The Mining Magazine

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CONTENTS

EDITORIAL

THE Shipping, Engineering, and Machinery Exhibition, which takes place every two years, is now being held at Olympia and will remain open till the end of next week. Official visits are being paid by the principal engineering societies, including the Institution of Mining and Metallurgy.

THE Sir John Cass Technical Institute, at Jewry Street, Aldgate, opens for the 1931–32 session this month. It makes a specialty of evening classes for those engaged in business during the day and affords facilities for education in chemistry, metallurgy, geology, and oil technology.

LUSAKA, it has been definitely decided, is to replace Livingstone as the capital of Northern Rhodesia. Situated 290 miles north of Livingstone and 80 miles south of Broken Hill, the new capital will be not so far away from the copper fields and will be nearer the centre of the country it will dominate. It will be recalled that in the MAGAZINE for June, 1929, attention was directed to this probability.

OUR Personal column records the death within two days of each other of two men to whom the present Witwatersrand gold-mining industry owes much. In 1884 Frederick Struben, after many years of diligent search, located the reef and but four years later, so rapid was the development following Struben's initial and subsequent discoveries, Alfred James was on the Rand applying the McArthur-Forrest cyanide process to the treatment of tailings, which was the foundation of gold extraction as practised to this day in that and many other goldfields.

THE ninth report of the Safety in Mines Research Board [1] reveals the work that has been carried out at Buxton, Sheffield, and elsewhere to discover means of overcoming dangers and difficulties encountered in mining. While most of the problems being tackled are those with which the coal miner is concerned, there are others that have a wider interest. Thus the work which is being continued under Professor Dixon at the Imperial College on wire ropes for winding and haulage purposes is of very general importance, as is also the work of Dr. Haldane and Mr. Ivon Graham on the investigation of atmospheric conditions in hot and deep mines, to both of which attention has been directed in the MAGAZINE in the past.

[1] H.M. Stationery Office. Price 2s.

AN important conference is being called for September 22, in London, by the China Association to consider the situation which has arisen as a result of the fall in the price of silver. Leading men in commerce and in the mining industry will be present, the latter including Mr. W. Pellew Harvey, president of the Institution of Mining and Metallurgy. The conference will be presided over by Sir Robert Horne. In considering this subject it is important to remember that the purchasing power of countries in the East is seriously affected by the loss of credit that has resulted from depreciation in the value of savings which are in the form of silver metal, as was emphasized in the MAGAZINE in February last. Base metal mining would also, of course, be given a considerable helping hand if the price of silver were stabilized at a higher price than at present.

TWO months ago a new European tunnelling record was set up during the work in connexion with the Manchester Corporation Haweswater Scheme, 181 feet being driven in one week. It is claimed that this record has been beaten during the recent operations at the Halkyn Tunnel, in North Wales, which previously held the record, 184 feet having been driven in 144 hours 20 minutes. In considering these figures it is as well to reflect that there are other factors apart from the drill which contribute to speed in tunnel driving. The time taken to handle broken ground has been considerably reduced by the improvements in mechanical mucking or slushing, as it is called, while much time in setting up drills can be saved with special appliances such as were used for the first time in this country by the contractors to the Manchester Corporation in the operations referred to.

FOR the first time in its history the British Association for the Advancement of Science is holding its annual meeting in London, the occasion being the centenary of its foundation. General Smuts is this year's president and the opening meeting, when he will formally assume that position, is to be held at the Albert Hall on September 23. The work of the various sections will begin on the following day and continue till September 30, nearly all the sessions being held in different buildings belonging to the Imperial College and in the neighbouring museums. Among papers of special interest to readers of the MAGAZINE the following might be mentioned:—On September 25 the physical section will discuss geophysical methods of prospecting, with special reference to the instruments employed, on September 28 the engineering section will hear a paper on methods of improving the Kata conditions of atmospheric air in deep-level mines, and on the following day the geological section is to consider ore-genesis in relation to petrographic processes.

The Faraday Centenary

The researches of Michael Faraday have been of such far-reaching importance and their effects on the present-day world so great that his name is like to be inscribed among the immortals. The ultimate effect of his work on our economic and social life is difficult to see, for Faraday was, after Boulton, Watt, and Stephenson, among those who have materially contributed to the rationalization of industry. His discoveries have had an important bearing on the construction of modern mining and metallurgical plant and the centenary celebrations which are being held in London this month will be of peculiar interest to members of these allied professions. The actual centenary which is marked on this occasion is the discovery of electro-magnetic induction, which is held to be the foundation-stone of our modern electrical age, although Faraday's later work has had an equally important effect on the development of metallurgy.

The early life of Faraday is so well known that reference to this period of his career is unnecessary here. It will suffice to say that Faraday first gained distinction as a chemist and to chemists he is known as the discoverer of benzene. His association with Davy at the Royal Institution commenced in 1813 and in 1815, after travelling with Davy on the Continent, he was re-engaged by the authorities at the Institution. The discovery of electro-magnetism by Oersted was made known in 1820, but it was not until ten years later that Faraday set up another epoch-making discovery when he was able to show how magnetism could be used to generate an electrical current. It has been said by Sir Ambrose Fleming that "in ten days' actual work during the autumn months of 1831 Faraday not only discovered the facts of current induction and magneto-electric induction as well, but embraced them all in the statement of one great generalization of the utmost simplicity." These researches, which finally led to the invention of the induction coil, the dynamo, and the transformer, were not, however, Faraday's only contribution to electricity. There followed years of work in many branches of this subject, including investigations into specific inductive capacity, researches into magnetism and light, and, most important to those associated with mining, his electro-chemical researches and inquiries into voltaic action, the foundation of modern electro-metallurgy. Thus he was a discoverer of an important method of providing power and a pioneer in its application.

Perhaps the feature of the celebrations which will be of most interest to miners and metallurgists will be the exhibition which is to be held in the Royal Albert Hall at the end of the month. The major part of this will, of course, be taken up by exhibits of electrical plant and equipment, but space has also been allotted to electro-chemistry and electro-plating developments. In the section illustrating modern aspects of electro-chemistry there will be a display illustrating the electrolytic recovery and refining of metals, in the provision of which the British Non-Ferrous Metals Research Association has taken a leading part. Most of the firms engaged in the production of non-ferrous metals, both at home and overseas, will show their products in this section. The exhibit devoted to electro-deposition and plating will also be of a representative character, among the items to be shown being small-scale models of nickel and chromium plating plants and also an automatic plating plant, an illustration of modern practice in the mass production of plated articles. The Research Department

at Woolwich will also have an exhibit, which will cover investigations into the control and improvement of plating processes. Specimens will be shown here illustrating decorative plating and protective metal coatings and there will also be a number of examples of articles plated with platinum-group metals. Results obtained in this direction have been very encouraging, although they are only commercially possible in view of the present low price of metals of this group. Among the specimens shown in this section there will be illustrations of the latest advances in plating with palladium and rhodium, the latter giving a particularly pleasing and untarnishable coat. Another branch of the plating industry which is of increasing importance, and which will also be illustrated at this centenary exhibition, is that dealing with the building-up of worn or undersized machine or structural parts, a complementary item being the coating of such parts by a metal harder than the original base, a process giving longer life to the articles treated. Finally mention should be made of the exhibits of the Royal Mint, the Victoria and Albert Museum, and the London School of Printing, which cover the field of artistic electrotyping.

Secondary Metals in the United States

In a time of declining metal prices the position of the primary producer is somewhat different from that of the producer from secondary sources. While the former is confronted with the problem of reducing the cost of ore production, the latter is not so handicapped, since he can obtain his raw material at a price which is contingent on that ruling for the finished metal. In the latter case, too, the cost of the available processes for the recovery of the metals involved will to a much larger extent decide whether extraction will be profitable. Nevertheless the continued fall in metal prices which was experienced last year made it unprofitable for many secondary metal producers and it is not surprising that the latest returns from the United States, covering the recovery of metals from secondary sources during 1930, should reveal, not only a substantial falling off in value, but a marked diminution in quantity. These figures show that the value of certain non-ferrous metals recovered from scrap in the United States declined from approximately £66,205,000 in 1929 to approximately £38,650,000 in 1930, although the quantity produced decreased by only 24 per cent. This great decrease in value was mainly due to lower prices for the principal metals concerned—copper, lead, zinc, tin, and antimony. The table below summarizes the production in short tons of secondary metals in the United States for 1930 and the figures for 1929 are added for comparison :—

	1929	1930
Copper, including that in alloys other than brass	417,600	332,800
Brass scrap remelted	298,500	192,000
Lead as metal	138,500	129,000
Lead in alloys	172,500	126,800
Zinc as metal	65,400	49,300
Zinc in alloys other than brass	11,600	7,700
Tin as metal	7,400	5,600
Tin in alloys and chemical compounds	26,900	20,600
Antimony as metal	52	
Antimony in alloys	11,079	8,082
Aluminium as metal	25,850	19,700
Aluminium in alloys	22,550	18,900
Nickel as metal	850	500
Nickel in non-ferrous alloys and salts	3,500	2,400

It is evident that the quantities of metal produced from these sources are significant considered in relation to the total amount of metal coming on to the world's markets.

Examining the figures given in some detail in the full report, the shipments of scrap copper and brass to Europe declined during the year under review and imports were less than in 1929. The production of secondary copper metal itself was estimated to be 244,800 tons, as compared with 297,600 tons in 1929, while the copper content of secondary brass and other alloys was 222,400 tons, against 328,950 tons, the total of secondary copper being 467,200 tons, as compared with 626,550 tons in the previous year. In the case of lead the secondary metal recovered by smelters whose main business is the treatment of ore was 48,135 tons, that coming from scrap and dross refiners amounting to 80,865 tons, the total of 129,000 tons comparing with 138,000 tons recovered in 1929. With these amounts must be reckoned the lead recovered in remelted alloys, which in 1929 amounted to 172,500 tons, whereas the total for 1930 was only 126,800. When it is realized that the total production of primary lead in the United States during 1930 was only 655,059 tons, it will be realized that the secondary metal, totalling altogether 255,800 tons, is an important item, seriously affecting the world's markets. Turning to zinc it is seen

that the production of unalloyed secondary metal fell from 65,400 tons in 1929 to 49,300 tons in 1930, while the zinc recovered in alloys, including brass, was 50,000 tons, against 87,270 tons. Only a slight fall was recorded in the case of zinc dust produced from dross, the amount in 1930 falling to 6,394 tons from the 7,424 tons recovered in the previous year, but the zinc content of zinc salts recovered from skimmings and such-like material was considerably lower, although the lithopone produced from similar sources increased from 65,364 tons in 1929 to 74,034 tons last year. The figures for tin show that secondary pig tin amounted to 5,600 tons in 1930, against 7,400 tons in the previous year, the tin recovered in alloys and chemical compounds declining from 20,900 tons to 20,600 tons. The other important metals covered in the return, as will be seen from the table, are antimony, aluminium, and nickel, the production of each of these showing a sharp decline in 1930, although the secondary production in each case is still a considerable factor.

Tin

Trade conditions throughout the world remain poor and weakness in the statistical position of any particular metal speedily reacts on a frightened market. If such were not the case it would be difficult to understand the present price of tin, in view of the returns published at the end of last month, which showed a decrease in the visible supplies. The position seems to be that the two important events of last month, which are dealt with later on and which were bound to react favourably on the price of the metal, have been more than counterbalanced by dissatisfaction with the August returns, uncertainty as to the outlook for the present month, a feeling that a further 10 per cent. cut all round in the quotas should have been imposed at the last meeting of the International Committee, and a lack of confidence in the trading situation generally.

The two important events of last month referred to were—first, the decision of the Malayan Government, as announced in the August issue of the MAGAZINE, to take steps to deal with the amount of tin produced during the first eight months of the year in excess of the country's quota and the cutting of the assessed production of the Malayan producers by 60 per cent. as from September 1 in order to counteract the excess, and, secondly, the announcement on August 25 of the formation of an International Tin Pool. The imminence of the formation of such a body has been mooted for some time. The constitution of the pool is a strong one, all the big participants in the quota scheme being members, and all have agreed to continue the quota scheme to the end of February, 1933. The official communiqué issued by the committee of control of the pool announced that it would work in close co-operation with the International Tin Committee, the chairman of the latter being ex-officio chairman of the control committee. The tin to be acquired by the new body is to be released in accordance with a sliding scale of prices, which has been approved by the Governments concerned, the initial release of 5 per cent. of the stocks to become effective if and when the price of the metal on the London Metal Market remains at more than £150 per ton for more than a month. The formation of the International Tin Pool was an important step toward the control of supplies of this commodity and the first result was the firmness of the market and an advance in prices, but the position weakened after the issue of the August returns, evidence of the continued lack of confidence in the future.

Whatever individual feelings may be as to the merits and demerits of the restriction scheme or the wisdom or unwisdom of interfering with the natural or unnatural laws of supply and demand, it is nevertheless quite evident that the controlling factor in the present situation is the continued poor consumption. The position of the various governments in the new scheme is uncertain, as it is not known whether they are to become actual purchasers of tin or whether their part is merely to finance the immobility of stocks, such as those existing in Holland and Malaya, but it is certain that they are gaining a degree of control over the situation. Informed opinion is inclined to discount the recent improvement in deliveries to America, the view being held that these are greater than can be accounted for by trade demands, and it is probable that consumers are taking advantage of the present low price to replenish their stocks. The position now appears to be somewhat akin to stalemate, present supply approximating to present demand, while the market awaits that return of confidence which alone will initiate the inroads into the accumulated stocks which still menace the situation.

REVIEW OF MINING

Introduction.—The firmness displayed by the new Government in carrying out its intention to balance the Budget, as the first step towards the restoration of confidence in sterling, might also be considered the first step towards a return to normal conditions. The position is also helped by the readiness of the new Ministers to recognize the fact that the next and perhaps the most important step will be to adjust the balance of trade.

Transvaal.—The output of gold on the Rand for August was 870,822 oz. and in outside districts 45,603 oz., making a total of 916,425 oz., as compared with 916,843 oz. in July. The number of natives employed in the gold mines at the end of the month totalled 209,409, as compared with 208,155 at the end of July.

The report of the Consolidated Main Reef Mines and Estate for the year ended June 30 last shows that ore reserves have decreased 195,740 tons to 1,936,560 tons, the value falling 0·3 dwt. to 6·9 dwt. This position is created mainly by the retardation of development on the Main Reef Leader, caused by the introduction of third stage hoisting at No. 3 shaft. During the year 773,800 tons of ore was crushed, yielding 267,501 oz. of gold, worth £1,131,796, silver and osmiridium bringing the total revenue up to £1,133,444. Working costs were £906,806 and working profit £173,706. Dividends paid during the year absorbed £151,542, equivalent to 12½ per cent.

Shareholders of the East Geduld Mines have been informed that the trial crushing was started on July 6, since which date the plant has been thoroughly tested and found satisfactory, the amount treated daily now being 1,500 tons. Up to the end of August 48,700 tons was crushed, a partial clean up yielding 4,196 oz. of gold, but a substantial portion of the ore crushed had not gone through all stages of treatment, while a considerable quantity of gold has been absorbed in the plant. Working expenditure for this period was £77,697.

It was stated last month that Dome Mines, which recently secured an interest in East Geduld, had acquired a large interest in the Grootvlei Proprietary, but this has been since denied by the chairman of the last mentioned company.

A circular to shareholders of Potgietersrust Platinums states that the world's principal platinum producers have been discussing the formation of a company to stimulate the uses of the metal and to regulate its marketing and that negotiations to this end are nearing completion. It is expected that the quota allotted to South Africa by the new controlling body will be insufficient to permit of the working of two mines and it is in consequence proposed to form a company to take over the two platinum mines at Rustenburg—the Eerstegeluk mine of the Potgietersrust company and the Waterval mine of the Waterval (Rustenburg) Platinum Mining Company. The whole of the issued capital of the new mining company will be allocated to the component companies on the basis of the valuation of the assets transferred.

During the year ended June 30 the realization of the equipment of Onverwacht Platinum proceeded very slowly, the net sum obtained being £3,176. The total assets of the company now amount to £54,756.

Severe rockbursts occurred on the Rand at the beginning of the month, several natives being killed and Europeans and other natives injured.

The profit of the Johannesburg Consolidated Investment Company for the year to June 30 last was £308,745, against £565,192 the previous year. The dividend rate was reduced from 15% to 7½%, the sum absorbed being £296,250. The report states that gross profits have been well maintained, but that owing to the abnormal depreciation in certain shareholdings it has been necessary to transfer £350,000 from reserve, leaving that fund at £650,000. The operations of the mines of the group have had very satisfactory results, the value of the gold produced during the year being approximately £13,000,000.

Shareholders of the Consolidated Gold Fields of South Africa have been informed that, although profits earned during the year ended June 30 last would have provided the dividends on both classes of preference shares, it has been decided, in view of the depreciation of all classes of securities, to postpone the payment of the dividend due on October 1 on the Second Preference shares.

Diamonds.—The production of diamonds in the Union of South Africa during the first half of the current year totalled 1,173,507 carats, valued at £2,557,547, showing a decrease in value of over £1,500,000 when compared with the output for the first half of 1930. Sales averages show the carat value to have fallen from 66s. to 40s.,

while present values are below half those of 1929. The average value of mined stones in the present year is 36s. and of alluvials 62s. 2d.

Southern Rhodesia.—The output of gold from Southern Rhodesia during July was 44,765 oz., as compared with 44,118 oz. for the previous month and 45,810 oz. in July, 1930. Other outputs for July were: Silver, 6,207 oz.; copper, 2 tons; coal, 52,647 tons; chrome ore, 5,859 tons; asbestos, 1,056 tons, and mica, 3 tons.

The accounts of Southern Rhodesia Base Metals for the year ended March 31 last show a loss of £28,882, increasing the debit balance to £38,988. Since the close of the accounts a debenture for £30,000, creating a first charge on the assets of the company, has been made in favour of Minerals Separation, Ltd., for the amounts advanced by them in connexion with the segregation plant at the Alaska mine. During the period reviewed 2,033 tons of concentrates was produced at the sulphide plant, while in the current year this plant produced 260 tons of concentrates before it was closed down. The segregation plant was completed in February last and worked satisfactorily up to the closing down of the mine in June.

At a meeting of shareholders of Mayfair Gold Mining Company, held in Bulawayo this month, it was resolved that the company should go into voluntary liquidation. Since the closing of the mine in June efforts have been made to let the mine on tribute, but so far without success. The company's indebtedness at July 31 amounted to £61,500.

By an order of the High Court the Rhodesian Corporation is to be permitted to make a complete inspection of the Globe and Phœnix mine, the company working the mine having been refused the right of appeal against this judgment.

Northern Rhodesia.—It is proposed by the Rhodesian Selection Trust to alter its arrangements for the provision of funds for the development and equipment of the Mufulira mine. The report for the year ended June 30 last shows that advances from the American Metal Company, Messrs. Cull and Company, and the Lehman Corporation, under the terms of the existing agreement, amounted to £781,250, increasing the total advance to £1,093,750, out of a guaranteed total of £1,500,000. It is now proposed that $7,500,000 of 6% debentures possessing conversion rights, out of a sanctioned total of $12,500,000, should be created forthwith and appropriated to satisfy the advances which have been made to the company. It is stated that construction work on the plant at Mufulira and the opening up of the mine are proceeding according to schedule and it is expected that all will be ready to commence production early next year. Of the 4·14% of copper present in the company's estimated ore reserves of 162,000,000 tons it is estimated that 96% is present as sulphides.

The report of the Rhokana Corporation for the three months ended June 30 last states that construction at N'Kana is up to schedule, while the erection of the permanent power plant at N'Changa was almost complete. A limestone property at Kabundi, near Bwana M'Kubwa, is being prepared for exploitation, the stone to be used as a flux at N'Kana, while arrangements are also being made to supply the Roan Antelope smelter.

The report of Luiri Gold Areas for the fifteen months ended March 31 last shows a debit balance of £12,840. It has been decided that options on shares maturing in 1931 be extended, so that they will run concurrently with 1932 options. During the period under review 21,762 tons of ore was treated for a bullion recovery of £39,721. In June last it was decided that the treatment of ore from Matala Hill should be discontinued and that only ore from the Dunrobin mine should be treated for the time being.

Nigeria.—The report of the London Nigerian Power Company to February 28 last shows the operating profit to have been £9,072. After writing off various expenses a balance of £213 has been carried forward. The demand for power by the mines was substantially curtailed owing to restriction schemes, but the number of units sold amounted to 4,895,952, a figure representing approximately 72½% of the original capacity of the installation. A new dam, known as the Ouree River dam, has now been completed, the capacity of the station being increased by 44%.

Australia.—In the circular to shareholders of the Wiluna Gold Corporation, briefly mentioned here last month, it was stated that on the 800 ft. level on the East Lode a cross-cut at 50 ft. had exposed the lode, which at that point was 10 ft. wide and of low grade, but that driving north and south from the cross-cut was proceeding. Recent advice is to the effect that the south drive

at 295 ft. has encountered ore of good grade, assaying 34s. per ton over the drive width of 4 ft. 6 in.

The strike of contract men in the employ of the Zinc Corporation, which was mentioned here last month, was called off at the end of August. Work was resumed on September 7, but for the time being it is only on a half-time basis.

The accounts of Barrier South for 1930 show a profit of £200, the debit balance brought in being thus reduced to £7,547. Operations on the Broken Hill field being so restricted, the directors have nothing further to report regarding development work on the Zinc Corporation's property, which adjoins that of the Barrier South.

Last year the company known as the Gold Mines of Australia was formed to take an option on the Mount Coolon mines and it is now announced that this has been exercised. A new company—the Mount Coolon Gold Mining Company—is to be registered, having a capital of 800,000 shares of 10s. each, of which 600,000 are to be issued. Gold Mines of Australia are to take 130,000 shares to repay expenditure and the remaining 470,000 shares will be issued in Australia.

Malaya.—During the year ended March 31 last Ulu Klang Tin made a profit of $14,200, which with the sum of $48,859 brought in gave an available total of $63,059. Of this amount $40,000 has been transferred to reserve, the balance of $23,059 being carried forward. During the year 781,893 cu. yd. of ground was treated for a recovery of 268½ tons of tin concentrates, the acreage worked being 24¼.

The report of the Raub Australian Gold Mining Company for the year ended February 28 last shows a profit of £41,008. The tonnage milled—31,620—was slightly greater than the previous year's total and the average gold content at 14·1 dwt. also showed improvement, while the gold recovered was 22,304 oz., against 17,132 oz. The bullion produced realized £93,970, working costs amounting to £49,280. The ore reserves at the end of the year were estimated to be 33,400 tons, of which 17,500 tons contain more than 10 dwt. per ton. The reopening of the Silensing mine is being considered by the company.

Canada.—The report of Keeley Silver Mines to February 28 last shows the year's output to have been 1,318,035 oz. of silver and 111,305 lb. of cobalt, the gross revenue being $503,458, against $492,537 in the preceding year. The profit was $139,294, as against $101,978, and the net surplus of $907,500 shows an increase of $140,077. Ore reserves have almost been worked out. While several good shoots were found during the period under review they were mined as soon as found, owing to the low price of silver. Some low-silver cobalt ore still remained and this is now being extracted.

The first report of the Huronian Mining and Finance Company, covering the period from October 25, 1929, to March 31, 1931, shows a net profit of $5,318, after writing $1,812 off claims and examinations and $1,385 off organization expenses. The net current liquid assets of the company are estimated to amount to $843,692, exclusive of the value of mining claims or interests in non-productive properties acquired at the time of organization.

Panama.—A circular issued by Panama Corporation last month stated that the erection of the smelting plant at Remance was well in hand and that the entire mill was operating successfully, treating 80 tons per day. Bad weather conditions somewhat interfered with the washing operations at El Mineral and on the Sabalo section, 11 oz. of gold being recovered from 338 cu. yd. at the former place.

Yugoslavia.—During the three months ended June 30 last Trepca Mines treated 63,752 tons of ore, recovering 9,659 tons of lead concentrates, assaying 76·6% lead and 27·3 oz. silver per ton, and 7,898 tons of zinc concentrates, assaying 51·3% zinc. The revenue for the period was estimated to be £95,511, while the total working costs were £56,749, the surplus of £38,762 representing 12s. 2d. per ton milled. The capital expenditure for the same period amounted to £14,162. The adit at the 610 m. horizon was advanced a further 104 m. and completed, while the 771 m. adit was advanced 38·5 m. and connected with the hoisting shaft. The total meterage driven during the period under review was 564·4.

Siberia.—At meetings of shareholders of the Tetiuhe Mining Corporation, to be held this month, they will be asked to approve a provisional agreement concluded between the directors and the Russian Government, with a view to the termination of activities and a return of the properties. The consideration to be paid has not yet been settled, but it will take the form of Russian bonds bearing interest at 7% and redeemable in annual instalments over a period of years.

ANCIENT MINING ACTIVITIES IN PORTUGAL

By FRANK A. HARRISON

In this article the author describes the work of the "ancients" in North Portugal, particularly in regard to the mining and treatment of auriferous sulphide ores in the area of the Minas dos Mouros gold mine.

Although it is known that the mines of Spain and Portugal were worked for centuries by people referred to to-day as the "ancients," it is doubtful if the vast extent and importance of the industry has generally been sufficiently recognized and appreciated. There is clear evidence that many of the mines were operated first by the Phœnicians and later by the Romans, whose occupation of the Peninsula lasted for some 450 years. In numerous districts there are to be found immense excavations, relics of both open-cast and stope-workings for base metals, principally tin, antimony, lead, and copper, although the larger and more important mines were opened for the winning of gold and silver.

In the present article the writer proposes to describe, in a more or less detailed manner, one particular mining area where immense gold workings have been found, which are of peculiar interest and importance from both an engineering and metallurgical point of view. This area is situate at an elevation of 1,000 metres in mountainous country, a few kilometres to the east of the railway station of Pedras Salgadas, Tras os Montes, Northern Portugal.

As will be seen from the sketch map shown in Fig. 1, the main rocks of the district are a steeply-tilted talcose schist of Archæan age, which is underlain by a coarse-grained porphyritic granite, the contact being very clearly defined. In this area two ore-bodies have been stoped-out by the "ancients" from surface to varying depths, one in the schists, known as "Gralheira," consisting of a regular and persistent series of parallel quartz-filled lenses with an east to west strike and vertical dip, the other, in the granites, known as the "Campo Reef," being a true quartz-filled fissure, very bold and well-defined, with a strike N45E, and a vertical dip, the width of the vein being from 2 to 4 metres.

The junction of the Gralheira and Campo reefs occurs at the contact of the schist and the granite and there appears little doubt but that both are, in reality, of the same age, in other words they were formed along two lines of weakness meeting at 45°, which were caused by the intrusion of the granite. In addition, the mineralized quartz-filling of both lodes is practically identical, consisting of a very hard blue-grey quartz, carrying an average of between 37% and 42% of sulphides in which pyrite, arsenical pyrites and galena predominate.

Analyses of typical composite samples of the vein filling show the following contents in the dried sample:

	%
Copper	0·15
Lead	5·50
Antimony	1·00
Arsenic	5·90
Zinc	1·00
Iron	9·30
Sulphur	5·65
Silica	71·50
	100·00

Silver per ton of 2,240 lbs., 7·50 oz.
Gold per ton of 2,240 lbs., 0·50 oz.

Another analysis, of a different but similarly taken sample, which was carried out in America, gave similar results:

	%
Lead	5·30
Iron	8·50
Copper and zinc present.	
Silver	6·80 oz.
Gold	0·46 oz.

The last analysis was made in the course of a test to determine the possibilities of treating the ore by differential flotation and the arsenic content was excluded.

Although some 200 assays have recently been made of the various specimens of this ore collected from the stopes and ancient dumps during the past two years, in no case has visible gold been detected. Even in the case of samples taken from an old pillar discovered at a depth of 50 ft. from the outcrop no gold was visible although one sample assayed as high as nearly 3 oz. of gold per ton.

These old workings were first seen and visited by the writer late in 1927, when particular attention was paid to the Campo and Gralheira sections. Careful examination showed that for an almost unbroken distance of some 6½ kilometres along the outcrop

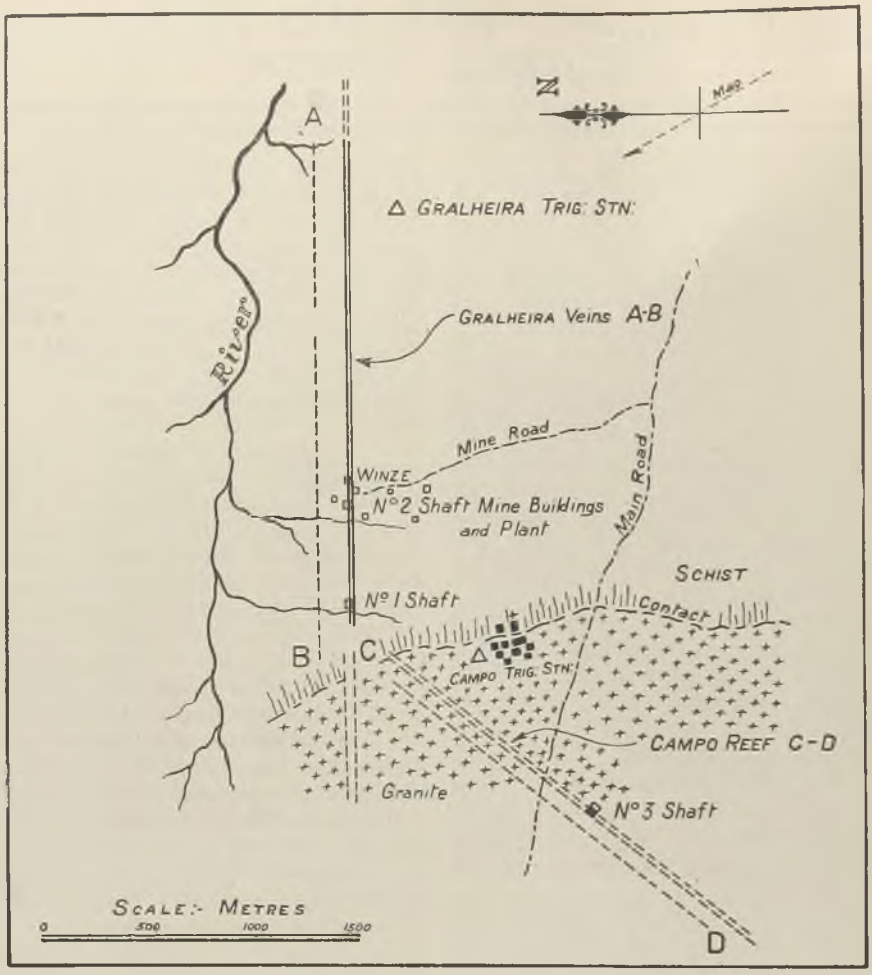


FIG. 1.—SKETCH MAP OF AREA.

the entire ore-body had been stoped out. (Fig. 2.) The stopes were for the most part filled with debris to within a few metres of the surface. No dumps of waste rock have been found commensurate with the magnitude of the work and, at first, no specimens of any ore was discoverable to indicate the objective of these old mine operators. Later, however, close to the Gralheira trigonometrical pyramid, some quite encouraging float stones of pegmatite, carrying coarse crystals of cassiterite were exposed when turning over one of the dumps. This later led to the discovery of a 2-metre wide pegmatite dyke carrying some tin throughout. On trenching for the extension of this dyke, it was found to be vertical and it cut across the main Gralheira formation at a bearing N45W.

The failure to find any such stanniferous pegmatite in the dumps along the main strike of the old workings led to the search for other ores. A few fragments of a bluish quartz showing some pyrite, galena and blende were collected which, on assay, showed comparatively high gold and silver values, the first series of 4 assays giving 3 to 10 dwt. of gold and 4 to 12 oz. silver. This provided reasonable evidence of the metals for which the important workings had been carried out. The deeper the dumps were probed the more samples were collected with similar satisfactory assay results.

Next a re-examination of the walls of the surface stopes was made, with the result that places were found where the indurated schist walls were heavily impregnated with

galena and other sulphides. Assays of this impregnated schist showed high lead and silver contents with from 1 to 5 dwt. of gold. The mineralization occurs as thin powdery layers between the laminations of the schist together with pockets of crystals. It was noteworthy that, in spite of diligent search, no quartz could be found in situ, which led to the conclusion that all of it had been removed for treatment.

The obvious solution of the problem of finding ore in situ was to sink through the debris-filled stopes to a level below the ancient workings and thus, if possible, expose the ore. This was done by means of three 3-compartment shafts, two (Nos. 1 and 2) being on the Gralheira section, 1,800 ft. apart at sites conveniently positioned with a view to later driving galleries in ore below the old working bottom, the third shaft, No. 3, being situated on the Campo Reef, some 2,500 ft. to the S.W. of No. 1 at Gralheira. All shafts are vertical, following the ore.

No. 2 shaft was the first to give results of interest. At the surface the stope width, clearly the width of the vein removed, was 45 in., gradually narrowing to 17 in. at a depth of 57 ft., thus corresponding to the lenticular form of the ore-bodies so clearly noticeable when viewed laterally on the surface. At this depth ore was struck from wall to wall in the central cut in the bottom of the shaft.

Fig. 2.—Ancient Workings: Minas dos Mouros Mine.

Table 1

Sample No.	Gold. Dwt. per ton.	Silver. Oz. per ton.
1.	50	11·9
2.	27	144·4
3.	18·6	57·5
4.	15·6	60·0

As the workings narrowed, portions of the foot and hanging walls had to be removed to keep the shafts of uniform

dimensions. Further sinking proved this ore to be a pillar, about 4 ft. by 3, left for safety in the course of the stoping out of the ore-body. Prior to the removal of this pillar 4 samples were taken, which, on assay, yielded the remarkable results shown in Table 1.

It seems doubtful that such values as those given could possibly be representative of the average value of that section of the ore-body already mined out, yet it was difficult to suppose that a small section of such richness would reasonably be selected for abandonment as a pillar, nor was there any sign of change or weakness in either foot or hanging wall at that spot, indeed the ground here was in every way sound.

As sinking proceeded the narrowing down of the vein and the stope width continued to the 70 ft. level, where the ancient workings ceased. Work was continued in undisturbed ground to the 105 ft. level, the vein gradually widening out again to about 8 in. The ore at this depth was similar in character to that in the pillar, assaying gold 10 dwt., silver 6 oz., and lead 5·9%.

At 65 ft. depth in the shaft, a mass of ancient oak timbers was encountered, together with earthern pipkin lamps, tiles, etc. An interesting feature of this oak mine timber is that at the elevation of over 2,000 ft. in this district there is but little oak to be found and where found it is stunted and seldom of greater diameter than 3 to 4 in. Pines and Spanish chestnut, however, have splendid growth at this elevation to-day and the former is abundant and very cheap.

From 85 ft. depth downward the water became a problem for hand baling and a Diesel engine of 50 h.p. and a compressor were installed and a drive of 100 ft. was driven eastward in ore at the 100 ft. level.

No. 1 shaft also reached the ancient working bottom at about 60 ft. from surface. The lense there, although narrowing somewhat, opened out again and at the 85 ft. level had a width of 11 in. and this is steadily increasing. The value and character of the ore is practically identical with that in No. 2 shaft.

No. 3 shaft, on the Campo reef, was sunk to 45 ft. in a vertical stope over 6 ft. wide and showed no narrowing of the vein throughout. Unfortunately in this shaft further work was not possible without mechanical pumps, the surrounding country having a heavy soil overburden for the most part under plough, thus allowing rather heavy surface water to drain into the old stope. A 2 in. discharge sinking pump would easily cope with the water even in the wet season, but hand-baling was out of the question.

The completeness of the extraction of all reef matter by the old workers, with the exception of the above-mentioned pillar in No. 2 shaft, together with the rareness of discarded fragments of ore in the dumps, leads to the conclusion that the entire ore-mass must have been worth removal and treatment.

Whilst this sinking work was proceeding other discoveries of great interest and importance were continually being made. The villages and corn-grinding mills in this locality are built almost entirely of split granite blocks and it was noticed that a very great proportion of these were of the same size and character, namely, rectangular blocks of intensely hard porphyritic granite, roughly 100 by 50 by 50 centimetres with, on the centre line of each of the 4 greater sides, 4 cup-shaped depressions. In addition, and built into the walls, there were broken sections of innumerable circular mill-stones, somewhat similar to such as are used to-day by the peasants to grind their corn in water-driven mills. The granite of these old stones is, however, harder than the granite of the neighbourhood, and must have been transported a considerable distance.

It was at first assumed that these two types of stones constituted the coarse and fine crushing plant of the ancients, and this assumption was later confirmed by the discovery of roasting furnaces and vast quantities of slags and scoria wherever these stones were found in quantities. These "dressing floors" are as a rule situated near the banks of the torrential streams in the vicinity of the mines and doubtless much of the recrushed slags was carried downstream during the seasonal floods, but near the furnaces, which were very naturally built into the hillsides above normal flood level, very large banks of slag remain to-day, from which many samples have been recently taken, which, when assayed, show 5 to 7 dwt. of gold, high silver values, and much metallic lead.

At this point it is perhaps desirable to describe more fully the nature of the ore mined and treated by the "ancients."

The quartz matrix is extremely hard, but heavily mineralized, the chief constituents being arsenical and iron pyrites, galena, blende, and other sulphides, together with silver and gold in highly paying quantity. Little more than a decade ago, before the differential flotation process had provided a practical and economic solution for the concentration of ores such as these, the treatment of this complex material would have constituted a grave problem for the metallurgist, yet here, at Mouros, is evidence that some process was known which was, presumably, successfully used by the " ancients " on hundreds of thousands of tons of ore.

What that process was might reasonably be deduced by examination of the dressing floors, furnaces, the treated and re-treated slags, and scoria. The ore was crushed and roasted and the resultant slags probably re-crushed and re-treated for the recovery of the precious metals. It will be noted that the mine ore contains five or more per cent of galena, a quantity which may have furnished the necessary excess of lead, corresponding almost exactly to the lithargine process of known antiquity. Much of the slag still existing, especially the coarser grained material, shows a profusion of prills of metallic lead.

This process of the " ancients " does not appear to have been particularly efficient, since almost every assay recently made of the scoria shows high values of gold and silver. This, coupled with the fact stated above, that practically the entire ore-body was removed and treated, cannot but lead to the supposition that the original precious metal content of the ore was very high ; further, the recent assays of discarded pieces of ore, which are so rarely found in the dumps, give consistently high values and it is unlikely that such discarded fragments carried values in excess of the average run of the ore mined.

Since the autumn of 1930 this ore has been subjected to numerous tests with a view to determining the best and most economical method of treatment to produce marketable products. As might be supposed the consumption of cyanide proved excessive and this method of extraction had to be ruled out, certainly as far as the main treatment was concerned.

Preliminary flotation tests in a bronze and glass laboratory cell, however, almost immediately indicated the most reasonable solution of the dressing problem. Various oils and reagents were tried which gave remarkably good and complete separation with a tail almost entirely free of mineral. Classified grinding and classification has proved that with this ore the mineral is entirely freed and the best results obtained with grinding to − 40 mesh, so that, the ore being extremely hard, great economy will result as regards crushing and the passage through the cells.

In order to check and confirm these flotation tests a sample of the ore was submitted to the Denver Equipment Company in America, a copy of whose analysis and report is quoted below, confirming the advantages which should result from the treatment of this particular ore by differential flotation methods.

TABLE 2

ANALYSIS AND FLOTATION TEST

Product	Product %	Troy oz. per ton. Gold	Silver	Analysis. Pb.	Cu.	Zn.	Fe.
Head . .	0·0	0·46	6·80	5·3	·05	·1	8·5
Lead Conc.	8·5	2·12	55·64	53·5			
Lead Midl.	1·1	0·5	12·90	9·3			
Iron Conc.	35·8	0·66	3·58	1·5			20·6
Tailings .	54·6	0·01	0·12	0·1			

PER CENT. RECOVERY

Amount tested	Product	Gold	Silver	Lead
1,000 grammes. Dilution 4—1. Dry through 4 mesh. Diluted 1—1 with water then by classified grinding for 11 mins. ; all through 60 mesh.	Lead Conc.	42·2	76·1	87·7
	Lead Midl.	1·2	2·3	1·9
	Iron conc.	55·4	20·6	10·4
	Tailings	1·2	1·0	—

Time required for conditioning . 10 minutes.
Flotation . . . . 4 ,,
Total . . . 14 minutes.

REMARKS.—Reagents used in lb. per ton after diluting 4—1 were :—

Sodium Carbonate 8·0
Cyanide . . . 0·1
Zinc Sulphate . 0·3
} Pulp conditioned 5 min. ; then

Cresylic Acid . 0·12
Ethyl Xanthate . 0·09
Yarmoor distilled Pine Oil . . 0·06
} then conditioned 5 mins.

followed by 4 mins. flotation yielding rougher concentrate.

These rougher concentrates were cleaned without addition of more reagents.

Iron had been so successfully depressed with soda-ash, cyanide, and zinc sulphate that excess sulphuric was required to reactivate. Then additional Yarmoor pine oil and ethyl xanthate was added to obtain iron concentrate. No time obtained due to misleading effect caused by these conditions.

As mineral is perfectly free at 60 mesh it would seem coarser grinding could and should be used as gangue is very hard.

Results show that flotation should be used as the ore responds beautifully and gives unusually good extraction with ideal concentrates obtained.

This Mouros ore carries so high a content of arsenic, 5·90%, that a recovery of it as a marketable product might be reckoned as a source of additional profit and in addition the production of sulphuric acid might also be worthy of consideration should a local market be found.

During the course of this exploratory work at Mouros, various other ancient workings of varying size and importance have been discovered, especially along the extension of the Gralheira mineralized zone, which is found to continue for over 50 kilometres to the east in a dead line. By far the greatest and most important workings, however, were found 5 kilometres due north of shaft No. 2 where, on a parallel mineralized zone, there are two immense open-cut workings, from which more than 20 million tons of rock have been removed.

The following description of these workings was written some months after they were first seen by the writer : On an E.–W. strike there is a highly mineralized vertical zone in Archæan schists, similar to those at Mouros, the zone lying close to the granite contact. The principal works consist of two vast open-cut workings, each approximately 300 metres by 150 metres by over 100 metres in depth, the one separated from the other by some 400 metres, in which connecting-space there exist considerable stope-workings and galleries, indicating probably either that the ore in the two open cuts was richer than in the intervening section, or that the values therein were more confined to definite leads. There is a possible third alternative, namely, separate ownership of defined areas farmed out by the old authorities.

Recent surveys show that from these two cuts not less than 20 million tons of rock have been removed and the present inability to discover any proportionately sized dumps of waste rock, leads to the conclusion that practically the whole of the rock so removed must have been crushed and treated. Similar absence of dumped debris is noticeable at Mouros, where the schists are equally hard and tough (Fig. 3). Hundreds of granite mortar blocks, circular mill stones, furnaces, and slags similar to those at Mouros, as well as finds of quartz, show that the ore and treatment thereof must have been similar to those at that mine.

These open-cuts are situate along the top of the longer axis (E.–W.) of a hogback of Archæan schist over two kilometres in length. The sides are precipitous and the worked veins, as seen in the stope workings on the N. and S. sides of the cuts, are practically vertical. For the first 25 metres or so of depth, drainage was effected by surface cuts and channels, but below this level drainage galleries were driven, the openings of many of which can now be seen in the north sides of both cuts, which side is closer, for adit driving, to the main-stream valley. Assays of the slags found in this area give precious metal values practically similar to those at Mouros.

The absence of waste rock dumps is here even more difficult to account for than at Mouros, owing to the great width (about 150 metres) of the cuts. Even without explosives these schists break in very large blocks and plates and had they been re-broken to a size convenient to be man-handled, immense dumps should reasonably exist somewhere close at hand, but to date none have been located. Sufficiently heavy mineralization of the schist between a closely separated series of quartz veins may perhaps have justified the crushing and treatment of the whole mass, a theory that may possibly at the same time account for the mining by stopes in the 400 metre section separating the two main workings.

The fact remains, however, that this vast mass of over 20 millions of tons of rock has been indisputably removed and this, together with the existing remains of large Roman camps close to the mines, point beyond question to the importance of the ancient mining industry and the very long period of activity in this region, probably extending over several hundred years. The Roman occupation of North Portugal lasted about 450 years and there is ample proof of Phœnician mining activity in the country prior to the advent of the Romans.

Considering the magnitude and undoubted importance of these great works, it seems strange that no continuance of the work took place after the withdrawal of the Romans from the Peninsula. Much of the work must have been done for generations by the natives of the country, who must have been quite *au fait* with all the methods and processes in use. The cessation may have been at the volition of the natives themselves

or the later invaders who overran the country, although a further possible reason may have been the impoverishment of the ore at depth. There seems, however, to be a strong argument against this last suggested reason, the real insuperable difficulty in all probability being water, which, in the absence of power driven pumps, frustrated the efforts of even those great engineers.

In this respect the lowest found adit is of great interest and probably affords the key to the puzzle. The mouth of this adit (Fig. 4) has its outlet 7 metres vertically above the level of the stream to the north, which has been previously mentioned, and the adit connected with the onetime bottom of the mine. From the exit 200 metres have recently been cleared, and it is now possible to examine the dimensions of this opening. It has a width and height of 5 metres and at intervals large circular rooms with vaulted roofs have been hewn out, these having a height and width of some 10 metres. In the centre and floor of each room there is placed a square block of granite around which there is a worn circular track such as might have been caused by an animal-driven whim.

In the bottom of, and along the extreme side of this drainage gallery a narrow channel, some 5 metres in depth, has been mined out, resembling a vertical stope. Through the large circular rooms this channel follows closely the curve of the wall, thus not interfering with the track around the centrally placed granite blocks.

Owing to the accumulation of surface debris at the mouth of the adit, the whole channel was filled with water, and, flush with the level of the adit floor there was a 1 to 3 in. crust of iron and other salts, as a rule strong enough to bear a man's weight. In the dry season there is a considerable air space between this crust and the top of the water.

The purpose of this channel, without doubt, was to permit of the deepening of the whole open-cut by 5 metres more than was possible with the adit alone. The bottom of this channel is only some 2 metres or so above the level of the river hard by, so that further deepening of the workings was not possible without mechanical pumps.

The sides of the open-cuts on the north and south are as near as possible vertical and are in reality the "walls" of the mineralized "zone," the width of which was 150–200 metres, thus showing that there was no pinching in depth from surface to the 100 metre level.

The two workings being 600 metres in length by an average of 170 metres in width, it is clear that the additional tonnage of rock available by the extra 5 metres of depth was about 1,428,000 tons.

As has been previously mentioned, various ancient workings are to be found for some 50 kilometres eastwards on the Gralheira strike, at which extremity there are known to be very important old workings. The

FIG. 3.—INDURATED SCHIST OUTCROP: MINAS DOS MOUROS MINE.

"leader," corresponding to the barren pegmatite at Gralheira, is different. There is here a well-defined outcrop, known as the "Filão dos Mouros," of glassy barren white quartz. Later fracture or fractures have evidently occurred along this line of weakness, the secondary quartz filling of which very much resembles the quartz at both the previously described workings to the west. This secondary mineralized "reef" can be followed in sections parallel to the foot-wall of the barren quartz reef (which is 4 to 6 metres in width) passing diagonally through it and then following along the hanging wall, passing back again to the foot. Galena is plentiful here and the silver content frequently over 1 kilo per ton; the gold

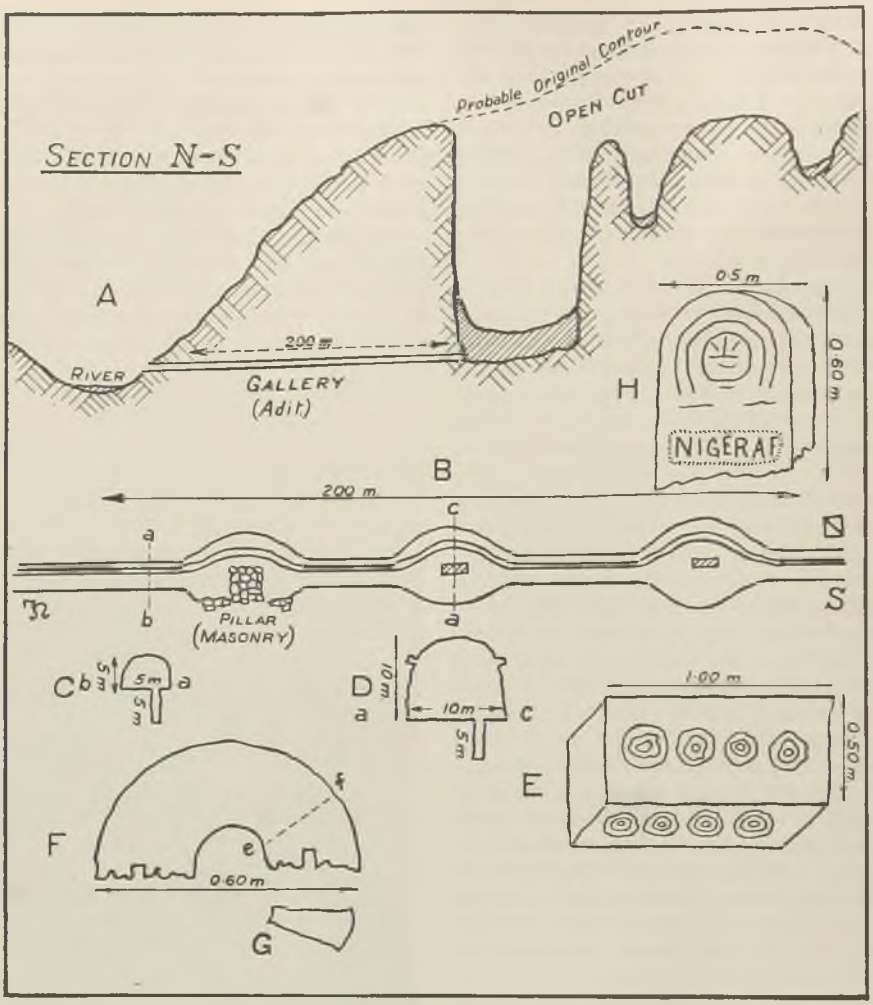


FIG. 4.—ROMAN OPEN-CAST WORKINGS: A, N-S SECTION; B, PLAN OF ADIT; C, SECTION a–b; D, SECTION a–c; E, GRANITE MORTAR-BLOCK; F, GRANITE MILLING STONE; G, SECTION e–f; H, ROMAN RELIC FOUND IN ADIT.

content, however, is low and seldom over 2 dwt.

Here again, as at Mouros, a tongue of intruding granite runs down at right angles to the main quartz reef and there are many important old workings by stopes in a parallel series of quartz veins in the granite. Assays recently made of quartz samples from these veins show higher values, averaging 9 to 12 dwt. gold and 7 oz. silver per ton. The strike of these veins is similar to that of the reef in the granite at Campo about 50 kilometres to the west, that is to say, N45E. The main feature of interest in this last described area lies in the confirmation of the gold values in this whole formation, carrying through the schists and into the granite, a not very usual occurrence. This is an encouraging feature, since it offers a reasonable assumption of the reefs and mineralization extending to considerable depths. On a parallel series of similarly mineralized zones, some 50 kilometres to the north of Gralheira, the same geological conditions are to be found, the veins also being in both Archæan schists and granite with immense Roman workings in both.

Both the engineering and metallurgical skill of these ancient workers was amazing and must have entailed wonderful organization including the recruiting, housing and feeding of a very large army of slave labourers. This may perhaps be better realized by the following summary: To

develop, break, transport to mills, treat, and generally deal with 20,000,000 tons of ore must have required about 2,000 workers toiling for 400 years of 300 days each year, every one of these men having as his task the breaking, crushing, transporting and treatment of 170 lb. of rock daily, which, considering the extreme hardness of both the schist and the vein matter and also the fineness to which the latter must have necessarily been reduced for treatment, constitutes probably far more than a possible maximum task. In addition the mine workers had to be fed and in North Portugal, where irrigation is necessary to raise most crops, one agricultural labourer cannot do much more than raise sufficient for himself and one other person. Thus to feed the above mine force would have required an equal agricultural force. Doubtless in the second century the relative value of both gold and silver was higher than rules to-day, but the fact remains that the discarded ore now being found in the ancient dumps shows high gold and silver values, as do also, comparatively speaking, the slags left after treatment by the process used in olden days. With modern flotation methods almost the entire precious metal contents is recoverable at a small operating cost.

The recent development of geo-physical prospecting and surveying will be of great interest and value on these particular deposits; the resistivity of both the schists and the granite should be remarkably constant, and the sulphide mineralization of these well defined zones might be expected to give definite indications since they are ideal for such methods.

Conditions for successful and economic mining operations in North Portugal are excellent, embracing: Abundant and good cheap labour, skilled and unskilled; good communications; water and dumping facilities; good climate and health conditions; existence of possible water-derived power, and the security of title and good mining laws.

CONDITIONS IN MEXICO

By R. S. BOTSFORD, A.R.S.M. M.I.M.M.

The author gives some observations based on a recent visit to the Sonora and Chihuahua mining districts.

It has occurred to the author that those having interests or contemplating a visit to Mexico might care to hear how recent progress there would affect them and to know that the country is quieting down, with the people willing and anxious to go to work. As evidence that the country may be considered as becoming more settled, the fact that from cities to the north first-class return fares are issued to principal cities in Mexico with insurance at ordinary rates, including insurance of baggage against loss up to and including return, even though travelling in outlying districts, might well be emphasized. Moreover, during his visit the author travelled on schedule and had no claim to make against the insurance companies—in fact, they won.

Large numbers of people cross the border daily from the United States on day excursions by motor coach, car, or train, returning the same day without the formality of obtaining a passport and tourists can obtain a six-months' passport without much trouble or expense. For business purposes the regular passport is issued just as in other countries.

Travelling to Sonora, the train of the Southern Pacific Railway of Mexico leaves Tucson, Arizona, passes through the border town of Nogales into Mexico, and thence on down the west coast of Mexico to the town of Navajoa, the nearest point on the main line to the mines of the Palmarejo and Mexican Gold Fields, Ltd., which it was the writer's purpose to visit. The same Pullman and dining car continues to Guadalajara, where passengers change for Mexico City. The only noticeable difference is that Mexican attendants take charge of the train within Mexico. Three hours are allowed at Nogales for customs formalities and the changing of money.

A Mexican peso is worth about 39 cents or 19½ pence, depending, of course, on the exchange. Since the author's return, however, the Government has passed a new monetary law, which is officially summarized in the following cable, published on July 27 last: " The Chambers passed to-day a new currency law, the principal points of which are: The silver peso of a fixed value as the monetary basis, minted peso coins and parts thereof being hereafter legal tender,

as are also notes issued by the Bank of Mexico, but these will be in voluntary circulation and only compulsory when paid to Government offices. Silver money is now legal tender for any amount, with the exception of fractions of the peso, which are legal tender up to limited amounts; such fractions will be accepted without limit as payment of duties or taxes. Debts payable in gold, contracted before this date, may be settled in silver. Foreign moneys will not

Canyon on Road to San Bernardo.

be accepted as legal tender and debts in such moneys may be settled in national money at the current rate of exchange. The above regulations may not be waived and anything not in agreement with them will have no legal force. A national monetary reserve will be created for the purpose of covering any deficit in foreign transactions and the levelling of rates of exchange. The minting of gold coins is entirely suppressed and these are henceforth deprived of all legal value. The import and export of gold in coin or bullion is permitted. Banks are obliged to repay in gold 30% of deposits made in gold. Reforms include the formation of a central banking board on which there will be official representatives and those of banks operating in the republic. The Bank of Mexico will assume the functions of a rediscount bank, with subordinate collaboration by other banks. The new law was previously approved by a recent council of Ministers and was submitted to the bankers at a meeting held to-day in the Ministry of Finance. The Chambers passed the law immediately and yesterday General Calles was appointed as President of the Administrative Council of the Bank of Mexico, he having taken an active part in all the foregoing arrangements. To-day, upon the publication of the notice a popular demonstration took place in favour of the adoption of the above-named regulations."

It will be noticed that gold may now be freely imported and exported from Mexico, whereas formerly the export was prohibited. Exporters of gold ore or products were originally required to import an equivalent amount of gold into the country as determined by the assay value of the ore or metallurgical product.

The new mining law of August 2, 1930, is now in force together with the new mining regulations interpreting it. The new law is intended to remove certain ambiguities previously existing and to overcome difficulties encountered in the administration of the enactment in its previous form. To those whom it may concern, it is important to become familiar with the new law, as there are, for example, paragraphs about monumenting, or remonumenting, claims where necessary that cannot be disregarded. Much of the modification in the new law has to do with conditions for taking up new concessions.

It has been the policy of the present Government to work for the solution of the agrarian problem as speedily as possible, and to further this end the various states have announced that they will hear no more claims for land and that the Local Agrarian Commission will be dissolved. The Foreign Claims Commission is now sitting in Mexico City examining claims against the Government for damage caused by the revolution. Claims are considered only for actual material damage. Under the circumstances comment is out of place.

The extensive motor coach and automobile traffic in California and throughout the United States has had its influence on Mexico. It is realized that the country

Author's Camp at Guadelupe.

scenes and contact with Latin-American life generally offer great attractions to tourists, particularly to the great neighbour north of the border, and it is evident everywhere that the Mexicans are preparing to get their share of the tourist traffic. Owing to the remarkable progress in highway construction in the republic, particularly in the border states of Tamaulipas and Nuevo Leon, many hundreds of miles of good-type and well-maintained motor-ways are now available to the motorist and pleasure seeker. These, together with the manifold attractions offered by the region which they traverse, as well as the mild climate characteristic of northern Mexico, present a new and unique field for the use of the motor-car. Shipping of motor vehicles is fast gaining the favour of motorists, who, after having visited the northern territory, desire to continue to Mexico City by rail, in order that the unfavourable features of the intervening regions may be avoided.

For years efforts have been made to construct a Pan-American highway through Mexico to Panama and thence over the Carretera al Mar on to Buenos Aires in the Argentine. The Pan-American highway

Zapote.

Mine Buildings at Palmarejo.

from Laredo, Texas, to Mexico City may not be travelled in its entirety by motor-car, owing to the existence of an impassable gap made by a mountainous and formidable region in the states of San Luis Potosi and Hidalgo, between Valles and Jacala, a distance of approximately 90 miles. Similarly the International Pacific highway, from Nogales to Mexico City along the west coast, follows comparatively near the Southern Pacific Railway of Mexico, passing through Guaymas and Navajoa-Mazatlan-Tepic-Guadalajara to Mexico City. One hundred and five miles is missing in this section, but a bypass is being constructed, although it is easy to cover this part by train.

The principal commercial centres are connected by aeroplane routes and there are flying fields at Mexico City, Tampico, Matamoros, Nuevo-Laredo, Ciudad Juarez, Torreon, Saltillo Durango, Mazatlán, Zacatecas, Ciudad Victoria, Aguascalientes, Leon, Tuxpan, Veracruz, Minatitlan, San Jerónimo, Tapachula, Villa Hermosa, Ciudad del Carmen, Campeche, and Mérida. Mexicans consider that their flying service is second only to that of the United States in the New World.

Even very small villages are connected by telegraph or telephone or both and the use of the telephone message or "telephonemma" is very common over shorter distances. There are many wireless stations and it is possible to communicate with Europe by telephone.

Mexico's history as a mining country is well known, but a few figures may not be out of place. The production of silver since the Spanish Conquest, in metric tons of 2,204 lb., has been given as follows :—

	Metric tons.
From 1521 to 1820	53,496
,, 1821 ,, 1905	57,774
,, 1906 ,, present	54,839
Total silver	166,109

The production of gold over the same period is as follows :—

	Metric tons.
From 1521 to 1820	182
,, 1821 ,, 1905	252
,, 1905 ,, present	602
Total gold	1,036

In addition to a notable production of other metals there was produced, in the period 1901–1930, 1,577,038,412 barrels of petroleum.

Exports greatly exceed the imports, the following figures relating to the year 1929 :—

Imports	Pesos Mex. 382,919,373
Exports	590,633,255

The mines of the Palmarejo and Mexican Gold Fields are approached from Navajoa, on the main line of the Southern Pacific Railway of Mexico, the route to the property lying eastward into the State of Chihuahua. Although there is a branch railway line as far as Alamos, 38 miles away from Navajoa, it is usual to go the whole distance to San Bernardo by motor-car, a distance of some 70 miles. Thence remains some 14 hours on mule-back to Chinipas, the town nearest to the mines. Alamos is a town of 4,000

Main Entrance to Mine at Palmarejo.

inhabitants, lying about 1,200 ft. above sea level, with a large wireless station, etc. Chinipas is a small town of 600 inhabitants with tri-weekly mail service, telegraph and telephone service, and lies at an altitude of 2,200 ft.

The property of the company comprises 125 square miles of hilly mining country in Chihuahua, the boundary of the property forming part of the inter-state boundary of Chihuahua and Sonora. The mill site, offices, etc., are at Zapote, just outside of Chinipas, on the Chinipas River. Here a 10 mile masonry power-flume provided about 650 h.p. for the mill and a ten-mile narrow-gauge mine-railway brought the ore from the mines in the hills at Palmarejo, altitude 3,000 ft.

Mr. E. T. McCarthy made a remarkably competent report on this property in 1909, foreseeing to a nicety the ore subsequently developed following out his programme. Moreover, the 380,000 tons of ore at that time was blocked out on four sides ready for stoping for his estimated cost. This is in addition to the considerable probable and possible ore at Palmarejo. The serious depreciation in the price of all metals except gold and mercury has now considerably modified the situation, but it is well to be

Old Machine Parts, Palmarejo Mine.

Distant View of Mine at Palmarejo.

ready for that increase in metal prices generally on which all are waiting.

Owing to the hilly nature of the country the mine has been developed by adits and there is no pumping problem. Plenty of cheap timber is available and conditions generally are good.

The silver-gold occurrence is at the favourable horizon in the andesite of the region. The principal development work has been on the Prieta and Blanca veins, east of their junction, the various feeders and other favourable conditions having produced a shoot on the Prieta vein 1,700 ft. long. The veins are typical quartz veins in andesite and quartz is the predominating gangue material. The silver occurs principally as argentite, the black silver sulphide, and the gold is associated with sparsely disseminated pyrite. As is so frequently the case in this part of Mexico there is manganese dioxide associated with the silver and this holds good also in respect to the several other vein-systems on the outlying parts of the property.

There are numerous rhyolite dykes traversing the country in a north-easterly to south-westerly direction and many of the occurrences of mineral both off and on the property are in proximity to them.

Guerra al Tirano Needle.

Apparently the mineralization is associated with the rhyolite period of intrusion. Many of the hills have a capping of rhyolite, which may conceal veins with valuable contents, as has happened on the Prieta vein at Palmarejo, where it has not been subsequently eroded.

Mexico has many more or less authentic stories of very rich mines worked by the early Spaniards or by the Jesuits, and forcibly abandoned at very short notice, being covered up against a later return. The archives in Spain and also in Mexico City have reference to good mines, which are hard to locate, names having changed. With so many veins and old workings visible and fallen in, it is easy to realize the difficulty. Falls of ground can and do easily cover up small openings. Indians who live high up on the hills seem to be acquainted with occurrences, but they dare not disclose the sites, as they believe that they will die if they do so. One or two rich mines have been discovered in the district by following Indians who have brought in ore for sale.

A year or two ago a party arrived on the property near the Guerra al Tirano mine with a letter describing a place on the hillside, but after two weeks they abandoned the search, having found nothing. There is the small furnace, long since abandoned, high up on the hill in full view beside a stream and a path leading higher up diagonally across the hill (an old mule trail) which ceases where the slope of the hill gets very steep. One of the searchers says he will have another try to discover this mine.

At another point, off the property, a mine which seemed to consist of little but old caved workings retained a considerable local reputation and was always of interest to the owner on that account. About a year ago, during the last rainy season, the torrential rains caused an extensive fall of ground, disclosing some old workings a little higher up the hill, joining the known vein at an angle with what is described as a highly mineralized vein of $40 to $50 per ton. A man came down from New York to sample it. While the writer was there apparently reliable information came telegraphically from Mexico City stating that this mine was indeed the famous Mexicana mine, identified from the old archives. Thus hope never dies for prospectors.

THE ESTIMATION OF ANTIMONY AND ARSENIC

By J. E. CLENNELL, B.Sc., A.I.M.M.

The author gives the procedure for the estimation of these elements by the sulphate-permanganate method.

INTRODUCTION.—This method of assay is in common use for the estimation of antimony in alloys such as white bearing metal and is far superior to all other methods known to the writer, as regards simplicity and rapidity. The object of the investigation detailed here was to determine how far the method is applicable in the presence of commonly occurring impurities, and also whether it could be applied to the estimation of antimony in ores, such as stibnite. As will be shown later, it is not only applicable for the latter purpose, but may be used with equal success for the estimation of arsenic in minerals such as realgar.

HISTORICAL.—The titration of antimony in a hydrochloric acid solution by means of permanganate appears to be due to Kessler [*Pogg. Ann.* (1862) *118*, 17].

The earliest reference to the titration of antimony in sulphuric acid solution which is known to the author is contained in an article by Wilson H. Low [*Journ. Amer. Chem. Soc.* (1907), *29*, 66 ; *Chemical Society Abs.* A. *92* (ii), 304 (1907)] entitled "Determination of Antimony and Tin in Babbitt, Type Metal and other Alloys." In this article, the process is stated to be applicable to alloys or sulphides of antimony and tin. These metals may be directly determined in one portion of the alloy without separating other ingredients. The procedure, so far as concerns antimony, given by Low is as follows :—The alloy may be decomposed by HNO_3, by H_2SO_4, or by a mixture of H_2SO_4 and K_2SO_4. Where possible, H_2SO_4 alone is used. If HNO_3 is first used, it must subsequently be expelled by boiling with H_2SO_4, after which some tartaric acid and K_2SO_4 must be added and the melt heated till all carbon has been oxidized. This leaves antimony and tin in the proper state for titration. . . . Some free H_2SO_4 must remain after these operations. . . . The test is made on 0·5 to 1 gm. of the finely divided alloy. After solution as above, it is cooled, 50 cc. water and 10 cc. conc. HCl added, heated to dissolve as much as possible, tartaric acid added if necessary to give a clear

solution and then further diluted with 110 cc. water and 25 to 30 c.c. more of conc. HCl. When thoroughly cool, the mixture may be titrated with permanganate, which is standardized in a similar way on pure antimony. The end-point is sharp, but the colour fades quickly owing to the large amount of HCl present. If less HCl were used, the end-point might still be sharp, but the reading would be lower than it should be. This is of no consequence if the permanganate has been standardized under the same conditions. . . . Lead and small amounts of copper do not interfere. Should iron be present in any quantity there might be some danger of ferrous sulphate being left after boiling with H_2SO_4. This difficulty is overcome by the treatment with HNO_3, H_2SO_4, K_2SO_4 and tartaric acid previously, described. . . . If arsenic were present, it would interfere with the antimony titration or be counted as antimony. It may easily be removed. [No method is suggested, however, for doing this.]

Albert H. Low ["Technical Methods of Ore Analysis," 5th Ed. (1911), pp. 27–33], gives a very similar method "applicable to sulphides and most mixed ores and low-grade oxides" which involves addition of $(NH_4)_2SO_4$, K_2SO_4, reduction with carbon introduced by adding a small piece of filter paper and heating until the free sulphuric acid is almost entirely driven off. (This is a very tedious and unpleasant operation, though accurate results can be obtained if carried out as described.) A method is also given for Hard Lead, etc. (*loc. cit.*, p. 33) as follows:—In the absence of arsenic, treat 0·5 gm. of the alloy precisely as described for ores until the usual melt is obtained. When cold, add 50 cc. of hot water and 10 cc. of strong hydrochloric acid. Heat until solution is complete and then boil off any SO_2 possibly present. Add 10 cc. more of strong hydrochloric acid, cool completely under the tap, dilute to about 140 cc. with cold water and titrate with permanganate. . . . "Tin, lead, and small amounts of copper and iron do not interfere." Directions are given for removal of arsenic by boiling with large excess of HCl, and also for procedure in presence of much copper.

A very similar method, in which, however, the reducing agent is omitted, is described by L. Bertiaux (*Ann. de Chim. Anal.* (1920) *2*, 273; *Chim. et. Ind.* (1920) *4*, 467) of which the following account is given in *Chem. Soc. Abstracts* (1920) ii, 710. "The alloy is dissolved by heating with sulphuric acid and sodium sulphate; the solution is diluted with water, HCl and a few drops of a 0·1% solution of Poirrier's Orange, and the mixture is titrated with standardized permanganate until the colour is just discharged. The HCl keeps the antimony sulphate in solution and as soon as all the antimony has been oxidized by the permanganate, the next drop of permanganate solution introduced reacts with the HCl, liberating Cl which decolorizes the Poirrier's Orange. Bismuth, copper, tin and arsenic do not interfere; iron is titrated together with the antimony, but its quantity may be estimated colorimetrically with thiocyanate in the solution in which the antimony has been titrated."

In principle, this process is the same as that generally followed, except that the sodium sulphate and the indicator for the end of the permanganate reaction are omitted. There are, however, two erroneous statements in Bertiaux's paper as quoted above, namely (1) that arsenic does not interfere and (2) that the error due to presence of iron may be corrected by a subsequent estimation of that element. As will be shown later, nearly all the iron is in the ferric state after solution of the alloy in H_2SO_4, and the small amount of ferrous iron could not be determined by subsequent titration as the whole of the iron will be in the ferric state after the permanganate titration is completed.

The quantities recommended by Bertiaux [*Chim. et. Ind.* (1920) *4*, 467, see abs. Inst. of Metals (1921) *25*, 434], are as follows:—Alloy (containing Pb, Sn, Cu or Bi) 5 gm.; dissolve in 40 c.c. boiling H_2SO_4 with addition of 10 gm. anhydrous K_2SO_4 or Na_2SO_4; dilute with 200 cc. water, add 50 cc. HCl and titrate with $KMnO_4$ (5·7 gm. per litre) after adding 2 drops of 1 : 1,000 solution of Poirrier's Orange or indigo.

Another reference to a similar process, in which, however, tin and antimony are first separated in an insoluble form by means of nitric acid, and the oxides then dissolved in H_2SO_4, is the following:—F. J. Mück [*Chem. Zeit.* (1922) *46*, 790, *Chem. Soc. Abs.* (1922) ii, 722; *Journal Soc. Chem. Ind.* (1922), 761 A], for the volumetric determination of tin and antimony in red brass. "2 gm. of the alloy is dissolved in 20 cc. of HNO_3, the solution evaporated to 5 cc., 100 cc. of boiling water added, the liquid boiled for 5 min. and the precipitate of antimonic and stannic acids filtered off, washed with hot 5% HNO_3 and dissolved in 15 cc. of strong H_2SO_4 and 10 cc. strong

HNO_3; 2 to 3 gm. of K_2SO_4 and 0·5 gm. of tartaric acid are added and the solution is evaporated to a syrupy consistency. After cooling, 180 cc. of water and 7 cc. of HCl are added, the solution is boiled for 5 min., cooled and titrated with permanganate for antimony. Another 30 cc. of water and 60 cc. of HCl are added; the tin is reduced by boiling with 2 to 3 gm. of antimony and titrated with iodine as usual."

In a later article by Bertiaux [*Ann. de Chim. Anal. et chim. appliquée* (1922) *4* (2), 77; abs. J. Inst. Met. (1922), 28, 671] antimony is determined in white metals and anti-friction alloys by dissolving 1 gm. of the turnings in strong H_2SO_4, diluting to 140 cc., adding 7 cc. HCl and titrating with permanganate. This is practically the method at present in use.

Other references to the process are the following:—

H. W. Thibault [*Australian Chem. and Met.* (1920) *3*, 31; *Chem. Soc. Abs.* (1921) *15*, 640; *J. Inst. Met. Abs.* (1921) *26*, 554], "Difficulties encountered in the determination of antimony in lead-tin-antimony alloys." The method suggested apparently involves titration in H_2SO_4 without addition of HCl until the end, the directions being:— "Dissolve 2 gm. of the metal in 50 cc. H_2SO_4 and 5 gm. K_2SO_4. When all is dissolved, dilute to 150 cc., cool to room temperature and titrate with permanganate until a pink colour is obtained before the true end point is reached. Add HCl drop by drop until the pale pink colour disappears and then finish the titration with permanganate."

C. C. Bissett [*Metal Industry* (1921) *18*, 381, 401 *Abs. J. Inst. Met.* (1922) *28*, 672], "the Analysis of White Metals." This contains nothing new so far as the estimation of antimony is concerned. Apparently the titration of antimony is made in presence of arsenic, as instructions are given for removing the latter after titration for antimony.

Titration of Antimony by the Sulphuric Acid-Permanganate Method

Principle of the Method and Reactions Involved.—A small weighed quantity of the alloy is heated with concentrated H_2SO_4 until completely dissolved or decomposed. The reaction appears to be as follows:—

$2Sb + 3H_2SO_4 = Sb_2(SO_4)_3 + 3H_2$.

Tin, lead and other commonly occurring metals are similarly dissolved and converted to sulphates. Copper, if present in large amount, is attacked with some difficulty so that the method is inconvenient in the case of high copper alloys.

After cooling, the solution is diluted with water and a little HCl. added to dissolve any basic salts which may separate, or to prevent their formation during the subsequent titration. In some cases the liquid must be heated again after addition of HCl, to dissolve the precipitate formed. In the case of lead, a deposition of $PbSO_4$ occurs on dilution, which may be disregarded, as it does not interfere in any way with the titration.

The mixture is then generally diluted further, cooled to room temperature and at once titrated with permanganate.

The antimony is converted from the antimonious to the antimonic condition as follows:—

$5Sb_2(SO_4)_3 + 4KMnO_4 + 16H_2SO_4 = 5Sb_2(SO_4)_5 + 2K_2SO_4 + 4MnSO_4 + 16H_2O$

from which it follows that $2KMnO_4$ is equivalent to 5Sb, or 1 gm. $KMnO_4$ to 1·926 gm. Sb. Since 1 gm. $KMnO_4$ is equivalent to 1·767 gm. Fe, the antimony standard may be calculated from the iron standard by means of the factor Fe × 1·0903 = Sb. If decinormal permanganate be used, 1 cc. $KMnO_4$ = 5·584 mgm. Fe = 6·088 mgm. Sb.

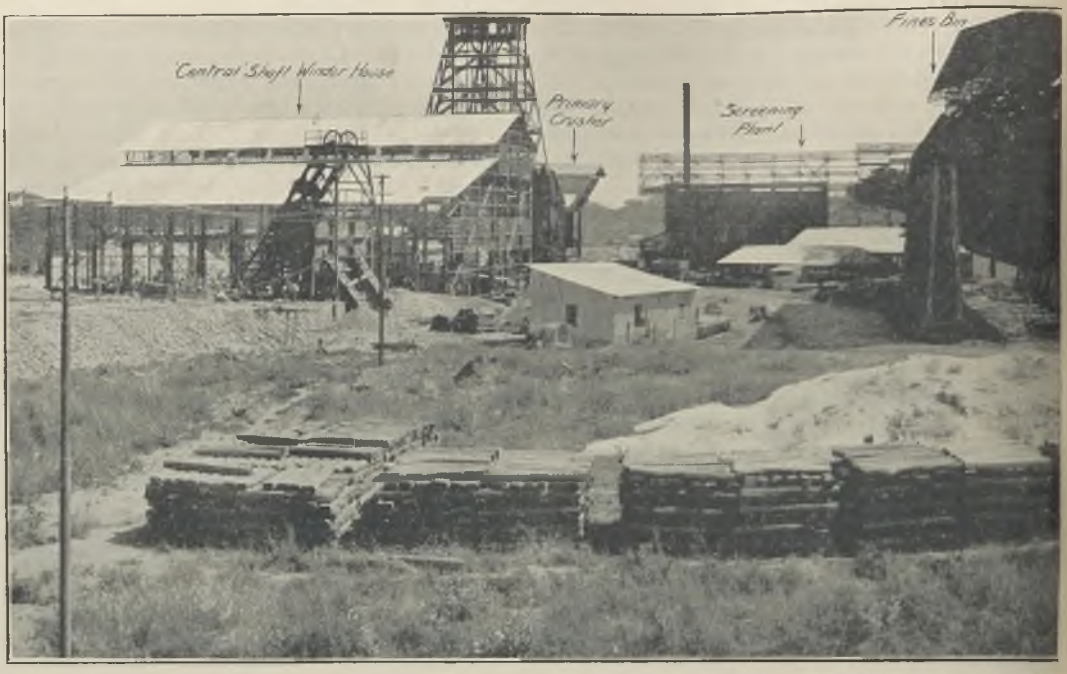
Quantities used and details of manipulation.—The finely divided alloy is conveniently dissolved by boiling in a wide test-tube with the required amount of conc. H_2SO_4. This "boiling tube" is supported on a ring stand or by means of a clamp in a vertical position and heated by means of a small gas flame until all bubbling has ceased and a perfectly clear solution is obtained. This is allowed to cool, poured into a beaker containing a measured volume of water, cooled again if necessary, the required amount of conc. HCl added, the boiling tube rinsed out with a further measured quantity of water and titrated to the point where a pink colour persists for (say) 15 seconds. (The colour usually fades rapidly on standing, but there is an unmistakable end-point when the proper conditions are observed.)

Identical results are obtained under widely different conditions of acidity and dilution. In the following tests, two sets of conditions were commonly used, of which the details are as follows:—

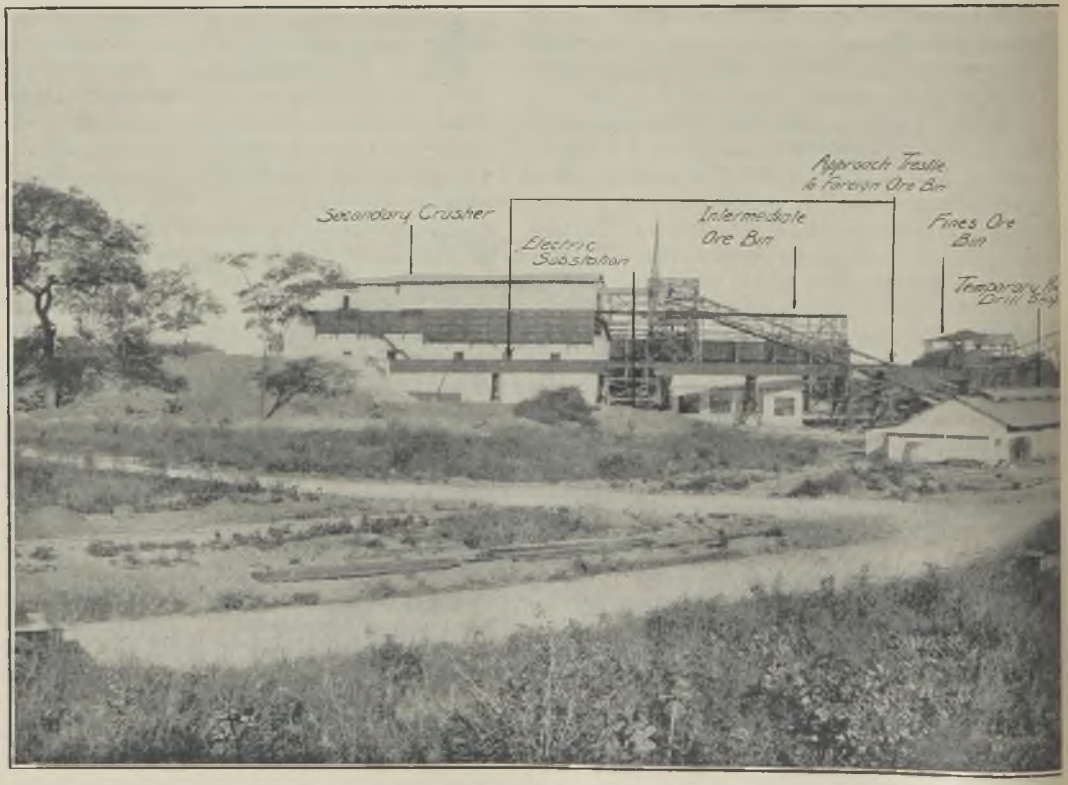
No.	*Alloy. mgm.*	H_2SO_4 *conc. cc.*	HCl *conc. cc.*	*Water cc.*	*Final Volume approximately cc.*
1	200	15	2	80	95
2	200	17	15	220	250

(*To be continued.*)

The report of the Rhokana Corporation for the quarter ended June 30 last stated that additional interest to the accom-



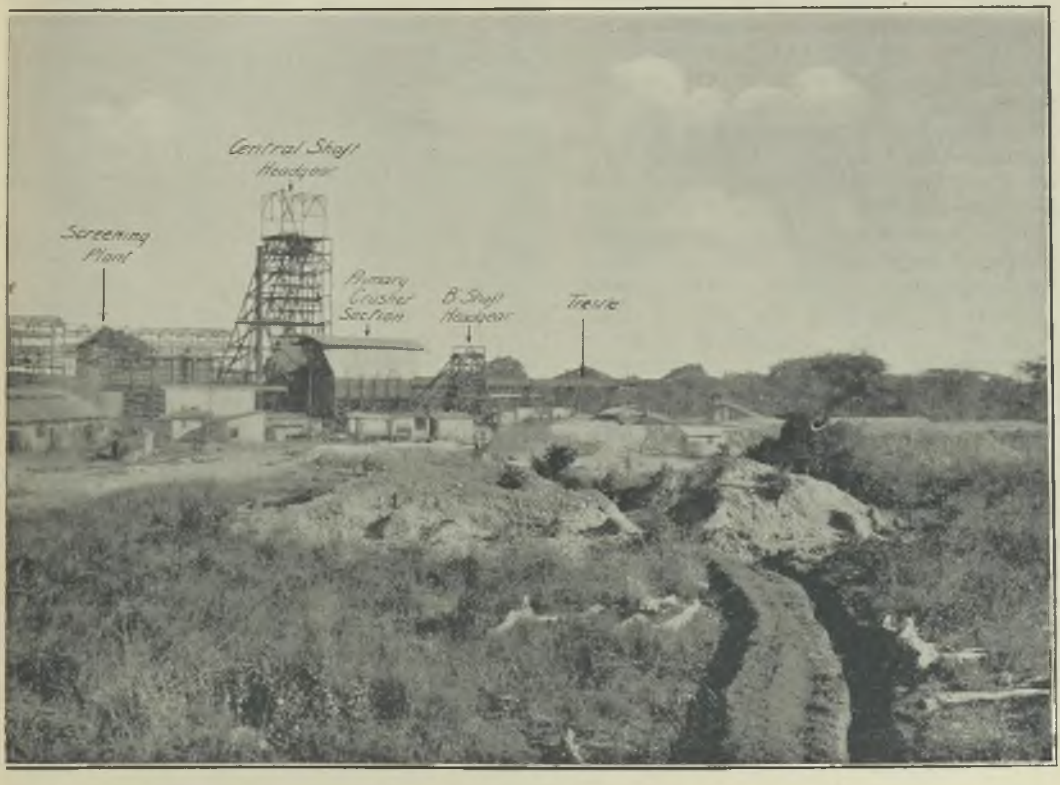
VIEW AT THE N'KANA



VIEW AT THE N'KANA

construction at N'Kana continued to be up to schedule, a statement lending panying photographs, taken recently.

MINE, LOOKING NORTH.



MINE, LOOKING SOUTH.

BOOK REVIEWS

The Principles and Practice of Geophysical Prospecting, being the Report of the Imperial Geophysical Experimental Survey. Edited by A. B. BROUGHTON-EDGE and T. H. LABY. Cloth, demy-quarto, xiv + 380 pages, with 261 illustrations in the text. Price 15s. London: Cambridge University Press.

The form and scope of the Report of the Imperial Geophysical Experimental Survey were dealt with in the MAGAZINE for last month, so that here it will suffice to say that the report presents a well-balanced treatment of the theory and application of geophysical methods, written with an easy style and commendable elegance which render it eminently readable. It gives an unbiased account of the experience of officers in charge of the various investigations, and describes the theory of the various methods with a soundness and completeness which is gratifying. Field tests were carried out by the electrical, gravimetric, magnetic, and to a limited extent the seismic methods, in country carrying sulphide and other ores, graphite, brown coal, saline waters, etc. In all, surveys were conducted in fifteen districts, in some cases over known deposits, while in others the investigations were followed by confirmatory drilling.

Remembering that the Geophysical Sub-Committee of the Committee of Civil Research had previously laid stress on the paucity of reliable information regarding the electrical methods, it is perhaps not unnatural that these methods should have been treated at greater length than the others. This step is well justified and those chapters dealing with the theory and apparatus of the various electrical methods are by far the most comprehensive and instructive that have yet appeared, and will do much to clear up many of the existing misconceptions regarding these methods. Of the eleven electrical investigations that were undertaken, perhaps the most interesting one was conducted over the Renison Bell tin-field in Tasmania, which was surveyed by three different electrical methods as well as the magnetic method. Speaking generally, the agreement between the methods used was good, while in certain instances the equipotential, electromagnetic and magnetic results correspond very closely.

Three gravitational surveys are described, the first one, undertaken at Gelliondale in Victoria being particularly successful. In this area, the existence of an extensive deposit of brown coal in close proximity to the surface presented very favourable conditions for testing the gravitational method, and the fullest advantage was taken of these circumstances. The results obtained, both qualitative and quantitative, are extraordinarily good and bear adequate testimony to the ability of the gravimetric method to reveal subterranean anomalies with accuracy under suitable conditions.

Magnetic surveys were conducted over six areas, one of which was the brown coal field at Gelliondale, just referred to. A rough correspondence was found in this locality between the results obtained by the two methods, where the gravitational and magnetic highs correspond respectively to the greater density and magnetic susceptibility of the Jurassic sandstone as compared with the sands, drift, and coal. Another magnetic survey was carried out over the gold deep leads at Gulgong in New South Wales, where all the four methods were tested. From the results obtained in this field it appears that the magnetic method may have some most important applications in the sub-basaltic deep-lead areas of New South Wales, Victoria and Tasmania.

During the early stages, it was not considered practicable for the survey to undertake seismic investigations, but this method was wisely included in the programme a year later. In view of the late commencement of the seismic work, an extensive programme was not possible, but the field party conducted tests over two of the most suitable areas that could be found in New South Wales and much valuable information was obtained. One of these surveys was over the gold deep leads at Gulgong.

The volume is fittingly concluded by a brief summary of the outstanding practical applications for geophysical work in Australia, indicating in the case of each method the possible applications and an estimate of the working costs. Throughout the report, all detailed observations have been omitted, in order to avoid unwieldiness, but it is understood that these are being preserved, so as to be available if required subsequently for further examination. The experimental survey has furnished a large accumulation of valuable experience in all branches of the subject, which is likely to have a far

reaching effect on the development of British geophysical instruments. Indeed, since the conclusion of this survey, British apparatus has already been designed and put on the market for all the various electrical, magnetic, and seismic methods, while an entirely new form of gravitational apparatus has also been made available.

This admirably clear and complete account of the various geophysical methods is an outstanding contribution to the development of applied geophysics, which will undoubtedly take a leading place in the literature of the subject, and will be a standard text-book for many years.

H. SHAW.

Determination of the Opaque Minerals. By C. MASON FARNHAM. Cloth, octavo, 236 pages. Price 17s. 6d. London: McGraw-Hill.

This book will be found particularly useful in the field because the author, with that object in view, has restricted the methods of investigation so that they can be carried out with apparatus consisting only of a suitable microscope, with accessories for examination of polished surfaces in incident polarized light, a few bottles containing reagents, hand-grinding plates, and a few abrasives. The first 14 pages give an outline of the technique for preparing polished sections of minerals, and for their examination in ordinary and in polarized incident light. Pages 15 to 20 give a bibliography of literature on this subject. The main part of the book, pages 21 to 128, gives an account of 220 mineral species, arranged alphabetically; and the two pages that follow contain a list of 93 so-called minerals that have been shown to consist either of mixtures of other minerals, or are doubtful species. Eight useful tables follow, in which the minerals are arranged according to their distinctive colours in mass, in powder, in order of hardness, specific gravity, electrical conductivity, reflectivity, and according to their internal reflection.

A special feature of the book is the detailed descriptions of the reactions of opaque minerals to standard reagents, as seen under the microscope. The colours of the stains before and after washing, before and after rubbing, etc., are described most carefully. The author has done a good deal of original work on microchemical tests, and in this volume has supplied valuable information, much of which has not previously been published. The recognition, however, of slight differences in colours of stains requires considerable practice and an eye for colour, and where the minerals, as frequently happens, contain inclusions of other minerals the method requires much care and skill.

Included in the list of 220 mineral species described here are many minerals that are very rare and some which are known only from a single specimen. The author justifies their inclusion by pointing out that the mineral curiosity of to-day may be found in abundance to-morrow; that a property believed to be characteristic of any mineral must be proved to be absent from all other minerals; and that the presence of apparently unimportant minerals in an ore may contribute information as to the mode of origin of a mineral deposit.

The book is clearly printed on good paper, and is of convenient size for use in the field. It will be found of valuable help to students of ore deposits, mining geologists, and mining engineers; and metallurgists will find parts of it of much interest.

WILLIAM R. JONES.

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

NEWS LETTERS

BRISBANE

July 21.

Mount Isa Mines.—Since the formal opening of the Mount Isa mines and works on June 15 the plant has been running smoothly and the field has settled down as an industrial centre. The monthly reports of the Government Mining Wardens are usually dry and sometimes uninteresting, but the official at Cloncurry, in speaking of the stage that has been reached at Mount Isa, waxes poetical, acclaims that what has been done there to bring the huge enterprise to fruition shows that the romance of mining has not passed, and describes the music of the machinery that has been set in motion by a turn of the electrician's hand as "a Song of Triumph—of the triumph of man and his implements over nature." He is certain, too, that this "music" will be heard in the land for many decades. Since the beginning of production the

price of lead, although still very low, has risen by over £2 a ton. The total quantity of ore treated at the mill during June was 29,423 tons, but the return of bullion obtained is not yet available. At the end of the month some adjustments were still being made in the smelter plant. When these are finished the bullion output will be materially increased. In the mining section, the preparatory work at No. 3 glory-hole has been completed and ore is now being drawn from seven glory-holes on the Black Star lode. At the Black Rock lode carbonate ore is being stoped from No. 2 and No. 3 levels. At No. 4 level the H. 52 south drive was advanced 55 ft. in ore. On the Rio Grande lode stoping is in progress on the main lode at No. 1 level, and also on the main and the hanging-wall lodes at No. 4 level.

Gold Discoveries.—The activities of the large number of men who are searching for gold with the help of funds from the unemployment relief tax and by assistance from Government prospecting votes, are resulting in many reports of finds in different directions. These reports at first are usually exaggerated, but some of them are being confirmed and in several cases the discoveries made are decidedly promising. In North Queensland a good few of the finds have led to the establishment of mining camps where many men are now at work, as well as to the re-opening of old fields that have lain dormant for many years. The most important of such prospecting results in Queensland has been a discovery in the Central district, at Canoona, near Rockhampton. Special interest attaches to this find as Canoona is the place where gold was first discovered, in 1858, in the north-eastern part of what was then a part of the Colony of New South Wales, but is now the State of Queensland. About a week ago a party of four prospectors who returned to Rockhampton reported a sensational strike five-and-a-half miles from the old Canoona field and brought with them 75 oz. of gold recovered in one day. Half a mile off the main northern road, about 30 miles from Rockhampton, these men, in following leads, worked up to a reef in serpentine country about 4 ft. in depth and found they were on very rich values. They brought up solid slugs of gold and more than 6 lb. of the metal was secured in a single day. One slab was 15 in. long, 15 in. wide, and up to an inch in thickness. A rush immediately followed the discovery, claims were pegged out by lamplight, and in one day about a hundred of these were taken up. The original gold discovery at Canoona, 73 years ago, was attended with disaster. The country in the vicinity was then inhabited by a very few people, scattered over a wide area, connected with a forward movement in pastoral occupation. Between 15,000 and 20,000 men, who had hastened to the spot from all over Australia and even from New Zealand, with only a week or two's rations, found the payable ground tried had already been worked out, were left stranded, and were only rescued by steamships sent for them by the New South Wales and Victorian Governments. The experienced few who remained at Canoona, however, soon made fresh strikes, and this field for a number of years was a prolific producer of gold. So keen is the present search for gold that prospectors are sinking a shaft in a street in the heart of the city of Ballarat in the hope of finding the continuation of a lead, discovered many years ago, that resulted in a rush.

Oil Prospecting.—Oil prospecting in Queensland, which a year or two ago was so active, especially in the Roma district, has almost ceased. Fresh arrangements have lately been made by the Australian Roma Oil Company to recover petrol by absorption from the gas in two oil bore-holes sunk at Roma by the Roma Oil Corporation and the former company is making some tests and doing certain work at other bores, but no boring is in progress. This state of things is attributable, not to any lack of faith in the oil possibilities of the region, but to the scarcity of money obtainable for such a speculative purpose as the search for oil. Dr. Woolnough, the Federal Government Geologist, has lately stressed what he has said before as to the chances of finding oil in Australia. He says that if an intensive search on a scientific basis were made, he has little doubt that oil would be found in commercial quantities within three years. In his opinion, however, local oil enterprises have so far used inadequate methods as compared with those of the United States.

Gold in New Guinea.—Mr. B. Dunstan, late Chief Government Geologist in Queensland, has lately returned to Brisbane from New Guinea, whence he was sent on

a visit of inspection of gold-mining areas by the Commonwealth Government. He has come back with the conviction that the prospects of gold-mining in this mandated territory are particularly bright and that the industry will be flourishing there during the next twenty years. He considers that the Edie Creek and Bulolo River areas will produce a good deal of the metal when the dredging machinery being obtained has all been installed; also that, later on, gold prospecting will be carried on more scientifically than now in the country beyond Edie Creek and towards the Papuan border, where gold is reported to occur over a very large area of country.

Gold in Central Australia.—A rich gold strike in Central Australia is reported by a prospector who lately returned from that territory to Mount Isa, in north-west Queensland. The locality of the find is 120 miles west of the Jervois Range mining camp, at the confluence of two small creeks in an extremely dry region. The discoverer exhibited some splendid gold specimens in support of his story. He came into Mount Isa, after leaving a mate at Lake Nash, to procure rations and other necessaries.

Western Australian Gold. — It is generally admitted that among the different States of the Commonwealth, Western Australia, for many years the largest producer of gold, may be expected to contribute most towards any of the substantial increase in production that is reasonably looked for as the result of the present revival in mining. It is also recognized that, as in Queensland, the prosperity of the industry lies in the working of large deposits on an extensive scale in order that low-grade ores may yield a profit. The Sons of Gwalia mine, with the assistance of the Western Australian Government, has developed from a mine that was threatened with a complete stoppage of operations into one which has prospects at depths equal to, if not better than, those of any other mine in the Western State. The feature of the Wiluna mine, which is being worked with the aid of British capital, is the magnitude of its operations, the extent of which may be gauged from the fact that from the time when ore was fed into the plant until the first tailings were discarded 12,500 tons of ore will have been transferred from the mine to the plant. In that mine, too, enough ore to keep the plant going for seven years has been proved down to the 800 ft. level. The Broken Hill Proprietary Company, which has entered into gold-mining ventures in Western Australia, has begun prospecting work on the north end of the Kalgoorlie field, where there is a chance of the continuation of the Kalgoorlie ore-bodies being discovered.

IPOH

August 8.

Restriction.—Persistent rumours have been circulated for weeks past to the effect that owing to an alleged underestimate of about 1,000 tons in the production for the first quota period of six months ending August 31 there would have to be a very heavy additional cut in the quota for the next period. It has also been said that miners were dissatisfied with their assessments and with the working of the restriction enactment generally. One remembers that the spreading of "alarm and despondency" is punishable under "King's Regulations" and it seems a pity that in times when the will to make the best of things is specially desirable and helpful there should be immunity for those who indulge in the industrious propagation of pessimism and unhelpful criticism. With regard to the working of the enactment there are many miners, including largely interested Chinese, who consider that the very difficult and complicated problems arising have been well and fairly handled under the existing regulations and for this much of the credit is due to the senior officers of the Mines Department who have been called upon to exercise patience and considered judgment under conditions involving the strain of prolonged overwork.

Quota Grouping and Adjustment.—With the purpose of helping small producers and to keep labour employed, grouping of quotas of producing mines has been allowed and such full advantage has been taken of this facility that actual output must have approached the total permitted more closely than could have been anticipated. Without the permission to group with others, many small mines would have had to close down, but by allocating production to the best advantage within each group maximum output has been possible within the sum of the assigned quotas. No new legislation

could be expected to provide fully for all the widely varying conditions, and some difficult cases have arisen. For example, the quota given to a dredging company on the recorded output and capacity of a dredge is held to be applicable to that unit only, and if the dredge has ceased operating its quota is not applicable to mining by other methods on the same Company's holdings even if on the same continuous block of mining leases on which in another part hydraulic mining has been in progress since before the dredge was built. In such a case it seems reasonable to argue that the company having expended capital on proving, acquiring and equipping the property must have right to work and produce tin ore by any methods not infringing the regulations normally applicable and to suspend or alter any of these methods according to circumstances. Their assessment and quota should therefore be on the total output and any other grounds accepted as valid for the period taken in their claim for assessment. Under the present regulations it is held that the quota based on the output from the dredge, which on grounds of policy has stopped work, can only be claimed if and when it resumes operations, and is not applicable to the expanding output from hydraulic mining.

Additional Restriction.—With regard to the anticipations of a very severe additional cut in the next quota period of three months from September 1 it can safely be said that the admittedly difficult circumstances will have full and careful consideration by the officials and most of the miners associated with them and that it is unlikely the recommendations of such a body of advisers will add needlessly to the difficulties of the mining industry. While irresponsible optimism is very dangerous and often leads to disastrous results, especially in such a business as mining, there is no excuse for the persistent and equally irresponsible croakers whose contributions of distrust and despondency provide a state of feeling highly favourable to Bolshevist activities.

Statistics.—The following indicates the statistical position as on July 31 given on the authority of one of the big smelting companies :—

	Tons.		*Tons.*
Visible Supplies .	51,401	down	153
Consumption . .	9,400	,,	500
Supplies . . .	9,300	,,	1,100
Shipments . .	7,591	up	300

Siamese Assessment.—The total assessment proposed for Siam is said to be about 10,000 tons, which seems highly adequate, but it may well be that the chief object in getting Siam into the restriction fold is to prevent expansion of activities there, which would probably soon result from the curtailments in British Malaya.

JOHANNESBURG

August 1.

Far East Rand Developments.—Thanks to the enterprise of the Union Corporation, Ltd., increasing interest is being shown in the south-east Rand, where drilling is now proceeding on the farm Vlakfontein No. 21 (which lies between the Daggafontein Mine property and the Nigel area) and where, it is hoped, active operations will shortly be resumed on Marievale. According to the plan which accompanied the report several years ago, of the Government Mining Engineer, Sir R. N. Kotze, upon the Far East Rand, the greatest depth of the Main Reef series occurs at 6,000 ft. and a little over upon the farms Vlakfontein No. 26, one of the properties of the Lace Proprietary Mines, Ltd. Withoek No. 149, immediately to the west of the last-named property, is largely below the 6,000 ft. line, but is still well within a fair workable depth. Between the 6,000 ft. and the 3,000 ft. contours are Vlakfontein No. 65, of the African and European Investment Company; Spaarwater, of the Lace Proprietary Mines; Grootfontein, now occupied in part by the Sub Nigel, and partly held by the New Consolidated Gold Fields; Vogelstruisbult, upon which the Rand Mines as well as the Gold Fields hold areas; Daggafontein; Grootvlei, belonging to the Lewis and Marks group; and the Geduld and Springs mining properties. Finally, between the 3,000 ft. horizon and the sub-outcrop of the reef series are the upper portion of the Sub Nigel and the adjacent part of Varkensfontein, upon which the Nigel claims are located; Marievale and Vlakfontein No. 21, where the Union Corporation is about to explore the Nigel extension towards the north-east; Rietfontein No. 11, of the Rand Rietfontein Estates and Palmietkuil, held by the African and European Investment Company.

Old Mine to be Re-Opened.—A Johannesburg syndicate has taken over the old Rietkuil gold-mine which is situated

about 11 miles west of Klerksdorp, Transvaal, and will restart operations at an early date. It is believed that with ample working capital and under good management the property should become a profitable producer. Formed in 1895, the old Rietkuil G. M. Co. owned a block of claims adjoining the Africander, which is still producing. There are three reefs on the Rietkuil and the average value of the richest of these when worked formerly was about 9 dwt. A considerable amount of shaft sinking and development was done by the former owners.

Iceland Spar Deposits.—Following on what appeared here last month it is interesting to add that in the course of a discussion at the Science Congress at Grahamstown some interesting specimens of Iceland Spar were exhibited and it was stated by various members that deposits of the mineral had been discovered in the Cape, Transvaal, and Orange Free State provinces and in one or two instances in large quantities.

Transvaal Emeralds.—Some of the Transvaal emerald mining companies which suspended operations some months ago on account of the unsatisfactory state of the markets for precious stones have resumed work. The Beryl Mining Co., the pioneer concern, which had been operating without interruption since its inception, recently started to put its waste dump through the sorting plant which was installed on the mine in the early part of 1930. Hitherto, the company had practised the old method of hand sorting and the waste dump had been allowed to accumulate until it reached considerable proportions. The effect of mechanical sorting proved to be an eye-opener. Whereas the old method of sorting had yielded approximately 55% of crystals, the present recovery is little short of 100%. It is anticipated that by the time the entire dump has been treated, the company will have recovered something like £6,000 worth of crystals. In May last a crystal weighing 130 carats was found in the western section of the mine. The crystal was not flawless, but one of the pieces cut realized £800, and the parcel in which this stone was included was disposed of for £1,700. Some months ago development on the second level was stopped in favour of enlarging the area for extended operations by open-cast methods. The main workings are being pushed out, north, east, and west. When this undertaking is completed, active development on the 2nd level down to 80 ft. will be resumed, with mechanical haulage. There is a probability that the policy of going deeper will be amply justified in the shape of larger and more perfect crystals. The rock formation, it is stated, shows much folding, weathering, and general disturbance in the upper portion of the workings and the crystals mined here are apt to be found suffering from these influences. At greater depth more stable conditions are in evidence.

Manganese Industry.—Like other base metal concerns, the Manganese Corporation of South Africa is feeling the pinch of reduced world demand and Russian dumping, and its exports of ore have fallen off considerably. Consequently, the Corporation has been obliged to curtail its white staff to about 18 or 20, and the natives to between 100 and 150. This is stated to be merely a temporary measure, however, and it is confidently anticipated that within the next three or four months the oversea position will improve and naturally be reflected in increased demand for the corporation's product.

Vanadinite in the Transvaal.—Interesting discoveries of vanadinite are reported to have been made on six farms in the Western Transvaal. A local geologist, who has examined the occurrences, says that one cavity, 15 ft. long, contained a ton of vanadinite which appeared in the uppermost portions of the dolomite in a beaded deposit of soft, blackish-brown, manganese earth or wad. It is suggested that research in connexion with discoveries of this nature should be placed in the hands of a specialist thoroughly acquainted with the needs and the difficulties of the iron and steel industry and that South Africa and especially the high uplands, with its many varieties of secondary ore-bodies and leachings of various base metals, has a very special interest for European and American industries.

Iron-Ore.—The South African Iron and Steel Industrial Corporation, which is erecting steel works at Pretoria, has put in an adit on its iron-ore deposit on the farm Vliegpoort, Rustenburg district, at a distance of 1,000 ft. from the base and 200 ft. from the summit of the mountain. The adit has traversed 40 ft. of good hematite containing 68% metallic iron and it is still in ore. The quantity of ore in the deposit is so enormous that most of the operations for many years to come will be open-cast or adit mining. Moreover, the cost of mining

this ore, which is regarded as being equal to the richest deposits in the world, will be relatively low, and it can be landed in the bunkers at Pretoria for less than 10s. per ton.

VANCOUVER

August 7.

The Mineral Industry.—In an introductory statement that accompanied a review and summary of the mineral industry in the Province for the six months ended June 30 last, the Hon. W. A. McKenzie, Minister of Mines, made the following comments: "Mining in British Columbia has withstood the shock of world depression and extreme low metal prices in a most satisfactory and remarkable manner. The figures show that for the period under review our mineral industry operated on an output basis of 84% of that recorded in the corresponding half-year period of 1930. While some falling off has occurred in the development of base-metal properties this has been compensated by the widespread revival in gold-mining and the keen interest in prospecting for placer gold. There are more men in the field than has been the case for many years. . . ." The following table shows in detail the estimated output for the first half of the current year and the corresponding period of 1930:—

Product.	*Value.*	
	1930.	1931.
Gold, placer and lode	$1,633,072	$1,509,041
Silver	2,310,952	1,234,684
Copper	7,343,750	3,052,170
Lead	6,822,528	3,960,242
Zinc	4,694,760	2,895,010
Coal	4,800,610	3,952,120
Structural materials	1,860,000	1,800,000
Miscellaneous minerals and metals	445,000	300,000
Total	$29,910,672	$18,703,267

The report, which has been compiled by Mr. John D. Galloway, Provincial Mineralogist, states that these figures are considered highly satisfactory, in view of the prevalent world depression and the consequent low prices for silver and base metals. Although on a generally reduced scale, production has been continued by the larger operators, with the exception of that of the Granby Company at their Copper Mountain property, which was closed down as its part in the general scheme of curtailment agreed upon by the principal world copper producers.

Gold Mining.—The development of base-metal properties has slowed down considerably and the very drastic economies accomplished by the larger mining companies have necessitated a material reduction in scouting and development operations on new properties by these leading enterprises. On the other hand, gold-mining has attracted much attention, and many potential properties that have remained undeveloped for years are now under investigation. The decrease in gold output for the past six months is accounted for by the lessened return of by-product gold from copper refining, in addition to lowered output from the Premier and suspension of operations by the Hedley Gold Mining Company at Nickel Plate. Increased production was furnished by the Pioneer, Reno and Union mines, where further development may be expected to provide greater output that will more than compensate for the decline in output from some of the old mines.

Prospecting.—Placer prospecting, which is experiencing a revival, is meeting with a measure of success and an increased gold output from this source is anticipated for the year. Of these, it is noted that a marked increase in placer-gold production from the Atlin section is indicated for this year, where the Cie. Française des Mines d'Or du Canada has struck rim rock, and possibly the old channel on Otter Creek, a condition that promises well for continuous production. On Ruby creek, a nugget weighing 47 oz. 13 dwt. (about 25% of volume is quartz) was recently picked up by two prospectors. On Slate creek in the Omineca Division, the Consolidated Mining and Smelting Company is carrying out an extensive programme of testing on the gravel beds. In the Cariboo and Quesnel Divisions important placer operations are in progress, on Lowhee, Moorehead, Cedar and Four-mile Creeks, and individual operators are meeting with success along the Skeena River and on Rainbow Creek, where some spectacular finds were recently reported. Much interest is being displayed in gold mining. Development at the Pioneer on Bridge River continues to be satisfactory, where plans are being put into execution for doubling the mill capacity. Active development at the Lorne property, adjoining the Pioneer, has been undertaken by the new owners, and exploratory work is in progress on the properties of Bridge River Consolidated, Ltd., which lies to the north of the Lorne,

and where it is considered that conditions are favourable for the development of an ore-body.

Company Results.—When it is realized that the low price of copper has cut profit margins to a minimum, the production and financial statements of the Granby and Howe Sound companies for the second quarter of 1931 must be considered as surprisingly good, in that they reflect great care on the part of the management to cope with an abnormal condition. The Granby Company showed a net profit of $7,405 for the three months period ended June 30, as compared with a profit of $170,078 in the preceding quarter, and $418,099 in the June quarter of 1930. Net production costs after crediting precious metals and miscellaneous income to copper, but exclusive of depreciation, depletion and federal taxes, were 8·078 cents per pound compared with a market price of 8 cents delivered. In the corresponding period of 1930, with much greater production, costs were 9·95 cents. After writing unsold copper in inventory down to 8 cents a pound, net income for the second quarter was equivalent to 1·65 cents per share and compares with 38 cents a share in the first quarter of the current year. In June a 25 cent quarterly dividend was declared, thereby reducing the annual rate from $2 to $1 per share.

The Howe Sound Company, which in addition to the Britannia Mine on Howe Sound, owns and operates properties in Mexico, reports a net income of $127,466 for the second quarter of 1931, compared with $319,698 during the March period and with $459,260 in the second quarter of 1930. For the six months ended June 30 last, net income is equivalent to 90 cents per share, compared with $2·38 per share for the corresponding period of 1930. Production at the Britannia amounted to 8,006,654 lb. of copper for the June quarter, which compares with an output of 8,054,620 lb. for the first three months of the current year. Production has now been curtailed and, as copper prices have declined still further since the beginning of July, the third quarter is not expected to show any improvement. A distribution to stockholders of 50 cents per share on 496,038 shares outstanding was made on July 15 last. The Britannia Company has started to drive a 9 by 12 ft. tunnel that will provide facilities for handling the entire mine output at mill elevation, or 4,100 ft. level. For this work the equipment includes a four-unit drilling carriage and a 30 h.p. electrically driven scraper-mucker. It is estimated that this tunnel, which will have an ultimate length of 10,000 ft., together with ore-passes and other necessary connexions, will require two years to complete and, in addition to its primary purpose, will aid in exploiting the downward extension of proved ore-bodies, as well as extensive exploration at a horizon considerably lower than present workings.

Consolidated Mining and Smelting Co., Ltd.—Receipts of ore and concentrates at Trail smelter during the first six months of 1931 totalled 233,077 tons, of which 229,697 tons were received from company mines and 3,380 tons from custom shippers. Production during the half year shows the following comparison with the corresponding period of 1930 :—

	1931.	1930.
Lead, tons	75,451	75,531
Zinc, tons	57,986	57,202
Copper, tons	355	5,889
Gold, oz.	12,458	11,869
Silver, oz.	3,381,240	3,434,590

The marked reduction in copper is due to the fact that blister copper from the Granby Company's operation at Anyox is now shipped to Copper Cliff for treatment.

Although no definite announcement has been made by the Consolidated relative to participation in the reconstituted zinc cartel, it is understood that zinc production at Trail has been curtailed by 35 to 40%. This would appear to correlate with the agreement reached at Brussels last month between the ten leading zinc-producing countries, outside of the United States, to reduce output by approximately 45% of full rated capacity until the end of 1932. Production by the Trail smelter normally represents about 90% of Canada's zinc output. Lead production has already been reduced by about 20%, in accordance with the voluntary curtailment programme that became effective on May 1, and which was ratified by world lead producers, exclusive of the United States. Consistent with its well-planned administration, the Consolidated Company has inaugurated a system of shift work that will distribute employment on an equitable basis and thus retain the services of as many men as possible while the present quiet conditions obtain. This has been arranged by grouping employees into four shifts in place of three, each shift working fifteen days, with an interval of five days

"lay-off" between each working period. This system became effective August 1. In departments where the shift system is not feasible, a definite number of days' work per week will be substituted.

TORONTO

August 18.

Sudbury.—International Nickel reported net operating income for the first six months of the year at $5,544,476, as compared with $10,429,583 for the corresponding period of last year. The net profits were $3,359,886 as against $7,883,874. The company's surplus at the end of the six months was $18,665,460, as compared with $24,997,902. A further curtailment of smelter operations and the tonnage of the Frood mine was made on August 3. One furnace was closed down, reducing the production of matte by about 15% The men released were given work on the reconditioning of No. 4 shaft, which is being re-equipped for ore-hoisting purposes. A new electric hoist is on order, which, when installed, will have a speed of around 2,000 ft. per minute and with the equipment of No. 3 shaft will give the Frood a total hoisting capacity of about 10,000 tons daily. Several changes have been made in the official staff, J. C. Nickolls, Copper Cliff, has been promoted from general manager to assistant to the president at Toronto; Donald MacAskill of Copper Cliff, from manager of the mining and smelting division to general manager; Dr. John F. Thompson from assistant to the president, to vice-president. The Falconbridge during the first months of the year exported to its refinery at Norway, 1,810,300 lb. of nickel, and 716,100 lb. of copper, as compared with 1,260,000 lb. nickel and 553,900 lb. copper during the first six months of 1930. The total value of nickel-copper during this period amounted to $433,851, as against $339,929. The improvement shown is largely due to the fact that the smelter did not go into production until March, 1930. Mine development westward on the 350 ft. level continues in good ore, a rise being run from the 1,000 to the 700 ft. level, cross-cutting on the way up proving satisfactory. At the Errington Mine of the Treadwell Yukon, in driving eastward on the 1,000 ft. level, favourable values have been encountered in the copper-zinc-lead ore, which is believed to be the eastern rake of the ore developed in large tonnages on the upper levels. Construction work on the new flotation mill for the Lake Geneva Mines property is practically completed. The mill is equipped with a Buchanan jaw-crusher and ball-mill, the crushing equipment having a capacity of upwards of 100 tons a day. The flotation units have yet to be installed, while power will be provided by a new diesel-driven generator. A new headframe, 55 ft. in height, has also been erected and an electrically-driven hoist, capable of carrying on mining to a depth of 1,000 ft., has been installed.

Porcupine.—The output of bullion from the mines in the Porcupine field during July from the treatment of 259,972 tons of ore was valued at $1,673,141, as compared with $1,584,620 from 264,823 tons of ore in June. The mill of the Hollinger Consolidated is treating 5,000 tons of ore per day, mill-heads being comparatively low, owing to the fact that the Schumacher shaft, from which the high-grade ore has been coming, is being deepened, the ore now coming from lower grade sections. Sinking is to be continued to a depth of 6,000 ft. as there is every reason to believe that enrichment will occur at depth, values obtained from diamond drilling below the porphyry intrusion being higher than anything found elsewhere on the property. The McIntyre Porcupine is actively pushing development, its programme calling for 10 miles of underground work a year. Driving in the Platt Vet section of the mine has reached the ore-zone and good commercial ore is being taken out on the 3,750 ft. level. This section is somewhat removed from the McIntyre-Hollinger zone and is believed to link up with the Vipond vein system. The gold output of the Dome mines during July was somewhat lower than during the earlier months of the year, amounting to $299,280, as compared with $328,700 for June and $320,628 for July of last year. The Coniaurum is opening up a new ore-body encountered on the 1,750 ft. level, which has been driven on for about 70 ft., disclosing a width of from 6 to 10 ft., with average values of from $25 to $30 to the ton in gold. The downward continuation has been opened up on the 2,000 ft. level for 200 ft., values going $6 to $7 per ton over a good width. The new 50 ton pilot mill of the Canusa has gone into operation, mine development

being carried on to the 100 and 200 ft. levels, the workings to be carried to a depth of 600 ft. At the Hayden the drive on the 700 ft. level continues to produce ore showing visible gold. Cross-cutting is being undertaken at this level towards a vein 20 ft. wide indicated by diamond drilling.

Kirkland Lake.—Six producing mines in the Kirkland Lake area during July yielded bullion to the amount of $1,858,369, from the treatment of 146,907 tons of ore, as compared with $1,886,233 in June when 144,415 tons of ore were milled. Extensive operations are under way at the Lake Shore where a new hoist is being installed. The new mill is running smoothly and is treating approximately 2,400 tons of ore daily. Four new levels, from 2,350 to 2,950 ft. are being opened up. The company has adopted the cut and fill method of mining which is expected to result in the mill-heads averaging from $16 to $18 per ton. The mill of the Wright Hargreaves is handling 750 tons of ore daily, mill equipment being added to increase the daily capacity to 800 tons. Shaft sinking has been halted at the 3,120 ft. level and five new levels will be opened up below the 2,500 ft. horizon. Lateral work is in progress at 2,400 ft., where a continuation of the ore development at the 2,250 ft. level has been opened up. A financial statement issued by the Teck-Hughes for the nine months ending May 31 showed a gross income of $4,451,324, operating costs being $1,550,520 and net operating earnings $2,900,814. After deductions for depreciation, etc., there remained a net surplus of $2,448,560. The No. 2 shaft of the Sylvanite mine, which has reached a depth of 2,500 ft., will be continued to 3,000 ft. The new levels which have been opened up are reported to be showing good mineral indications, while the work on the upper levels is encountering higher values in gold. The Bidgood is sinking to depth of 500 ft. A vein showing high-grade ore has been cut below the 375 ft. level and will be opened up at depth. The Barry-Hollinger mill is now treating 100 tons of ore daily, having an average value of $7·50 per ton. Work on the 1,875 ft. level is meeting with encouraging results. The Moffatt-Hall in shaft sinking has encountered two more veins of a promising character. On the 150 ft. level about 140 ft. of ore has been developed, average values being about $14 to the ton.

Rouyn.—The Noranda Mines is maintaining its position by continuing to devote attention mainly to gold production. During the six months ending June its output is approximately estimated at 31,800,000 lb. of copper and $2,528,340 in gold, indicating the production of 8 cents in gold for each lb. of copper. An extensive programme of development at depth is being undertaken. The two main shafts will be put down from the 2,000 ft. level another 500 ft. and diamond drilling will be carried on to test the structure between 3,000 and 4,000 ft. The company is developing its claims in Pascalis township, North-Western Quebec, where a shoot of high-grade ore has been opened up. Channel sampling yielding assays of $25 in gold to the ton. The Waite-Montgomery has ceased production since the first of the year, but has been maintaining active development operations. The shaft is being put down to a depth of 1,000 ft., and a rise started from the 700 ft. level to the surface. The Granada is carrying out its deep development programme and the shaft is being sunk to its first objective of 750 ft. Ore-bodies on the 625 ft. horizon yield mill-heads averaging $14 gold to the ton. An interim report of the Siscoe Gold Mines, Ltd., for the first six months of the year shows a production of $334,836, with costs before depreciation and taxes of $159,265, leaving a mine profit of $175,571. During the period the ore milled amounted to 24,177 tons of an average grade of $14·11 per ton with a recovery of $13·88 per ton. The ore reserves are estimated at 100,000 tons. The policy of the management is to concentrate on development in order to put in sight sufficient ore to warrant the increase of the mill capacity to 400 tons per day.

Patricia District.—Renewed interest in this district has been aroused by an important gold strike at Red Lake on an island four miles from the Howey gold mines, which is described as one of the richest made in the district. The vein has been traced for 750 ft. and its value proved by the sinking of test pits at intervals. J. A. Munro, who made the discovery, has given an option to the Coniagas Mines, Ltd., who will develop the property. The mill of the Howey is treating about 600 tons of ore per day, production in July amounting to 77,954 tons, as compared with 65,001 tons in June.

Production is expected to be increased by the new sorting equipment, which is now nearly ready for operation and this will bring the tonnage up to 700 or 750 tons per day. Metals Development Company, with holdings in the Red Lake section on which considerable progress had been made in development, have arranged for re-financing, with a view to the resumption of operations in the near future.

Manitoba.—The Silica vein on the property of the Manitoba Flin Flon carries high gold values. Field advice reports gold returns of $37, per ton, and 2·80 ounces of silver over a 60 ft. channel sample. It is proposed to ship material from this body to the Flin Flon smelter for flux. The smelter has made an offer of $1·50 per ton for the silica and in addition will account for any precious metal values existing in the ore. The main shaft at the Gem Lake property in Central Manitoba, is now down to depth of 700 ft., and driving will be carried on at two new levels. The vein is reported to have been cut at 695 ft., carrying considerable gold. Development at the Gold Pan in the Elbow Lake field has been attended with promising results.

PERSONAL

R. Allen is home from West Africa.

Bernard Beringer is expected home from Peru in the autumn.

S. E. Birch has returned to Nigeria.

Stanley W. Carpenter is returning from Nigeria.

L. M. Cockerell has returned from Dutch Guiana.

F. H. Cothay has left for Nigeria.

P. C. Delaitre is leaving Paris for French Equatorial Africa.

C. Stansfield Hitchen has left for the United States.

R. A. Mackay having returned from Cyprus has left for Panama.

H. H. Martin has left for Ecuador.

G. R. Nicolaus is home from West Africa.

G. S. Rice has returned to the United States.

R. C. Riley is returning from India.

James Roberts is returning to Italy.

F. J. Ryeland has left for Colombia.

R. S. Steedman is returning to Malaya.

Murray Stuart has left for Germany.

F. L. Thomas is home from Australia.

G. Eaton Turner has left for West Africa.

E. J. Wayland is home from Uganda.

George Albert Chapman died suddenly in New York on August 15 at the age of 51. He was a Member of the Institution of Mining and Metallurgy and had been associated with Minerals Separation, Ltd., since 1904.

John William Hinchley, who died on August 13, at the age of 61, was professor of Chemical Engineering at the Imperial College. He was an Associate of the Royal School of Mines and in 1903 went to Bangkok as chief assayer of the new Siamese Mint. On his return he started teaching and also acted in a consulting capacity. For many years he was secretary to the Institution of Chemical Engineers.

William Thomas, who died at Perranporth on August 16, at the age of 74, had for some time past been the Camborne correspondent of The Mining Magazine. He was formerly head of the mining and surveying department of the Camborne School of Mines and will also be remembered as manager of the Botallack mine, St. Just. In addition to being prominently associated with various Cornish technical institutes, he was for some time a Member of the Council of the Institution of Mining and Metallurgy.

Frederick Pine Theophilus Struben, who died on September 7, at the age of 81, is said to have been the actual discoverer of the Witwatersrand Goldfield. As a young man he farmed and prospected with his father, who was in charge of four magistracies in Natal colony. He prepared a geological map of the Transvaal embodying the results of 13 years of careful prospecting. In January, 1884, he found a reef at Sterkfontein and a company named Sterkfontein Junction Mining Syndicate was formed in March of that year, of which Struben, his brother, and two friends were the members. He subsequently made several further discoveries and is credited with tracing the main reef on a number of other farms.

George Cleghorn Mackenzie, secretary-treasurer of the Canadian Institute of Mining and Metallurgy, died suddenly at Bark Lake, Quebec, on August 22, aged 54. He was born at Kincardine, Ontario, graduated in Arts at Trinity College, and in 1905 received his degree in mining engineering from Queen's University, Kingston. For some years Mr. Mackenzie was engaged in iron mining in Nova Scotia and in 1908 was appointed to the staff of the Department of Mines at Ottawa. During the war he was secretary of the Munitions Resources Board, created to advise the Government on war supplies. After engaging for a short term in commercial life, Mr. Mackenzie was appointed to the post which he occupied for ten years until his death, and in which he will be especially remembered outside Canada for his work in connexion with the Second Empire Mining and Metallurgical Congress in 1927.

Alfred Trewartha James died at Johannesburg on September 5, at the age of 64. He was prominently identified with the introduction and application of the cyanide process for gold extraction throughout the world, which was first applied in 1889 to the treatment of Rand tailings. He acted in an advisory capacity to several of the leading gold mining companies, and was technical manager of the Cassel Gold Extracting Company. In 1897 he retired in order to enter into partnership with J. S. MacArthur. For the period 1908–1909 he was president of the Institution of Mining and Metallurgy, of which he had been a member since 1895, and he was a Fellow of the Chemical Society and the Geological Society. As mentioned in The Mining Magazine for August, Mr. James went to South Africa towards the end of last year, with a view to instituting legal action against various Rand companies in connexion with the use of certain patent processes of gold extraction.

TRADE PARAGRAPHS

Denver Equipment Co., of Denver, Colorado, publish the first issue of their *Flotation News* which contains a number of items to interest those engaged in milling.

G. A. Harvey and Co. (London), Ltd., of Woolwich Road, London, S.E. 7, have published a booklet on the subject of the cause and prevention of rust and corrosion in iron and steel which deals with the galvanizing of these metals.

E. W. Oakes and Co. and **William Turner and Co.,** both of Sheffield, have amalgamated their bullion businesses under the title of Oakes, Turner and Co., which has become a subsidiary of **Johnson, Matthey and Co.,** of Hatton Garden, London, E.C. 1.

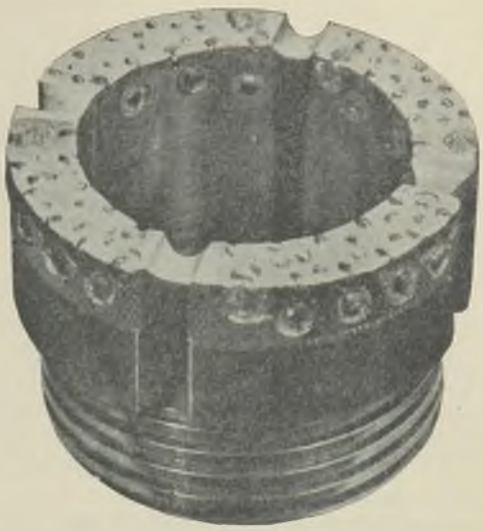
Adam Hilger, Ltd., of 24, Rochester Place, London, N.W. 1, publish Bulletin No. 3 dated June, 1931, on the subject of spectrum analysis. This deals with applications of these methods to mineralogy, chemistry, and metallurgy and cites references to the work of various authorities.

Nor-Rust Liquid Lead Co., Ltd., of Iddesleigh House, Caxton Street, London, S.W. 1, have been awarded a contract by the Great Western Railway Company for the coating of some 200,000 ft. of steel with Nust at one of the company's docks. Nust is a new form of anti-corrosive pigment which resists not only water and atmospheric attack but also that of acid vapours.

W. and T. Avery, Ltd., of Soho Foundry, Birmingham, issue particulars of a testing machine recently supplied to the Ontario Department of Mines which is to be employed for carrying out tensile tests on heavy gauge wire rope specimens —6 ft. in length and 3½ in. diameter. The machine is capable of exerting a load of 1,000,000 lb. and the poise of the beam is electrically controlled.

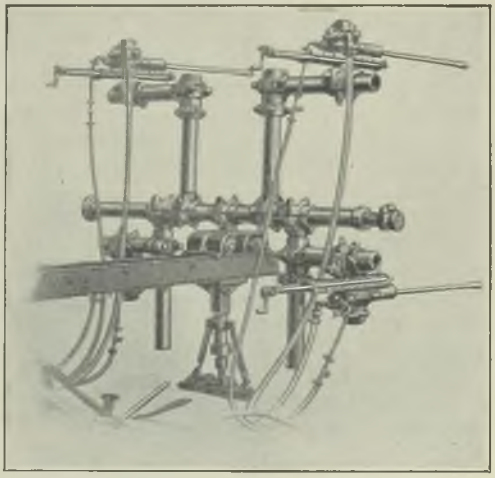
Mavor and Coulson, Ltd., of 47, Broad Street, Mile End, Glasgow, have just celebrated their jubilee and in connexion therewith have issued a booklet drawing attention to the principal steps in the progress of the firm which began by actively applying electric lighting locally and later elsewhere in Scotland. This was followed by further extensions in electrification and the development of ironclad enclosed electric motors and later the construction of the first coal cutters. Further developments to assist the coal miner included the productions of shaking conveyors. The company had the satisfaction in 1930 of securing the largest coal cutter contract ever awarded to a single firm.

J. K. Smit and Zonen, of Amsterdam, issue a booklet describing the introduction and use of "finehards and diamhards." Attention was first directed to this matter in the MAGAZINE for February, 1930, when it was pointed out that the increased price of carbons, or boarts, for diamond drilling had resulted in the production of a substitute in the form of small diamond crystals which were set in the bits of core drills in the same way as boarts and which, while considerably cheaper, were no less efficient. An example of a drill bit so set is shown in the accompanying photograph from which it will be seen that the stones are set over the whole face, including inside reamers. The manner of the setting of the stones is important and the makers have what they call different "layouts" for different rock hardnesses. The small stones, the makers admit, are "bound to break," but provided the drills are not run too long performance is unaffected.

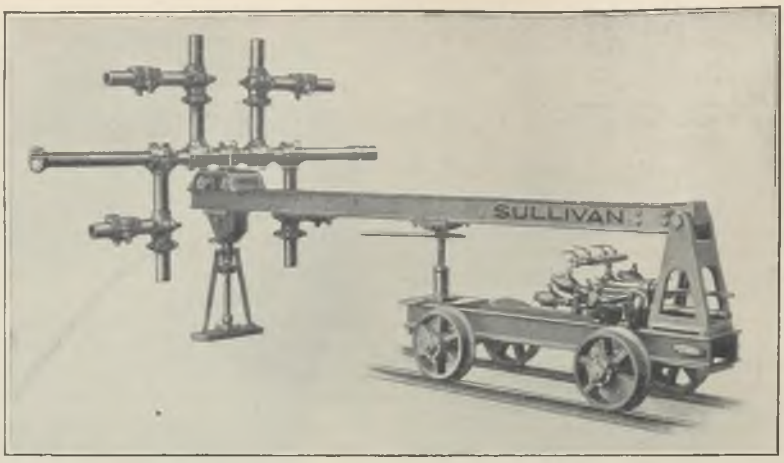


DRILL BIT SET WITH SMALL DIAMONDS.

Sullivan Machinery Co., of Salisbury House, London, E.C. 2, have issued a new catalogue of hoists for scraper mucking. These are made in two and three drum types for electric, compressed air, or Diesel engine drive and ranging in power from 75 down to 7½ h.p. The catalogue is fully illustrated and shows a number of these machines and also examples of operations in different mining fields. Elsewhere in this issue of the MAGAZINE attention is directed to the improved efficiency in tunnelling operations that has resulted from the mechanical handling of broken ground. The Sullivan Company also direct attention to their "Quickset" drill carriage for tunnelling



DRILLS MOUNTED ON SULLIVAN CARRIAGE FOR TUNNELLING.



Drill Carriage set up in Position for Drilling.

which was first used in this country by the contractors engaged in operations for the Manchester Corporation Waterworks Haweswater Scheme. As mentioned elsewhere these operations recently resulted in what was at that time a new European tunnelling record with drills of **Holman Bros.** manufacture. The carriage is shown in the above illustration, from which it will be seen that it holds four drills. It provides a standard drill mounting consisting of a heavy cross-bar with extension screws, carrying four short columns with arms for the drill, giving complete freedom of movement vertically and laterally. It is supported on a double I-beam girder, which in turn is carried by a four-wheel truck for moving. After the round of holes has been drilled in the tunnel face, the cross-bar jack screws are loosened from the walls of the tunnel, the forward frame support hooked up out of the way, the cross-bar with its drills, run back on the frame, and the whole carriage pulled back to the nearest siding. This arrangement permits the use of any one of the modern, efficient mechanical loading machines to get rid of the muck in the quickest possible time. The drill carriage is then run forward again into the heading, and the set-up occupies but a few minutes, as the drills are already located on the column arms, and the hose and water connections already completed. Only one connexion for air and one for water are needed for the carriage. These two lines are connected to the manifold seen at the rear end of the carriage. From this separate air and water lines lead to each individual drill. An automatic line oiler is attached at the manifold in the hose line leading to each drill. With this rig the four drills can be in operation in 15 to 20 minutes after the carriage reaches the heading face, as compared with 45 minutes to an hour required when separate mining columns and arms are employed. A well-trained crew has set up and started drilling with the carriage in ten minutes.

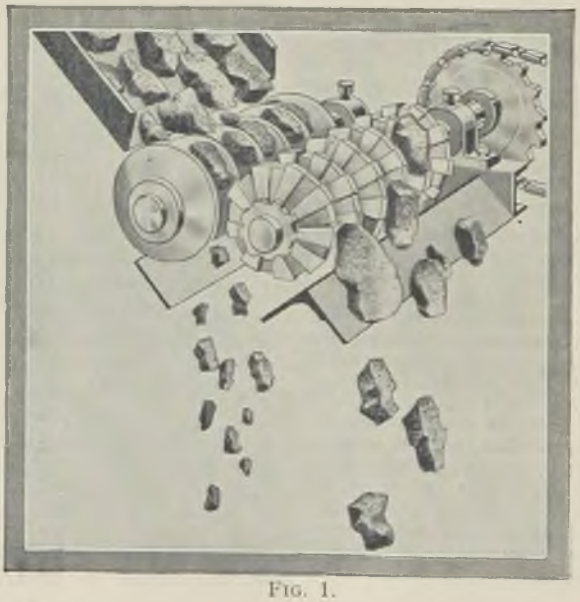


Fig. 1.

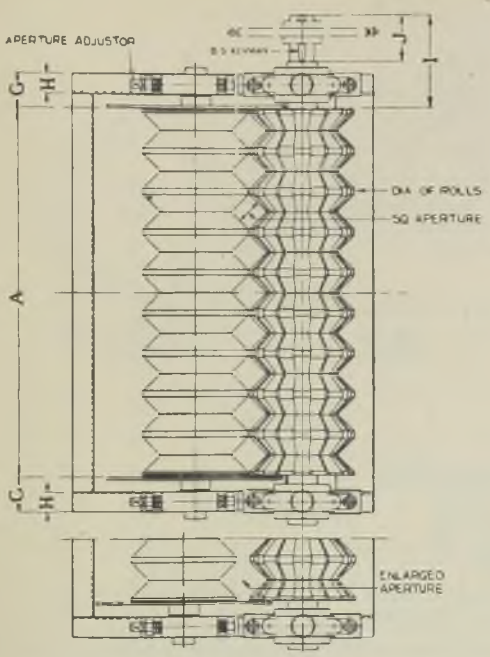


FIG. 2.—PLAN OF ROSS TWO-ROLL VIBRATING SCREEN.

THE ROSS TWO-ROLL VIBRATING SCREEN

A new type of vibrating screen which promises a number of interesting applications has been developed by Ross Patents, Ltd., of Abbey House, Victoria Street, London, S.W. 1, which is associated with Ross Screen and Feeder Co., of 247, Park Avenue, New York City. The firm will be remembered as the makers of specialities such as the Ross feeder and the drop bar screen to which attention was directed in the MAGAZINE for February, 1926, and September, 1927.

The manner of operation of the new screen is conveyed by the pictorial representation in Figure 1. This, however, explains only the principle and does not reproduce the precise form of the two roller members referred to in what follows. The screening element consists of two rolls, one free and the other driven. Both the rolls are corrugated and in addition the driven roll has each corrugation serrated as is shown in the plan drawing in Figure 2. The effect of these serrations is to lift the oversize particles, particularly those near aperture size. In addition, vibratory movement is imparted to the aperture by reason of the slight but rapid alternations in size as serration follows serration. Looking down on the two rolls during screening it is seen that the oversize is kept jumping about until it is carried over, while the fines pass smoothly through. There is thus no crushing action. There is, however, a tendency for some fines to be carried over with the oversize, but this objection is overcome by having a second, and where necessary a third, set of rolls, which are arranged in cascade as shown in Figure 3.

From the foregoing it is evident that this screen is suitable for handling hard or soft (even friable) material. Tramp iron will, moreover, not stop it, as it is capable of rejecting all sorts of shapes of scrap metal with the oversize, as has been effectively demonstrated to us on a working model. The rolls are adjustable so that various aperture sizes may be presented to the feed as required (see Figure 2).

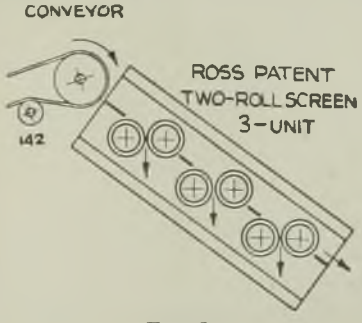


FIG. 3.

METROPOLITAN-VICKERS DEVELOPMENTS

In February last some attention was given in these columns to new winding engines recently constructed by Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, and in connexion therewith brief descriptive notes were included of two important improvements which have been recently incorporated in winding engine installations, namely, the automatic system of braking and a new type of hydraulic slip regulator.

The firm issue a descriptive booklet referring to these and other developments and from this it is possible to reproduce the accompanying illustrations respectively of the brake and regulator. With regard to the brake, the diagrammatic arrangement shown in figure 1 is explained in the following notes: The horizontal shaft A of the governor is driven by the gears from the drum shaft or other solidly connected portion of the rotating parts of the winding engine, and transmits motion through a wheel and bevel pinion to the vertically mounted spindle of the governor, on the lower end of which is rigidly fixed a disc B, rotated with the spindle C. Immediately above the disc and normally rotating with it, but not rigidly attached, is a flywheel inertia member D, which has on its underside an attachment by means of flexible links E to the disc B. The flywheel D is centred co-axially on the verticle spindle C by means of a special ball bearing, and is free to move axially and circumferentially with respect to the spindle. Coupled to the flywheel is a valve F, which regulates the supply of oil to the oil-operated relay G located in the base of the casing of the main control valve. Surrounding the valve piston is a ported sleeve H, which is coupled by means of links to the emergency solenoid J and the driver's lever.

Braking is initiated by the movement of the sleeve H of the main control valve by means of the driver's lever or the operation of the emergency gear. Either movement will cause a deceleration of the winding drums as a result of the application of the brakes, the actual resulting change of speed being measured by the angular displacement of the flywheel D with respect to the disc B, on which it is supported. This angular movement is translated

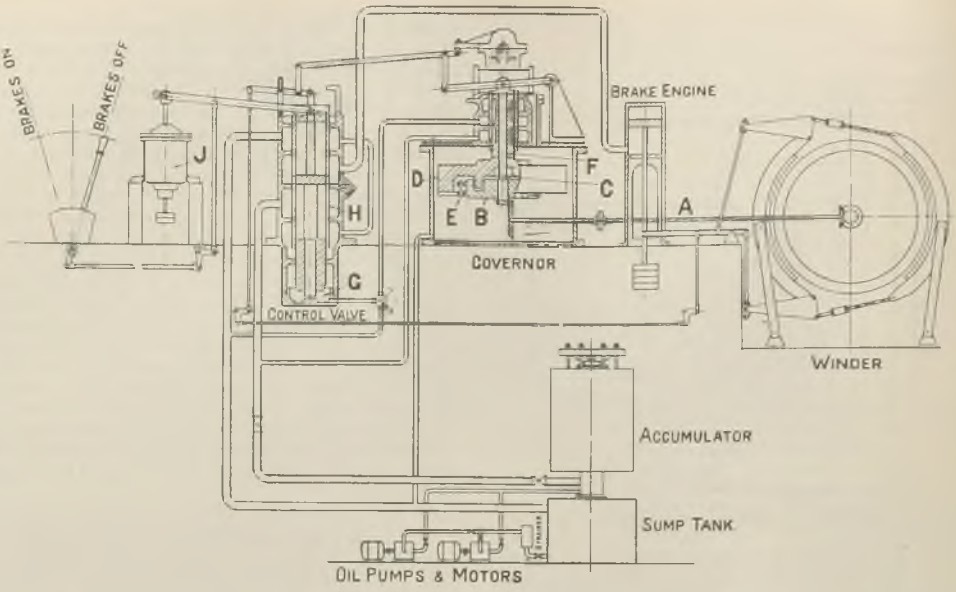


FIG. 1.—DIAGRAMMATIC ARRANGEMENT OF AUTOMATIC BRAKE GOVERNOR FOR METROPOLITAN-VICKERS WINDING ENGINES.

into vertical motion by the action of the links E, on which the wheel D is suspended, thus raising the valve F and admitting pressure to the relay cylinder of the main valve, the piston of which is also raised.

The governing is obtained by the automatic positioning of this combination of valves with respect to the change of speed of the winding drum; therefore the driver's lever or the emergency gear (either of which operates the brakes) may be calibrated in ft./sec.^{2} (deceleration) as the position of the operating lever, and in consequence the position of the sleeve of the main valve, corresponds in each and every case to some definite rate of deceleration quite independent of the load in the cages at the time of the application of the brakes.

The hydraulic slip regulator is illustrated in figure 2, the installation here being that recently completed for Broken Hill South Mine, New South Wales. The regulator is a development of exceptional interest in that it makes possible the use of either synchronous or synchronized induction motors to drive flywheel motor-generator sets used with Ward-Leonard winders and thereby gives the advantages of power factor control that are obtained

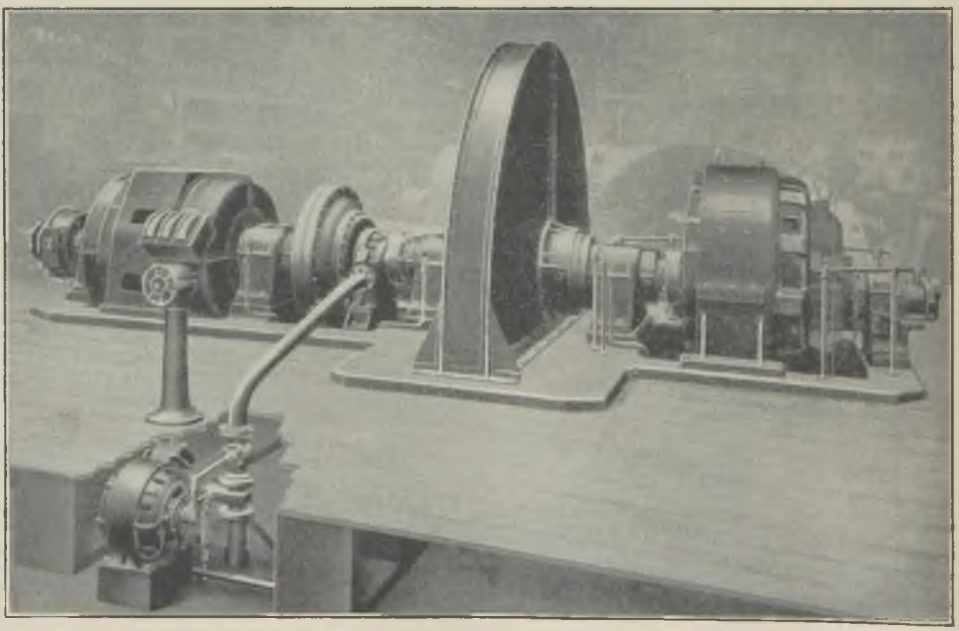


FIG. 2.—METROPOLITAN-VICKERS HYDRAULIC SLIP REGULATOR FOR WINDING ENGINES.

SOME RECENT METROPOLITAN-VICKERS WINDER INSTALLATIONS ABROAD

No. of Sets	Motor			Supply		Duty			System	Customer	Location
	R.m.s. H.p.	Max. B.h.p.	R.P.M.	Volts	Periods	Shaft Depth in ft.	Speed in ft. per min.	Net Load in lb.			
*2	1350	2700	280	3300	50	2500	1500	19000	W.L. Geared	Anglo American Corporation of S.A., Ltd.	N'Kana, N. Rhodesia.
*2	1300	2600	27·5	3000	50	1100	1404	20000	W.L. Geared	Roan Antelope Copper Mines, Ltd.	Luanshya, N. Rhodesia.
*2	1085	2170	55·7	6600	40	2780	1740	13440	W.L. Direct Coupled	North Broken Hill, Ltd.	Broken Hill, N.S.W.
*2	875	1800	55·7	6600	40	2090	1750	11200	W.L. Direct Coupled	Broken Hill South, Ltd.	No. 7 Shaft, Broken Hill, N.S.W.
*1	700	1400	53·2	6600	40	2852	1746	7840	W.L. Direct Coupled	Zinc Corporation, Ltd.	Broken Hill, N.S.W.
1	425	850	355	3000	50	781	1002	9000	A.C. Geared	Rio Tinto Co., Ltd.	Spain.
1	400	800	565	6000	50	1400	810	8800	,, ,,	Arcos, Ltd.	Shaft 16A, Russia.
1	400	800	350	2200	50	963	—	11200	,, ,,	Tharsis Sulphur & Copper Co., Ltd.	Alguida Mines, Spain.
1	170	350	280	6000	50	920	810	4400	,, ,,	Arcos, Ltd.	Shaft 6s, Russia.
1	160	320	565	3300	50	—	—	—	,, ,,	Selection Trust, Ltd.	Trepca Mines, Yugo-Slavia.
1	150	300	323	550	40	2800	696	3920	,, ,,	Zinc Corporation, Ltd.	Broken Hill, N.S.W.
1	100	200	940	550	50	1200	600	4480	,, ,,	Mufulira Copper Mines, Ltd.	N. Rhodesia.
1	70	140	480	3300	50	—	—	—	,, ,,	Mount Isa Mines, Ltd.	New South Wales.
1	50	100	360	3300	50	—	—	—	,, ,,	A. Yule & Co., Ltd.	India.

* These installations are equipped with the Metropolitan-Vickers hydraulic slip regulator.
The first four installations in the above list are also equipped with the Metropolitan-Vickers brake governor.

with motors of these types. The general principle of this operation was described in the notes already referred to above. The following additional matter may, however, prove of interest. The coupling is supplied with oil from a pressure tank and when full drives a flywheel generator on full load at a speed two or three per cent. below the synchronized speed of the driven motor. When the coupling is empty the flywheel and generator are completely disconnected from the driven motor. The slip of the coupling is directly proportioned to its filling and so by regulating the speed of oil to the coupling it can be made to slip and it is this characteristic that is made use of when using the coupling as a slip regulator.

The booklet from which these notes have been taken contains also interesting information with regard to the recent contracts for winding engines of which the above tabulated list includes the more important. The rest of the booklet is taken up with details of other specialities of interest to mining men, notably arc welding equipment easily transportable for use underground, special types of motors for mining service, switchgear, control gear, and mining transformers.

METAL MARKETS

COPPER.—Fairly steady conditions prevailed throughout August, electrolytic in New York ruling most of the time at 7·75 cents per lb., f.a.s., after opening the month at 7·87½ cents, whilst Standard values in London after ruling fairly steady, closed with rather a firmer tone. Sentiment has been encouraged a little by reports that American producers are contemplating more drastic cuts in output, although optimism has been held in check by the recent further increase in the unwieldy American stocks. Consumption remains quiet.

Average prices of Standard Cash Copper: August, 1931, £32 12s. 3d.; July, 1931, £34 9s. 1d.; August, 1930, £47 11s. 4d.; July, 1930, £48 6s. 10d.

TIN.—The Standard tin market was firm last month, sentiment having been strengthened by the conviction that at last the operation of the Restriction Scheme is beginning to influence the statistical position. The Tin Pool is, in addition, said to be operating. Meanwhile demand has remained comparatively sluggish.

Average prices of Standard cash tin: August, 1931, £114 19s. 1d.; July, 1931, £111 11s. 1d.; August, 1930, £135 1s. 2d.; July, 1930, £134 11s. 10d.

LEAD.—The London lead market during August was by no means firm, although rallies occurred at times. Industrial demand is poor and meanwhile surplus stocks remain far in excess of requirements, whilst the commencement of operations at the Mount Isa Mines in Queensland represents a further menace to the market. In America the price last month remained steady at 4·40 cents per lb.

Average mean price of soft foreign lead: August, 1931, £11 19s. 4d. July, 1931, £12 16s. 3d.; August, 1930, £18 4s. 8d.; July, 1930, £18 2s. 2d.

SPELTER.—Moderately firm conditions prevailed on the spelter market throughout August, mainly owing to recognition of the determined manner in which the Spelter Cartel is endeavouring to readjust output to consumption. World stocks have already begun to recede. Consumers, however, are still unable to buy very extensively owing to the continued depression in the demand for finished products. In America the price receded from 3·87½ cents per lb. to 3·80 cents.

Average mean price of spelter: August, 1931, £11 14s. 7d.; July, 1931, £12 10s. 9d.; August, 1930, £16 4s. 2d.; July, 1930, £16 9s. 5d.

IRON AND STEEL.—The British pig-iron market last month remained in the doldrums, the very limited output being adequate to satisfy the current demand. Imported pig-iron continues to compete keenly in Scotland. Cleveland makers maintained prices at their fixed minima, No. 3 G.M.B. being quoted at 58s. 6d. per ton; hematite was none too firm with East Coast

LONDON DAILY METAL PRICES.

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

	COPPER.				TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD.
	Standard.		Electrolytic.	Best Selected.				Soft Foreign.	English.			
	Cash.	3 Months.			Cash.	3 Months.				Cash.	Forward.	
Aug.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
11	32 7 6	33 4 4½	35 15 0	33 5 0	111 13 9	114 2 6	11 6 3	11 17 6	13 5 0	12⅝	12⅝	84 10½
12	32 8 1½	33 6 10½	35 15 0	—	115 17 6	117 17 6	11 7 6	11 16 3	13 5 0	12⅝	12⅝	84 11½
13	32 11 10½	33 11 3	35 15 0	—	116 0 0	118 12 6	11 5 0	11 15 0	13 5 0	12⅝	12⅝	84 11½
14	32 16 3	33 15 0	36 10 0	33 15 0	116 2 6	118 12 6	11 3 9	11 12 6	13 5 0	12⅝	12⅝	84 11½
17	32 19 4½	33 18 1½	36 10 0	—	115 11 3	118 1 3	11 1 3	11 7 6	13 0 0	12⅝	12⅝	84 10
18	32 9 4½	33 6 10½	36 0 0	33 5 0	114 8 9	116 17 6	11 0 0	11 10 0	12 15 0	12⅝	12⅝	84 11⅜
19	32 9 4½	33 6 10½	36 0 0	—	113 18 9	116 6 3	11 7 6	11 12 6	13 0 0	12⅝	12⅝	84 11⅜
20	32 5 7½	33 3 1½	36 0 0	—	115 3 9	117 13 9	11 18 9	11 16 3	13 5 0	12⅝	12⅝	84 11⅜
21	32 8 1½	33 5 7½	36 0 0	33 5 0	115 15 0	118 6 3	11 13 9	12 0 0	13 5 0	12⅝	12⅝	84 11⅜
24	32 13 1½	33 10 7½	36 0 0	—	114 11 3	117 1 3	11 8 9	11 18 9	13 5 0	12⅝	13	84 11⅜
25	32 10 7½	33 6 10½	36 0 0	33 5 0	116 18 9	119 11 3	11 11 3	11 18 9	13 10 0	12⅞	12⅞	84 11½
26	32 9 4½	33 6 10½	36 0 0	—	119 11 3	122 2 6	11 15 0	12 3 9	13 10 0	12⅝	12⅝	84 11½
27	32 14 4½	33 11 10½	36 0 0	—	121 1 3	123 11 3	12 1 3	12 5 0	13 10 0	13	13	84 11¼
28	32 14 4½	33 11 10½	36 0 0	33 5 0	120 1 3	122 11 3	11 16 3	12 2 6	13 10 0	12⅝	12⅝	84 11
31	33 1 3	33 18 1½	36 12 6	—	121 1 3	123 13 9	11 11 3	12 0 0	13 5 0	12⅞	12⅝	84 10
Sept.												
1	32 18 9	33 16 10½	36 10 0	33 10 0	120 1 3	122 11 3	11 10 0	11 6 3	13 0 0	12⅞	12⅝	84 10⅜
2	32 16 10½	33 13 1½	36 5 0	—	118 6 3	120 16 3	11 8 9	11 1 3	12 10 0	12⅞	12⅝	84 9½
3	32 10 7½	33 6 10½	36 5 0	—	117 11 3	120 1 3	11 2 6	11 1 3	12 10 0	12⅞	12⅞	84 9½
4	32 4 4½	33 1 3	35 10 0	33 0 0	115 8 9	118 0 0	11 0 0	10 18 9	12 10 0	12⅞	12⅞	84 9¾
7	31 10 7½	32 8 1½	35 10 0	—	115 1 3	117 11 3	11 2 6	10 18 9	12 10 0	13	13	84 9¾
8	31 1 10½	31 18 1½	35 10 0	32 10 0	114 11 3	117 3 9	11 0 0	10 17 6	12 5 0	12⅝	12⅝	84 11½
9	30 11 10½	31 7 6	35 0 0	—	113 18 9	116 8 9	10 15 0	10 13 9	12 5 0	13	13⅛	84 9½
10	30 15 7½	31 10 7½	35 0 0	—	115 1 3	117 11 3	10 16 3	10 16 3	12 5 0	12⅝	13	84 9½

Nos. at 61s. or less. British finished steel was dull. During the month Continental steel exhibited an extraordinarily weak aspect, though business remained very unsatisfactory even at the low levels registered at the close of the month.

Iron Ore.—Extremely quiet conditions prevailed during August and best Bilbao rubio is offering at about 14s. per ton c.i.f. for prompt cargoes.

Antimony.—Very little business has been done recently and at the close of July English regulus was quoted at £34 up to £42 10s. per ton. Chinese was offering for shipment at about £20 to £20 5s. c.i.f. or about £22 10s. to £22 15s. ex warehouse for spot.

Arsenic.—Cornish white continues very scarce and rather nominal at about £20 10s. per ton f.o.r. mines, but Mexican high-grade is in fairly liberal supply at about £17 to £17 5s. c.i.f. Liverpool.

Bismuth.—The official price remains at 6s. per lb. for 5 cwt. lots and over, demand remaining fairly good.

Cadmium.—A quiet but steady business continues at 1s. 9d. to 1s. 10d. per lb., according to quantity.

Cobalt Metal.—Interest in this article is restricted at the moment, but the official price remains at 7s. per lb.

Cobalt Oxides.—Current quotations remain at about 4s. per lb. for black and 4s. 9d. for grey, sellers still being anxious for business.

Chromium Metal.—The plating trade still absorbs fair quantities at about 2s. 6d. per lb.

Tantalum.—There is practically nothing doing and prices are nominal at between £40 and £50 per lb.

Platinum.—Quiet conditions have ruled throughout the past month, but prices are unaltered at £7 14s. to £8 per oz. for refined metal.

Palladium.—There is nothing much moving, but prices are steady at £3 12s. 6d. to £4 per oz.

Iridium.—Sponge and powder are quietly steady at £18 to £19 per oz.

Osmium.—About £13 per oz. is named for this metal, which, in common with others of the platinum group, has been very slow recently.

Tellurium.—In the absence of sales, quotations remain nominal at 9s. 6d. per lb.

Selenium.—High grade powder still changes hands fairly regularly at about 7s. 8d. to 7s. 9d. per lb., ex warehouse Liverpool.

Manganese Ore.—Apart from some German purchases of Russian ore against 1932 requirements, the market continues as dull as ever. Current quotations are rather nominal at about 9½d. per unit c.i.f. for washed Caucasian ore, 11d. to 11¼d. c.i.f. for best Indian, and 10d. c.i.f. for good 48% Indian.

Aluminium.—With makers adhering firmly to the old price level of £85 per ton less 2%, delivered, for ingots and bars, buying has remained very poor.

Sulphate of Copper.—English material is quoted at about £18 10s. to £19 per ton, less 5%.

Nickel.—The output of refined nickel is now not much more than a quarter of full capacity, but leading interests uphold prices at £170 to £175 per ton, according to quantity.

Chrome Ore.—Some cheap parcels continue to come on the market, but leading interests are holding for about 80s. per ton c.i.f. for good 48% material.

Quicksilver.—Business has remained negligible and prices have tailed off to about £16 per bottle, net, for spot material.

Tungsten Ore.—Consumers still show very little interest in acquiring fresh supplies and the current value of Chinese 65% ore for forward shipment is about 12s. 3d. to 12s. 6d. per unit c.i.f.

Molybdenum Ore.—About 28s. 6d. to 30s. per unit c.i.f. is named for 80 to 85% concentrates.

Graphite.—Demand is slow, but prices are unaltered at £12 to £13 per ton c.i.f. for raw 85 to 90% Madagascar flake and £14 to £15 c.i.f. for 90% Ceylon lumps.

Silver.—On August 1 spot bars stood at 13d., but, with very little demand about, values slipped back to 12⅝d. by August 15. The incidence of substantial German purchases for coinage purchases, however, coupled with some Indian bear covering improved matters a little, and on August 31 spot bars closed at 12⅞d.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
August, 1930	878,474	42,607	921,081
September	860,311	42,865	903,176
October	884,632	41,929	926,561
November	844,038	40,715	884,753
December	867,202	41,290	908,492
January, 1931	873,872	40,704	914,576
February	800,991	38,946	839,937
March	869,331	41,667	910,998
April	840,259	42,078	882,337
May	867,949	42,330	910,279
June	855,073	42,677	897,750
July	872,198	44,645	916,843
August	870,822	45,603	916,425

TRANSVAAL GOLD OUTPUTS.

	July.		August.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	100,500	£155,771	98,000	£151,481
City Deep	87,500	22,146	80,000	20,629
Cons. Main Reef	68,000	22,826	67,700	22,814
Crown Mines	271,000	84,014	267,000	84,196
D'rb'n Roodepoort Deep	47,700	15,456	48,200	15,328
East Rand P.M.	160,000	43,092	160,500	43,009
Geduld	86,400	27,704	86,600	27,586
Geldenhuis Deep	73,400	16,922	74,200	16,949
Glynn's Lydenburg	6,200	2,331	6,200	2,594
Government G.M. Areas	213,000	£414,634	204,000	£403,519
Kleinfontein	52,600	10,882	48,800	10,158
Langlaagte Estate	80,000	£114,131	78,000	£110,535
Luipaard's Vlei	32,500	£34,500	31,000	32,998
Meyer and Charlton	18,400	£17,577	18,300	£18,059
Modderfontein New	169,000	67,866	166,000	66,816
Modderfontein B	77,000	22,788	76,500	22,668
Modderfontein Deep	46,000	23,370	44,700	22,614
Modderfontein East	75,000	21,885	72,500	21,527
New State Areas	83,000	£172,236	82,000	£170,290
Nourse	72,000	21,712	72,000	21,389
Randfontein	235,000	£266,527	235,000	£266,474
Robinson Deep	99,000	28,589	98,500	28,476
Rose Deep	63,200	12,989	62,500	12,612
Simmer and Jack	83,000	22,975	74,100	20,812
Springs	74,500	£152,729	71,000	£144,950
Sub Nigel	36,500	30,608	36,500	30,526
Transvaal G.M. Estates	16,200	4,919	16,400	5,269
Van Ryn	45,000	£42,611	45,000	£43,111
Van Ryn Deep	64,000	£95,038	62,000	£95,599
West Rand Consolidated	61,000	£65,931	94,500	£106,305
West Springs	74,500	£77,300	72,800	£74,657
Witw'tersr'nd (Knights)	63,000	£54,374	64,000	£53,913
Witwatersrand Deep	37,300	11,890	36,600	11,569

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, 1930	2,741,634	28 1	19 8	8 5	1,153,549
June	2,651,970	28 2	19 7	8 7	1,141,197
July	2,706,900	28 5	19 8	8 9	1,184,107
August	2,693,100	28 3	19 6	8 9	1,174,828
September	2,653,250	28 5	19 8	8 9	1,160,430
October	2,741,080	28 5	19 7	8 10	1,212,822
November	2,628,800	28 4	19 7	8 9	1,145,097
December	2,661,200	28 6	19 9	8 9	1,160,548
January, 1931	2,721,316	28 3	19 8	8 7	1,171,456
February	2,481,600	28 6	20 1	8 5	1,045,980
March	2,718,400	28 2	19 9	8 5	1,151,017
April	2,592,800	28 7	20 1	8 6	1,105,711
May	2,751,400	27 10	19 6	8 4	1,149,105
June	2,698,100	28 0	19 7	8 5	1,140,399
July	—	—	—	—	1,155,466

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
August 31, 1930	202,257	14,788	5,754	222,799
September 30	205,061	14,706	5,767	225,534
October 31	206,778	14,482	5,032	226,292
November 30	205,030	13,973	4,748	223,751
December 31	203,473	13,763	4,607	221,843
January 31, 1931	209,442	13,865	4,325	227,632
February 28	209,777	13,740	4,333	227,850
March 31	207,239	13,436	4,106	224,781
April 30	208,770	13,242	4,030	224,042
May 31	207,109	13,305	3,689	224,103
June 30	207,209	13,286	3,345	223,840
July 31	208,155	13,512	1,817	223,484
August 31	209,409	13,563	1,705	224,677

PRODUCTION OF GOLD IN RHODESIA.

	1928	1929	1930	1931
	oz.	oz.	oz.	oz.
January	51,356	46,231	46,121	45,677
February	46,286	44,551	43,385	42,818
March	48,017	47,388	45,511	42,278
April	48,549	48,210	45,806	43,776
May	47,323	48,189	47,645	43,731
June	51,762	48,406	45,208	44,118
July	48,960	46,369	45,810	44,765
August	50,611	46,473	46,152	—
September	47,716	45,025	46,151	—
October	43,056	46,923	45,006	—
November	47,705	46,219	44,351	—
December	44,772	46,829	46,485	—

RHODESIAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,800	9,931	24,800	9,803
Globe and Phœnix	6,110	5,298	6,200	5,244
Lonely Reef	7,000	3,232	7,400	3,290
Luiri Gold	1,040	£4,385	1,083	£4,286
Rezende	6,400	2,645	6,400	2,652
Sherwood Star	4,800	£8,611	4,800	£8,754
Wanderer Consolidated	15,200	3,680	15,400	3,724

WEST AFRICAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	4,664	£8,748	—	—
Ashanti Goldfields	12,510	14,463	12,610	14,477
Taquah and Abosso	9,170	£13,876	9,859	£14,957

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
August, 1930	38,579	1,864	323
September	32,034	1,992	429
October	39,687	1,685	628
November	33,708	2,174	436
December	42,097	3,105	260
January, 1931	27,306	—	405
February	38,370	4,458*	458
March	34,946	4,482	898
April	38,891	3,250	732
May	38,255	4,196	784
June	47,507	3,194	893
July	38,785	—	—
August	52,501	—	—

* Jan. and Feb.

AUSTRALASIAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Value £	Tons	Value £
Associated G.M. (W.A.)	5,452	8,719	5,010	8,270
Blackwater (N.Z.)	4,030	8,011	3,550	6,811
Boulder Persev'ce (W.A.)	7,340	16,550	7,304	16,210
Grt. Boulder Pro. (W.A.)	11,631	31,744	—	—
Lake View & Star (W.A.)	15,007	26,998	—	—
Sons of Gwalia (W.A.)	13,964	15,327	13,050	15,434
South Kalgurli (W.A.)	8,766	15,583	9,006	15,589
Waihi (N.Z.)	18,435	{ 6,341* 42,522†	18,052‡	{ 5,979* 43,008†

* Oz. gold. † Oz. silver. ‡ To August 22.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	July.		August.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	3,750	2,208	3,700	2,110
Champion Reef	8,400	5,552	8,400	5,435
Mysore	14,012	6,812	11,948	5,809
Nundydroog	2,119	4,603	9,003	5,975
Ooregum	10,360	5,005	11,953	5,612

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	July.		August.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	9,820	14,641	9,670	15,095
Frontino Gold (C'lbia)	4,040	15,768	3,890	15,584
Fresnillo	95,877	2,668*d*	—	—
New Goldfields of Venezuela	5,800	1,940*	5,670	1,880*
Oriental Cons. (Korea)	16,981	102,415*d*	16,416	91,363*d*
St. John del Rey (Brazil)	—	44,400	—	40,800
Santa Gertrudis (Mexico)	32,353	51,454*d*	—	—
West Mexican Mines	1,520	36,000*d*	—	—

d Dollars. * Oz. gold.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

January, 1931	5,450	July, 1931	4,757
February	5,470	August	—
March	4,461	September	—
April	4,510	October	—
May	5,089	November	—
June	4,813	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	June	July	August
Ayer Hitam	59½	148¾	—
Batu Caves	18½	30	38
Changkat	50	55	95
Gopeng	59½	72	37
Hongkong Tin	113	133	9¾
Idris Hydraulic	23¾	33½	34
Ipoh	19¾	17½	23¾
Kampar Malaya	80	78	32
Kampong Lanjut	95	73	90
Kamunting	243	237	197
Kent (F.M.S.)	36	36	28
Kinta	22½	23½	18
Kinta Kellas	41½	—	—
Kramat Tin	70	95	95
Kuala Kampar	53	46	21
Kundang	25	18	10
Lahat	223	17½	17½
Lower Perak	132	116	—
Malaya Consolidated	27¾	27½	39¾
Malayan Tin	148¾	153	102
Malim Nawar	29	25	27
Pahang	216	262	221
Penawat	71½	81½	—
Pengkalen	62¾	68	13½
Petaling	128	114½	87
Rahman	71⅛	71⅛	71⅛
Rambutan	12	10½	4
Rantau	14½	14	17
Rawang	76	150	122
Rawang Concessions	85	60	68
Renong	35½	27⅜	37
Selayang	22¾	14½	15
Southern Malayan	178½	151½	120
Southern Perak	73½	20¾	—
Southern Tronoh	40	39	—
Sungei Besi	36	47	58
Sungei Kinta	41	18	23
Sungei Way	89½	77½	32¾
Taiping	25	22	21
Tanjong	36	—	—
Teja Malaya	24¾	18½	—
Tekka	34½	29	41½
Tekka-Taiping	33	76	51
Temengor	6⅜	9½	7½
Temoh	39½	—	—
Tronoh	84	81	72

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	June	July	August
Anglo-Nigerian	43	47	44½
Associated Tin Mines	181	200	247
Baba River	4	4	4
Batura Monguna	3½	—	1⅜
Bisichi	32	41	39
Daffo	4½	6	—
Ex-Lands	44	48	54
Filani	4	—	3½
Jantar	20	22	22
Jos	10⅜	13	—
Juga Valley	6	6	8½
Kaduna Syndicate	25	20	21
Kaduna Prospectors	9	13	17
Kassa	10	11	10
London Tin	140	140	144
Lower Bisichi	4	4	4½
Naraguta Extended	8	—	—
Nigerian Consolidated	11	—	7½
Offin River	3½	3	3½
Ribon Valley	12	14	16
Tin Fields	4½	6	—
United Tin Areas	17	16½	16½
Yarde Kerri	14	4	5

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	June	July	August
Anglo-Burma (Burma)	27	38½	—
Aramayo Mines (Bolivia)	186	244	—
Bangrin (Siam)	71½	92½	101⅜
Beralt	32*	34*	34*
Consolidated Tin Mines (Burma)	96	116	180
East Pool (Cornwall)	48½	48½	48½
Fabulosa (Bolivia)	70	58	45½
Kagera (Uganda)	—	10	—
Kamra	72½	60	—
Malaysiam Tin	21	6½	6½
Mawchi	267*	211*	—
Patino	1,333	1,306	—
Pattani	37½	69	—
San Finx (Spain)	22½*	22*	—
Siamese Tin (Siam)	162½	190½	214
Tavoy Tin (Burma)	55	50	75
Tongkah Harbour (Siam)	55	54	40
Toyo (Japan)	81½	75½	68
Zaaiplaats	13	—	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		July	August
Broken Hill South	Tons lead conc.	7,255†	4,199
	Tons zinc conc.	7,610†	4,583
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	460,000	460,000
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	345	354
Messina	Tons copper	743	801
Mount Isa	Tons lead bullion	2,211	—
Mount Lyell	Tons concentrate	3,778*	—
North Broken Hill	Tons lead conc.	5,170	4,900
	Tons zinc conc.	4,630	4,530
Rhodesia Broken Hill	Tons V_2O_5	22½	27½
	Tons slab zinc	—	—
Roan Antelope	Tons concentrates	3,645	4,790
San Francisco Mexico	Tons lead conc.	3,654	3,571
	Tons zinc conc.	3,664	3,345
Tetiuhe	Tons lead conc.	878	1,010
	Tons zinc conc.	2,069	2,177
Trepca	Tons lead conc.	3,899	3,632
	Tons zinc conc.	2,916	3,385
Zinc Corporation	Tons lead conc.	1,705†	—
	Tons zinc conc.	1,066†	—

* To Aug. 12. † To Aug. 8.

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

	June.	July.
Iron Ore ..... Tons	201,612	176,247
Manganese Ore ..... Tons	4,383	7,150
Iron and Steel ..... Tons	246,334	231,017
Copper and Iron Pyrites ..... Tons	25,301	21,283
Copper Ore, Matte, and Prec. ... Tons	2,572	3,141
Copper Metal ..... Tons	15,579	14,932
Tin Concentrate ..... Tons	5,966	5,316
Tin Metal ..... Tons	999	1,134
Lead Pig and Sheet ..... Tons	26,520	30,301
Zinc (Spelter) ..... Tons	15,100	13,312
Zinc Sheets, etc. ..... Tons	1,386	1,903
Aluminium ..... Tons	892	685
Mercury ..... Lb.	70,934	69,796
Zinc Oxide ..... Tons	572	636
White Lead ..... Cwt.	12,174	13,829
Red and Orange Lead ..... Cwt.	3,511	2,700
Barytes, ground ..... Cwt.	47,648	45,152
Asbestos ..... Tons	1,354	1,993
Boron Minerals ..... Tons	986	147
Borax ..... Cwt.	30,075	18,683
Basic Slag ..... Tons	1,382	2,635
Superphosphates ..... Tons	1,792	1,341
Phosphate of Lime ..... Tons	29,258	23,343
Mica ..... Tons	175	95
Sulphur ..... Tons	1,104	3,446
Nitrate of Soda ..... Cwt.	48,634	88,530
Potash Salts ..... Cwt.	87,080	80,293
Petroleum: Crude ..... Gallons	38,597,851	30,646,530
Lamp Oil ..... Gallons	20,507,282	19,474,085
Motor Spirit ..... Gallons	83,457,352	80,357,342
Lubricating Oil .... Gallons	7,327,197	9,013,335
Gas Oil ..... Gallons	5,388,784	5,516,757
Fuel Oil ..... Gallons	13,478,285	35,564,137
Asphalt and Bitumen ..... Tons	20,406	20,427
Paraffin Wax ..... Cwt.	105,953	88,419
Turpentine ..... Cwt.	16,186	11,685

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	June.	July.	August.
Anglo-Ecuadorian	20,257	21,354	20,662
Apex Trinidad	48,310	50,070	46,450
Attock	1,594	1,818	1,483
British Burmah	4,401	4,495	4,410
British Controlled	—	38,763	46,648
Kern Mex	960	912	971
Kern River (Cal.)	2,587	3,068	3,027
Kern Romana	935	877	996
Kern Trinidad	4,932	4,751	5,037
Lobitos	25,909	28,107	26,250
Phœnix	61,359	71,862	64,565
St. Helen's Petroleum	5,278	5,266	5,127
Steaua Romana	80,610	80,830	80,550
Tampico	2,606	2,418	2,801
Tocuyo	2,136	2,155	2,026
Trinidad Leaseholds	15,650	17,400	18,800

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted

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

PRICES OF CHEMICALS. September 11.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		17	9
,, 80%	,,	1	14	3
,, Glacial	per ton	56	0	0
Alum	,,	8	7	6
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.			11
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate, comml.	,,	40	0	0
,, Sulphate, 20·6% N.	,,	5	10	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
,, Sulphide, golden	,,			9
Arsenic, White (foreign)	per ton	18	10	0
Barium, Carbonate, 94%	,,	4	10	0
,, Chloride	,,	8	5	0
,, Sulphate, 94%	,,	6	15	0
Benzol, standard motor	per gal.		1	2½
Bleaching Powder, 35% Cl.	per ton	7	0	0
Borax	,,	13	10	0
Boric Acid	,,	22	0	0
Calcium Chloride, solid, 70/75%	,,	5	5	0
Carbolic Acid, crude 60's	per gal.		1	2
,, ,, crystallized, 40°	per lb.			5½
Carbon Disulphide	per ton	16	10	0
Citric Acid	per lb.			10½
Copper Sulphate	per ton	18	0	0
Creosote Oil (f.o.b. in Bulk)	per gal.			4
Cresylic Acid, 98-100%	,,		1	8
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine	per oz.		1	0
Iron, Nitrate 80° Tw.	per ton	6	10	0
,, Sulphate	,,	2	2	6
Lead, Acetate, white	,,	31	7	6
,, Nitrate (ton lots)	,,	28	15	0
,, Oxide, Litharge	,,	26	10	0
,, White	,,	36	10	0
Lime, Acetate, brown	,,	7	0	0
,, ,, grey, 80%	,,	12	0	0
Magnesite, Calcined	,,	9	10	0
Magnesium Chloride	,,	5	10	0
,, Sulphate, comml.	,,	3	15	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	1
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	1	14	6
Phosphoric Acid. S.G. 1·500	per ton	29	15	0
Pine Oil	,,	42	10	0
Potassium Bichromate	per lb.			4½
,, Carbonate, 96/98%	per ton	23	10	0
,, Chlorate	,,	27	10	0
,, Chloride 80%	,,	9	5	0
,, Ethyl Xanthate	per 1,016 kilos	55	15	0
,, Hydrate (Caustic) 88/90%	per ton	27	5	0
,, Nitrate	,,	19	17	6
,, Permanganate	per lb.			5½
,, Prussiate, Yellow	,,			6¾
,, ,, Red	,,		1	8
,, Sulphate, 90%	per ton	10	10	0
Sodium Acetate	,,	16	10	0
,, Arsenate, 45%	,,	20	10	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			3½
,, Carbonate (Soda Ash) 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	,,	20	5	0
,, Cyanide 100% NaCN basis	per lb.			8
,, Ethyl Xanthate	per 1,016 kilos	53	5	0
,, Hydrate, 76%	per ton	14	10	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (ordinary)	,,	10	0	0
,, Phosphate, comml.	,,	10	0	0
,, Prussiate	per lb.			4¾
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	2	15	0
,, ,, (Salt-Cake)	,,	2	17	6
,, Sulphide Conc., 60/65%	,,	8	15	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	9	5	0
,, Roll	,,	9	5	0
Sulphuric Acid, 168° Tw.	,,	4	5	0
,, ,, free from Arsenic, 140° Tw. .	,,	3	0	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	9	0
Tartaric Acid	per lb.			10
Turpentine	per ton	46	0	0
Tin Crystals	per lb.			10½
Titanous Chloride	,,			10
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	,,	20	0	0
Zinc Oxide (White Seal)	,,	35	0	0
Zinc Sulphate	,,	8	5	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	Aug. 10, 1931. £ s. d.	Sept. 10, 1931. £ s. d.
SOUTH AFRICA:		
Brakpan	2 15 0	2 18 0
City Deep	4 3	5 6
Consolidated Main Reef	1 1 3	18 9
Crown Mines (10s.)	4 5 0	4 9 6
Daggafontein	2 9 6	2 13 0
Durban Roodepoort Deep (10s.)	14 6	15 6
East Geduld	2 17 0	2 17 6
East Rand Proprietary (10s.)	13 3	13 9
Geduld	3 18 9	4 1 3
Geldenhuis Deep	8 3	8 6
Glynn's Lydenburg	5 0	5 0
Government Gold Mining Areas (5s.)	1 11 0	1 11 6
Langlaagte Estate	1 4 0	1 4 0
Meyer & Charlton	18 0	18 9
Modderfontein New (10s.)	2 12 6	2 10 0
Modderfontein B (5s.)	9 3	9 6
Modderfontein Deep (5s.)	1 0 0	18 9
Modderfontein East	1 7 0	1 7 0
New State Areas	2 3 0	2 3 9
Nourse	16 3	16 9
Randfontein	1 1 9	1 5 3
Robinson Deep A (1s.)	15 6	15 0
" " B (7s. 6d.)	9 3	9 6
Rose Deep	5 6	5 3
Simmer & Jack (2s. 6d.)	3 6	3 3
Springs	2 19 6	3 3 0
Sub Nigel (10s.)	3 2 6	3 2 0
Van Ryn	8 3	9 6
Van Ryn Deep	1 0 0	19 6
Village Deep (9s. 6d.)	2 3	2 6
West Rand Consolidated (10s.)	9 6	10 0
West Springs	12 9	12 3
Witwatersrand (Knight's)	9 0	11 0
Witwatersrand Deep	3 9	4 6
RHODESIA:		
Cam and Motor	1 0 0	1 2 6
Gaika	3 6	3 6
Globe and Phœnix (5s.)	13 6	11 6
Lonely Reef	15 0	14 0
Mayfair	3 9	4 6
Rezende	17 6	18 9
Shamva	1 0	1 0
Sherwood Starr (5s.)	12 6	13 9
GOLD COAST:		
Ashanti (4s.)	1 13 0	1 12 3
Taquah and Abosso (5s.)	3 6	4 0
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	2 3	2 3
Great Boulder Propriet'y (2s.), W.A.	1 0	1 0
Lake View and Star (4s.), W.A.	8 6	8 0
Sons of Gwalia, W.A.	4 0	3 9
South Kalgurli (10s.), W.A.	11 6	11 6
Waihi (5s.), N.Z.	13 6	13 6
Wiluna Gold, W.A.	13 0	7 0
INDIA:		
Balaghat (10s.)	2 0	2 9
Champion Reef (10s.)	6 0	6 6
Mysore (10s.)	7 3	6 6
Nundydroog (10s.)	13 6	13 6
Ooregum (10s.)	2 9	2 6
AMERICA:		
Camp Bird (2s.), Colorado	3	3
Exploration (10s.)	2 6	2 0
Frontino and Bolivia, Colombia	11 3	11 3
Mexican Corporation, Mexico (10s.)	3 6	3 6
Mexico Mines of El Oro, Mexico	1 6	1 6
Panama Corporation	13 6	10 6
St. John del Rey, Brazil	18 6	18 6
Santa Gertrudis, Mexico	6 9	6 9
Selukwe (2s. 6d.), British Columbia	1 9	1 9
MISCELLANEOUS:		
Chosen, Korea	2 6	2 6
Lena Goldfields, Russia	6	6

COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	3 6	3 3
Esperanza Copper	13 9	13 9
Indian (2s.)	1 0	9
Loangwa (5s.), Rhodesia	2 4	2 3
Luiri (5s.), Rhodesia	1 3	1 3
Messina (5s.), Transvaal	6 0	5 0
Mount Lyell, Tasmania	14 6	12 6
Namaqua (£2), Cape Province	4 6	4 6
Rhodesia-Katanga	10 0	10 0
Rio Tinto (£5), Spain	16 15 0	14 10 0
Roan Antelope (5s.), Rhodesia	9 6	7 6
Tanganyika Con.	18 9	15 6
Tharsis (£2), Spain	2 9 6	2 1 3

LEAD-ZINC:	Aug. 10, 1931. £ s. d.	Sept. 10, 1931. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	6 3	5 0
Broken Hill Proprietary, N.S.W.	8 6	8 0
Broken Hill, North, N.S.W.	1 12 6	1 10 0
Broken Hill South, N.S.W.	1 3 9	1 2 6
Burma Corporation (10 rupees)	6 9	6 3
Electrolytic Zinc Pref., Tasmania	12 6	12 6
Mount Isa, Queensland	8 0	7 6
Rhodesia Broken Hill (5s.)	1 0	9
San Francisco (10s.), Mexico	9 6	8 0
Sulphide Corporation (15s.), N.S.W.	5 6	4 9
ditto, Pref.	8 0	7 6
Zinc Corporation (10s.), N.S.W.	13 9	12 6
ditto, Pref.	2 15 0	2 10 0

TIN:		
Aramayo Mines (25 fr.), Bolivia	18 9	17 6
Associated Tin (5s.), Nigeria	4 3	4 3
Ayer Hitam (5s.)	12 0	11 6
Bangrin, Siam	10 0	11 0
Bisichi (10s.), Nigeria	4 6	4 6
Chenderiang, Malay	1 6	1 6
Consolidated Tin Mines of Burma	2 0	1 9
East Pool (5s.), Cornwall	6	6
Ex-Lands Nigeria (2s.), Nigeria	1 3	1 3
Geevor (10s.), Cornwall	2 0	2 0
Gopeng, Malaya	1 12 6	1 12 6
Hongkong (5s.)	14 0	14 0
Idris (5s.), Malaya	6 6	6 9
Ipoh Dredging (16s.), Malay	13 0	13 0
Kaduna Prospectors (5s.), Nigeria	5 0	4 6
Kaduna Syndicate (5s.), Nigeria	12 6	12 6
Kamunting (5s.), Malay	5 3	5 0
Kepong, Malay	9 6	10 0
Kinta, Malay (5s.)	7 0	6 6
Kinta Kellas, Malay (5s.)	5 6	5 6
Kramat Pulai, Malay	1 0 0	1 0 0
Lahat, Malay	5 0	5 0
Malayan Tin Dredging (5s.)	17 0	16 3
Naraguta, Nigeria	6 6	6 6
Nigerian Base Metals (5s.)	6	6
Pahang Consolidated (5s.), Malay	5 6	5 0
Penawat ($1), Malay	1 0	1 0
Pengkalen (5s.), Malay	10 0	10 0
Petaling (2s. 4d.), Malay	8 3	8 0
Rambutan, Malay	5 0	5 0
Renong Dredging, Malay	12 6	12 6
Siamese Tin (5s.), Siam	7 0	7 3
South Crofty (5s.), Cornwall	2 3	2 3
Southern Malayan (5s.)	9 6	9 0
Southern Perak, Malay	1 6 3	1 5 0
Southern Tronoh (5s.), Malay	6 0	6 0
Sungei Besi (5s.), Malay	7 0	7 0
Sungei Kinta, Malay	10 6	9 0
Tanjong (5s.), Malay	6 9	7 6
Tavoy (4s.), Burma	3 3	3 6
Tekka, Malay	13 0	13 0
Tekka Taiping, Malay	11 6	11 0
Temengor, Malay	1 6	1 6
Toyo (10s.), Japan	2 0	1 0
Tronoh (5s.), Malay	12 0	12 0

DIAMONDS:		
Consol. African Selection Trust (5s.)	9 6	6 3
Consolidated of S.W.A. (10s.)	3 6	2 9
De Beers Deferred (£2 10s.)	3 12 6	2 15 0
Jagersfontein	16 3	13 9
Premier Preferred (5s.)	1 9 6	1 5 0

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

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers: also notices of new books and pamphlets, lists of patents on mining and metallurgical subjects, and abstracts of the yearly reports of mining companies.

TESTING THREE-PHASE WINDERS

In the *Journal* of the South African Institute of Engineers for July J. J. P. Dolan outlines a simple method of testing three-phase winding equipment during normal operating conditions. The author says that the method outlined is of sufficient practical accuracy and is used by several engineers. A stop watch, tachometer, or, preferably, an autographic record of speed conditions, and a graphic record of the power demand, as recorded by a graphic recording watt-meter, and two observers constitute the testing equipment and staff.

diagram. This curve indicates expensive operating conditions and without further knowledge would indicate one or more of the following causes :—

(*a*) That the motor was overloaded ;
(*b*) that the liquid controller was unsuitable ;
(*c*) that the electrolyte condition needs improving ;
(*d*) that the driver was not operating the hoist properly.

(*a*) *That the motor was overloaded.*—That the speed of an induction motor is a function of the

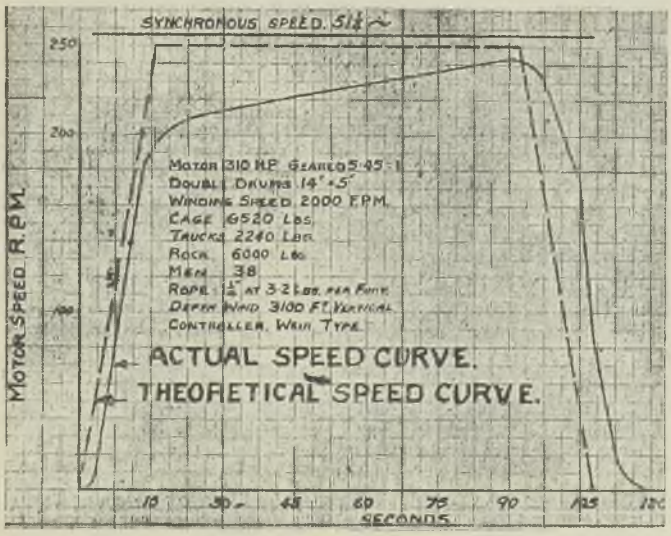


FIG. 1.—SPEED CURVES FOR NORMAL ROCK-RAISING LOAD.

As the loss of power in the rotor circuit is proportional to the slip, the rotor efficiency at all points during a wind can be deduced if a suitable speed curve is available. Consequently, a preliminary test can be made by an observer and recorder, using a stop watch and tachometer ; the tachometer being held to the rotor shaft and the observer calling out the speed conditions at five second intervals from start to stop, and the total time of the wind. The recorder should have a column marked off from zero at five seconds intervals per line, so that the numbers relating to speed are written down seriatim without reference to time. Four or five consecutive trips should be a good index to the actual operating conditions. For more accurate determination of the speed curve at the beginning and end of the wind, separate tests may be necessary with a different speed change on the tachometer. Fig. 1 shows a speed curve obtained by such methods for a certain winder. The data relative to winding conditions is tabulated on the

motor loading is well-known to electrical engineers ; to those who may not be clear on this point the following illustrations may help :—

(1) If Fig. 1 is studied it will be observed that the speed after 30 seconds is 218 r.p.m. and after 83 seconds is 240 r.p.m. ; the speed gradually increasing with the time interval. As this is a diagram of speed for balanced winding conditions, it is obvious that the motor load must be decreasing during this interval, as the load on the ascending side is decreasing and the load on the descending side is increasing, due to the extra hanging rope.

(*b*) *That the liquid controller was unsuitable.*

(*c*) *That the electrolyte condition needs improving.*

That an unsatisfactory speed curve, when the loading is normal, may be traceable to either or both of the foregoing is demonstrated in the following manner :—It is well-known that in starting up a slip ring induction motor the maximum resistance of the starter is inserted at commence-

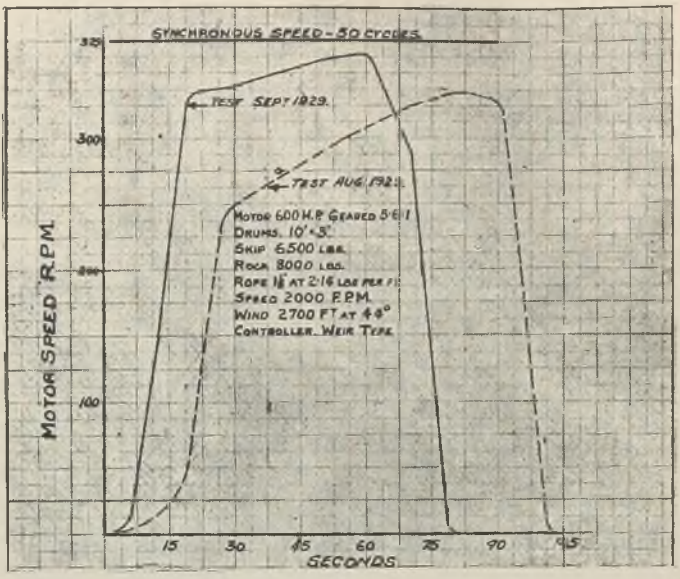


FIG. 2.—SPEED CURVES FOR NORMAL ROCK-RAISING LOAD.

ment, and the resistance is gradually reduced as the motor speeds up until, if brush lifting and short-circuiting gear is used, the final rotor resistance is that of the windings. With the usual winding equipments on the Reef, it is not usual to short-circuit the controller, and consequently, in addition to the rotor winding resistance, the rotor resistance includes the resistance of leads to controller and the resistance between the fixed and moving electrodes through the electrolyte path. If this added resistance is high, much greater slip for a particular torque results. As rotor winding resistances are low, the resistance of leads and controllers, even of the best designs, are comparable in magnitude.

In starting a winding motor, the electrical condition is analogous to the "locked rotor test condition," and, consequently, it is necessary to have a suitably high resistance in the rotor circuit. Consequently a controller may be unsuitable, due to too small a variation in its range of resistance.

TABLE 1.—SPEED DATA: R.P.M.

	Number of Test.				
Seconds.	1.	2.	3.	4.	5.
0	—	—	—	—	—
5	—	—	—	—	—
10	100	—	100	100	—
15	160	120	125	160	130
20	195	170	140	195	155
25	220	240	175	230	180
30	250	260	210	265	195
35	270	285	240	285	230
40	285	300	270	300	250
45	290	310	285	310	263
50	296	320	295	318	270
55	306	323	305	322	280
60	310	328	310	330	288
65	285	290	315	290	304
70	240	240	290	220	304
75	180	170	230	130	278
80	110	—	160	—	216
85	—	—	—	—	130
Stop	89	87	90	84	93
R.p.m.-secs.	18005	17976	17900	17814	18160
R.p.m..	300·08	299·6	298·3	296·9	302·6
k.w.h.	7·64	6·63	7·84	6·35	6·85

TABLE 2

Number of test	1	2	3	4	5
Total power consumption, k.w.h.	7·64	6·63	7·84	6·35	6·85
Power used before start, k.w.h.	1·23	0·38	0·91	0·31	0·30
Power during running, k.w.h.	6·41	6·25	6·93	6·04	6·55

With the necessary high starting resistance, a controller with an unsuitable range must have a final resistance higher than is advisable for economical operation.

Where the controller range is sufficient, high final resistance may be due to the electrolyte solution being too weak, and in that case the remedy is obvious.

(*d*) *That the driver was not operating the hoist properly.*—If it is assumed that the controller has a sufficient range and that the electrolyte is of correct strength, it is still possible to cause operating conditions to show high resistance in the rotor circuit. As the travel of the electrodes is generally proportional to the movement of the driver's lever, it is possible for an ultra-cautious person to so operate the controller lever, and consequently the controller, that the rotor circuit resistance remains high throughout or through a greater portion of the wind.

Further testing and analysis showed the faulty condition being due to an unsuitable liquid controller.

Fig. 2 shows two curves from tests made "before and after treatment." At the time of the first series of tests the motor appeared over-loaded, was over-heating seriously, had to be kept continually on ore handling with a minimum of time available for shaft and track inspections. Slight alterations were made to the liquid controller and electrolyte and resulted in the improved speed curve shown in full lines. The motor is no longer over-heating and easily handles the necessary tonnage without encroachment of the time allotted to other essential services.

A complete analysis is offered hereunder of a series of tests made on a winder operating in an incline. Tachometer readings were taken every five seconds, and a graphic record of power demand was obtained by means of a graphic recording wattmeter with a paper speed of six inches per minute.

Table I shows the speed tabulation for five of the tests. The line marked r.p.m.-secs. is the sum of the products of time and average speed in revolutions per minute for the time intervals, and if these products are divided by 60 the winder motor revolutions as deduced from the test are obtained. It will be noted that though the speed curves figures differ considerably, the totals are comparable and offer an index to the accuracy of the method. The power consumption shown in the last line in k.w.h. indicates considerable variation in consecutive trips.

Fig. 3 shows the speed curve corresponding to the data in Table I for Test No. 1; that this is very inefficient is easily discernible.

An examination of the wattmeter charts showed that a varying amount of power was consumed before the winder began to move. This may be due to—

(*a*) unsuitable controller;

(*b*) habit of driver to apply power against brakes and await signal to move.

In these tests the second of these was the cause, and Table II shows what an expensive habit this can be.

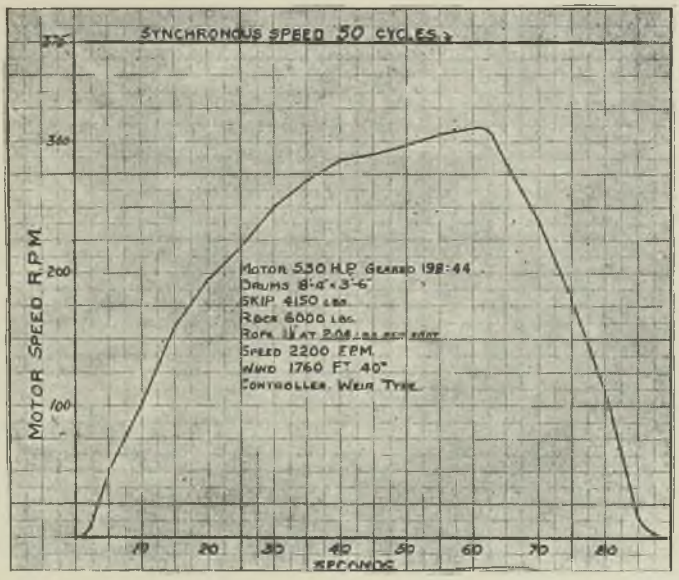


Fig. 3.—Speed Curve for Normal Rock-Raising Load: Test No. 1.

Fig. 4 shows a tracing of the wattmeter chart for No. 1 test and the power used before starting of hoist has been hatched. The speed in r.p.m. at five second intervals has been added to the chart.

Table 3 shows a complete tabulation of the analysis of the data of test 1, as shown in Figs. 3 and 4.

The derivation of the various columns in this table is as follows:—Cols. 1 and 2 from the wattmeter chart, Fig. 4.

Col. 3: The electrical losses include iron and C_2R loss, and for this machine was derived from

$$= 14{\cdot}6 + 12{\cdot}8 \frac{(\text{load kw})^2}{(375)} \text{ kw.}$$

Col. 4: Col. 2 minus Col. 3.

Col. 5: Speed in r.p.m. from tachometer test,

TABLE 3.—ANALYSIS OF TEST No. 1.

1. Time Secs.	2. Total K.W.	3. Mach. Loss.	4. Nett Power K.W.	5. Speed R.P.M.	6. Effective K.W.	7. Pull lb.	8. Acceleration F.P.S.P.S.	9. Force lb.	10. Nett Pull lb.	11. Effective Kw-Sec.	12. R.P.M. Secs.	13. Sum R.P.M. Secs.	14. Skip Travel Feet.
0	600	47·2	552·8	0									
							0·98	1592		191·3	125		
5	624	50	574	[50]	76·54	11532			9940			125	12
							0·98	1592		545·3	375		
10	576	45	531	100	141·6	10667			8756			500	49
							1·176	1911		877	650		
15	528	40	488	160	208·2	9802			8687			1150	112
							0·686	1115		1110	887		
20	490	36·6	453·4	195	235·8	9109			8313			2037	199
							0·49	796		1160	1038		
25	420	30·6	389·4	200	228·4	7821			6865			3075	301
							0·588	956		1164	1175		
30	384	28·1	355·9	250	237·3	7150			6513			4250	415
							0·392	637		1153	1300		
35	336	24·9	311·1	270	224	6250			5772			5550	543
							0·294	478		1087	1388		
40	300	22·8	277·2	285	210·7	5569			5410			6938	678
							0·098	159		1019	1437		
45	276	21·5	254·5	290	196·8	5112			4920			8375	819
							0·118	192		972	1465		
50	264	20·9	243·1	296	191·9	4883			4565			9840	962
							0·196	318		949	1505		
55	250	19·8	230·2	306	187·8	4623			4496			11345	1109
							0·078	127		911	1540		
60	234	19·6	214·4	310	177·2	4306			4306			12885	1260
								Total k.w.-secs.		11138·6	1488		
65				285				Total k.w.h.		3·09		14373	
											1312		
70				240								15685	
											1050		
75				180								16735	
											725		
80				110								17460	
											425		
85				[60]								17885	
											120		
89				0								18005	1760

TABLE 4.

Number of test	1.	2.	3.	4.	5.
Useful power consumption, k.w.h.	2·11	2·11	2·11	2·11	2·11
Total actual power consumption, k.w.h.	7·64	6·63	7·84	6·35	6·85
Power used before start, k.w.h.	1·23	0·38	0·91	0·31	0·30
Power used during running, k.w.h.	6·41	6·25	6·93	6·04	6·55
Power—Load plus friction, k.w.h.	3·08	3·08	3·17	3·10	2·94
Overall efficiency, %	27·6	31·8	26·9	33·2	30·8
Efficiency on running power, %	32·9	33·8	30·4	34·9	32·2

TABLE 5.

Number of test	1.	2.	3.	4.	5.
Revolutions, Table I	300·08	299·6	298·3	296·9	302·6
Actual revolutions	299·5	299·5	299·5	299·5	299·5
Difference	0·58	0·1	1·2	2·6	3·1

TABLE 6.—Parts per 100,000 of Solution.

Number	1.	2.	3.	4.	5.	6.
Specific Gravity	1·15	1·12	1·001	—	—	1·000
Sod. Car.	1,320	950	6·4	—	—	—
Sod. Bicarb.	290	290	—	40	80	40
Sod. Sulph.	5·7	3·0	78·8	27	305	—
Sod. Hydrate	—	—	14·4	—	—	—
Sod. Cl.	14·3	19·2	2·3	50	2,220	20
Mag. Sulph.	15·3	20	Trace	18	36	Trace
Calc. Sulph.	—	—	13·6	16	104	16

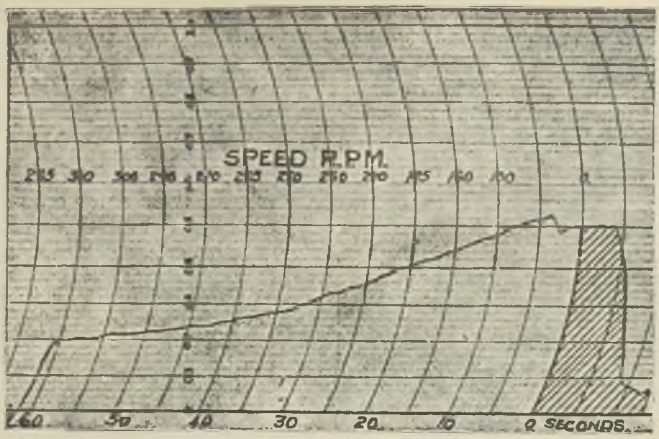


FIG. 4.—CHART CONSTANT 1·0 = 1,200 k.w.: HATCHED AREA = POWER CONSUMED BEFORE WINDER STARTS.

as shown in Table I and in Fig. 4. Two values bracketed are obtained by interpolation.

Col. 6 is based on the well-known fact that the efficiency of the power transference to the rotor is given by the ratio,

$$\frac{\text{actual speed}}{\text{synchronous speed}},$$

the synchronous speed of this motor being 375 r.p.m. at 50 cycles.

Col. 7: The effective pull at drum radius can be computed from

$$\text{Pull} = \frac{\text{Power transmitted}}{\text{Speed}}$$

In this case the rope speed at synchronism is 36·7 feet per second. Then

$$\text{Pull} = \text{k.w.} \times \frac{1000}{746} \times 550 \times \frac{375}{\text{r.p.m.}} \times \frac{1}{36{\cdot}7}$$

$$= \frac{7533\ \text{k.w.}}{\text{r.p.m.}}\ \text{lb.}$$

Col. 8: The acceleration in feet per second is derived from the rate of change of r.p.m. per second and the full speed value for 375 r.p.m.

$$\text{Acceleration} = \frac{36{\cdot}7}{375} \times \frac{R_1 - R_2}{t_1 - t_2},$$

as the time intervals are five seconds. This reduces to Acceleration = 0·00196 $(R_1 - R^2)$ feet per sec.^{2}, where

R_2 = r.p.m. at beginning of time interval.

R_1 = r.p.m. at end of time interval.

Col. 9 is deduced from calculated values of the moment of inertia of the rotating masses and shaft elements referred to an equivalent weight at the rope centres. Acceleration force = Mass times acceleration rate. The force in this instance = 1,625 × acceleration values of Col. 8.

Col. 10 is the deduction of Col. 9 from Col. 7; this, then, gives the pull equivalent to static conditions at different points in the shaft.

Col. 11 is the product of the mean effective power in k.w. (Col. 6) for each interval and the duration of the interval. The sum of the total divided by 3,600 gives the k.w.h. or effective units absorbed in doing useful work and overcoming all frictional losses.

Col. 12 is the product of the mean r.p.m. for each interval and the length of interval in seconds.

Col. 13 is the progressive sum of Col. 12, and is a measure of the distance travelled by the skips.

Col. 14 is the conversion of the progressive sums

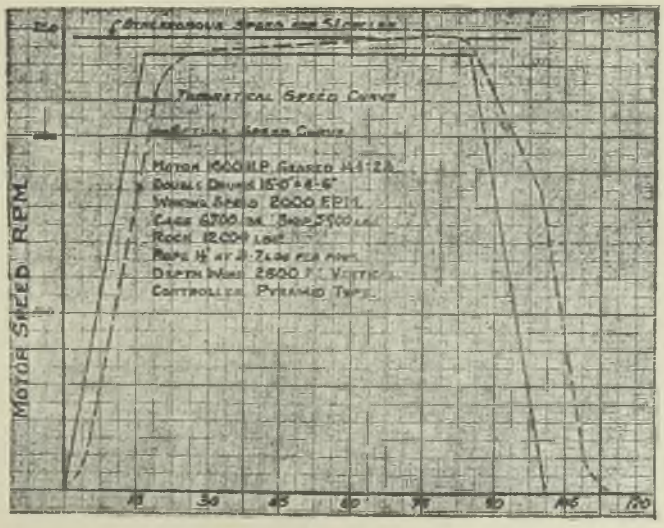


FIG. 5.—SPEED CURVES FOR NORMAL ROCK-RAISING LOAD.

of Col. 13 into skip travel, based on the knowledge that the total length of wind is 1,760 feet.

An analysis on the foregoing basis was made on the five sets of test figures and wattmeter charts, and Table 4 shows a summarized comparison of the results obtained.

The theoretical useful power consumption is obtained on the assumption that a full rock load of 6,000 lb. is lifted a vertical height of 934 ft.

$$\text{Power} = \frac{934 \times 6{,}000}{550}$$

$$= 10{,}200 \text{ h.p. secs.} = 2{\cdot}11 \text{ k.w.h.}$$

After these tests slight alterations were made to bring the efficiency up to normal.

Accuracy of Method.

In any non-scientific method of testing, the first question to be replied to is generally: "How accurate and what reliance can be placed on the test data?"

(*b*) resistance of rotor theostatic control too high;

(*c*) faulty manipulation by driver.

Calculations can be made to check the load on motor so as to eliminate this point.

Observation can check the "human factor." The writer has found that it generally pays to enlighten the driver of the object of the test and what is expected of him, otherwise, human nature being what it is, he operates the machine cautiously by not throwing the controller lever over in the usual manner, with the result that the test conditions are not normal. In one case a trip of 120 seconds normal was extended to 180 seconds when a test was made, the driver taking no less than 84 seconds to bring the controller to full speed position, due to his belief that we were acting as "policemen."

Fig. 5 shows an actual speed curve for a 1,600 h.p. winder and the theoretical curve on which the

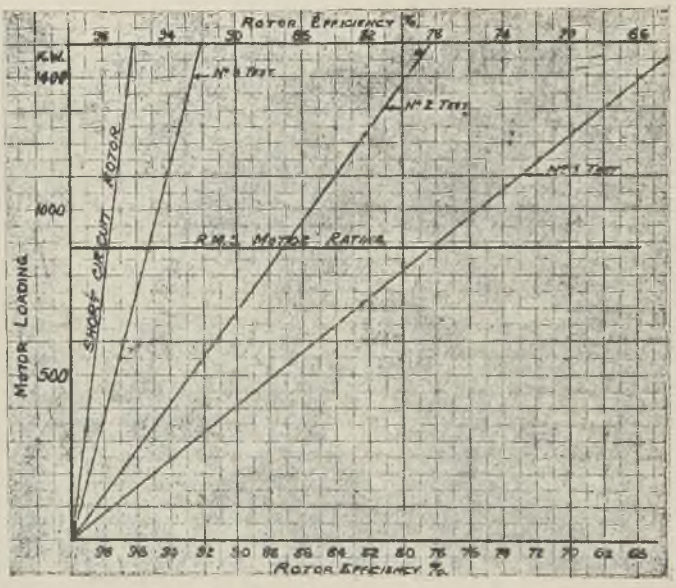


Fig. 6.—Torque-Speed Curves.

The speed determination appears the most "rule of thumb" method, and, consequently, an analysis of this data should be illuminating. The total revolutions of the motor for this winding distance was 299·5, as determined by check readings with a revolution counter and further checked by calculations from the actual length of wind diameter of drums and gear ratio. Table 5 shows the revolution values for the five tests. The errors are small, indicating that the errors of observation inseparable from this type of test are compensating.

The recording graphic wattmeter has an instrument error about the range tested of less than 1% when checked against standard instruments. As the instrument transformer ratios were such that one inch corresponds to approximately 260 k.w.s., the estimation of the power values can be done with sufficient accuracy.

The limitation of this method is that an undesirable speed curve does not directly indicate the cause, such as—

(*a*) Machine being overloaded;

normal h.p.-time diagrams were based. It will be observed that—

(1) Certain time was wasted at the start, due to the necessity in this case of bringing the skip slowly out of the tipping gear;

(2) the practical acceleration curve paralleling the theoretical curve shows the motor as capable of accelerating the hoist at the rate required;

(3) the gradual increase of speed after full speed is obtained, due to the down-going load decreasing the motor load; this is usually neglected from the theoretical viewpoint, though naturally it is expected that the curve should take this form;

(4) the two rates of retardation, due to the driver "feeling" his brakes before it was really necessary to brake the hoist.

This curve is fairly good, but with more confident handling has been improved, so that the theoretical and practical cyclic times agree.

Fig. 6 shows the improvement effected in rotor efficiency of a 1,184 h.p. winder, as the result of data obtained from a series of tests and improvements effected to the electrolyte.

Before closing his paper the author emphasizes that this method of testing, though eminently practical and of considerable practical utility, falls short of the perfect method proposed by Mr. L. B. Woodworth before the Institute of Electrical Engineers. In his method the necessary recording instruments are assembled on a panel, and a permanent record is obtained by means of a cinema camera.

Controllers and Electrolytes.—As liquid controllers are practically the only means at present in use on the Rand for regulating the type of winders under discussion, some general notes regarding these are given. The controllers may be sub-divided into two types—

(*a*) Fixed electrodes with controlled depth of electrolyte ;

(*b*) movable electrodes.

Of the first type the most common is the " weir " type with " dipper " plates, and though this type is by no means ideal, most winders on the Rand of moderate rating have been successfully operated with this controller. A serious objection is the stream of " sparks " at each dipper plate when the electrolyte level approaches the plate. This " sparking " must set up an oscillatory current in the rotor circuit which probably accounts for the " high frequency " effect of flash-overs in controller and rotor occasionally met with during winding. This type has also a very limited range, and when the electrolyte conditions are such as to ensure satisfactory control at starting and under reverse current, the final resistance is high and results in large rheostatic losses and slow full speed of motor. It would seem that if the three or four different length dipper plates per phase were replaced by plates of equal length or a box cylinder, cone, pyramid or other solid, some of the disadvantages of this type would be eliminated.

There are several makers of moving electrode controllers, the main feature of this type being the fairly long travel of the moving electrode giving a long path through the electrolyte at starting and when using reverse current for braking. Some designs attempt by various means to reduce the controller resistance when the two electrodes are " home," but the best means, which would be the short-circuiting at the rotor slip rings, is not favoured locally. This type of controller is used on most winders over 1,000 h.p., and in my opinion the simpler the design the better the apparatus. Most of the electrodes in use on the Rand are of iron plating, though a few are of bronze and armco iron, but in the weak solutions usually used the life of the iron plating is sufficient to outweigh advantages to be obtained by using other metals.

The electrolytes most favoured are—Carbonate of Soda ; caustic Soda ; and common Salt, but the strengths of solution are such that they can seldom be classified as true electrolytes, but merely as alkaline solutions. Caustic soda has the least ohmic resistance per inch cube, and would be the most satisfactory to use in a starter or controller where the cooling of the electrolyte was done by means of water passed through piping laid in the electrolyte ; but where, as is usual, the caustic soda solution is cooled by spraying into a pond, it is generally reduced to a carbonate or bicarbonate of soda solution. It would, therefore, seem, under usual conditions, that a carbonate of soda solution is to be prefered. Cement is attacked to a certain extent by both the carbonate and hydrate of sodium. On one mind where the use of caustic soda was preferred, it was found that on starting up a new winder with the solution being pumped to a new concrete sump that the strength of the solution appeared to deteriorate rapidly ; the effect was to cause a marked decrease in the value of the full speed obtainable ; whether this was due to chemical action in the sump absorbing the caustic soda, or whether it was due to the conversion of the hydrate to carbonate, the ohmic resistance of which is practically double that of the hydrate, was never determined. The addition of common salt was stated to have remedied matters, but this may have been due to increased conductivity and not from chemical effect. Common salt, sodium chloride, has a greater corrosive action upon iron than the others, and is disliked especially for underground purposes, on the assumption that chlorine gas may be evolved. This latter is possible on theoretical grounds, but experiments on small vessels have shown that the gas evolved is reabsorbed in the solution.

In practice, electrolytic action is negligible when using alternating current, even when the number of cycles is very low.

The following table shows the analyses of a number of controller solutions used on various winders, and regarded as being most suitable for the particular conditions of operation.

Nos. 4 and 5 were stated to be solutions of caustic soda and common salt, though the analyses show none. No. 6 was Rand Water Board water. An analysis of various scales from controller tanks showed the scale as being mainly hydrated iron oxide, and that the iron oxide was magnetic.

MINERAL ZONES IN NORTHERN BRITISH COLUMBIA

Recent work in north-western British Columbia, which has led to an understanding of the more general features of the potential mineral-producing zones known to occur along the eastern side of the Coast range is described by F. A. Kerr in the *Canadian Mining and Metallurgical Bulletin* for August.

The author reminds us that geographically, northern British Columbia is more or less isolated. It is cut off from the central part of the Province by a rugged and mountainous country which, except for the telegraph line and a rarely travelled trail along it, is not penetrated by any developed routes or lines of communication. To the west, it is cut off from the Pacific by the Coast range, an extremely rugged area sixty to eighty miles in width which, except along the few navigable rivers cutting across it, cannot be readily traversed. Politically, it is further isolated in this direction by the narrow strip of south-eastern Alaska which borders the coast and extends inland to the axis of the range. To the north is the Yukon territory and to the east Alberta, which, of course, in these parts are so poorly developed as to assist little in relieving the isolation of northern British Columbia. Physiographically, this part of the Province, like that farther south, is divided into northwest-southeast zones : to the west is the Coast range, east of this the Interior plateau, then the Cassiar and Rocky mountains and,

beyond, a relatively low and flat country forming part of the great Mackenzie River district.

Northern British Columbia, so far as ready accessibility now is concerned, is subdivided into sections corresponding to the immediate drainage basins of the navigable waterways: in the north, Atlin Lake, then Taku River, Stikine and Iskut Rivers, and to a lesser extent the Unuk and Whiting Rivers; and from the south, by way of Portland Canal. Development work, whether it be in the nature of rough exploratory surveys, prospecting, or mining, must expand from these highways toward the more remote sections. The Alaska–Yukon highway, proposed to be constructed through the central part of the Province, will afford another and important means of spreading development.

Any immediate substantial development of northern British Columbia would seem to depend largely, if not solely, on its mineral resources. Its timber and agricultural possibilities would seem to be negligible and its other resources are only of minor importance. Its attractions for the tourist are unlimited, but it lies beyond other tremendous areas of the Province and of Alaska, which are equally well blessed and much more thoroughly equipped.

The Coast range, in which the geological work has been largely carried on, is extremely rugged, with a relief of over 10,000 ft. Its axis is marked by extensive ice and snow fields, from which great glaciers extend many miles. Eastward from the axis, which is the western boundary of British Columbia, there is in general a decrease in ruggedness and in the extent of ice and snow. The mountains become less steep and forbidding; vegetation, though more extensive, is less dense and much less of an obstacle to travel. Still farther east the mountains fall away abruptly or imperceptibly merge with the Interior plateau, a relatively flat country which, in northern British Columbia, is extensively covered by Tertiary and Recent lavas. The great valleys which cut through the Coast range, though they offer entry to otherwise practically inaccessible country, contribute greatly to the ruggedness. In the Glacial period they afforded a means of outlet for the great ice field of the interior and, as a consequence, are wide and deep and present in most places precipitous slopes.

Previous to the present work it had been known that the core of the Coast range in northern British Columbia was occupied by the same great batholith which extends throughout the central and southern parts of the Province and, to the north, in Yukon territory. Since the contact zone in various sections had produced important mining camps, the untouched sections of the north were considered to have sufficient potentialities to warrant extensive investigation. This work resolved itself primarily into an effort to ascertain something definite about these potentialities and to give some definition to the zones most favourable for mineralization; and secondarily, to ascertaining which sections of these zones were sufficiently accessible to be of economic interest at present. Accessibility was also, of course, the guiding factor in carrying out this work: those sections which can be fairly readily prospected and developed have been carefully surveyed while the intervening areas have been covered only in a cursory manner to link up the geology throughout.

General Geology.—The core of the Coast range is occupied by a great batholith of granitic rocks which probably average granodiorite in composition. These intrude badly deformed and highly altered Palæozoic sediments capped by a thick series of Permo-Carboniferous limestone, and Mesozoic volcanics, also highly deformed, which include a series of interbedded sediments (largely conglomerate) and pyroclastics, with, in some sections, coal. Upper Cretaceous sediments in considerable thickness and masses of Tertiary and Recent lavas occur locally, and in the Interior plateau just to the east the latter are very extensive.

From a purely scientific viewpoint, the Coast range of northern British Columbia probably presents as fine a set of conditions as can be found anywhere in the world for the study of a batholith and its associated phenomena. The great relief of 10,000 ft., the extreme ruggedness, the very limited vegetation, and the tremendous extent of fresh glaciated and broken surfaces, afford an unusually favourable opportunity for study, though these advantages are considerably offset by the extreme difficulty of travel, the large areas obscured by ice and snow, and the extent of the absolutely inaccessible sections.

Mineral Relationships.—The definition of the mineral relationships of the Coast range centred around a study of the batholith and its associated phenomena, since this mass is believed to be responsible for practically all of the mineralization in north-western British Columbia. In the field, it has been found that the batholith is readily divisible into two groups of intrusives and that these in turn can be subdivided, so that the mass as a whole really is made up of two or more distinct batholiths. The two major groups of intrusives, which are so characteristically coloured as to be designated in the field as the "brown granite" and the "grey granite," are of decidedly different ages, as also are, probably, the groups within them. Full consideration of this composite character is of paramount importance in determining the mineral relationships. The "grey granite," especially certain phases of it, is known to have extensive associated mineralization. On the other hand, the "brown granite" would seem to have been more of a detriment than a benefactor, since it cut into and destroyed large masses adjacent to the grey granite which might have been expected to be the most productive, and in itself was not a sufficient producer of mineral concentrations to make up for this loss. The influence of various phases and various parts of each phase seems to have been very different and, as a consequence, there are a great many factors governing the possible distribution of mineral deposits.

The nature of intruded rocks in their ability to receive and harbour mineral deposits exerts a further influence of considerable importance. So far as broader relationships are concerned, the most important phase of this subject to be considered is the relative susceptibility of the various formations to replacement by the different types of mineralizing solutions. It has been found that in certain localities the volcanics have been particularly favoured by the solutions, in preference to the altered sediments—even possibly including the limestone—though this may be more apparent than real and due to the fact that the latter are very limited in extent compared to the former.

Mineral Zones.—The most important factors

North-Western British Columbia: Ruled Pattern—Coast Range Batholith; Arrow Pattern—Zone favourable for Mineralization; Heavy Line around Mapped Areas.

in defining the mineral zones were the location of the eastern contact of the main batholithic mass and the determination of the limits of satellites. The main contact has now been traced fairly accurately for about 220 miles from just north of the Unuk river to some 16 miles north of the Taku, and is known approximately throughout the rest of its length in northern British Columbia. To the west of the contact is the batholithic zone, made up largely of granitic materials with a relatively small percentage of non-intrusives, included mainly as roof pendants. Because of the composite character, the batholith itself has much less of a barren aspect than is usually attributed to such masses. Both south and north of the area under discussion, mineral deposits of importance have been found within the granitic rocks and in many sections that have been studied where intrusives of different ages were in evidence, mineralization was also observed. Thus these rocks are known to have potentialities, but in a degree so inferior to those of the non-intrusives that, in the present undeveloped state of the area, they hardly warrant attention. The roof pendants, however, which constitute the other division of the batholithic zone, like those farther south which have been the location of some of the Province's largest mines, are well mineralized and constitute the most easily defined zones of high potentiality. They generally warrant careful prospecting. However, unless they are defined on geological maps or are definitely located, their prospective value is not sufficient to warrant a search for them through the granitic areas, at least while greater expanses of equally potential ground lie beyond.

To the east of the main contact is the zone of batholithic influence. This constitutes in its entirety a broad mineral zone of considerable potentiality extending northwest-southeast along the batholith, throughout its entire length. The eastern boundary of this zone is not so readily defined as the western and at best is more truly a gradation with decreasing potentiality eastward. However, there are certain factors which give it some definition. In parts of the interior, great areas of Tertiary lavas, by their complete masking of the underlying rocks, mark the limit of any possible mineral zone. It has been possible, however, to indicate a boundary, though more indefinite, still farther west. The zone of batholithic influence, so far as considerable mineralization is concerned, is marked by certain rather definite as well as indefinite characteristics. The more important of these, besides mineralization itself, are the presence of numbers of satellites or small protrusions from the mass, either exposed or indicated to lie not far below the surface, and changes in the character and structure of the rock. From a study of these features, a tentative eastern limit has been fixed to the zone favourable for mineralization. To the south, in the Stewart and Alice Arm districts, and to the north, around Atlin—areas in which extensive prospecting has revealed numerous mineral deposits—a boundary to include all known discoveries gives a zone of about the same width. Of the relatively few discoveries in the section under discussion, all lie within the zone, although travel has been more

extensive and chances of discovery consequently greater just beyond than within the boundary.

The broad contact zone of the batholith, so far as its immediate potentialities are concerned, must be divided into areas easily accessible, accessible, and relatively inaccessible. The first group of easily accessible sections includes areas along 100 miles of the Stikine, 40 miles of the Iskut, and 40 miles of the Taku. The second group of accessible areas includes extensions of these areas north and south along the western edge of the range and up the various tributary rivers such as the Inklin, Sutlahine, Nakina, Talsekwe, King Salmon, and South fork of the Taku; and Shakes, Chutine, Mess, Yehinico, Scud, Craig, and Kahtate of the Stikine system. The Whiting, between the Stikine and Taku, offers entry into a small section but does not afford reasonably easy access to any area of sufficient size or potentiality to warrant attention from the prospector at present. The Unuk is navigable with difficulty into a fairly large area of considerable promise. The telegraph trail and other trails from Stewart and Atlin offer further, though somewhat more difficult, means of entry into the general favourable zone and a number of lakes afford landing sites for aeroplanes.

The easily accessible sections, comprising over 2,500 squ. miles, have been mapped or partially mapped both geologically and topographically. The results of this detailed work have contributed considerably to defining the relative mineral potentialities. It has been found that the whole zone is studded more or less by satellites of the main mass. These satellites are in part associates of the various intrusive phases of the batholith and in part differentiates which may have no counterpart now exposed in the main mass. Many other protuberances from the granitic core are indicated, by induced phenomena in the intruded rocks, to lie not far below the surface. Mineralization of intruded rock is largely the result of factors closely associated with contacts; therefore, disregarding certain other factors, the extent of mineralization should bear a direct ratio to the extent of contact at or near the surface. In other words, a straight contact produces a smaller potential area than a crooked one, and likewise one that dips steeply is less effective than one of gentle dip and, further, is much less effective than one with gentle dip combined with series of bumps or undulations. The Iskut River area seems to afford the most nearly ideal relationships, whereas the section around Telegraph Creek is representative of the least favourable type. Another important factor, as previously noted, is that, while certain phases have been associated with extensive mineralization, others have not. Without going further into the reasons for the conclusions reached, it is interesting to note some of the results obtained. For instance, confined to the vicinity of the lower Craig River is a porphyritic phase which seems to have been the most potent mineral producer of all those observed. The areas between the masses of this material constitute a zone displaying to casual geological investigation—having been too little prospected to have brought to light a fair measure of detailed information—very abundant evidence of extensive mineralization. This smaller zone lies in a larger area extending west to the main batholithic mass, in which there exist very extensive contacts with an intrusive phase which in places seems fairly definitely to be responsible for important mineralization—at any rate mineralization has been observed in all sections. Further, the Permo-Carboniferous limestone and Mesozoic volcanics, the distribution of which can be fairly well defined, seem to have been more susceptible to mineralization and to have been affected in many places in such a way that the location of deposits is relatively easy. Thus a zoning as to potentialities in order of merit can be delimited: first, the areas of these formations in the porphyry zone, then this zone itself, and finally the broader area described.

Along the Stikine, between the Scud and the Chutine, one relatively non-productive phase is fringed by discontinuous masses of another phase which is responsible for much mineralization. Wherever this latter phase is in contact with limestone, there is a continuous series of contact deposits. Where the contact is with volcanics, the ore minerals occur in altered sheared or shattered zones of a very distinctive and easily recognizable appearance. This zone has been successfully prospected near the Stikine though without as yet producing anything of commercial value. Last summer a new series of deposits was discovered in it within less than half a mile of the most frequented part of the district.

Well beyond the batholith in the same section are three satellites which may be closely related to the productive phase just described. They, too, have associated mineral deposits and it is not unlikely that around these are more or less continuous favourable zones. Similar satellites have been noted elsewhere, thereby indicating other areas of more than average potentialities.

Still farther north, in the Taku district, the mineral deposits which attracted so much attention last year lie in a zone which is fairly well defined by certain geological features. This is penetrated by a series of small satellites believed to be the source of the mineralization. The deposits here exhibit distinctive characteristics which, when understood, aid greatly in their discovery.

In the various ways outlined, and in others less tangible, an effort is being made to define the areas of varying degrees of potentiality and to offer guides which may assist in bringing to light most quickly some mineral deposits of economic value. The area to be prospected is so vast in terms of human effort needed to be expended to cover it that only a very limited part of it can be examined properly in any one season. It is, withal, a land which needs much more than ordinary inducements to bring about its development. With its great sea of mountains, it presents a ruggedness which requires such physical energy as to discourage at times even the stoutest. To lug a pack through the trailless jungle-like growth of the lower levels; to pull it up precipitous slopes, often to be baffled by unscalable cliffs; to face the hazards of great ice fields, deeply crevassed glaciers, and swiftly flowing icy streams and rivers, requires unlimited optimism, more than can be conjured up in the mind of the average prospector by the presentation of the favourable geological conditions. These factors, together with unfavourable climatic conditions and difficulty of access of more than a very limited area, have deterred all but a very few from carrying on prospecting campaigns.

BORE-HOLE PUMPS FOR MINE DRAINAGE

Results actually obtained in working an installation employing pumps suspended in bore-holes for mine drainage are given by L. C. Stuckey in the *Bulletin* of the Institution of Mining and Metallurgy for August. In this connexion it will be recalled that an article by G. P. Chaplin, in which a system of bore-holes was used as an aid to shaft-sinking, appeared in the MAGAZINE for October, 1930. The present author's experience was obtained on an installation which has been in use for over two years. He says that the conditions for which the bore-hole drainage was selected were favourable in that the area consisted of porous schists intersected by five lead lodes, one of which is exploited over a length of one-and-a-half miles, the lodes themselves being crossed by fissures and never more than half-a-mile apart.

While the lodes had been worked extensively during the last twenty years, apart from native workings, work had been confined to the upper portions accessible by adits, and practically no work had been done below water-level, which remained constantly about 31 m. (101 ft.) above sea-level. It was observed that percolation of surface waters caused the level to rise simultaneously in all the lodes, but when falling again to normal it fell at approximately the same rate in three of the lodes while in the other two, partly in eruptive rock, the seepage was slower. Another reason for the consideration of a central pumping scheme was that one of the principal inclined shafts had been intersected by a dyke of decomposed eruptive, running almost parallel with the direction of the shaft, which required close timbering, conditions with which the local labour was unable to cope successfully.

BORE-HOLE.—A central position was chosen for the bore-hole, which was drilled 55 cm. (21·6 n.) in diam. at the top, with an iron casing which left a clear 50 cm. (19·7 in.) internal diam. from top to bottom. An old shaft was utilized which had been sunk to water-level a distance of 34 m. (111 ft.) from surface, this being timbered to 2 m. by 3 m. inside dimensions. For the drilling a contractor was employed who provided all plant and tools, the drilling rig being the ordinary rope with percussion tools.

The drilling time was two months, and the bore-hole was put down 131·4 m., or 100 m. below sea-level. The pump chamber was excavated and lined with masonry, the roof and floor were concreted, and the erection of the pump was completed in the following month and tested in May, 1928. The total cost was £3,500, including the transport and erection of plant and material.

BORE-HOLE PUMPS.—The two main types of pump used for dewatering from bore-holes are:

(1) The combined pump and motor submerged and suspended in the bore-hole by the rising main.

(2) The centrifugal pump submerged in the bore-hole driven by a vertical shaft from a superimposed electric motor, the pump and shafting being suspended by the rising main from the base plate of the motor at the top of the bore-hole.

(*a*) *Submerged Motor-Pumps.*—These pumps are comparatively modern and their chief application has been for oil-pumping. There are three types:

(1) Compressed Air.—A hermetically sealed unit in a casing maintained at half-an-atmosphere above the exterior water pressure by compressed air, or a neutral gas, the motor thus working normally directly connected to the pump. Suitable pressure conditions are determined by an air bell and air dryer, and a pressure regulator controls an air compressor at surface. Usually the motor is above the pump with a special stuffing-box between motor and pump, and the air bell to indicate the water pressure is placed on the rising main just above the pump. These pumps are made in various sizes up to 100 kw.; they have a good output, are light in weight, and cost less than the shaft-driven type, but they require skilled attention, especially in sinking operations when the varying degree of submergence would vary the water pressure. A composite cable conveys power, compressed air, and the manometer tubes.

(2) In this type the motor has no protection from water since both rotor and stator are in water, the current being reduced to low-tension by a transformer on surface. The pump is filled with clear water before lowering into position. For greater depths the transformer is placed in a sealed chamber below the motor to economize transmission losses on the low-tension current. The efficiency of this class of motor is lower than that of No. 1, owing to the friction of the water round the rotor, but the attention required is much less. A filter is fitted to clean the water entering the motor, and the pump is usually placed on top of the motor and directly connected to the rising main.

(3) This type has the stator hermetically sealed by the interposition of a metal cylinder between it and the rotor. The rotor is in water and the losses by friction and electrical losses through the metal sheath reduce the efficiency. A modified form is the Reed Cooper pump which draws the water through the rotor while the stator, protected by a metal sheath, is immersed in oil.

These pumps are made 10½ in. to 14⅝ in. in diam., with 2,900 r.p.m. The h.p. is from 6 to 40, with an over-all efficiency stated by the makers to be from 0·44 to 0·615. The water output varies from 2,800 gals. per hour with 197 ft. head up to 116 tons, say, 26,000 gals., per hour with 216 ft. head.

In all these classes of submerged motor pumps the ball bearings (stainless) in the motor chamber require greasing every six months, and stainless steel is used for parts working in water. The length of the motor pump unit is generally from 1·8 m. to 2 m., and the weight approximately 980 lb.

With the local conditions as stated, and owing to the difficulty and expense of providing skilled attention, it was decided to put in the mechanical transmission type with vertical shafting to work on three-phase current, 380 volt, 50 period, with which the mine is supplied from its own transformers.

(*b*) *Vertical Shaft Pumps.*—Particulars of the set used are:

Motor.—Normal h.p. 48, capable of developing 54 h.p. Rev. per min., 875. Weight, with support base, 1,780 kg.

Rising Main.—Steel pipes with flange joints form the rising main by which the pump is suspended from the support base of the motor. Pipes are usually 10 ft. long, ¼ in. thick, and of 7¾ in. internal diam.

Inside the rising main are smaller pipes forming a continuous inner chamber which serves to carry

the brass guides for the vertical driving shaft. These pipes are 5 ft. long and of $3\frac{3}{8}$ in. internal diam., $\frac{1}{16}$ in. thick, and screwed into the brass guide sleeves at every joint.

Driving Shaft.—This is of solid round steel in 10-ft. lengths, $1\frac{1}{4}$ in. in diam., and butt-jointed, with conical sleeves on which two rings are pressed by a special screw press supplied by the makers. After working and removal for repairs, it has been found that these clamps become slack and allow the rods to rotate, so a soft iron key was inserted in a small groove cut in the butt ends of the shaft rods, which prevents the rods from turning but would yield in the event of abnormal stresses.

Delivery.—This would usually be alongside the motor at the top of the bore-hole, but in this instance the piping was continued 34 m. up to the top of the vertical shaft, to a surface reservoir. The stop valve, non-return valve, and manometer were placed alongside the motor. The internal diam. of the delivery pipe was 5 in.

It is perhaps advisable to note that as a general rule the vertical shafting inside the bore-hole should not be called upon to transmit more power than is necessary to raise the water out of the bore-hole itself; the raising of the water to surface should be done by an auxiliary pump.

Suspension.—The rising main is bolted to the heavy support base of the motor, the interior pipes being screwed into a stuffing-box immediately above. The shafting runs through the interior piping to a double ball-bearing which provides the suspension, an adjustable steel disc being used to take up wear and to adjust the position of the pump impellers. It does not seem correct in principle for the weight of the shafting to affect the alignment of the impellers with the diffuser vanes, and the interposition of a sleeve connexion allowing sufficient play for the adjustment of the suspension independently would obviate this.

Pump.—A nine-stage centrifugal pump with bronze impellers and diffuser vanes, having an outside diam. of 46 cm. (18 in.) and a length of 1·45 m. The capacity of the pump was:

75 cub. m. per hour (275 g.p.m.) with a head 216 ft.
62 „ „ (227 g.p.m.) „ „ 246 ft.

The efficiency was 68%, and the horsepower required 38 h.p. at the pump.

The length of piping in the bore-hole was 46 m., the suction and windbore 5·4 m., and the length of pump and connexions 1·6 m., making a total length of 53 m. (174 ft.) in the bore-hole, and reaching to 72 ft. below sea-level.

The weights of these components were:

Weight of the Pump	. .	908 kg.
Exterior Pipes	. .	2,266 „
Interior Pipes	. .	278 „
Shaft and Joints	. .	1,057 „
		4,509 kg. or $4\frac{1}{2}$ tons.

Maintenance.—The chief item under this head was the wear on the brass guides, and the vertical shafting, this being greatest in the centre of the length. It was found that, if the length of rods did not exceed 46 m., the wear is not excessive. Neither the pump nor the motor showed any appreciable signs of wear after two years of work.

To overhaul the pump, or to effect repairs, it is necessary to dismount the motor and to lift the motor base with the string of piping attached. Wooden clamps are bolted on the piping at the top of the borehole, the base is removed, and then each length has to be clamped and disconnected separately. The interior pipes and sleeves are also unscrewed, and the shafting is disconnected by slackening the rings on the conical clamps. For this purpose it is advisable to have a slow-motion capstan to lift the weight, equipped with a quicker speed for lowering; an ordinary block and tackle is too slow.

Cost of Working.—With electric power costing 1·45*d.* per kw.h., and including line and transformer losses the power consumed was:

In 1929 the pump ran 6,734 hours using 238,137 kw.h. or 35·3 kw.
In 1930 „ „ „ 4,079 „ „ 151,714 „ „ 37·1 „

The costs in 1930 were divided as follows:—

	£	s.	d.
Wages and Sundries . . .	55	14	0
Electric Current	918	4	0
Repairs and Renewals . . .	139	14	0
	£1,113	12	0

In the first year (1929) the pump worked full time in order to lower the water to the first level, and then reduced to 12 hours per day while driving. Sinking was resumed in the second year and the hours were increased to 17 and latterly to 24. In the second year repairs and renewals were a heavier item. The average cost per hour for the two years works out at 5s. 4d. per hour. The water level of the district was lowered in this period an average of 40 m. or 131 ft. The water is brackish and contains 4·7 grm. per litre of salts, of which the principal are common salt (NaCl) 56·7%, and gypsum ($CaSO_4$) 18·4%.

Observations.—In view of the difficulty of inspection and the consequently reduced reliability, this bore-hole installation could not be considered a permanent one, but rather as a means of gaining considerable time in de-watering the area and in sinking the main shafts. For the type employed the economic limit of depth in the bore-hole was estimated at about 50 m., and an arrangement had therefore to be devised for the lowering of the pump to utilize the bore-hole at greater depths, dealing with the water so raised by means of a permanent installation for the upper levels.

Taking for example the present installation, the water would be lowered to 19 m. below sea-level, a small pump shaft for the rising main and ladderway, 2 m. by 3 m., would be sunk to the 19 level, the sump cut, and a centrifugal pump with direct connected motor put in there as a permanent pump. When this new pump has the water under control a cross-cut is driven to the bore-hole, the casing is cut and a new chamber with a foundation collar is put round the lower portion of the bore-hole. The motor is then removed and re-erected at the new level, the upper portion of the bore-hole serving to lift the piping.

Advantages.—The rapidity of draining the water enabled four main shafts to be sunk without difficulty in soft ground. The usual pumping difficulties were avoided, as the water pumped is quite clear and the stoppages associated with gritty water are absent. If good tackle is provided for raising and lowering the pump and piping, repairs are neither slow nor expensive, though the pump should in any case be overhauled every six months.

Originally provision was made by the makers for filling the interior pipes with lubricating oil, but the water pressure forced the oil out in a few hours. It was found that a liberal application of Stauffer grease on rods and joints minimized the wear.

With regular inspection this type of pump required no skilled attention except when actually under repair.

Mining Practice at Valedon, New Mexico.—Mining methods at the Eighty-Five mines of the Calumet and Arizona Mining Co., near Valedon, N. Mex., are discussed in Information Circular 6413 of the United States Bureau of Mines, written by R. B. Youtz. A production of 7,000 to 8,000 tons per month of siliceous copper-gold-silver ore is mined from steep veins occurring in igneous country rocks, chiefly granodiorite. Ore shoots are persistent and veins, ranging from 2 to 10 ft. wide, average 5 ft. in width, usually with commercial rather than structural limits. In the upper levels both walls and vein filling are hard and firm and will stand open indefinitely, but below the 1,350 ft. level more intense mineralization of the walls has taken place, requiring cut-and-fill methods in some places. Experience has shown the ore to be so uniformly continuous that the only exploratory work now practised consists in the routine opening up of deeper levels, with some extra cross-cutting and rising near the ends of the vein. Reserves are estimated in 100 ft. blocks on the basis of channel samples, with proper allowances for horses of waste, dilution, and discrepancies between mine and smelter assays.

The mine is developed in the usual way by vertical shafts (two for operating use), drives, cross-cuts, and rises. Development, drilling and blasting, and shaft-sinking details are well treated. An interesting feature of the latter is the use of key-board blocking, which has proved superior to stull-blocking in shaft timbering. Shrinkage has always been the most important stoping method at this property. Inclined cut-and-fill stopes are resorted to where the walls are very weak, where the vein is wide but contains horses or bands of waste, or where high-grade ore occurs in narrow veins. All ore is hand sorted from the surface picking belt.

Shrinkage stoping is usually done in connexion with drive-back timbering, although in wide veins or where the ore immediately above the drive is of marginal grade, pillars may be left. These pillars are usually recoverable on completion of the stope from below, if their grade warrants. In firm ground cribbed manways are carried through the broken ore between stopes. This necessitates special drawing procedure to prevent crushing of the manways by runs of ore occasioned by unequal drawing on the two sides. In heavier or faulted ground, small pillars are left to protect the manways, with dog-holes broken through to the stope at about 35 ft. intervals. Where foot-wall drives have been made stopes are carried direct to the level above; otherwise the floor pillar may be recovered later. Ore remaining in stopes as drive-back pillars or cones between chutes is pulled through the stope below. Present extraction is close to 100%, although considerable waste from the walls must be sorted out.

Cut-and-fill stoping is treated in detail. Pumping is an important item, some 450 gallons per minute being raised in several lifts. Ventilation has become a problem in the bottom level, where the mine water has a temperature of 104° F. All underground labour is on a contract basis. Total mining cost in August, 1930, was $4·49 per wet ton with a production of 1·45 wet tons per man-shift. In two typical shrinkage and two cut-and-fill stopes, stoping costs were $1·23 and $1·75, and $2·45 and $2·37 per ton, respectively.

Copper Milling in Arizona.—Milling practice at the Old Dominion Company's concentrator, near Globe, Arizona, is described in Information Circular 6467 of the U.S. Bureau of Mines, by D. L. Forrester and W. B. Cramer. The concentrator was built in 1914 and was originally designed for the treatment of about 800 tons of ore per 24 hours by combined gravity and flotation methods. At present the treatment is entirely by flotation and the capacity is about 1,500 tons per day. The multiple-pipe matless-type flotation machine was developed at this plant. Mr. Forrester describes the development of this machine and gives the results of comparative tests made with various machines operating on Old Dominion ore.

Copper ores, principally chalcopyrite, containing some gold and silver, are treated. The gangue ranges from fairly pure quartzite to a mixture of quartzite and limestone, or quartzites and diabase, or combinations of the three. The coarse crushing plant produces a product of ¾ in. maximum size by gyratory crushers set at 4 in., disc crushers set at 1½ in. and rolls operated in closed circuit with screens having ¾ in. holes. The concentrator contains two grinding units, one of 1,225 tons and the other of 275 tons daily capacity. In the larger unit the ore is reduced by rolls followed by two stages of grinding in ball-mills, the secondary ball-mills operating in closed circuit with rake classifiers. A bowl classifier is placed between the two grinding units receiving the primary ball-mill products as feed and delivering a sand product to the secondary grinding units and an overflow which joins the product of secondary grinding for flotation treatment. In the smaller unit the ore is ground in a rod-mill operated in closed circuit with a rake classifier.

The flotation department contains two similar units each of 750 tons daily capacity. One unit comprises one primary cell which receives flotation feed ground to about 6% plus 48-mesh and produces finished concentrates. The tailings from this machine are treated in one secondary cell. The secondary cell makes finished concentrates; the tailings are distributed to two tertiary cells. The tertiary-cell concentrates are ground in the secondary ball-mills and join the flotation feed to the primary flotation cells. The tailings of the tertiary cells are distributed to two scavenger cells which produce waste tailings and concentrates, the latter being cleaned in one intermediate cleaner cell. The cleaner-cell concentrates join the tertiary-cells concentrates for additional grinding and flotation treatment and the cleaner-cell tailings are pumped to the head of the tertiary cells. Flotation re-agents comprise lime, potassium ethyl xanthate, reconstructed oil, and pine oil. Flotation concentrates are dewatered in a classifier, thickeners and a filter.

For the first five months of 1930, the concentrator treated 213,431 tons of ore which averaged 2·37% of copper. The concentration ratio was 12·36 tons into 1, the recovery of copper amounted to 89·07% and the concentrate produced contained 24·43% of copper. For 1929, direct concentrator costs amounted to $0·699 per ton of ore treated.

Mining at the Verde Central Copper Mine.—Methods and costs of mining at Verde Central Mines, Inc., Jerome, Ariz., are described in Information Circular 6464 of the United States Bureau of Mines, prepared by R. H. Dickson. The Verde Central mine in 1929 and 1930 was producing

about 10,000 tons of ore per month, averaging about 2·9% copper and 0·4 oz. of silver. The ore occurs in shear zones in Pre-Cambrian greenstone at or near the contact between the greenstone and a large quartz-porphyry stock. The ore-bodies, consisting of quartz with disseminated pyrite and chalcopyrite, are about 15 ft. in thickness, 50 to 300 ft. long, and stand nearly vertical.

The stoping zones extend from the 600 to the 1900-ft. levels and are developed by a vertical, 3-compartment shaft, cross-cuts, and drives at 150-ft. vertical intervals. About 1 ft. of development work is required for every 60 tons of ore extracted. Both the greenstone and porphyry are hard, firm rocks which permit openings to be driven without timbering. The cost of 13,000 ft. of driving and cross-cutting in 1927 was $11·98 per foot.

Stoping is done chiefly by shrinkage, sometimes followed by filling if it is desired to extract the pillars of ore left under the levels. Occasionally where faulting has created bad wall conditions, inclined cut-and-fill stoping is used. An interesting feature of the shrinkage stoping practice is the blasting chamber constructed above each chute. This provides a safe and convenient place in which to do much of the necessary secondary breaking, and increases tramming efficiency. Cribbed rises are carried up through the broken ore for passage-ways into the stopes.

Hand tramming and storage-battery locomotives are used for underground haulage, the latter for distances over 600 ft. Ore is hoisted in double-deck cages. Development work is done under a bonus system. Stoping is contracted on a square yard basis, similar to the Colorado plan of payment by the fathom. The mine is ventilated by natural draught which passes down through an old inclined shaft and a series of rises to the lowest level, the desired amount of air being taken off at each level and upcast through the stopes and the main shaft.

In addition to an itemized statement of stoping costs in units of labour, power and supplies, details of stoping cost in dollars are given for 14 months in 1929 and 1930.

Amalgamation at Porcupine.—The description of milling at a small gold mine adjacent to the Hollinger and McIntyre properties at Timmins, Ontario, by R. A. Vary, in Information Circular 6433 of the United States Bureau of Mines, is of particular interest as an instance where, with a small initial outlay for plant and equipment, development of a mine has been carried on almost entirely on proceeds from a 25-ton pilot mill. About 75% of the gold in the ore is free milling and fairly coarse. The crude ore is fed to a crusher which breaks the ore to about 1 in. size. Next it is reduced to about ½ in. by rolls and is then ground in a ball-mill until about 65% passes through 200 mesh. The ball-mill discharge is thinned with water and distributed to two 4 by 8-ft. copper amalgamation plates with 4 ft. of blankets at their lower ends, 40% of the total gold recovery being made on the plates.

The discharge from the plates goes to a duplex classifier which is in closed circuit with the plates and the ball-mill. The rake product from the classifier is returned to the ball-mill and the overflow runs to an impact amalgamator attached to a sand concentrating table. The amalgamator catches fine gold which has escaped the plates, blankets, and traps. The table concentrates average $40 per ton and after dewatering are cyanided by an affiliated company. The table tailings go to the waste dump.

The concentrates caught on the blankets and in the traps are ground in an amalgamation barrel. The amalgam is retorted in the plant and the sponge gold is melted and cast into ingots at the refinery of the affiliated company. The average grade of bullion is gold 770 fine, and silver 120 to 140 fine. The total operating cost per ton of ore treated is $1·85.

SHORT NOTICES

Construction Methods.—F. E. Rogers describes the construction methods used on Cushman Tunnel No. 2 near Potlatch, Washington, in *Mining and Metallurgy* for August.

Mining Methods and Costs.—Information Circular 6503 of the United States Bureau of Mines by C. W. Wright summarizes some of the data arising out of the study of mining methods and costs, which was undertaken by the Bureau about three years ago.

Mine Models.—The use of models for the study of mining problems is discussed by P. B. Bucky in Technical Publication No. 425 of the American Institute of Mining and Metallurgical Engineers.

Cyaniding Low-Grade Ore.—George J. Young describes a process for the cyaniding of low-grade gold ores now in use at the Mountain Copper Company's property in California in *Engineering and Mining World* for August.

Copper Refining. The plant of Canada Copper Refiners Ltd., at Montreal East, is described by W. M. Goodwin in the *Canadian Mining Journal* for August.

Open-Hearth Furnace Control.—W. Trinks describes the automatic control of open-hearth furnaces in *Mining and Metallurgy* for August.

Copper-Cadmium Separation.—The quantitative separation of copper and cadmium by reduction with potassium formate is discussed by E. I. Fulmer in *Industrial and Engineering Chemistry* (Analytical Edition) for July 15.

Chromium-Nickel Determination.—L. H. James describes a method for the determination of nickel and chromium in the same solution in *Industrial and Engineering Chemistry* (Analytical Edition) for July 15.

Electrical Prospecting.—In the *Canadian Mining and Metallurgical Bulletin* for August, H. Lundberg, T. Zuschlag and F. Kihlstedt describe the expansion and progress of electrical prospecting.

Coal.—The relationship between oxidizability and the composition of coal is discussed by W. Francis and H. M. Morris in Bulletin 340 of the United States Bureau of Mines.

Silver-Tin Deposits of Oruro.—W. Lindgren and A. C. Abbott describe the geology and mineral relationships of the silver-tin deposits of Oruro in Bolivia in *Economic Geology* for August.

Phosphate in Morocco.—The phosphate deposits of Kourigha, Morocco, are described by A. C. Lawson in *Economic Geology* for August.

Brazilian Diamonds.—In *Economic Geology* for August, L. J. Moraes and D. Guimaraes describe the diamond-bearing region of Northern Minas Geraes, Brazil.

Offset Drainage Damage.—C. A. Warner suggests a method of estimating the quantity

of oil and gas lost by offset drainage in *Mining and Metallurgy* for August.

Lubricating Oil Consumption.—The relationship between volatility and consumption of lubricating oils in internal-combustion engines is discussed by G. Wade and A. L. Foster in Technical Paper 500 of the United States Bureau of Mines.

RECENT PATENTS PUBLISHED

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

1,907 of 1930 (351,503). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Metallic magnesium and substantially pure chlorine are produced by electrolysis of a molten electrolyte having a greater specific gravity than magnesium in a specially constructed tank.

3,669 of 1930 (352,005). New Jersey Zinc Co., New York. Zinc vapour produced during the smelting of zinc ores is freed from lead and other impurities by passing it through a suitably controlled eliminating medium consisting of materials about to be subjected to the reduction operation.

6,666 of 1930 (351,510). A. C. Jessup, Clamart (Seine), France. The production of electrolytic magnesium metal is carried out in a specially designed tank, which protects the new metal from attack by anode produced gases, the electrolyte at its working temperature having a specific gravity equal to or greater than that of magnesium.

7,713 of 1930 (352,931). N. Leslie, Westbury, Tasmania. Ore treatment apparatus consisting essentially of a chamber with converging bottom, an adjustable upcast pipe within the chamber, and a circulating pipe to deliver compressed air or water under pressure at the bottom of the upcast pipe.

8,944 of 1930 (351,514). O. N. Rikof, Broxbourne, Herts. Elutriation is carried out in a vessel confined by forwardly and upwardly diverging side walls, sand being withdrawn at the bottom of the vessel.

10,897 of 1930 (352,477). Patent A.-B. Grondal-Ramen and N. E. Lenander, Stockholm. Sulphur-bearing gases obtained during pyritic smelting operations are freed from dust in suitable apparatus and then passed to a catalyst chamber, which is maintained at a temperature of 350–400° C., suitable catalysts being metallic oxides. This chamber reduces all sulphur compounds except sulphur dioxide, which can be subsequently reduced by known means, the sulphur recovered by this means having a high degree of purity.

12,567 of 1930 (352,580). F. M. Wiberg, Falun, Sweden. The reduction of ores by gases is carried out in a specially designed series of vertical receptacles for the ore.

12,581 of 1930 (351,150). International Nickel Company and R. C. Stanley, New York. Nickel-copper-bearing material is treated with alkaline sulphides in order to effect a separation of the copper and nickel as impure copper and nickel sulphides.

13,060 of 1930 (352,137). H. Blumenberg, Los Angeles, California. Borax ores are treated with water and the borax solution treated with calcium chloride solution, the precipitated calcium borate being filtered off.

13,613 of 1930 (351,653). G. N. Kirsebom, Trollhattan, Norway. Metallic compounds, such as flue dusts, slimes, or slags, are reduced by adding arsenic and causing such arsenic to react with a fused alkali metal compound.

18,348 of 1930 (353,184). Oesterreichisch-Alpine Montan-G., Vienna. Waste water containing cyanide is treated on the countercurrent principle by waste gases containing carbon dioxide, the hydrocyanic acid set free being recovered in known manner.

21,649 of 1930 (352,269). G. Laubmeyer, Kassel-Wilhelmshöhe, Germany. Underground air is collected by means of special apparatus, in order that it may be tested for such gases as will indicate the presence of mineral or other deposits.

23,017 of 1930 (351,295). Oesterreichisch Amerikanische Magnesit A.-G., Carinthia, Austria. Metallic magnesium is recovered from its compounds by electro-thermic means, using charcoal as a reducing agent.

29,610 of 1930 (352,832). A. Folliet and N. Sainderichin, Paris. A continuous process for the agglomeration of finely divided ferruginous ores or concentrates in which the ore is fed through a suitable chamber in a thin layer, a mixture of ore and fuel being subjected to the action of hot air forced into it under pressure.

39,035 of 1930 (353,371). New Jersey Zinc Co., and E. H. Bunce, New York. Zinciferous materials are reduced by mixing with carbonaceous material, agglomerating, coking, smelting the coked agglomerate and recovering the zinc produced after the elimination of lead and other impurities.

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.

Safety Explosives: The safe use of explosives in coal mines. "What every mining man should know" No. 4, Safety in Mines Research Board. Paper covers, 63 pages, illustrated. Price 3d. London: H.M. Stationery Office.

Electric Fuses: The Pressures Produced on Blowing Electric Fuse Links. The Effect of the Surrounding Atmosphere. Safety in Mines Research Board Paper No. 67. By G. Allsop and P. B. Smith. Paper covers, 19 pages. Price 6d. London: H.M. Stationery Office.

Firedamp: The Ignition of Firedamp by Coal-Mining Explosives, 1. Gallery Experiments. Safety in Mines Research Board Paper No. 69. By H. C. Grimshaw and W. Payman. Paper covers, 45 pages, illustrated. Price 1s. 6d. London: H. M. Stationery Office.

Spontaneous Electrification in Coal-Dust Clouds. Safety in Mines Research Board Paper No. 71. By S. C. Blacktin and H. Robinson. Paper covers, 17 pages, illustrated. Price 6d. London: H.M. Stationery Office.

The Lancashire Coalfield.—The Lower Mountain Mine, the Burnley, Accrington, Darwen, and Bacup Area. Department of Scientific and Industrial Research: Fuel Research. Physical and Chemical Survey of the National Coal Resources No. 19. Paper covers, 90 pages, illustrated. Price 2s. 6d. London: H.M. Stationery Office.

Annual Report of the Secretary for Mines, 1930, and the Annual Report of H.M. Chief Inspector of Mines. Paper covers, 218 pages, illustrated. Price 3s. 6d. London: H.M. Stationery Office.

The Geology of Manchester and the South-East Lancashire Coalfield. Geological Survey Memoir. Explanation of Sheet 85. Paper boards, 240 pages, illustrated. Price 5s. London: H.M. Stationery Office.

British Columbia. Report of Minister of Mines, 1930. Cloth, royal octavo, 468 pages, illustrated. Victoria: Bureau of Mines.

Manitoba: Its Resources and Development. By F. H. KITTO. Paper covers, 191 pages, illustrated, with map. Ottawa: Department of the Interior, National Development Bureau.

Uganda. Annual Report of the Geological Survey Department, 1930. Paper folio, 44 pages, illustrated, with map. Price 3s. Entebbe: Geological Survey Department.

New South Wales. Annual Report of the Department of Mines, 1930. Paper folio, 105 pages, illustrated. Price 6s. Sydney: Department of Mines.

South Australia. Mining Review No. 53, 1930. Paper covers, 147 pages, illustrated. Adelaide: Department of Mines.

Western Australia. Reports on Investigations conducted in the Metallurgy Laboratory of the School of Mines of Western Australia, Kalgoorlie. By W. G. CLARKE and B. H. MOORE. Paper folio, 45 pages. Perth: Mines Department.

United States Petroleum Refinery Statistics, 1929. Bureau of Mines Bulletin 339. Paper covers, 125 pages, illustrated. Price 30 cents. Washington: Superintendent of Documents.

Mineral Resources of the United States. 1929, Part I, pp. 485–506, Bauxite and Aluminium, by C. E. JULIHN; pp. 525–580, Copper, by C. E. JULIHN and H. M. MEYER; pp. 675–727, Zinc, by E. W. PEHRSON; Part II, pp. 373–388, Mica, by B. H. STODDARD; pp. 389–420, Cement, by B. W. BAGLEY; pp. 421–521, Petroleum, by G. R. HOPKINS and A. B. COONS; pp. 523–567, Asphalt and Related Bitumens, by A. H. REDFIELD. 1930, Part II, pp. 1–13, Fuel Briquettes, by W. H. YOUNG and J. M. CORSE; pp. 45–57, Carbon Black, by G. R. HOPKINS and H. BACKUS.

Accidents at Metallurgical Works in the United States, 1929. Bureau of Mines Technical Paper 503. By W. W. ADAMS. Paper covers, 34 pages. Price 10 cents. Washington, Superintendent of Documents.

Congrès International des Mines, de la Métallurgie et de la Géologie appliquée. June, 1930. Compte Rendu. Paper covers, 211 pages. Liége: Comité Organisateur.

Russia. The Foreign Trade of the U.S.S.R. Birmingham Bureau of Research on Russian Economic Conditions, Memorandum No. 2. Paper covers, 24 pages. Birmingham: The University.

Kingston's Continental Price Conversion Tables. By A. G. KINGSTON. Cloth, 79 pages. Price 4s. London: Kingston's Translations Institute.

COMPANY REPORTS

Modderfontein East.—This company, formed in 1917, works a gold mining property on the Far East Rand. The report for the year ended June 30 last shows that 850,500 tons of ore (a new record tonnage) was milled, the gold recovered amounting to 249,609 oz. The value of the gold yield was £1,060,319, while silver and osmiridium recovered increased the total revenue to £1,065,543, equivalent to 25s. per ton milled. Working costs amounted to £873,179 and the working profit to £192,364. Dividends paid during the year absorbed £186,161, equal to 20%. The available ore reserves at the end of the year were estimated to be 1,985,600 tons, averaging 5·9 dwt. over a stoping width of 45·7 in., as compared with 2,013,000 tons, averaging 5·8 dwt. over 46·9 in., at the end of the previous year.

Nourse Mines.—Formed in 1894, this company works a gold mining property on the Central Rand. The report for the year ended June 30 last shows that the tonnage milled, at 805,400, was a record for the mine, exceeding that of the previous year by 85,700 tons. Gold bullion recovered amounted to 237,836 oz., worth £1,008,542, while silver and osmiridium values increased the total revenue to £1,010,807. Working costs at £926,692 were equivalent to 23s. per ton, against 23s. 6d. in the previous year, and the working profit was £84,115. Dividends paid during the year absorbed £58,775, equal to 7½%. The ore reserves available at the end of the year were estimated to be 1,413,500 tons, averaging 6·1 dwt. over a stoping width of 43 in., as compared with 1,291,500 tons, averaging 5·9 dwt. over the same width, at the end of the previous year. The increased tonnage and value are principally due to more favourable conditions prevailing on the South Reef in the vicinity of No. 1A incline.

Bisichi Tin.—This company was formed in 1910 and works alluvial tin properties in Northern Nigeria. The report for the year 1930 shows that 863 tons of tin concentrates was produced, realizing £88 7s. 5d. per ton, against 979 tons, realizing £127 per ton, in the previous year. The working profit was £8,603, against £24,078, and the net profit £1,335, increasing the credit balance brought in to £5,061. The ore reserves are estimated to be approximately 10,000 tons, but no valuation for the Fusa, Forum, and Ninghi areas is included in this figure.

Blackwater Mines.—This company was formed in 1906 and works a gold mining property in the Reefton district, New Zealand. The report for the year 1930 shows that during the year 41,112 tons of ore was crushed for a recovery of £70,094. Working costs amounted to £60,378, the working profit being £9,716, which, by reason of the gold premium, was increased to £14,154. The net profit for the year was £884, increasing the credit balance brought in to £6,758. The ore reserves at the end of the year were estimated to be 84,660 tons, averaging 9·6 dwt., an increase of 11,160 tons in amount and 0·09 dwt. in value when compared with the previous year.

DIVIDENDS DECLARED

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

Ayer Hitam.—1½d., less tax, payable Sept. 30.

Kramat Pulai.—6d., less tax, payable September 19.

Kramat Tin.—6d., less tax, payable August 31.

Nundydroog.—6d., less tax, payable October 8.

Rawang Tin Fields.—3d., less tax, payable October 16.

Witbank Colliery.—1s., less tax, payable October 3.

NEW REGISTRATION

Goonvean and Rostowrack China Clay.—Registered as a private company August 26. Capital: £50,000 in £100 shares. Objects: To acquire china clay and china stone properties and rights. Directors: Viscount Falmouth and W. F. Cawood. Office: 6, Biddocks Court, St. Austell, Cornwall.