balance being obtained by flotation operations. The milling cost for April, 1931, amounted to $0·55 per ton of ore treated.

Shaft Sinking at Grand Saline, Texas.— Shaft sinking practices and costs at the Morton Salt Company Mines, Grand Saline, Texas, are discussed in Information Circular 6640 by M. Taylor, published by the United States Bureau of Mines. The shaft is a circular one, 14 ft. 6 in. finished inside diameter, and was sunk through layers of sand, clay, and shale, grading into a soft sandstone down to a depth of 190 ft., below which was a cavernous limestone containing salt water and extending to a depth of 208 ft. below surface. This formation was followed by 5 ft. of anhydrite lying immediately above the salt, which was encountered at a depth of 213 ft. Below this point the shaft was sunk 451 ft. in salt to a depth of 664 ft. below the surface or 677 below the finished shaft collar. To a depth of 107·25 ft. the shaft was a drop-shaft sunk by means of an open steel caisson shoe and at this depth the caisson was landed in shale and sealed. The caisson was 24 ft. outside diameter, and 16 ft. inside diameter. The first 28 ft. were sunk with a stiff-leg derrick and clam shell bucket, below which point hand shovelling into a sinking bucket was used. At a depth of 157½ ft. the ground hardened enough to withstand grouting pressures and from that depth down to the salt, grout holes into which cement was injected under pressure for the cementation of water bearing rock and sand, were drilled ahead of the excavation. This work required the use of large quantities of cement. A total of 131 grout holes were drilled aggregating 2,711 ft.

The difficulties encountered and the methods of drilling and blasting, mucking, pumping, grouting, and lining the shaft, are described in detail in the circular, which contains five illustrations. Tables are included, giving details of blasting practice, sinking performance data, concreting performance data, grouting data, and costs per vertical foot of shaft for sinking and lining the caisson section, rock section and salt section of the shaft, respectively. The caisson section (115 ft.) cost $212·14 per ft., the rock section (115 ft. to 226·33 ft.) $183·25 per ft., and the salt section (226·33 to 677 ft.) $62·17 per ft. The caisson section required 79 days to complete, the rock section 55 days, and the salt section 86 days.

Sinking Practice and Costs.—Shaft sinking practice and costs at the Pim shaft near St. Francois, Mo., are discussed in Information Circular 6588 of the United States Bureau of Mines. The shaft was sunk to a depth of 755 ft. to develop a body of disseminated lead ore which had been explored by diamond drilling. The shaft is 6 by 20 ft. in the clear and passes through 70 ft. of red clay, gravel, and small bolders, 40 ft. of broken rock consisting of 20 ft. of calcareous sandstone and 20 ft. of limestone, the balance of the shaft being in solid rock, mostly limestone and shale. In addition to concreting the portion of the shaft which was in surface material, it was later found necessary to line it with concrete to a depth of 212 ft. below the surface. Details of drilling, blasting, mucking, and timbering are given in the circular, together with performance and cost data covering each of the three operating periods into which the work was divided. The second and third periods included sinking and timbering through 620 ft. of solid rock, from a depth of 110 ft. to 730 ft. which required the drilling of 32,838 ft. of holes and hoisting 9,972 buckets of rock. Drilling required 4,726 man-hours of labour, mucking 7,744 man-hours, and timbering approximately 6,820 man-hours. The concreting was done in two sections, the first from surface to a depth of 98 ft. and the second from 98 to 212 ft. The first section required 332 cu. yards of concrete and the second section 286 cu. yards. The placing of concrete required 2,592 man-hours of labour for the first section and 3,192 man-hours for the second section.

The cost of sinking from surface to 730 ft. was $76·17 per ft., of which $43 06 was for labour and $33·11 for explosives, timber, other materials and supplies, and power. The cost of concreting 212 ft. of shaft was $11,953·68 or $56·38 per ft. of shaft concreted. The total cost for sinking and concreting was $67,567·26 or an average of $92·56 for the 730 ft. of shaft sunk by the contractor. The shaft was later deepened to 755 ft. by the mining company.

Purchasing and Supply Methods.—Methods employed in the purchasing and supply departments of the Miami Copper Company are described in considerable detail in Information Circular 6623 of the United States Bureau of Mines by Fred L. Bishop and Albert E. Keller. After a brief description of the property, plant, and operations of the company, the authors take up the purchasing and supply departments in more detail, pointing out the advantages incident to the supervision of both by one man, the purchasing agent. Duplication of effort, lost time, and unnecessary expense are eliminated in considerable degree by this arrangement. After a description of the supplies and equipment used and the classification in vogue for handling them in the warehouses and on the books, the paper presents a description of the accounting, invoicing, discounting, and statistical-recording practices employed, followed by a more detailed discussion of the procedure of the purchasing and supply departments. As a means of clarifying the discussion, a lot of fifty shovels is used as an example, and these shovels are followed from the time of being ordered until some of them are requisitioned for use in the mine and the rest are stocked. A set of sample forms serves to illustrate the test, which concludes with a description of the filing systems.

Equipping a Mine in the Tri-State District.—The cost of developing to the operating stage and equipping a small or medium-sized mine in the Tri-State lead and zinc district is discussed in Information Circular 6591 of the United States Bureau of Mines, by J. R. Reigart. This circular is the first of a series dealing with the cost of developing and equipping small and medium-sized mines in various mining districts. The Tri-State district is favourably situated as regards climatic conditions, transport, water supply, and power facilities, and labour conditions are excellent. The shallow depths at which the ore deposits occur is another favourable factor. Nevertheless, the hazards of exploration are such that, in common with other less favourably-situated districts, financial difficulties have been numerous. Exploration is conducted by churn drilling from the surface, and upon proving sufficient ore on a tract to warrant development and equipment for production, a mill shaft and one or more auxiliary or field shafts are sunk to the bottom of the ore-bearing horizon, a milling plant is erected and actual production of ore commences very soon thereafter.

The author discusses the geology, leasing system, hazards of exploration, prospecting equipment and methods, exploration costs, mine development, shaft sinking, mill flow sheets and equipment, together with the costs of the various operations, giving examples of actual costs at a number of properties. In conclusion, a statement is given showing what costs might be expected on the average from the exploratory stage of a property to the time of productive operation with a mill of 350 tons capacity in ten hours on an 80-acre tract. The various segregated costs in the following statement are discussed in detail:—

Legal expense	$3,500
Exploration	40,000
Dewatering	25,000
Land Improvement	1,000
Mine development	40,000
Milling plant	100,000
Transport	5,000
Miscellaneous buildings	3,500
Auxiliary water supply	5,000
Total cost to operating stage	$223,000

Theoretical Metallurgy.—Bulletin 350, "Contributions to the Data on Theoretical Metallurgy: I. The Entropies of Inorganic Substances," by K. K. Kelly, has been published by the United States Bureau of Mines. The author states that the present trend in metallurgical research is toward application of the methods of thermodynamics to metallurgical reactions. Such methods have been used by the chemist for many years, but the metallurgist has been slower to appreciate their direct applicability to his problems and their exactness. Thermodynamic data on substances important in metallurgy are scattered throughout technical and scientific literature, and the present work is an attempt to collect all the available data referring to one important thermodynamic property and to supply sufficient discussion to make the results readily usable by metallurgists.

It is the purpose of this publication to give values of the entropies at 298·1° K. (25° C.) for those elements and common compounds, such as oxides and sulphides, for whose calculation the necessary data are at present available and to call attention to means of obtaining approximate values when data are lacking. Previous tables for the elements may be found in the various textbooks. Recent data, however, make it necessary to revise many of their values. The final purpose of the present publication is not only to present recalculated figures in such form as to be readily usable by metallurgists, but also to furnish a tabulation into which data that may become available in the future can consistently be inserted.

SHORT NOTICES

Gold Mining in Ontario.—A description of underground operations and of operating costs at the Parkhill gold mine, where a very narrow vein of high-grade gold ore is mined, is given by A. R. Lawrence in the *Canadian Mining Journal* for August.

Magnesite Mining.—G. J. Young describes the practice and equipment for mining and processing magnesite at a mine in California in the *Engineering and Mining Journal* for August.

Caging and Skip-Loading Devices.—An article on caging and skip-loading devices by Lucien Eaton appears in the *Engineering and Mining Journal* for August.

Aerial Ropeways.—R. F. Emerson deals with the electric operation of aerial ropeways in the *Engineering and Mining Journal* for August.

Carbon Dioxide as Explosive.—In *Chemical and Metallurgical Engineering* for August, F. H. Kneeland gives a description of the use of carbon dioxide cartridges for blasting.

Platinum Recovery in South Africa.—The results of a study on the methods of recovering platinum from South African ores are given by C. Gotze in *Metall und Erz* for August 1.

Skip Hoist.—A new skip hoist installed at Noranda Mines is described in the *Canadian Mining Journal* for August.

Refuse Tipping.—In the *Iron and Coal Trades Review* for August 19 a novel automatic dirt tipper is described.

Apatite Flotation.—The plant of the Russian Apatite Trust for the beneficiation of apatite ores at Khibinogorsk is described by N. K. Karchmer in *Engineering and Mining Journal* for August.

Copper Refinery.—V. A. James gives an account of the equipment of the new refinery at Copper Cliff, Ontario, in the *Canadian Mining and Metallurgical Bulletin* for August.

Boliden.—In the *Engineering and Mining Journal* for July E. Wesslau describes the activities of the Boliden Mining Co. in the Skellefteaa district of northern Sweden.

Trail Reduction Works.—An account of a visit to the Trail reduction works of the Consolidated Mining and Smelting Company is given in the British Columbian *Miner* for August.

Interpretation of Diamond Drill Cores.—A method which is sometimes of use in the interpretation of diamond drill cores is described by E. Wisser in *Economic Geology* for August.

Lepidolite in South-West Africa.—W. P. de Kock discusses the geology of the lepidolite deposits of South-West Africa in a paper read before the Geological Society of South Africa on June 27.

Diamonds.—S. H. Ball gives an account of the diamond and the diamond industry in the *Transactions* of the Royal Canadian Institute, Vol. XVIII, Part 2, 1932.

Carbon Dioxide Exploitation.—The exploitation of natural carbon dioxide in the manufacture of "dry ice" is described by R. C. Fleming in *Mining and Metallurgy* for August.

Special Alloys in Chemical Engineering.—An article on special alloy steels as applied to chemical engineering by T. G. Elliot, R. J. Sarjant, and Dr. W. Cullen appeared in the *Journal* of the Society of Chemical Industry for June 10 and 17.

Tri-State Lead-Zinc Deposits.—C. K. Leith discusses structures of the Wisconsin and Tri-State lead-zinc deposits in *Economic Geology* for August.

Gold in the Belgian Congo.—A discussion on gold developments in the Belgian Congo by R. Anthonie appears in the *Engineering and Mining Journal* for August.

Potash in New Mexico.—E. P. Partridge describes the application of polyhalite from Texas and New Mexico as a fertilizer in *Industrial and Engineering Chemistry* for August.

Vein Solutions.—In *Economic Geology* for August, W. H. Newhouse discusses the composition of vein solutions as shown by liquid inclusions in minerals.

Solubility of Alkaline Earth Minerals.—F. G. Straub describes experiments to determine the solubility of calcium sulphate and calcium carbonate at temperatures between 182° and 316° C. in *Industrial and Engineering Chemistry* for August.

Electrochemistry at the Hoover Dam.—The possibility of the development of electrochemical industries at the new Hoover dam now building on the Colorado River is discussed by J. A. Carpenter and A. M. Smith in *Mining and Metallurgy* for August.

RECENT PATENTS PUBLISHED

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

5,955, 5,956, and 6,101 of 1931 (375,370, 375,795, and 375,798). R. F. Bacon, New York. A chlorination process for the recovery of sulphur from iron-sulphide-containing materials.

8,912 of 1931 (375,840). E. Platone, Florence. For the purpose of forming copper sulphate solutions, copper moistened with sulphuric acid is first oxidized in an upward current of air, the oxide formed being then dissolved in dilute sulphuric acid.

9,224 of 1931 (375,404). H. C. Erith and R. C. Erith, London. Semi-continuous kilns for the burning of bricks and similar purposes.

10,409 of 1931 (376,743). Vereinigte Stahlwerke A.-G., Düsseldorf. A sintering process for fine ores in which the previously-roasted ore is delivered hot on to a layer of solid glowing coke, additional heating gases being conducted over its surface from lateral firing passages.

11,842 of 1931 (375,476). Vereinigte Aluminium-Werke, A.-G., and H. Guisberg, Lautawerk/Lausitz, Germany. A system of recrystallization applied to molten aluminium oxide—aluminium sulphide slags is found to yield an upper layer of Al_2O_3 crystals fairly free of TiO_2.

12,069 of 1931 (375,480). N. Nielson, Copenhagen. Dry grinding in closed circuit, mainly using ventilating air currents to extract the ground material.

23,415 and 24,092 of 1931 (376,988 and 376,534). New Jersey Zinc Co., New York. Zinc-base die-casting alloys substantially free from magnesium.

24,540 of 1931 (376,080). Metallgesellschaft A.-G., and M. Schiechel, Frankfort-on-Main, Germany. Decolorization of barytes by calcination, the addition of certain oxides being found sufficient to transform coloured inorganic impurities into colourless compounds, or into less noticeable colours.

25,126 of 1931 (376,544). C. Padberg, Wuppertal-Barmen, Germany. Zinc-oxide containing materials are mixed with certain sulphates, dried, and heated, the zinc sulphate formed being subsequently extracted by leaching.

34,665 of 1931 (377,079). Karl Schmidt, G.m.b.H., Neckarsulm, Germany. Carbon tetrachloride mixed with an alkali bifluoride and silicon-chloride is found to be a suitable agent for separating oxides from molten aluminium or aluminium alloys.

3,761 of 1932 (376,198). Metallgesellschaft, A.-G., Frankfort-on-Main, Germany. Sintering-belt improvements.

6,571 of 1932 (376,683). Klöckner-Werke, A.-G., and O. Kippe, Germany. Milk of lime or milk of dolomite is used for the precipitation of magnesia from a solution of dolomite in nitric acid.

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.

Textbook of Metallurgical Problems. By A. Butts. Cloth, octavo, 425 pages. Price 24s. London: McGraw-Hill.

Modern Coal Cleaning Plant. By S. H. North. Cloth, octavo, 159 pages, illustrated. Price 5s. London: E. and F. N. Spon.

Petrography and Petrology. By F. F. Grout. Cloth, octavo, 522 pages, illustrated. Price 30s. London: McGraw-Hill.

Dana's Textbook of Mineralogy. Fourth Edition. By W. E. Ford. Cloth, octavo, 851 pages, illustrated. Price 34s. London: Chapman and Hall.

Miami-Picher Zinc-Lead District. By S. Weidman, with chapters on mining methods by C. F. Williams, and milling in the Tri-State district by C. O. Anderson. Cloth, octavo, 177 pages, illustrated. Price $2.50. Norman, University of Oklahoma Press.

Ripper's Steam Engine Theory and Practice. Eighth Edition. By W. J. Goudie. Cloth, octavo, 841 pages, illustrated. Price 25s. London: Longmans, Green and Co.

Lubricating Oil Tests and Their Significance. Second Edition. By J. E. Southcombe. Paper boards, 92 pages, illustrated. Price 2s. 6d. London: Henry Wells Oil Co.

Safety in Mines Research Board: Index to Publications, Vol. VII, 1931. Reports and papers relating to research into coal dust, firedamp, and other sources of danger in coal mines. London: H.M. Stationery Office.

National Coal Resources: The Northumberland and Durham Coalfield. Physical and Chemical Survey of the National Coal Resources No. 24. Price 2s. London: H.M. Stationery Office.

Mines Department: Eleventh Annual Report of the Secretary for Mines, 1931, and the Annual Report of H.M. Chief Inspector of Mines, 1931. Paper covers, 220 pages. Price 3s. 6d. London: H.M. Stationery Office.

Reports of H.M. Inspectors of Mines, 1931: 3—Yorkshire Division, by E. H. Frazer. 7—Swansea Division, by T. Ashley. Paper covers, each price 1s. London: H.M. Stationery Office.

Nigeria: Annual Report on the Geological Survey, 1931. Paper covers, folio size, 40 pages, with maps. Price 2s. 6d. London: Crown Agents for the Colonies.

Tanganyika Territory: The Kimberlite and Associated Occurrences of the Iramba Plateau. Geological Survey Short Paper No. 10. By Dr. E. O. Teale. Paper covers, 10 pages, with sketch map. Price Shs. 2. Dodoma: Geological Survey Department.

New South Wales: Annual Report of the Department of Mines, 1931. Paper covers, 107 pages, with map. Sydney: Department of Mines.

British Columbia: Summary and Review of the Mineral Industry for the six months to June 30, 1932. Compiled by J. D. Galloway. Paper covers, typescript, 50 pages. Victoria: Department of Mines.

Tin Production: Summarized data. United States Bureau of Mines, Economic Paper 13. By J. B. Umhan. Paper covers, 34 pages, illustrated. Washington: Superintendent of Documents.

Cap Lamps and Ventilation: Permissible Electric Cap Lamps and Ventilation in Certain California Mines and Water-Tunnel Construction. United States Bureau of Mines Bulletin 359. By S. H. Ash and J. H. Rankin. Paper covers, 36 pages, illustrated. Washington: Superintendent of Documents.

Low-Grade Manganese Ores: A Study of High-Manganese Slags in Relation to the Treatment of Low-Grade Manganiferous Ores. United States Bureau of Mines Technical Paper 523. By C. H. Herty, Jr., J. E. Conley, and M. B. Royer. Paper covers, 36 pages, illustrated. Washington: Superintendent of Documents.

Silver: Consumption of Silver in the Arts and Industries of the United States. Bureau of Mines Economic Paper 14. Papers covers, 18 pages. Washington: Superintendent of Documents.

Metal-Mine Accidents in the United States, 1930. Bureau of Mines Bulletin 362. By W. W. Adams. Paper covers, 99 pages. Washington: Superintendent of Documents.

Quarry Accidents in the United States, 1930. Bureau of Mines Bulletin 366. By W. W. Adams. Paper covers, 88 pages. Washington: Superintendent of Documents.

Mineral Resources of the United States, 1931. Part II, pp. 1–21. Fluorspar and Cryolite, by H. W. Davis; pp. 23–32, Potash, by A. T. Coons. Washington: Superintendent of Documents.

Minnesota: Quaternary Geology of Minnesota and Parts of Adjacent States. United States Geological Survey Professional Paper 161. By F. Leverett. Paper covers, quarto, 148 pages, with maps. Washington: Superintendent of Documents.

Kingston's Sterling Fluctuation Tables. Card Folder. Price 1s. London: Kingston's Translations Institute.

DIVIDENDS DECLARED

Amalgamated Zinc (De Bavay's).—2½%, less tax, payable October 8.

Balaghat.—Pref. 2s. 9d., Ord. 2s. 3d., less tax, payable September 23.

Burma Corporation.—2 annas, less tax, payable October 15.

Electrolytic Zinc.—Pref. 4%, less tax, payable October 27.

North Broken Hill.—1s. (Australian currency), less tax.

Nundydroog.—2s., less tax, payable October 6.

Witbank Colliery.—6d., less tax, payable October 10.

NEW COMPANY REGISTERED

British-Iberian Minerals. — Registered as a private company August 27. Capital: £1,000 in £1 shares. Objects: To carry on business as owners and workers of mines containing gypsum, barytes, talc, sulphur, mica, and any other minerals, and to acquire any mines, mining rights and land containing any kind of mineral at Garrucha, Carboneras, Aguilas, and Almeria, in Spain or elsewhere. Directors: E. W. Barnett, J. Hocking, E. E. Barnett, W. R. Hocking. Office: 17 Mincing Lane, E.C.3.