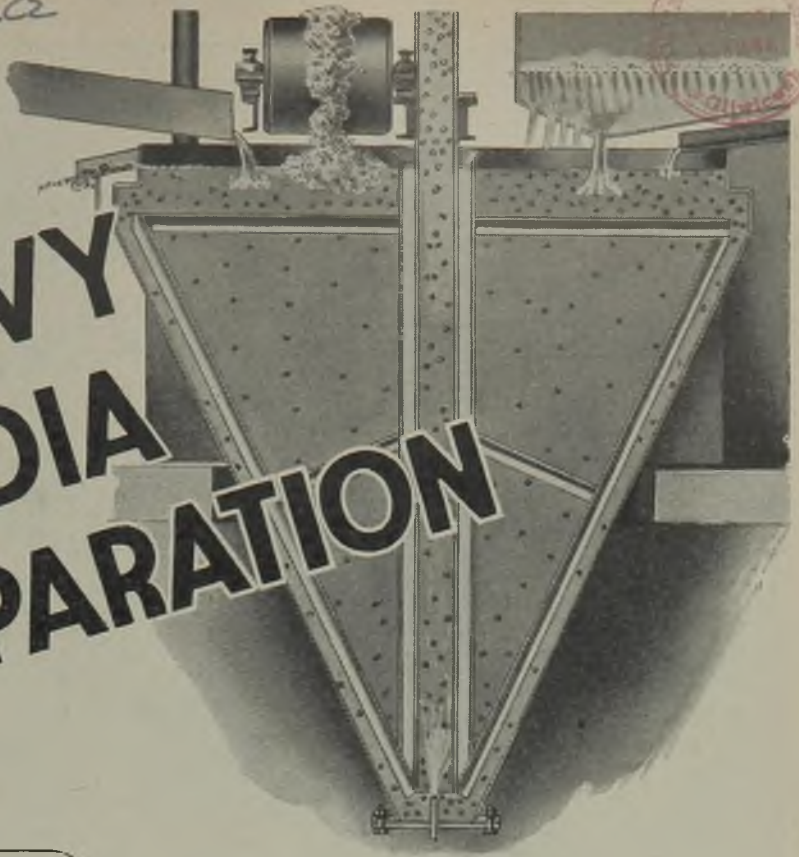
The Mining Magazine

VOL. LXXV. No. 2. LONDON, AUGUST, 1946. PRICE ONE SHILLING



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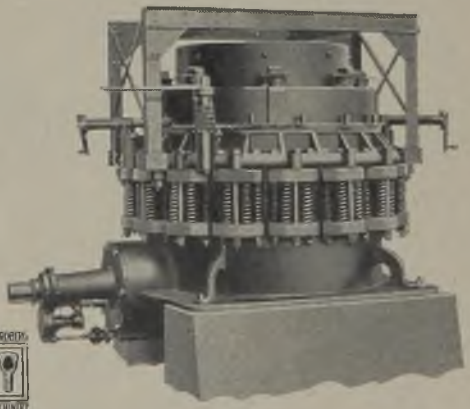

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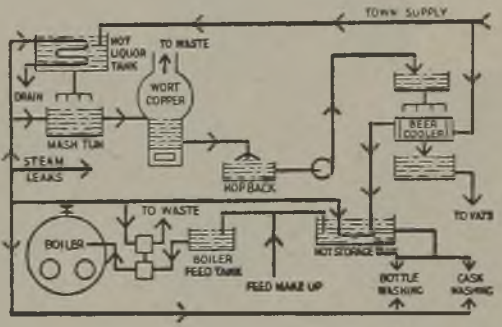
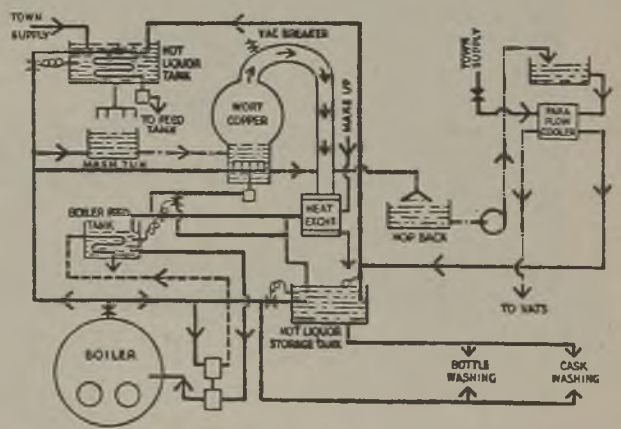
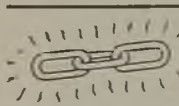
FOR COMPLETE DETAILS SEE "FUEL EFFICIENCY NEWS," JANUARY, 1946.



Before a small brewery used 13 tons of coal weekly to produce 70 barrels per day.



After the same brewery for the same output, consumed only 7 tons per week.



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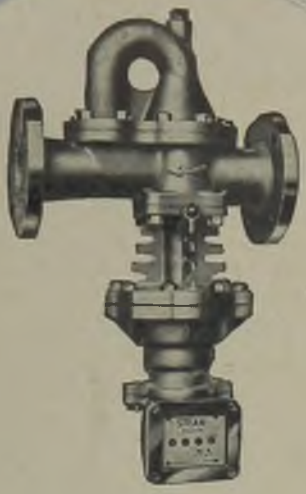

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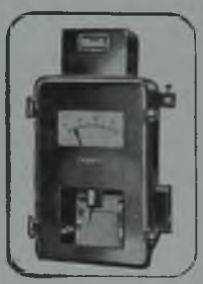

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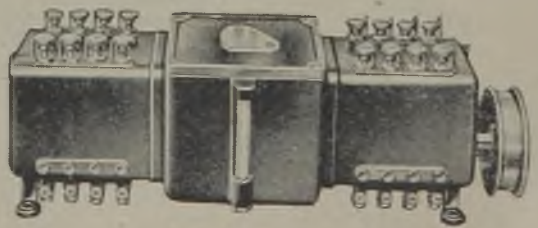

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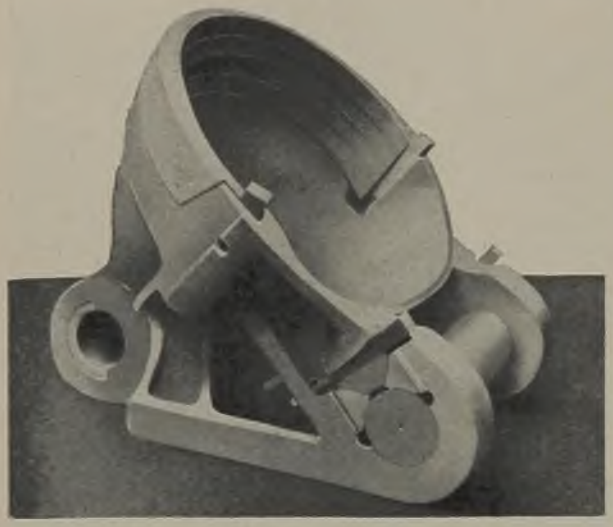
DREDGER GEAR



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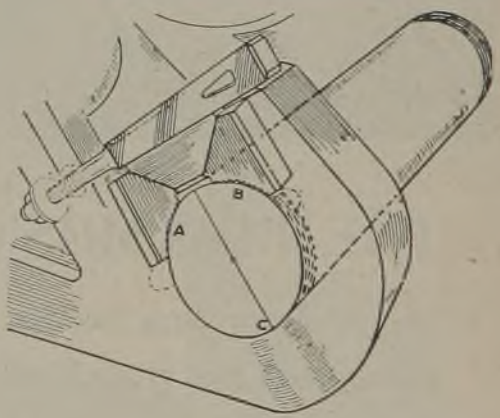

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The Mining Magazine

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CONTENTS

EDITORIAL

THE New Zealand Government announces its intention to enlarge the Otago School of Mines and to augment its equipment, particularly in connexion with plans for the development of its policy of taking over " worth-while " coal mines.

IT was recently announced that the tribunal appointed to determine the " global sum " of compensation to be paid for the assets of the coal industry to be transferred to the National Coal Board under the Coal Industry Nationalization Act of 1946 had issued its award. The amount involved is set at £164,660,000.

SPEAKING at the recent annual general meeting of the Malayan Chamber of Mines held in London the chairman, Mr. A. G. Glenister, said applications for financial aid towards rehabilitation were now being received from operating companies and that they were being examined by the Government. The Chamber had been able to minimize delays in obtaining supplies, but while requests had been dealt with as quickly as possible delay in starting up many of the " A " class dredges was inevitable. A few dredges had been started up and certain hydraulic mines had commenced production on a small scale.

EARLIER this month the London official selling price for silver was raised from 44d. per oz. to 55½d. It will be recalled that the quotation was advanced to 44d. from its war-time level of 25½d. on September 24 last. The new change is directly attributable to the recent increase from 71·11 cents to 90½ cents per oz. in the United States Treasury's buying price for newly-mined domestic silver, which had the effect of raising the price of foreign silver in American markets to 90⅜ cents per oz. The advance in price is thought likely favourably to influence silver mining operations in various parts of the world.

CLAIMS by British owners for the restoration of the control of properties in Yugoslavia are to be dealt with by a Mixed Commission which has been set up in Belgrade. In order to facilitate the work of the United Kingdom representative in presenting and pursuing claims for such restoration a register of British property in Yugoslavia is now being established. It is to be kept in the Trading with the Enemy Department, 24, Kingsway, London, W.C. 2, to which address application should be made for the appropriate forms. Similar registers are also being established for those having rights and interests in Czechoslovakia and Poland, since it is also announced that the Government is now willing to represent such claims to the Governments of those countries.

United Kingdom Mineral Resources

The constitution of the Government Committee of Inquiry into the metalliferous and other mineral resources of this country was announced in the House of Commons earlier this month by the Minister of Fuel and Power. The name of the chairman, Lord Westwood, was given in our July issue. The other members of the committee, which is predominantly technical, are: Mr. T. Balogh (Institute of Statistics, Oxford University), Mr. A. R. Davies (a member of the firm of Messrs. T. C. Horabin and Partners, industrial consultants), Professor W. R. Jones, Mr. L. C. Hill (of the Rio Tinto Company), Professor A. O. Rankine, Professor J. A. S. Ritson, Mr. Stanley Robson (of the Imperial Smelting Corporation), Mr. Tom Steele, M.P., Captain Peter Thorneycroft, M.P., and Mr. R. E. Yeabsley (a member of the firm of Messrs. Hill, Vellacott and Co., chartered accountants). The secretary is Mr. W. C. C. Rose. The committee is to be known as the " Mineral Development Committee " and has been given the following terms of reference: " To inquire into the resources of minerals in the United Kingdom, excepting coal, oil, bedded ironstone, and substances of widespread occurrence; to consider possibilities and means of their co-ordinated, orderly, and economic development in the national interest, and to make recommendations in regard thereto." No notice has yet been given of when the committee is to start work, but it will, no doubt, first have the opportunity of reviewing the evidence collected during the war by the Non-Ferrous Minerals Development Committee appointed by the Minister of Supply, of which Sir William Larke was chairman and Professor

Ritson also a member. Of this earlier committee Mr. T. Eastwood and Dr. M. MacGregor of the Geological Survey were also members and it seems a pity that the Survey is not represented on the body now set up. However, the new Mineral Development Committee is worthily constituted and it is to be hoped that its work may have more effect on the Government's attitude to metalliferous mining than has that of others in the past.

As we have so often pointed out before this country sadly lacks a Government department capable of undertaking the type of work that is carried out by the Bureau of Mines in America. The United States' non-ferrous mining industry is, of course, vastly more important than our own and, as a revenue producer, of more immediate interest to its Government. This country, however, has had past mining history and the output of our mineral fields and the aptitude of British engineers have played no small part in the expansion of mining activities all over the world. At present, with the exception of the surviving Cornish tin industry, there is little that would warrant the formation of an official organization capable of handling urgent operating problems, but from a larger viewpoint we may conceive that our position, at the heart of an Empire, may be such as to warrant at least an examination of such a project. The British Dominions overseas are quite capable of dealing with questions affecting their own mineral industries ; indeed, we might have taken as our mirror Canadian action in this respect instead of the United States Bureau. Britain has, nevertheless, wide interests in overseas mining and many Colonial dependencies looking homeward for support. A central institution here capable of helping them would do much to assure the development and conservation of Imperial mineral resources.

The suggestion thrown out in the previous paragraph may, of course, be thought impracticable. The Minister can, however, do several things to strengthen the hands of institutions already in being. The Geological Survey, for instance, now taking a welcome practical outlook on mineralized areas in this country, might well be provided with the means of carrying out vital exploratory work. A drilling department capable of testing likely areas could not only confirm geological theory but provide tangible evidence of mineral resources, while the ability to run a bulldozer over an outcrop might solve many a structural problem and give valuable aid in assessment work. At the same time we may be permitted to refer once again to the importance of fostering fundamental research in mineral dressing in this country. This can be done directly by suitably equipping and staffing one of the laboratories already in existence. Mineral dressing is rapidly changing to mineral processing and the change is likely to be accelerated as the richer deposits become exhausted and complex and lower-grade bodies achieve new importance as mineral reserves. If the establishment of a central organization is considered out of the question then surely these are two practical steps that the new Committee might with justice recommend. They might, indeed, be the only steps possible at the outset.

British Mining Interests Overseas

Mining companies registered in this country have long felt the need of a representative association able to speak for the industry as a whole and in the MAGAZINE for November last it was noted that such a body was in process of formation. The registration has now been approved by the Board of Trade of the British Overseas Mining Association (B.O.M.A.). As readers will recall, a Mining Taxation Committee was formed in 1942. The results it achieved determined the leaders of the industry to create a permanent organization representative of all overseas mining interests in this country and the present Association is the result.

The activities of the British Overseas Mining Association are intended to cover all metals and minerals mined overseas by companies registered in or directed from this country and one of its prime functions will be to continue to review the question of taxation and to ensure that the benefits of the industry are not lost to this country for any technical, commercial, or political reason, the Association being prepared to work in close consultation with the Government on the strategical aspects involved. It will also interest itself in tariff policies as well as in the compilation of statistics relating to the mining industry. The Association emphasizes its readiness to welcome co-operation with other organizations such as the British Non-Ferrous Metals Federation, the British Non-Ferrous Smelters'

Association, and all associations interested in common problems. It is supported by a majority of mining companies and is an entirely non-technical body. The activities of the Association are not intended to overlap or to compete in any way with those of existing Chambers of Mines in Empire countries. Its primary function is to protect the interests of companies in the United Kingdom operating, managing, or acting as consultants to mines or ancillary plants abroad. The Association believes that it can work in close co-operation with other Empire mining organizations and that it will be able on occasion and when requested to render them assistance in negotiations with the British Government and in various other ways.

The President of the new Association is Lord Geddes and its vice-president is the Hon. R. M. Preston. At an inaugural luncheon held in London on September 29 Lord Geddes indicated the benefits British overseas mining confers on the United Kingdom as being classified in four groups—namely, contribution to employment, the foreign exchange provided, the strategical importance, and the part played in opening new territories and establishing secondary industries therein. He referred in no uncertain terms to the rôle which this country has played in the development, first, of its own mineral deposits and, secondly, of those in many countries overseas. He suggested that the economic significance of metals could not be over-emphasized. Before the war, Lord Geddes said, oversea mining companies provided the United Kingdom by way of exports and dividends returned with one job out of every 85 jobs provided by all other sources of employment. The wasting assets abroad are, indeed, likely to disappear entirely unless foreign owners can be persuaded to come to London for financial and other services. To this extent the industry depends on the goodwill of the Government and it is to ensure this and to serve mineral interests overseas that the new Association has been formed. It deserves the backing of all mining companies operating abroad and the only wonder is that it was not formed long ago.

Nigeria in 1944

According to the Nigerian Mines Department Annual Report for 1944, which has recently become available, the feature of the year was the record export of columbite, which was more than double the best annual figure previously achieved. Throughout the year under review the Ministry of Supply naturally required the maximum possible output of tin ore, the whole of the production going to Britain for smelting, and the Chief Inspector of Mines also reports that a great deal of interest was shown in columbite, which, in Nigeria, is a by-product of tin mining. He notes that the ground mined in the Colony is partly alluvium and partly detritus, derived from two distinct mineralizations associated with an Older and Younger granite respectively. Over 90% of the cassiterite exported from Nigeria, he says, is from mines working in ground derived from the Younger granite and in nearly all these mines columbite is associated with the cassiterite, in some mines in quantities worth recovering. Columbite, like cassiterite, survives through the detrital stage, the report states, into well-sorted and much-concentrated alluvial placers, but in very few paddocks of the "Younger Granite" mines is the weight of columbite in a cubic yard greater than the weight of cassiterite. Through all the price fluctuations of both minerals, however, cassiterite has been more valuable than columbite, so that even the mines which are the chief producers of columbite are essentially tin mines. Mines in the neighbourhood of Kuru in the Jos Division of the Plateau Province produce a columbite which is almost a pure columbic oxide. All Nigerian columbite was sold, it is stated, to one purchaser in the United States. Before the war ore was required to contain not less than 55% combined columbic and tantalic oxides, of which not more than 4% could be tantalic oxide. In the period under review ore should contain not less than 65% combined columbic and tantalic oxides, of which not more than 8% should be tantalic oxide, the combined oxides being paid for as columbic oxide. The average price was 45s. a unit. Often associated with the Older granite are pegmatites and some of these have cassiterite-columbite-tantalite mineralization. The separation of columbite from the sluice-box concentrates depends mainly on its magnetic properties and the increased demand for columbite resulted in large and more powerful magnetic separators being installed. During the second half of 1944 some tantalite was exported. The unrefined gold bullion declared on mineral returns for the year was 8,995 oz.

MONTHLY REVIEW

Introduction.—While the peacemakers have resumed their disputations in Paris, business generally continues to expand, in spite of the worry created by the winter coal outlook. Mine labour is short at the pits, which means that while workers are at a premium there is small improvement in production and coal stocks are approaching a dangerous "low." Much will depend in this country on the weather we experience next January and February.

Transvaal.—The output of gold from the Rand Mines for June was 995,765 oz. and from outside districts 22,778 oz., making a total of 1,018,543 oz. for the month. The number of natives employed in the gold mines at the end of June was 305,822, as compared with 309,190 at the end of the previous month.

In the middle of July the South African Treasury announced that a new agreement had been concluded covering the sale of gold by the South African Reserve Bank to the Bank of England for 1946–7. The agreement, effective as from January 1 last, means that producers are to be paid 172s. 6d. per fine oz.—an increase of 3d. per oz. on the price paid last year.

A recent circular to shareholders of Geldenhuis Deep, Ltd., states that the resolution passed at the extraordinary meeting held in May last, which provided for the reduction of the capital of the Company to £283,334 in 10s. shares and the return to shareholders of 5s. per share in cash, had been confirmed by the Supreme Court of the Union.

Shareholders of the Welgedacht Exploration Company have been informed that it has been decided to take steps to re-open the mine and to erect a plant with a milling capacity of 25,000 tons per month. It is proposed that the funds necessary to meet the capital expenditure involved should be provided by means of an issue of debentures; shareholders are to be advised of the details of the proposals in due course.

In the three months to June 30 last sinking operations were continued at No. 1 shaft of West Driefontein Gold Mining; it had reached a depth of 519 ft. at the end of the period and the erection of the permanent headgear was proceeding. Sinking was also resumed at No. 2 shaft. It is stated that the No. 2 Level drive of the Blyvooruitzicht mine, which it is intended to advance into the West Driefontein mine, was 170 ft. away from the common boundary at the end of the quarter.

The Joint Ore Shaft at Springs Mines and West Springs was sunk 578 ft. to 4,245 ft. in the June quarter. In the same period No. 4 shaft at Daggafontein Mines was deepened 61 ft. to 101 ft., while No. 5 shaft at Brakpan Mines was sunk 68 ft. to its final depth of 3,583 ft. below the collar.

The statements of New Modderfontein Gold Mining and Nourse Mines for the June quarter record the acquisition of new mining rights. New Modderfontein has taken over the undermining rights of approximately 11 partly-worked claims adjoining its western boundary on the Farm Benoni No. 3 for £10,000, while for £3,400 Nourse Mines has acquired the rights of an area of approximately 34 claims adjoining its southern boundary on the Farm Elandsfontein No. 26.

In the three months to June 30 last the circular ventilation shaft at Blyvooruitzicht Gold Mining was sunk to a depth of 274 ft.

Bore-hole S.N. 5 being put down by Sub Nigel, Ltd., on the Kimberley Reef was completed on May 1 at 3,152 ft. The economic zone of the Reef group was traversed between 2,893 ft. and 2,985 ft., but all the reefs cut had negligible gold content.

At June 30 last No. 3 shaft at Vogelstruisbult Gold Mining had reached a depth of 1,824 ft., while No. 4 shaft was down to 1,523 ft.

The reports of Marievale Consolidated and Van Dyk Consolidated for the June quarter both record shaft-sinking advances. In the period No. 5 shaft at Marievale was advanced to 2,482 ft. and No. 5 shaft at Van Dyk had reached a depth of 1,031 ft.

Last month it was announced by West Witwatersrand Areas that in view of the numerous reports to the effect that the next flotation by the company is imminent the directors wish to state that an application for a lease from the Government of the

Union of South Africa of portions of the Farms Doornfontein No. 139 and Varkenslaagte No. 46 was submitted to the Mining Leases Board under date of December 31, 1945. Receipt of the application was duly acknowledged, but no further communications have been received from the board. It is stated that should advice be received that the application has been granted an announcement will be made.

With the recent announcement of the dividend for the year ended June 30 last, shareholders of the Johannesburg Consolidated Investment Company were informed that, subject to audit, the profit for the year before providing for taxation was £1,155,305. It is proposed to place £300,000 to reserve, while £459,533 is required for taxation and £380,187 for the dividend, leaving £15,585 to be carried forward.

In the report for the three months to June 30 last shareholders of Middle Witwatersrand (Western Areas) are informed that a 22½% interest has been acquired in Strathmore Gold Mining, which is to acquire and prospect a block of ground in the Klerksdorp District. Drilling is proceeding, it is stated.

The internal shaft at the Alpine (Barberton) Gold Mine was sunk 133 ft. to the No. 17 level in the six months to June 30 last.

In the June quarter the mill at Rooiberg Minerals Development treated 7,305 short tons of ore and 3,275 short tons of alluvial ground and recovered 125 long tons of tin concentrates. The estimated working profit for the period is given as £6,023.

Amalgamated Collieries of South Africa, Ltd., is holding an extraordinary meeting next month when resolutions are to be proposed to increase the capital of the company to £2,500,000 by the creation of 500,000 new £1 shares. It is proposed to redeem the debenture capital and to provide funds for development.

Apex Mines announced earlier this month that as result of spontaneous combustion underground a fire had broken out in one section of the Middelburg Steam Colliery's workings necessitating sealing off of the area and the abandonment, at least temporarily, of approximately 40,000 tons of coal therein. No material damage had been suffered by any property on the surface and operations on the mine were stated to be continuing normally.

Orange Free State.—New Union Goldfields, Ltd., last month announced the formation of the Union Free State Mining and Finance Corporation, with an initial working capital of £1,000,000, as well as of the first subsidiary of the new Corporation—Free State Gold Areas, Ltd.

Southern Rhodesia.—In the three months ended June 30 last sinking was started on the Redwing shaft at Rezende Mines. The company has called an extraordinary meeting in Salisbury for August 30 when it is to be proposed that the capital be increased to £79,200 by the creation of 264,000 new 1s. shares, of which 188,570 are to be offered to existing shareholders at 5s. per share. The new funds are required for mill expansion and for development work generally. It is stated that after a period of low development returns recent results have proved encouraging.

Northern Rhodesia.—A strike of artisans that broke out on July 16 made it necessary for the operating companies in Northern Rhodesia to cease copper production on July 18. At the time of writing it is hoped that mediation may prevail and that production can soon be resumed.

Gold Coast.—It is announced that the Treasury has now given consent to an issue of 253,125 of Taquah and Abosso Mines 4s. shares at 24s. per share. This capital increase, which was reported in the April issue, is intended to provide finance for plant expansion. It is intended eventually to treat 50,000 tons of ore monthly.

At an extraordinary meeting of South Banket Areas to be held later this month resolutions are to be considered involving a reduction of the capital, splitting the resulting 2s. shares into 1s. units, and thereafter increasing the capital of the company to £900,000 by the creation of 7,733,983 new 1s. shares.

Nigeria.—Lower Bisichi (Nigeria) Tin Mines proposes to reduce its capital by returning paid-up capital no longer required.

Belgian Congo.—The Union Minière du Haut Katanga reports an output of 160,200 metric tons for 1945. Production during the first half of the current year averaged 13,000 tons monthly.

Angola.—The accounts of Companhia de Diamantes de Angola for 1945 show a profit of Esc. 30,458,302, of which Esc. 19,560,000 is required for the dividend of Esc. 12 per share. During the year 1,017,945 cu. metres of ground was dealt with, the diamond

output being 803,887 carats. In the first five months of the current year some 436,627 cu. metres of gravel yielded 326,391 carats.

Kenya.—Shareholders of Rosterman Gold Mines have received a summary of a report by Dr. Stansfield Hitchen, covering the recent encouraging development results obtained on the Quartz Vein Reef on the 19th Level at a vertical depth of 1,740 ft. On the 19th Level quartz of the normal Rosterman "make" has appeared in the vein-channel in increasing amounts and there has been a corresponding improvement in gold content. There are grounds for believing, Dr. Hitchen states, that an ore-shoot may lie immediately beneath the 19th Level. The fault encountered just past the "horse" in E.D. 490′ N. on No. 19 Level is a post-mineralization fault and should not in any way affect the tenor of the ore-vein. In addition, the report goes on to say, recent observations seem to indicate the existence of a series of lesser veins, mainly grouped between Nos. 2 and 3 Footwall reefs, from which it should be possible to derive some high-grade ore.

Australia.—The report of the Zinc Corporation for 1945 shows a profit of £127,378 and an available total of £190,421, of which £31,652 is required for the preference dividends and £87,777 for dividends on the ordinary capital, equal to 2s. 6d. per share. The ore milled during the year was 425,542 tons, of an average grade of 15·2% lead, 3·8 oz. silver, and 11·4% zinc. Lead concentrates produced totalled 81,489 tons, containing 60,346 tons of recoverable lead and 1,514,930 oz. of silver. The zinc concentrates produced amounted to 81,311 tons, of an average assay value of 52·4% zinc. In his statement accompanying the report and accounts the chairman reviews the work of the Corporation in the war years. From 1939 to 1943 the ore mined totalled 3,312,914 tons, some 480,132 tons of lead, 12,007,177 oz. of silver, and 627,593 tons of zinc concentrates being recovered. In the period 771,000 tons of ore was added to the reserves. The chairman says that the Corporation has for a considerable time past carried on an increasingly intensive survey of the possibilities of extending its mining and associated activities. It is preparing a geological and geophysical organization to determine as far as possible the prospects of major additions to the ore resources of the Broken Hill district as a whole.

During 1945 New Broken Hill Consolidated sent 3,468 tons of development ore to the Zinc Corporation mill, where 381 tons of lead concentrates and 604 tons of zinc concentrates were recovered.

The accounts of Mount Isa Mines for the year ended June 30, 1945, now available, show a profit of £126,236. The operations of the company for that year were reviewed by our Melbourne correspondent in the June issue.

Great Boulder Proprietary Gold Mines reports a profit of £93,261 for 1945, the accounts showing an available total of £201,802. A final dividend equal to 12½% has been declared. During the year under review 306,212 dry tons of ore was treated and 71,563 oz. of gold recovered. The ore reserves at December 31 last were estimated to be 2,392,426 tons, averaging 5·3 dwt. in value.

Shareholders of Morning Star (G.M.A.) Mines have been informed that treatment and hoisting were re-started on July 15 last.

With the recent dividend announcement shareholders of Sons of Gwalia, Ltd., were informed that the profit for 1945 was £34,789. The company recently announced that during repair work under No. 2 Plat in the Main Shaft a fall of ground occurred on July 24, which necessitated a stoppage of underground operations. The milling plant ceased on July 25. It was expected that operations would be resumed early in the current month.

New Zealand.—The accounts of Blackwater Mines for 1945 show a profit of £2,368 and a total of £16,048 available, of which £15,000 has been placed to reserve. In the year under review 24,387 tons of ore was treated and 10,314 oz. of gold recovered. The ore reserves at December 31 last were estimated at 78,308 tons, averaging 9·26 dwt. in value.

The Consolidated Gold Fields of New Zealand reports a profit of £1,207 for 1945 and an available total of £16,621. Of this amount £15,000 has been transferred to reserve.

Malaya.—Gopeng Consolidated reports a loss of £870 for the year to September 30 last, the balance brought in being thereby reduced to £34,913.

The accounts of Pengkalen, Ltd., for the year to September 30 last show a loss of £167 and a credit balance of £4,336 carried forward.

Mexico.—San Francisco Mines of Mexico reports an estimated operating surplus of

$785,000, U.S. currency, for the three months ended June 30 last.

Yukon.—The accounts of the Yukon Consolidated Gold Corporation for 1945 show a profit of $105,978. The president, in his address accompanying the report and accounts, states that production for the year was $918,441·82, obtained from the operation of Dredges Nos. 3 (Klondyke Valley), 7 (Quartz Creek), and 11 (Hunker Creek). The yardage mined by the dredges in 1945 was 2,682,743 cu. yd. at a cost of 21·79 cents per cu. yd. Stripping plants were operated at Nos. 7 (Quartz Creek), 8 (Middle Sulphur), 10 (Dominion Creek), and 11 (Hunker Creek). A total of 1,038,110 cu. yd. of muck was removed at a cost of $96,923·82, or 9·33 cents per cu. yd. Labour could be found for only two thawing plants—at Nos. 7 and 11. A total of 477,054 cu. yd. was thawed at a cost of 7·97 cents per cu. yd. No thawing was done in 1944. Plans for the current season call for the operation of Dredges Nos. 3, 4, 8, 10, and 11 for the whole season and No. 7 for part of the season. Stripping will be carried on at the areas of Nos. 6, 7, 8, 9, 10, and 11, and thawing at Nos. 6, 7, 8, 10, and 11. An order is to be placed for a new dredge to replace No. 5 which was destroyed by a fire caused by lightning in July, 1943. It is hoped to have the new dredge constructed before the end of the season of 1947. A lease has been given to Yukon Alluvial Golds, Ltd., on the 144 claims owned by this company on Henderson Creek, a tributary of the Yukon River entering below the Stewart River. The Corporation is to receive 10% of the gross recoveries, *plus* the return of $34,459·58 expended in prospecting and development work.

Spain.—Esperanza Copper and Sulphur reports a profit of £1,211 for 1945 and a credit balance of £6,624 carried forward. A scheme of arrangement between the company and its debenture holders was recently sanctioned by the Court, which confirmed a reduction of capital from £350,000 to £87,500.

Exploration Company.—The report of the Exploration Company for 1945 shows a profit of £8,540. After making all the adjustments sanctioned by the recent re-organization the debit balance brought in is reduced to £6,056. The chairman of the company, in his statement accompanying the report and accounts, reports the acquisition of new interests in West Africa and says that the subsidiary company (South American Exploration Co.) hopes to commence gold production in Nigeria on a modest scale in the current year.

Mining Trust.—The accounts of the Mining Trust, Ltd., for 1945 show a surplus of £43,140 income over expenditure, after charging £47,363 for Income Tax and National Defence Contribution. The debit balance brought in was thereby reduced to £492,172. In his statement accompanying his report and accounts the chairman refers to the question of re-organizing the capital of the company, suggesting that consideration of this matter should await a clarification of the earning capacity of Mount Isa Mines, which is resuming the production of lead-silver bullion.

Tanami Gold Mining Syndicate.—The report of the Tanami Gold Mining Syndicate for 1945 shows a profit of £7,769, which reduced the debit balance brought in to £7,107. The chairman, in his statement accompanying the report and accounts states that as a result of a report by Dr. Stansfield Hitchen the Syndicate had decided to take up additional capital in the subsidiary company (the Borderland Syndicate, Ltd.) and to help in financing a programme of exploration.

NEW COMPANY REGISTERED

Anglo-Iberian Mining and Trading.—*Capital :* £100 in £1 shares.

DIVIDENDS DECLARED

* Interim. † Final.

(Less Tax unless otherwise stated.)

***African and European Investment.**—2½%, payable Sept. 17.

***Ashanti Goldfields Corporation.**—27½%, payable Sept. 19.

***Bibiani (1927).**—5%, payable Sept. 19.

***Cerro de Pasco Corporation.**—50 cents.

†**Charterland and General.**—10%, payable Aug. 17.

†**Ferreira Estate.**—1s., payable Sept. 12.

†**Filani (Nigeria).**—6¼%, free of tax, payable Aug. 3.

†**Glynn's Lydenburg.**—2s., payable Sept. 12.

***International Nickel.**—40 cents, payable Sept. 30.

†**Johannesburg Consolidated Investment.**—3s. 6d., payable Sept. 11.

***McIntyre Porcupine.**—55½ cents, payable Sept. 3.

***Morning Star (G.M.A.) Mines.**—6d. (Aust.), payable Aug. 23.

***Mount Morgan.**—Pref. 3½%, payable Aug. 15.

†**Northern Rhodesia Co.**—7½%, payable Aug. 3.

†**Sons of Gwalia.**—1s. 3d., payable Sept. 11.

***Victoria Gold Dredging.**—1s. (Aust.), payable Aug. 28.

†**Willoughby's Consolidated.**—3½d., payable Aug. 1.

†**Zaaiplaats Tin.**—12½%, payable Sept. 13.

†**Zinc Investments.**—2½%, payable Aug. 16.

Venezuela—The Venezuelan Andes and the Coastal and Interior Ranges

By John C. Davey, A.C.S.M., M.Inst.M.M.

A seventh article on the resources of this South American country.

Introduction

The Venezuelan Andes chain is a spur of the great Andean mountain system that parallels the western seaboard of South America. Just north of the common boundary between the republics of Ecuador and Colombia the main Cordillera de los Andes splits into three branches—*viz.* :—(1) The Cordillera Occidental, or Western Range ; (2) the Cordillera Central, or Central Range, and (3) the Cordillera Oriental, or Eastern Range. The last-named, sometimes called the Cordillera de Bogotá, continues its north-easterly trend from the region of Pasto to Pamplona, whence it follows a northerly course for about 300 miles and terminates in the lowlands of the Guajira Peninsula. In the vicinity of Pamplona a north-easterly spur extends into Venezuela, forming the Cordillera de los Andes of that country. Thus, these two branches of the main Cordillera Oriental form a Vee-shaped mountain barrier within which lies Lake Maracaibo Basin. The Cordillera Oriental is known in Venezuelan territory as the Sierra de Perija and is further sub-divided into a southern and northern sector—named, respectively, Serrania de los Motilones and Serrania de Valledupar. The Sierra de Perijá is a rugged mountain mass with several peaks reaching 8,000 ft. to 9,000 ft. above sea-level, the greater part of which region is uninhabited and there is no well-defined trail into it either from the Colombian or Venezuelan foot-hills. Some fierce Indians of the Motilone tribe inhabit the southern ranges and often make raids on settlements and temporary oil-camps situated close to the foot-hills.

The Venezuelan Cordillera de los Andes extends from the State of Tachira through Merida and Trujillo, where it reaches its maximum height and then descends to less than 3,000 ft. some eight miles south-west of the town of Barquisimeto, in the State of Lara. Further to the north-east the valley of the Yaracuy River forms a gap, probably in a fault plane, between the north-easterly trending Western Andes Range and its extension eastwards along the north coast of Venezuela. This mountainous province covers an area of some 61,140 square kilometres, or only 7% of all Venezuelan territory, although it contains more than 50% of the total population. A great part of the country's principal agricultural products come from the Andean hills and the whole province is essentially agricultural.

The Andean mountain chain in Venezuela has been subdivided into the following units :—

(1) The Western Venezuelan Andes or Cordillera de los Andes.

(2) The Coastal or Caribbean Range, also named La Cordillera de la Costa, La Cadena del Litoral, or La Cordillera Costañera, which sub-division also includes the smaller, parallel ranges of the Serrania del Interior, or Interior Range.

(3) The Eastern Coast Range, La Cadena del Norte, or Serrania de la Costa, comprising the Peninsulas of Araya and Paria and the eastern extension of the Serrania del Interior.

Historical

In pre-Colombian times the Venezuelan Andes were occupied by numerous tribes of Indians, which have long since been absorbed by the march of civilization. Little is left to-day of their primitive culture, but as tribes they are remembered in numerous place and river names—su h as, Timotes, Uribantes, Chama, Capacho, Tariba, Cuica, etc. Each tribe was ruled by a *cacique* and both he and his people were much influenced by the *piache*, or priest, and medicine-man. Following the expulsion of the Welsers from Venezuela in 1556 the Spanish conquistadores arrived to continue the search for mineral wealth. The towns of Barquisimeto, Tocuyo, and Valencia had already been founded and some gold mines located at Buria (1551). Disappointed by the absence of large gold deposits, many of the Spaniards asked for, and obtained, grants of land extending into the Andes, where the climate was mild and healthy. Merida was founded in 1558, San Cristobal in 1561, La Grita in 1576, and Pedraza in 1591. The Venezuelan Andes were settled with comparatively little opposi-

tion from the Indians, many of whom retreated into Colombian territory and into the trackless forests of the Sierra de Perijá, where some tribes, especially the Motilones, continued to attack foreign settlers until 1800.

The Andinoa rarely left their mountains to work in the hot paludal plains and lowlands and the *llanero* and other inhabitants of the hot coastal valleys and towns dreaded the cold air and winds (*parameos*) of the high Andean ranges. Thus the Andinos developed a more pure-blooded strain, were hardy and self-reliant, with bodies free from malaria fever, but subject to pneumonia and other bronchial troubles. As a result they dominated the country for many years in politics and military might. The Andino generally has a pleasant disposition, is polite, and as a servant is very loyal to his employer.

(1) The Western Venezuelan Andes Physiography

This section of the Andean chain, some 220 miles long and averaging a little less than 60 miles wide, extends from the State of Tachira through the States of Merida and Trujillo and disappears under thick sediments in the south-eastern sector of the State of Lara. The western part of the State of Tachira occupies what is known as the Tachira Depression and it is only in the northern part of this State that the Venezuelan Andes become prominent. The most important peaks are the Paramos of Batallon (10,528 ft.), between the towns of La Grita and Pregonero, Las Agrias (10,006 ft.) between Vargas and Sucre, and El Zumbador (9,046 ft.), between Vargas and Cordero (see map No. 9). In the State of Merida it is divided into two roughly-parallel ranges by the valleys of the rios Chama and Mucuties in the central part and by the Rio Motatán in the north-western. The southern unit includes the Cordillera de Merida and the Serrania Negra.

These ranges have their highest points in certain "massifs," including the Sierra Nevada, south-east of Merida, and the Sierra de Santo Domingo, north-east of that town. To the north of the Rio Chama is the Sierra del Norte, or La Culata, and the Mucuruba, Conejos, Capaz, and Avispa "massifs," while west of the towns of Bailadores and Tovar is the Tovar "massif," or Cordillera de Tovar. These deeply-dissected mountain masses meet in high plateaux or peaks, called locally *paramos*. The highest peaks, are found in the Sierra Nevada, the Sierra de Santo Domingo, and the Sierra del Norte and include the Pico Bolivar (16,423 ft.), Pico La Columna (16,406 ft.), Pico Humboldt (16,210 ft.), La Concha (16,144 ft.), Paramo Piedras Blancas (15,619 ft.), and several others more than 13,000 ft. above sea-level. The perpetual snow line is located about 15,000 ft. above sea-level, but occasionally snow is seen as low as 13,000 ft.

On the borders of the State of Trujillo the Andes split into three branches. The Sierra

Fig. 28.—Andinos near the Paramo of Muchuchies, State of Merida : Elevation 11,500 ft.


LAGO DE MARACAIBO
ZULIA
TRUJILLO
MERIDA
TACHIRA
COLOMBIA
CORDILLERA DE LOS ANDES
Encontrados
Palmira
San Carlos
Sta Barbara
El Vigia
Chiguara
Lagunillas
Ejido
MERIDA
Mucuchies
Mucuchachi
Pregonero
San Cristobal
Rubio
La Fria
Cucuta
Colon
San Antonio
Bailadores
Tovar
Sta Ana
Sto Domingo
Pta Piedra
Otopion
Sta Barbara
Betijoque
Sab de Mendoza
Motatan
Carache
Escuque
Mendoza
La Puerta
Timotes
La Quebrada
Bocono
Biscucuy
Barinitas
Barinas
Pedraza
Guanare
Ospino
Scale
The Western Venezuelan Andes
Including The
States of Tachira, Merida & Trujillo
State Boundaries
International Boundaries
Approximate +200 metre Contour
Mineral Deposits
Airports
Trails
Roads
Rivers
Railways
State Capitals
Towns

del Norte swings some 30° to the north and finally disappears under the sediments of the Lake Maracaibo basin. A central branch, the Cordillera de Trujillo, extends north-eastwards into the State of Lara. It has several notable peaks—such as, La Teta de Niquitao (13,140 ft.) and the Paramo de Cendé (11,978 ft.). A southern range is split by the valley of the Rio Bocono and its south-western half is known as Ramal de Calderas and the northern as Ramal del Rosario. Each has one prominent peak—the former the Paramo Guirigay (12,792 ft.) and the latter the Paramo Rosario (10,249 ft.). The Paramo de Cendé marks a point on the boundary between the States of Trujillo and Lara and from this peak the Andean chain is split into two branches. One follows a northerly trend, forming the Sierra de Barbacoas and the other an irregular north-easterly branch, forming the Sierra de Portuguesa. The first extends due north at an elevation of over 9,000 ft. for a distance of about 15 miles and amongst the prominent peaks in it are the Paramo Las Rosas (10,643 ft.), Paramo La Nariz (9,715 ft.), and Paramo Los Nepes (9,479 ft.). The Sierra de Portuguesa peaks are somewhat lower and the following are the most prominent :—Alto de Baramito, 7,367 ft., and Alto de los Guedes, 7,183 ft.

Glaciers and Glaciation

Only the highest parts of the Sierra de Nevada are now occupied by glaciers, although there is evidence that these and others once extended to lower levels. At least 10 small glaciers have been identified and named, but very little is known of them beyond the fact of their existence (1).[1] Evidence of a more widespread glacial covering is seen in several U-shaped valleys, roches moutonnées, and small lakes of glacial origin. The latter include the Laguna de Gallo, west of Pico Bolivar, the Laguna de Chorro, south-east of Pico Bonpland, the Laguna Grande of Paramo Santo Domingo, an unnamed lake below the Paramo Negra, etc.

Alluvial Terraces or " Mesas "

These form a very striking physiographic and morphological feature of the Western Venezuelan Andes, although they have received very little attention from geologists, at least to the extent that little or nothing has been published about them. Many of the towns in the states of Trujillo, Merida, and Tachira are built on these *mesas* and amongst the more important are Tovar, La Grita, Merida, San Cristobal Timotes, Bailadores, and Lobatera. In the foot-hills, especially on the south-east flank of the Andes between Ciudad Bolivia and Ospino, there is a zone of alluvial terraces varying in width from several kilometres, south-west of Guanare, to practically nothing near Ospino (State of Portuguesa).

[1] Figures in parenthesis refer to bibliography given at the end of this article.

Fig. 29.—Looking towards Valera from the Mesa Carvajal, State of Trujillo.

Fig. 30.—Mesas near Timotes.

The following personal observations may serve to illustrate the extent of these mesas in the above-named Andean States. Proceeding towards Valera (State of Trujillo) from Pampan through La Concepcion one crosses the Mesa Carvajal on which the Valera air-port is situated. This is a flat alluvial plain some 2,160 ft. above sea-level and its steep western side faces the Motatán River. From its top at Carvajal village, to the level of the river bed at its foot (1,460 ft.), there are five terraces at different levels, including a very minor one in process of formation.

Alluvial terraces are also evident between Motatán and Valera and in the Jimenez River valley south of Pampan (State of Trujillo), where some exceed 190 ft. in height at various points and have the appearance of having been deposited as lacustrine sediments.

Continuing from Valera to Timotes (State of Merida) the road closely follows the Rio Motatán and near the latter town, which is built on an extensive mesa, the alluvial terraces are again very prominent in this valley. At Timotes the river passes close to the eastern limits of the town and is encroaching on the built-up area. During June, 1943, a heavy rain caused the river to

Fig. 31.—Gravel Terraces at Timotes, State of Merida.

Fig. 32.—Series of Alluvial Terraces near Bailadores, Merida.

rise 12 ft. in eight hours and undercut its western bank, close to the town, causing the destruction of several houses (Figs. 30 and 31).

Above Timotes there are several tributary rivers entering the Rio Motatán almost at right angles to its course. These are building up alluvial fans and erosion by the Rio Motatán is causing the formation of benches at their mouths and creating additional problems for the State road engineers. Proceeding towards Merida from Timotes the main Andean Highway climbs steeply up to the Paramo de Mucuchíes (13,500 ft.), which is a spur of the Cordillera del Norte and forms the divide between the valley of the Rio Motatán and that of the Rio Chama.

Alluvial terraces are again very prominent as Merida is approached and this town is situated on a *mesa* some 10 miles long by nearly two miles wide, at an elevation of 5,380 ft. above sea-level. From Merida down to Estanques (elevation 1,450 ft.), a distance of 45 miles, the main highway follows closely the Rio Chama and terraces are in evidence for the greater part of this distance. Between Estanques and Tovar (14 miles) the road follows the Rio Mucuties and here there is less evidence of alluvial terraces, but before entering Tovar (elevation 3,120 ft.) they appear again and the largest single terrace has a height of approximately 320 ft. On the outskirts of Tovar the terraces reach an altitude of 3,575 ft. above sea-level, on the Mesa of La Playa, elevation 4,460 ft., and on the Agua Azul Mesa, elevation 5,478 ft.

In the neighbourhood of Bailadores there are typical examples of terraces in the main valley and large alluvial cones at the mouth of the transverse valleys. (Figs. 32 and 33.)

Proceeding from Bailadores towards La Grita (State of Tachira) there are alluvial terraces up to a maximum elevation of 8,530 ft. above sea-level and the top of the Paramo La Negra is only 1,640 ft. higher. The town of La Grita is also built on an alluvial bench at an elevation of about 4,723 ft.

The town of Pregonero, on the banks of the Rio Uribante, is also on an alluvial bench at an altitude of 4,140 ft. above sea-level, as well as several others that do not merit special mention here. The alluvial terraces on the south-eastern flank of the Andes have already been mentioned briefly in a previous article on the Western Llanos and the villages of Los Nevados and Cavacas are built on such terraces. Thus, in the inner valleys of the Western Venezuelan Andes there is a vertical distance of at least 7,400 ft. between the altitude of the highest alluvial terrace and the lowest and, if the low terraces on the outer flanks of the Andean range are included, there is a maximum difference of 7,870 ft.

These terraces, benches, or mesas appear to have been formed in two different ways, either as the result of :

(1) The cutting down of alluvial cones by the action of major rivers with a course normal to the transverse streams, or by

(2) erosion, by the principal existing

Fig. 33.— Typical Terraces in the Rio Chama Valley.

younger rivers, of the alluvial material deposited in old lagoon, or lake, beds formed as a result of narrow valleys being temporarily blocked.

There is a good example of the last-named seen from the road between La Grita and Bailadores. At El Cerrito there is an alluvial bench across the valley forming a dam at an elevation of about 8,036 ft. above sea-level. On the far side of this barrier is the source of the Rio Escalante and the head of the Pueblo Hondo valley. A closer study and more accurate recording of the individual heights of benches and their altitude above sea-level would provide extremely valuable information on the extent of the uplift of this section of the Andean chain and past glacial action.

Drainage and Features

Numerous fast-flowing streams have their source in the flanks of the Western Andes and a few are harnessed to hydro-electric power plants. There are two main drainage systems: (1) The north-west trending rivers that have their source in the north-west flank of the Andes and empty their waters into Lake Maracaibo basin. These include the Rios Motatán, Zulia, Escalante, Torondoy, Chimomó, Capaz, and Chama.

Table 35

	Elevation Above Sea-Level. Ft.	*Mean Av. Annual Rainfall, in.*	*Av. No. Rainy days per Annum.*	*Mean Annual Av. Temp., ° F.*	*Relative Humidity %*
(1) *Estado Tachira*					
San Cristobal	2,706	57·8	124	71·2	87·0
Rubio	2,870	44·0	106	68·0	80·0
Pueblo Hondo	6,960	58·0	—	—	—
Campo Elias	3,556	96·9	—	—	—
Doradas	656	243·8	—	—	—
(2) *State of Merida*					
Merida	5,487	71·7	190	66·7	78·0
Timotes	6,642	46·4	—	—	—
Páramo de Mucuchies	13,845	26·6	—	—	—
(3) *Estado Trujillo*					
Trujillo	2,591	35·5	93	77° F.	—
Valera	1,794	49·2	—	—	—
Boconó	4,018	42·3	92	—	—
Motatán	1,115	40·6	—	—	—
(4) *Estado Lara*					
El Tocuyo	2,040	15·4 [1]	—	—	—

[1] 11 months (Jan.–Nov.).

(2) The south-east trending rivers that have their origin in the south-east flank of the Andean mountains and form tributaries of the Rio Apure, which flows into the Rio Orinoco. The most important include the Rios Portuguesa, Guanare, Boconó, Santo Domingo, Caparo, Masparro, Paguey, and Mucuchachi.

Climate

Because of the great range in altitude from 1,115 ft. at Motatán to 16,423 ft. on the Pico Bolivar, there is naturally a great variation in the climate of the Western Andes. The climatic zones, or belts, have been divided by Dr. H. Pittier into :—

(1) Tropical, or Hot Zone (" The Tierra Caliente " of the Venezuelans). From sea-level to 1,000 metres (3,280 ft.) with an average annual temperature of 27° C. to 28° C. and extremes 36° C. to 15° C., or 80·6° F. to 82·4° F. and 96·8° F. to 59° F., respectively.

(2) Sub-tropical or Temperate Zone, (" Tierra Templada "), between 1,000 and 2,800 metres (9,184 ft.). Mean annual temperature 12° C. to 20° C. (53·6° F. to 68° F.).

(3) Sub-Alpine, or Cold Zone, (" Tierra Fria ") from 2,800 metres to 3,800 metres (12,404 ft.) mean annual temperature 11° C. to 5° C., (51·8° F. to 41·0° F.).

(4) The Frost Belt, or Zone of the Paramos (" Tierra Gelida " of Pittier) between 3,800 metres and 5,000 metres (16,400 ft.). Mean annual temperature 0° C. to 5° C. (32° F. to 41·0° F.).

Unfortunately there are very few meteorological stations in the Venezuelan Andes, but the data given in Table 35 will give some idea of the climate in three of the zones mentioned (2 and 3).

Temperature.—The mean annual temperatures vary from 82·0° F. in the lowest parts of the Andes to 41·0° F. on the " paramos." The diurnal variation is often great and this is especially so in the vertical zones between 6,500 ft. and 12,000 ft.

Rainfall.—All the region occupied by the Western Venezeulan Andes has sufficient rainfall to meet the needs of the people and all agricultural requirements throughout the year. Omitting El Tocuyo, which is actually not in the Andean mountain chain, the average annual rainfall varies from 39·37 in. to 96·89 in. The driest months are November, December, January, and February and those of heaviest precipitation are April, May, June, and October. The heavy rains begin in Tachira during March and in the other States during April and May.

Trujillo is different to the other Andean stations in that the driest months are February, June, July, November, and December and the wettest January, then March, April, and October. There is no record of the rainfall in the vicinity of Lagunillas (State of Merida), but from this town westwards to Estanques, a distance of some 20 miles, there is a very arid region in which little else but cacti and acacias grow and the precipitation is probably less than 30 in. per annum. In the southern parts of the States of Tachira and Merida and Trujillo there is usually a short dry period in June or July known locally as " veranito de San Juan."

Humidity.—There is a considerable range in the degree of humidity, as might be expected in a region with such extreme differences in elevation and vegetation. Precise data are lacking, but it can be said that the greatest degree of humidity is experienced in the south-western and southern parts of the State of Tachira and that on the Páramos the humidity is always high. The only exact information available is that given in Table 35.

Economic Geography

The Western Venezuelan Andes is an important economic unit and on account of the comparatively good climatic conditions it constitutes, next to the Cordillera de la Costa, the most densely populated region of Venezuela.

Population.—The greater part of the States of Tachira, Merida, and Trujillo lie within this physiographic province and Table 36 gives the relative areas and populations according to the last census (1941).

Table 36

State.	*Area in* Km_2	*Population.*	*Population Density Persons/km².*
(1) Tachira	11,100	245,722	22·13
(2) Merida	11,300	192,994	17·07
(3) Trujillo	7,400	264,270	35·71
Totals & Av.	29,800	702,986	23·59

The State of Tachira is an important agricultural area and in addition, because it is adjacent to the Republic of Colombia, it is a depôt for considerable international commerce. The population of the principal towns

is shown in Table 37 with the names of their respective Districts. Other towns with more

Table 37

Town.	*Population.*	*District.*
(1) San Cristobal (capital)	31,447	San Cristobal
(2) Rubio	5,778	Junin
(3) San Antonio	4,943	Bolivar
(4) Tariba	4,734	Cardenas
(5) San Juan de Colon	4,118	Ayacucho
(6) La Grita	3,918	Jauregui
(7) Independencia	2,122	Capacho
(8) Pregonero	1,671	Uribante
(9) Lobatera	804	Lobatera

than 1,000 inhabitants include :—Santa Ana (1,850), Ureña (1,658), Michelena (1,149), and Seboruco (1,015).

The State of Merida, with a slightly larger area than Tachira, has a much smaller population (Table 38) due partly to its greater area of uninhabited high altitudes and also as the result of the toll of erosion at lower levels and the greater lack of communications, especially motor roads. Other towns

Table 38

Towns.	*Population.*	*District.*
(1) Merida (capital)	4,544	Libertador
(2) Tovar	4,173	Tovar
(3) Ejido	2,719	Campo Elias
(4) Timotes	1,775	Miranda
(5) Lagunillas	1,160	Sucre
(6) Mucuchies	610	Rangel
(7) Bailadores	434	Rivas Davila
(8) Torondoy	167	Justo Briceño

of local importance are Santa Cruz (1,839) and Palmarito (579).

Of the three Western Andes States Trujillo is the smallest but has by far the largest population. Its principal towns are shown in Table 39. Some other towns of local importance are Sabana Grande (1,909), Motatán (1,888), and Sabana de Mendoza (1,598).

Table 39

Town.	*Population.*	*District.*
(1) Valera	10,553	Valera
(2) Trujillo (capital)	6,954	Trujillo
(3) Bocono	4,181	Bocono
(4) Betijoque	3,419	Betijoque
(5) Escuque	2,196	Escuque
(6) Pampanito	2,158	Trujillo
(7) Corache	2,010	Corache
(8) Pampan	1,969	Trujillo
(9) Jajo	791	Urdaneta

Health.—The people of the Andes are generally short and stocky, fair-skinned and ruddy complexioned in marked contrast to the darker, taller, and generally thinner inhabitants of the lowlands. There is less miscegenation and the present inhabitants of these three States are mostly descended from indigenous tribes of Indians and Spanish settlers. Amongst the common diseases and sicknesses of this region are tuberculosis, nefritis, pneumonia, diarrhœa, and cancer. The percentage of ankylostomasis in the States of Tachira and Trujillo is high, but for some unknown reason it is much lower in the State of Merida.

The Andino engaged in agricultural pursuits is very hard working and generally is paid a much smaller wage than his fellow countrymen in the coastal belt and in the Lake Maracaibo oil-camps.

Labour.—It is possible to obtain the services of guides, or "Baquianos," and a few labourers in the Western Andes, but much more difficult to recruit a labour force for any new industry unless considerably higher than normal wage rates are offered. In the coffee season labour has to be temporarily imported from Colombia for collecting this important bean. The Andean labourer is essentially an agriculturist and a hard worker and seems to prefer this open-air life to any indoor occupation or the more exacting work of a miner or navvy.

Agriculture and Industry

The principal agricultural products are coffee, cacao, corn (maize), wheat, sugar, tobacco, potatoes, onions, plantains, and garlic. Most of the land is split up into small parcels or lots and between 20% and 30% of the surface of these Andean states is under cultivation. A large percentage of the remainder is on mountain slopes too steep or too arid and eroded to be of any agricultural use. (Fig. 35.)

The State of Tachira has the largest coffee production of all the Venezuelan States, while Trujillo, Lara, and Merida occupy second, third, and fourth places respectively. The production of cacao is now very small and in Tachira has given way mainly to the cultivation of rice, of which it is the largest producer in the country. Trujillo is the eighth largest producer of corn (maize) and Merida and Tachira eleventh and twelfth respectively. Much sugar-cane is grown in the lower parts of the Andes and Tachira is the country's fourth largest producer, with Trujillo and Merida also leading producers.

Fig. 34.—View of the Sierra del Norte from the Town of Merida.

It may be of interest to record observations made on the maximum elevations at which some of the above crops are cultivated :— Potatoes are found up to 11,650 ft., wheat and corn (maize) up to 11,360 ft. above sea-level, peas up to 7,600 ft., sugar-cane up to 6,560 ft. and onions, garlic, parsnips, cabbages, and platanos up to 5,248 ft. Generally coffee, bananas, and tobacco are grown below an elevation of 4,270 ft. The highest level of tree growth is about 12,000 ft. and there are no inhabited places above 11,740 ft. Most of the agricultural products are consumed in the country, but the coffee bean is exported through the ports of Maracaibo and Puerto Cabello.

Timber.—The northern slopes of the Western Andes are very heavily wooded and extend from an altitude of about 8,000 ft. down to the rain forests of Lake Maracaibo Basin. The south-eastern portion of Tachira is also heavily wooded, but on account of

Fig. 35.—Serious Effects of Uncontrolled Erosion, State of Merida.

poor communications the good timbers have been little used for commercial purposes. Usually between 6,700 ft. and 8,200 ft. there is a thick growth of first-class sub-tropical trees and the principal varieties of timber include, caoba, cedro, jabillo, vero, zapatero, roble, cartán, and pardillo. In Southern Lara, near the borders of Trujillo, the following trees are more common :—Alcornoque, algarrobo, camito, macanilla, cartán, and cedro.

Some cattle are raised in Tachira, but many more are fattened after arrival from the Western Llanos before passing into Colombia. There are no heavy industries in these States, but there are a few light industries such as sugar-mills, metal workshops, hat and cigarette factories, power plants, etc. Mining and quarrying on a very small scale has been confined to the production of mica, and limestone for lime making and road metal.

(To be concluded)

An Escape Tunnel in Germany

By D. J. Rogers, A.R.S.M., B.Sc.(Eng.), M.Inst.M.M.

An account of a project that failed.

Introduction

The tunnel described here will contribute very little to the technical side of mining, but it is a record of the sort of job which was going on in Germany in the Prisoner of War camps. It is only one of hundreds, no better and no worse—variations of one theme—to get back to England. In one camp alone it is believed no less than 35 tunnels were going at one time and in about the 18 months of the camp's existence there were no less than 63 made. These figures may not be exact, but they are near enough. As for the proportion of successful projects ; it was very small. The tunnel was slow and arduous, often dangerous, and the time it took to drive it increased the chances of it being discovered. It had one tremendous advantage over most methods of escape, however. If it " broke " a considerable number of people could be pushed out ; many without a chance, owing to lack of enough rations or enough home-made compasses or all the other paraphernalia, but often a chosen and lucky few made the grade and all the failures made the success worthwhile.

Here a word might be said of the fellows in the camp who backed up the escape. Those who made the clothes, traced and drew maps, and did a thousand jobs in support, without thought of reward or having a chance themselves. For every man who got home there were a score who helped and who stayed behind to help others.

At the time that this particular tunnel was made the initial discomforts of P.O.W. life were just beginning to be alleviated. The first three or four months after May, 1940, represented the lowest ebb. Red Cross food was a mere trickle. German rations were inadequate and the big field was scoured for dandelion leaves as a supplement to the meagre diet. The potatoes supplied by the Germans were rotten in the literal sense, but they insisted that all the old stocks should be eaten before new would be introduced. A miscalculation on the part of the German Quartermaster had created a large stock of bread in the camp and this had gone mouldy. In some cases 25% of one's daily bread ration was absolutely green and, even for the prisoners, quite inedible. As an indication of the state to which the prisoners were reduced, the average pulse rate had dropped to below 50 and in some cases below 40, compared with the normal 78 ; purely as a result of starvation. Almost the only thought in one's mind was food and there were many who thought back regretfully on wasted food. One officer in the camp constantly bemoaned the fact that on the morning of capture he had thrown his eggs and bacon out of a window as he couldn't face them in the cold light of morning. All this shortage had come at a time when food was desperately needed. For all the officers had been deliberately marched up to 200 miles after capture by the Germans on practically no food in order to reduce the desire to escape.

The food supplied was bulky—soup and potatoes—and the stomach swelled with its load. The difficulties of negotiating a swollen stomach in the narrow workings of a tunnel

are manifold. In addition, there were practically no books in the camp, few recreations except lectures which had been organized, and there were practically no cigarettes ; every weed and plant that grew in the camp had been tried in pipes or rolled up in paper as substitutes for tobacco. It is against the background of a slow emergence from these conditions that the following pages should be read.

General Description

This particular tunnel was started in September, 1940, under the stage of a theatre. The theatre was a typical drill-hall, with stage at one end. It lay as a detached building on the southerly side of the barrack-like building which had once been the summer palace of the Archbishop of Salzburg, but those who lived in it in the 20th century could hardly believe that it had ever been luxurious. The sketch plan (Fig. 1) shows the projected course of the tunnel, which, as can be seen, passed under the foundations of the theatre building, crossed the so-called field, and was meant to come out on the bank of a river, which was a kind of by-water of the river Salzach and about 70 yards from the starting point. The escape point was a good one and the only real danger was dogs, as the guards were very confident of the impregnability of their castle and would not bother to go far beyond the peripheral barbed wire.

When the tunnel started, no one had, naturally, any idea of what sort of ground would be met. It turned out to be very unsatisfactory. It started in clay, but most of its distance was in a gravel bed, which sometimes stood like a gravel bank on the sides of the tunnel, at others rushing in like water. These rushes would happen with great speed once started, but the diggers got to know them and were usually well prepared with plenty of timber available. Circumstances which will be described later required a minimum of dirt to be brought out of the tunnel. It went slightly down grade partly to assist natural ventilation and to provide for the tunnel coming out at the selected point.

Tunnel Team.—The original team consisted of five members with an infantry colonel in command. Very strict instructions were given about security. The idea was to keep the tunnel as much a secret from the other prisoners as from the Germans. This was a very wise precaution. Someone was always liable to say something quite accidentally at the wrong time, when, perhaps, an English-speaking German was in hearing—and they often pretended to know no English. These instructions were well kept.

One at least of the original members kept his participation from his own mess. They had no idea he was doing anything so shady. People were often not liked on teams because they could not help looking sinister and conspiratorial as soon as they had a secret to keep.

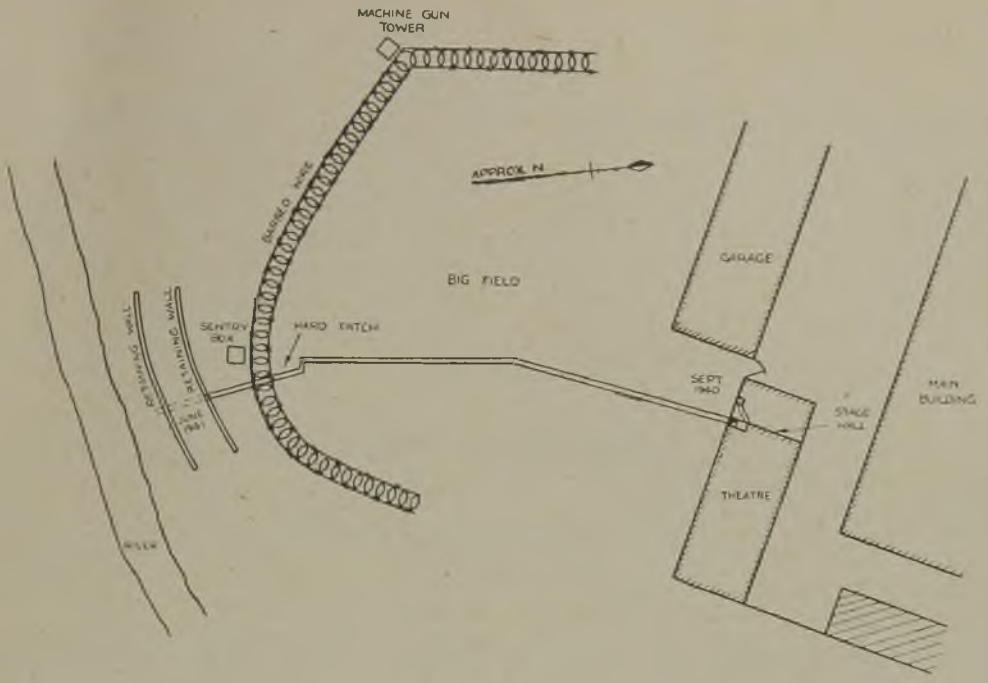
As the tunnel grew longer more people were recruited, mostly for muck disposal. Many wished to go underground, but it was policy to keep the same teams all the time as the work went faster with people who knew their stuff. In fact, two men did all the digging and timbering throughout the life of the tunnel. These two were the only members who were down the tunnel every day it was open for work.

It was agreed before the tunnel started that if, for any reason, it was considered that the suspicions of the Germans had been raised work would cease at once for a period ; this was kept up until almost the end.

The Work

The first job that was taken on was to get through a wall which lay under the footlights of the stage. This was tackled from under the stage. Here, for some reason, the Germans had covered the bare earth with a coating of loose sawdust about a foot thick. The method of approach was about midday to enter the theatre when no Germans were in sight. One then wandered about the theatre, always deserted, in case Germans followed in soon after, having perhaps spotted one entering. After 10 minutes the particular officer would slip under the stage from the back and wait until he got a further signal. After a while the normal theatre gang would arrive who, by arrangement, were in the team or who knew what was going on. Signals were then given by words and the chap underneath began his job. Signals were arranged so as to give the worker time to get out from under and be busily occupied behind if the Germans came in on one of their " snooping " expeditions.

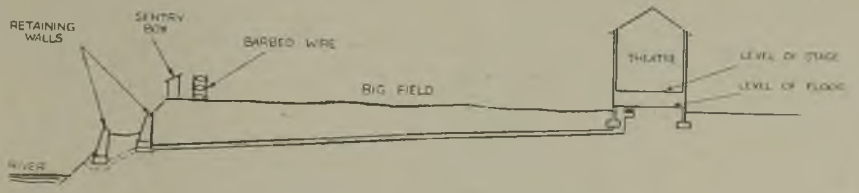
The wall was tackled at a point below the level of the sawdust which was scooped away into a compact pile. If there was an alarm, this pile could quickly be pushed back into the hole and an escape made. The tools used for this stage were an ordinary 3-in. screw and



SKETCH PLAN OF TUNNEL LAYOUT

APPROX SCALE

0 100 200 FEET

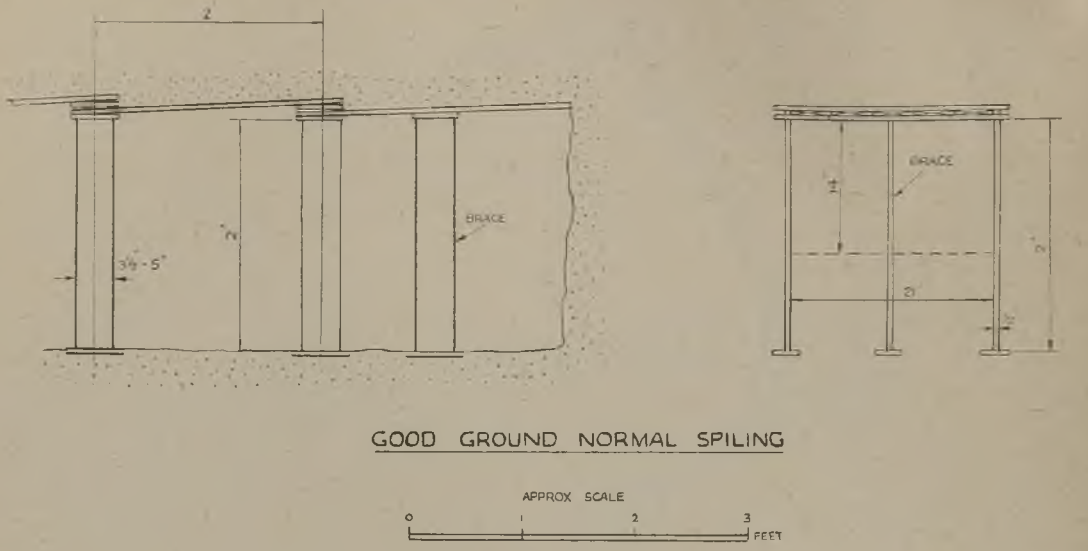


SKETCH SECTION OF TUNNEL

APPROX SCALE

0 100 200 FEET

Fig. 1.



GOOD GROUND NORMAL SPILING

Fig. 2.

the sharp point of a poker. The screw was set in a handle. The method was to drill a hole into the mortar and then another a little way alongside. The sharp point of the poker was then used to gouge away the piece of mortar in between. The poker was a strong one and could be used as a sort of pinch-bar. This work was a bit hard on the hands after the first brick and knuckles were always getting barked. That wall was 9 in. thick, but it took five weeks to get through. It could not have been ordinary mortar ; it must have been concrete. The whole team had a day off when the first brick was pulled out. Eventually a hole 18 in. by 12 in. was made, for which a lid was made and the sawdust scooped back to cover the entrance.

As this hole was made through to under the theatre floor, it was hoped that there would be hollow spaces underneath, as in English floors. There was real disappointment when it was found that the underneath was packed with loose sand and gravel. The joists of the floor had been levelled off on this ballast and the floorboards nailed down. Hence everyone was afraid that if the gravel were removed the floor would collapse. The grand piano in the theatre was arranged in such a way that people would be discouraged from walking on the particular piece of floor. Meanwhile the team, in full committee, had toyed with the idea of starting in another place, but eventually it was decided to carry on. An operation was carried out on the lines of catching up a sill-floor in a cut and-fill stope.

The timber used was the well-known bed-board, familiar to every Prisoner of War in Germany. The beds provided by the Germans consisted of the equivalent of three box beds, one on top of the other. Straw palliasses were used and to hold them in place each bed was provided with nine so-called bed-boards. These were pieces of deal plank 2 ft. 3 in. long, $\frac{1}{2}$ in. thick, and from $3\frac{1}{2}$ in. to 5 in wide. In order to obtain these a levy was made on all officers in the camp. However, the greatest bag of bed-boards was made when the Germans suddenly decided to move some 500 officers to another camp. They went off at 5 a.m. and, in the turmoil caused by their leaving, their beds were stripped of bed-boards. Nearly a thousand must have been collected that night. Many of these were hidden underground or put up as temporary shelves in rooms or used to make up previous deficiencies in beds with the intention of using them later.

Bed-boards were carried into the theatre by tucking them through the waistband and under the shirt. They made one's gait a little stiff-legged, but by moving slowly and wearing a great coat the effect was good.

The excavation under the floor was purposely made a large one to provide space for storage, changing of clothes, and to allow some freedom of movement. Its size was some 7 ft. long, 2 ft. wide, and 2 ft. high.

Excavation

With the approach well camouflaged and the chamber ready the tunnel proper could now begin. The first phase was to sink a shaft down the inside wall of the building so that the tunnel could be started under the foundations. No one wished to break through another wall and was prepared to sink any distance to avoid it. The shaft was 2 ft. by 2 ft. in size. If any reader has ever worked in a really small shaft he will realize that this size of shaft is about the practical limit of smallness. Anything smaller than this and one cannot stoop for digging and the work is considerably slowed. The shaft was sunk a distance of 5 ft. with three sets made from bed-boards. It had to be spiled downwards and was lined with cardboard as the gravel sides would not stand. A small ladder was made on the side and the building side of the shaft was left open for the tunnel. Everybody was pleased when the shaft was finished and on the direct line for outside the wire.

The tools now in use, which continued in use till the end of the tunnel, were an ordinary fireside shovel, one thin poker, penknives, and a very " ropey " pair of pliers. There were other tools used by the stage carpenters, but these were under parole from the Germans and it was a particularly maddening feature to see one of the stage hands sawing while the tunnel carpenter and set maker was cutting his wedges and making his bed-boards the right length with a penknife, which admittedly was sharpened to a razor edge.

After the spiling experience in the shaft it was decided to start in with the same method in the tunnel and accordingly, on a noteworthy day, the first set was put in. The standard tunnel set at this stage consisted of one bed-board as a cap and two as legs with the legs standing on small footboards. This gave the tunnel a finished size of approximately 2 ft. by 2 ft. The first 20 ft. was in clay, which stood quite well, deceptively well, as it turned out. Perfectly ordinary spiling was resorted to (Fig. 2). The back boards were driven forward over the set with a T-piece under them as soon as they got any distance ahead. The digger sat for his job with a small plank to sit on and a mucking board to make easier digging off the floor. Using the poker, he dug out a small hole for each plank some three or four inches deep and drove them forward individually. Then the whole face was broken down on to the mucking board with the poker and all of it was mucked over one shoulder, using the shovel, to the assistant behind. He, in turn, loaded it into a tin basin attached to a rope. When full it was pulled by a third to the shaft who dumped it in the chamber for later disposal (Fig. 4).

At first silence was maintained, but as soon as the tunnel was well away conversation, shouting even, were freely indulged in and spirits were high as progress was made every day.

However, the first 20 ft. in clay proved, on the whole, to be the easiest driving. Soon it was decided that 2 ft. was too large and

Fig. 3.—Camp Orchestra on the Stage :

The entrance to the tunnel is on the left of the photograph, just behind the second man in the second row. Workers were in the tunnel at the time the photograph was taken.

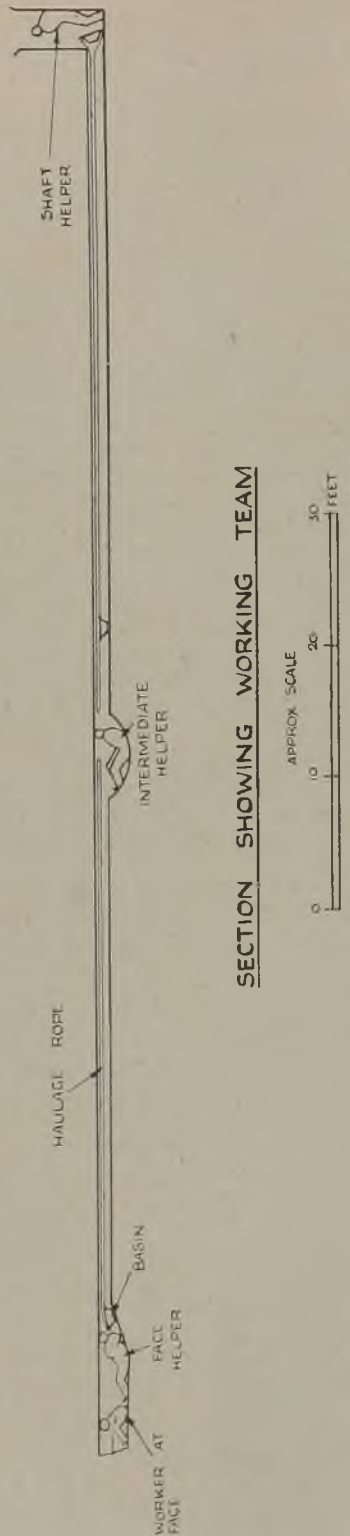


Fig. 4.

accordingly the cap was reduced to less than 2 ft. which made the width about 21 in. The full height was maintained and it made the tunnel nice to work in. The slight downhill grade helped the ventilation and the air was very good. At 20 ft., however, gravel was encountered. At first it was fairly easy going and required no side spiling. Then suddenly the face collapsed like water and there was a rush which filled the end and which buried the legs of the digger. It became necessary to spile sides and top. This was quite a complicated procedure. Scabbing boards were made inside each set, top and bottom, to resist the side pressure of the legs from spiling operations. The back-boards were spiled forward as usual, with a T-piece for supporting them forward, and the side boards were driven forward a lessening amount downwards so as to conform more or less to the angle of slope of the gravel. They were kept facing outwards by means of a cross-piece. This made the face pretty awkward for mucking, but it was managed (Fig. 5).

The great difficulty was to get in the forward set, as, owing to the loose ground, bases for the legs could not be excavated, so an extra or false set was put in half-way and spiling re-began from here. As soon as these new spiling pieces were fully forward a set could be put under the original spiling boards and the false set removed and replaced when the next set of spiling boards moved forward. So loose was the gravel that not the slightest gap could be left between the spiling boards or small stuff would trickle through and with conditions as they were no extra stuff could be tolerated. Fortunately these conditions were not always present, because it took a lot of bed-boards to do this work and the amount that could be stolen was limited.

Another difficulty was concreted bits of gravel. This caused one change in direction of the tunnel which was annoying. The first piece encountered was in the roof and it sloped slightly upwards and away. At first it made a fine roof, but when it began to get high it was very difficult to form a new brow in the loose gravel. Naturally the stability of the sets depended on having weight on them. In the end a reinforced set had to be used well wedged to the hard band before spiling was restarted. It does not sound much on paper, but it really was a very tricky operation. However, in the end it was made.

The tunnel went through its worst period

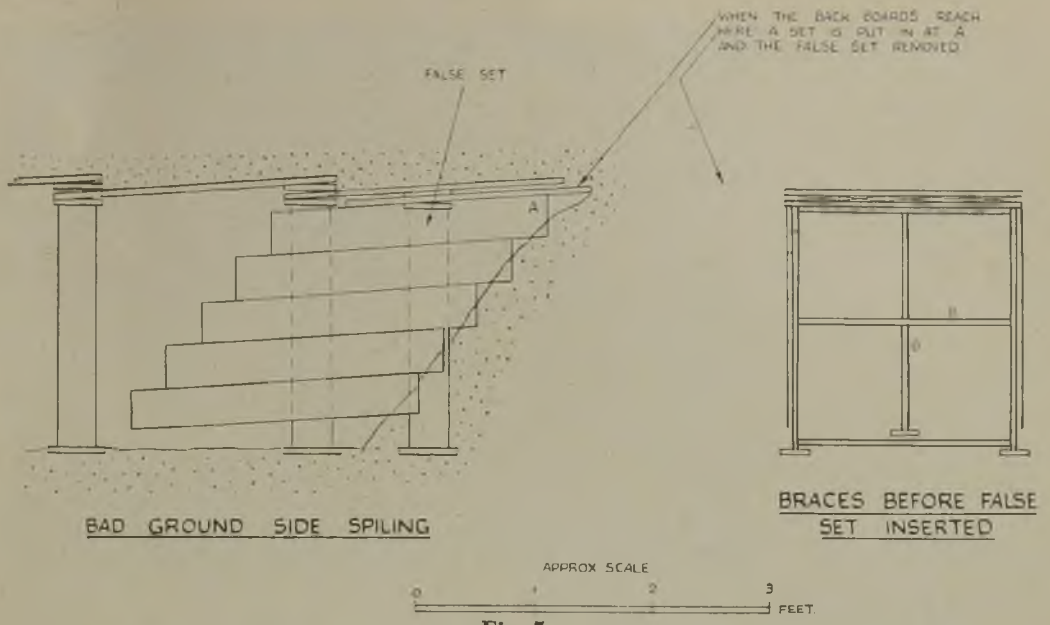


Fig. 5.

in the Spring of 1941. During the winter the field which lay over the tunnel had been flooded and converted into a skating rink. It was realized that when the thaw came bad conditions would occur, but it was hoped that the clayey part of the tunnel would stand up and, as the gravel was dry anyway, it was hoped that percolating water would not reach it. The hopes over the gravelley part were realized, but one morning when the working party entered it was found that some 10 ft. of the clayey part of the tunnel had collapsed. Fortunately the sets were secure and also the backboards, but with only a tiny triangle of open space left under them. The clay was horribly wet, but a hole was scraped through under the sets and the worker lying on his back was able to reach round the backboards to find the extent of the cave over the set ; a job that had to be done gingerly as more stuff might be brought down. It was found that there was at least $3\frac{1}{2}$ ft. of open space over the sets.

This presented two problems : First, the re-support of the tunnel and, secondly, to try to get the material back, as stowage space for material in the camp was strictly limited. These problems were settled as follows :— A number of woollen socks was requisitioned from the officers in the camp and these were filled with some of the caved material. Starting from one end of the cave, actually the inside end, the first set was well lagged on the sides and a wall of filled socks was put over it. Lying then on his back with his nose right against the backboards the worker threw the material, by digging behind his head, through a narrow opening right behind this wall. This was tiring work and difficult, since it was impossible to see what one was doing. As soon as this space was filled a wall was built one set further back and again the same process was carried out. This went on for a week. The clay was wet, sticky, and cold ; altogether most unpleasant. However, it was finished and practically all the material was thrown back into the cave and the tunnel was saved. As a precautionary measure the whole of the clay length of the tunnel was lined with timber and there was no more trouble.

Disposal of Dirt

This was the main problem and one which was never satisfactorily solved. It was probably the difficulties of disposal which eventually gave away the tunnel to the Germans.

At first the method was to clear a trench in the sawdust under the stage and fill this with the dirt, afterwards recovering with sawdust. This was done over the whole area and at the same time some of the sawdust was taken away and burnt so as to give more space under the stage. The floor was thus

gradually raised and the attention of the Germans was not attracted. Then, suddenly, the German commandant authorized a dressing room to be made behind the stage and, according to a design prepared by the British, this included deepening the floor behind the stage by about 3 ft. This was a heaven-sent opportunity for getting rid of stuff under almost fool-proof conditions. For every shovelful of legal dirt taken out for this excavation, at least two shovelfuls of illegal dirt went and eventually there was an almost frightening amount of material lying outside the theatre. To the British it looked obvious that there was far more material there than there should have been, but the Germans seemed to notice nothing unusual. The time for the excavation was dragged out to about two weeks.

Then came another stroke of luck. The German Commandant decided in the interests of security that the space under the stage should be securely boarded up. This was the only time when this nasty creature ever became a pleasant thought in British minds, since it now meant that the space under the theatre stage could be filled up solid with dirt. One board in the floor on the side of the stage had a knot hole in it. The nails were taken out. It was then keyed to its end neighbour by two headless nails and at the other end (the wall end) a slot was cut in the wall. This provided our new entrance. Normally the board was well wedged. To lift it the wedges were loosened, the board was slid end-ways (using the knot hole) into the slot at its wall end. This freed the nails at the other end and the whole board could be lifted. So well was it done that the Germans never discovered this actual entrance. From this entrance a lagged tunnel eventually led to the original hole in the wall and the rest of the stage was solid with dirt.

By now the tunnel was some 120 ft. long and was still more or less full size. It had always been hoped that sufficient space could be found for the dirt and that in the last length of driving it could be stored in the tunnel itself by filling it up as high as possible. This was now begun and the size of the tunnel became 21 in. wide by some 14 in. high.

It was now impossible to get along the tunnel except by wriggling flat on one's back. In fact the tunnel was " tailored " to fit a man lying flat and he progressed like a snake. It took some 15 to 20 minutes to get the length of the tunnel. " Tramming " was still by means of the tin basins, except that there were now four stations owing to the lack of straightness. These stations were left at full height and provided turning points as well as working points. The full team in the tunnel now was six. A digger, a mucker just behind him, two others along the length of the tunnel, one at the bottom of the shaft, and one at the top (Fig. 4).

It was discovered quite early on that the dream that all material could be stored in the tunnel could not be realized. So it was decided to take a little material out every day and try to restore the balance. Better, it was thought, a little every day than eventually to reach a condition when a very large amount would have to be hidden daily.

This daily excess was dumped down the lavatories. It was loaded into some 60 socks per day. These were hung open end downwards, and tied from the shoulder under the battle dress tunic and during the busy part of the day a stream of officers were strolling casually between the lavatories and the theatre. Several tons were disposed of in this way. Then, suddenly, the Germans decided to clean out the sewage system. In came the pumps with German efficiency and pumping began, but instead of the usual material up came gravel. All became flap and flurry. German officers turned up importantly and one went down the man-hole to investigate. Some Britisher had already foreseen this and simultaneously every plug in the building was pulled and a deluge came roaring down the pipes. This led to a pretty fast exit by the German officer with his jack boots pretty wet. However, these lighter moments did not help our muck disposal problem and, in addition, the Germans had become highly suspicious. The tunnel was closed down for a week as a precaution.

By the end of this week (it was now sometime in May, 1941) a new method of disposal was decided on. The ubiquitous sock was still hung from the shoulder and its open end came opposite the trouser pocket. The pocket was split open and the end of the sock held in the hand. Then one went for a walk and during the walk the stuff was allowed to trickle down the trouser leg and so on to the ground so that one left a constant stream of gravel as one walked along. Some tons of material were got rid of in this way, but it was not safe. There was always the danger that one had to take one's hand out of one's pocket, which would have meant an immediate stream of material that would have been

Fig. 6.—One of the Camp Shows :

The dark object in the bottom left corner is part of the piano standing in the position referred to in the text.

a little difficult to explain. This accident never happened, but there is no doubt that the Germans were being most observant and they probably saw quite a lot. This method was still in use when the tunnel was found by the Germans.

Ventilation

No special measures were adopted for ventilating the tunnel ; as already mentioned it was hoped that its slight down grade would take care of this. In addition, of course, there was air in the gravel. For the first 130 ft. or so these hopes were realized and the air was always cool and fresh. However, as soon as the vertical dimension of the tunnel was shortened, the air became very close and eventually it was quite impossible for any naked flame to burn even at the beginning of the shift. A match, for example, when struck, had no flame but merely a little glowing line passed across the head with a lot of smoke. Work, however, continued (it had to), but opportunities were taken for airing the tunnel by leaving the entrances open. The number of people working was reduced as far as possible and no one was allowed as far as the face until he had been " conditioned " by work further back. Shortness of breath was a great nuisance. Latterly, after a few shovelfuls had been dug, one had to stop and catch one's breath and several people complained of headaches. The worrying item was if someone had passed out in the tunnel ; Heaven knows how he could have been got out.

Had there been no possibility of getting air, some kind of a ventilation system would have been put in, but at some 200 ft. it was hoped that a small 1-in. hole could have been punched through to surface as we were nearing the bank. That would have cured the trouble. There was also the fact that it was considered a bad time of the year for ventilation anyway—the Spring—when the outside temperature approximated to the underground temperature. In the hot Bavarian summer it was hoped that natural ventilation would improve, but before the summer the tunnel had been found by the Germans.

Lighting

The tunnel was lit by electric light throughout. The theatre line was tapped at the footlights under the stage and the wire was stolen in the camp. Bulbs were comparatively easily come by. For the first 100 ft. or so there was no difficulty, as a two-wire system was installed. However, no more wire could be obtained and, perforce, a one-wire system with earth return was used. This worked all right from the light point of view, if somewhat dim, but the earths in the tunnel were most unpleasant. Crawling over them was just an endless series of electric shocks, which were most unpleasant, especially in damp working clothes. The strength of the shock seemed to depend on the distance between the crawler's points of contact. Thus,

if he rested his weight, lying full length, on his hands and toes, the shock was severe. Eventually the tunnel was deepened at the earthing points so that in crawling the knees and hands could be kept close together which reduced the shock considerably. It might be added that a fatal accident occurred in another tunnel later, due to the use of these earthing points.

Altogether there were five lights in the tunnel, including a clip light for the actual face. Fortunately at that time the Germans did not switch the lights off during the day. In the later years of the war they came on at dusk and went off at 9.30 or 11 p.m., depending on the camp. This was, of course, to avoid lights being used for tunnel driving.

Surveying

The tunnel was driven as straight and at as even a grade as circumstances permitted. It was set off underground by means of a prismatic compass, which someone had smuggled into the camp in the heel of his boot. The direction on the surface was obtained by " co-planing " from a window in the Castle. This could be done some distance back in the room and was relatively safe. To have taken a compass bearing in the open would have been to court disaster.

Levels were a little more difficult. The rough elevation of the exit end was taken by comparing the height of a man with the height of the exit point above the level of the river. This was done as carefully as possible and the probable error was not more than about 2 ft. To obtain the slope of the tunnel a long straight-edge was made with a sheet of three-ply fixed at one end. On the sheet was marked a line exactly at right angles to the straight-edge and a plumb bob was hung along it. When the bob coincided with the line the straight-edge was dead level. The use of this device was so obvious as hardly to require description. One end of the straight-edge (7 ft. long) was held against a cap, while the other was held against a ruler which rested on another cap. When the bob was brought to the pencil line the straight-edge was dead level and the ruler read off direct the difference in elevation. In one 100-ft. stretch of tunnel the difference between inward and outward readings was only about $\frac{1}{2}$ in.

The tunnel started at about 5 ft. below the surface and at its length of 220 ft., when found, had reached some 19 ft. of depth below surface.

The Last Phase

At the end of May, 1941, the foundations of the first retaining wall was struck and it was estimated that some 20 ft. of tunnel remained to be built. Progress, however, was slow. Ventilation was practically non-existent and the air was so bad that three blows with the poker made the worker out of breath and even conversation was spasmodic. The tunnel struck the foundation some 18 in. above its base. The tunnel was continued and finished against the wall with long legs for the caps, so that the base of the tunnel was brought some 2 ft. below the bottom of the foundations.

Now the gravelly nature of the tunnel changed. Clay reappeared and there was also some moisture trickling down on the plane of weakness caused by the wall. However, when the tunnel started to go under the foundations, hopes ran high. An objective had been struck and its direction and location showed that the tunnel was running on a true course. It was hoped that with the considerable drop of the surface level on the far side of the retaining wall a hole could be pierced through to surface to give much needed air. For this purpose an iron bar had been carefully preserved—some 4 ft. 6 in. long with a sharp point. How this valuable tool had been obtained was not known, but it came in for its share of admiration as a means of allowing a speedier advance.

Shift work had by now been reduced to two men per shift and there were two shifts per day. The morning shift did the mucking, while the digging was done on afternoon shift. Morning shift ran from about 10 till about 11.30 a.m. and the afternoon shift (the digging shift) was from 12.30 till 3.30. By this time a definite signalling arrangement had been made. Half an hour before the time for coming out the lights in the tunnel flashed once as a time signal. At 15 minutes to go three flashes meant all clear to come to the shaft, while one flash at this time meant " come back to the shaft but be quiet as there are Germans about." As a further precaution the underground men never signalled from inside when they reached the shaft.

The last shift (as it turned out) was a digging shift with two men. They went in as usual at 12.30 and slowly made their way

to the face and by 1.0 p.m. work had already begun. By now the tunnel had passed under the foundations and this shift was the first serious attempt to punch a ventilation hole through to surface. After a hard struggle the bar was pushed upwards for its full length, but there was no sign of daylight. An excavation was made round the end of the bar and by this means a further 1 ft. was made upwards, but still no daylight. However, two discoveries were made which were very gratifying. These were a worm and a root, the first sign of life that had been struck in the tunnel for its full length. They were like a rich strike, because it meant that surface was coming down to meet the tunnel and nine months of work was reaching its culmination. They were carefully placed in a matchbox.

By now it was 3.0 p.m., but the expected time signal was not made. However, as underground men do the world over it was reckoned that the surface chaps were playing the fool, slacking as usual, and duly at 3.15 p.m. the two workers started back along the tunnel for the shaft. Provided this was done under alarm conditions, there was no harm done. The assistant went first with the face man some 20 ft. behind him. The assistant was practically at the shaft when the face man heard a kind of scream and at the same time the shaft light went out. The digger's reaction was that the roof had come down on his assistant. So digging in his toes and elbows hard, he speeded up so that he could start rescue operations. However, the next thing was a very bright light shining down the tunnel and a German screaming for him to come out and to hurry up. Instead of an accident the Germans had broken into the tunnel and were standing round a hole in the floor which they had cut with axes and they were all armed with revolvers or rifles with fixed bayonets. Thus nine months work went for nothing !

The Germans, however, were very impressed with the tunnel. It was photographed from every angle and for a week afterwards generals and their staffs came from all over Germany to see it. No doubt the German staff at the camp made a lot of capital out of the fact that they had brilliantly discovered the tunnel before it had broken.

The two officers went to solitary confinement for 10 days. This, of course, was a standard form of punishment inflicted by the Germans, but actually it was heaven to be alone for a period after living in the over-crowded quarters provided by the Germans. They were also presented with a bill for 1,016 Marks by the Germans in respect of more than 1,000 bed-boards. This bill was paid by the camp. The final official length given by the Germans was 66 metres (220 ft.).

The Germans sent a man down the full length of the tunnel and it gave a great deal of satisfaction in the camp when it was reliably reported that this man was violently sick as a result of the trip. He had not been " conditioned " in the careful way adopted by the British. The Germans then dug down from surface at two points and filled the tunnel with barbed wire. It was pleasing to the surveyor to note as a check to his work that these holes were on the projected line of the tunnel.

Retrospect

This tunnel failed in its main object. Nevertheless there were many factors on its credit side. There was, for example, the effect on morale. It was depressing to be a prisoner during the winter of 1940–41. The fortunes of Britain were at their lowest ebb and the attitude of the Germans was correspondingly " cocky " ; an annoying condition which acts on the Germans like strong wine. Food was bad and Red Cross supplies were uncertain and erratic, although they were improving rapidly as from the beginning of 1941. In fact conditions for P.O.W.'s were at their worst.

Those, therefore, who were mixed up with escape schemes were stimulated by their efforts to rise above their environment and while the tunnel lasted the members of the team were as happy as anybody in the camp. Not only were they doing something, but they were doing it as a team, which was even better. Their minds were actively engaged on their tunnel problems and did not have so much time to ponder on their fate, as those with nothing to do and, in fact, nothing even to read. The tunnel, indeed, fulfilled, in spite of its failure, the second duty of every P.O.W. (the first being to escape) and that is to keep himself fit. Furthermore experience at escape work was gained. Lessons were learnt and applied later through practically all the P.O.W. camps in Germany and although better tunnels were built in the years that followed it was a real satisfaction to all the members of the team that they were associated with the first really long tunnel driven by the British in World War II.

Ore-Dressing Notes

(6) *Gold.*

Roasting Flotation Concentrates

It is the common experience of most mills which use bulk flotation as a step in the concentration of gold-bearing pyritics, that such a concentrate presents special problems in connexion with its cyanidation. One general method uses direct extraction, taking special precautions to deal with the unusual concentration of cyanicides, the difficulties in handling high-density solids, and in settling and filtering extremely fine pulps. Another makes a pyro-metallurgical approach, shipping the concentrates to smelters for specialized treatment. A third applies its pyro-metallurgy on the spot, in the form of a sweet-roasting treatment so controlled as to maintain the calcined gold in a suitable state for dissolution by the cyanide. In a recent paper [1] Messrs. Stitt and Locke give a detailed account of the third technique as applied to Rietfontein flotation concentrates. Well-deserved tribute was paid on the discussion of this paper to the fact that details were presented clearly enough to guide a specialist handling a similar problem elsewhere. The value of inclusion of dimensions and working details of the appliances used is not always recognized by technical writers.

In brief, the concentrates are roasted, and agitated with sulphuric acid to remove copper for re-precipitation on steel scrap, while the residual solids from the extraction are returned to the cyanide circuit. The flotation concentrate carries over 80 dwt. of gold per ton, with 35% of pyritic iron, 10% copper, 2% arsenic, and nearly 4% of iron oxides, so that it is, like all Rand bankets, fairly docile. Testing showed that a simple roast at between 590° and 650° C. would produce a calcine suitable for cyanidation capable of yielding 96% extraction of the gold. A plant able to handle 200 tons of concentrate monthly was decided on. Since roasting reduced the weight 28% and leaching of the calcine a further 9% the daily capacity of 6·6 tons of flotation concentrate and 4·2 tons of leached calcine was provided.

Thickened concentrates are dewatered in box vacuum filters to 20% moisture, and tipped on to a drying place along which they are shovelled. They take three hours to reach a 5-ton bin feeding two reverberatory roasting furnaces, each with its hearth in three steps arranged to segregate treatment into the stages new feed, partly roasted, and finishing. Some 800 lb. of dust is recovered monthly from the furnace flues and returned with the new feed. Roasting time depends on the sulphur content of the feed, over-roasting leading to trouble in subsequent separation. The issuing calcine must pass a $\frac{1}{8}$-in screen, arrested sinter being broken and returned to the furnace. Special trucks, each holding 0·35 ton of calcine, now cool, store, and deliver with practically no dust loss to the leaching section, after a simple test has proved roasting to be complete.

After leaching in $\frac{1}{2}$% H_2SO_4 the pulp is batch-filtered and the solids are washed repeatedly until free of copper. The filtrate is then clarified and run over steel scrap, a copper cement being cleaned up twice monthly. The cake is pulped and pumped to a cone, the spigot discharge of which is run through a small ball-mill to break up any lumps of calcine, the cone overflow joining the mill discharge en route to the cyanide agitators. From this point on there is little unusual in the handling, beyond the need for good control of alkalinity to avoid filtration trouble. The whole paper is so presented as to constitute a valuable practical guide in a type of operation likely to become increasingly important.

(7) *Maintenance.*

Machine Records

The busiest people are not usually the most efficient, particularly when lack of foresight and method is a main cause of their business. In the modern mill there is every reason for simple organization to ensure the smooth continuity of operation. In a plant running a 24-hour day it is far easier to systematize inspection and maintenance than to carry on until something wears out or breaks down, leading to improvised working during repair. All machinery has parts which wear down and need periodical adjustment or replacement, as well as special lubrication attention from time to time. The excellence of modern manufacturing methods allows of liberties with loading and maintenance, but it is far wiser to regard such extra value as an insurance on which the operator should avoid drawing under normal running condi-

[1] Stitt, D. D., and Locke, N. B. *Journ.* Chem. Met. Min. Soc. S.A., Nov.–Dec., 1945; The Mining Magazine, Feb., 1946.

tions. If a maintenance log is kept for each machine in the mill, it is easy to ensure that each wearing part, oil sump, etc. is looked at according to schedule and it is also easy to arrange that all such inspection and repair is done, during the day shift, by the maintenance gang with such specialized outside help as has been arranged for before shutting down. Where the machine requiring service is the only feeder to a line of other machines it is possible to plan a general check-up of that line. Because the work has been arranged, it can be done at a time when the mine stores are open and such specialists as the mechanical and electrical engineers are available. All this helps to ensure a quick and thorough overhaul, instead of the strain and flurry of an emergency shutdown, perhaps occurring during the graveyard shift, when neither external skilled aid nor special stores are quickly available.

There need be nothing elaborate about the system. A book is sometimes used, with pages for each item of plant needing periodic service, but a better way is to use some kind of a card index combined with a " bring-up " diary. The card can carry the history of the tool and be booked up by the maintenance foreman each time a job is done. This card then returns to the mill manager's office. Suppose the item of plant to be, say, a bank of flotation cells and that once a month the impellers are adjusted and reversed, while at ball-mill re-lining time the motors are checked over and the corners of the cells thoroughly cleaned out. The diary on the manager's table has shown it to be time for the monthly reversal and the card is sent to the maintenance foreman with an action instruction. On its return, booked up with a record of action taken, there may be a note that, say, No. 7 cell of the bank seems to have a worn impeller. The cards are consulted and it is found that the ball-mill feeding this bank of cells will be down for re-line in a few weeks. The diary is then marked to ensure impeller reversal in the usual routine month and a special note is attached regarding need for check on the suspected impeller. The ball-mill card is also " flagged " to ensure that when re-lining is being arranged a new impeller will be drawn from store in case it needs replacement. If it is used, the replacement date will be logged on the bank card, together with any pertinent detail which may help to avoid premature failure in future. Incidentally the information on rate of wear which accumulates on the cards can be of value when deciding what stock of spares should be carried.

(8) *Flotation.*

Cell Design

Recently a new cell was put on the market, designed by Professor Fahrenweld. In view of the world-wide success of the flotation machine originally associated with him the performance of this machine will be watched with interest. Mill men have by no means reached the end of flotation machine design. The chief requirements include thorough air-sweeping, right bubble size, adequate agitation, quiet froth discharge, avoidance of short-circuiting of pulp between entry and discharge, low power and wear, accessibility for cleaning, froth-column control, air-volume control, mild scrubbing action with some types of feed, positive draught in return circuits, and avoidance of sand-up when power fails. At present these virtues are spread over a multiplicity of types of machine, but probably more and more of the desired qualities will be built into less and less appliances as time goes on. To take one simple point—the introduction of air from an external compressor. One machine simply blows a jet of low-pressure air on to the underside of an impeller. Another streams it in through a disc-mat, while others use piping penetrating to various depths, a cylindrical rotating arrangement, or plain matting. The problem, on the laboratory scale, proves to have some interesting aero-dynamic and hydro-dynamic aspects connected with streamlining, baffling, pulp density, and frother concentration. It is unlikely that all the above-mentioned commercial machines are making the best possible use of power, since they differ so fundamentally in their methods of applying it, although all are successful and widely used.

There is nothing in the design of popular flotation cells which brings them into closely similar groupings in the way that, for instance, all crushers divide into jaw, gyratory, etc. Crushers have been in the field long enough to settle to a few basic patterns and this they have done by the old-fashioned method of trial and error, with the gradual weeding out of the least efficient. Flotation is developing in a world less apt to use such an expensive road to efficiency, but as long as we have our present diversity of machines, with more coming along all the time, one must suspect that the laboratory

technician holds but a lowly place on the engineering side of the industry. It is not enough to maintain a testing service which can show whether a customer's ore can be floated. What is wanted is a service which investigates the firm's own product and assures that good streamlining and proportioning are making the wisest use of the power needed to aerate a pulp efficiently.

(9) *General.*

Progress Report

A recent report [1] covering the 1946 annual meeting of the American Institute of Mining and Metallurgical Engineers shows how far and how fast mineral dressing has moved from the status of an art toward that of an exact science. More than 30 papers were presented in the six sessions held. Those on flotation considered such recondite matters as the count of collector ions on a given surface area ; measurement of that all-important area with better precision ; electromigration as an investigator's tool in flotation chemistry ; flotation cell mechanics ; frother chemistry ; new chelate collector, and differential non-sulphide flotation. It is hoped to review some of these papers in detail in future notes.

Electrostatics and sink-float received notice, as did the practical application of milling and such things as tailings dams, centrifugal pumps, and mill planning. Grinding received close attention, but the author of the report comments that much remains to be done in this field. With that sentiment one cannot fail to agree wholeheartedly. The present research position is that the tantalizing and fascinating problems of flotation physics, electronics, and chemistry are claiming an undue share of attention at the expense of the less-obviously intricate and unknown problems of comminution. Yet these two things, grinding and flotation, are not separate activities but mutually dependent and they combine to constitute a single economic operation. There are times when the industrialist who foots the bill, both in processing and in the cost of sustained research, should do a little dictating as to the objectives of that research. Comminution is still the most expensive part of the flow-sheet and at present there are gaps in our knowledge which, if filled in, should reduce costs substantially. More important still the implications of comminution as a means to an end are not fully considered, owing perhaps to the tendency for research to be specialist rather than co-operative.

[1] Counselman, T. B., *Min. Met.*, Apr., 1946.

Engineering Log

The peak year of world production of gold was 1940, with a steady decline through the war. In 1945 the final figure is of the order of 26,500,000 fine oz.—a 35% drop from 1940 and a 2% fall from 1944. Silver was down to 127,300,000 oz. If the return to normal includes a correlative improvement in the output of the money metals gold mining should prosper. The " if " is referable to the bogy of inflation, which must operate against expansion so long as working costs continue to rise while the market price remains officially fixed at pre-war level by the big consumers.

* * *

A serious cultural loss was sustained during the " fire raid " on London in December, 1940, when Paternoster Row was burned out. During the war over 10,000,000 books, beside manuscripts, were lost, including the scientific and educational material so important to rehabilitation ; it will take several years to make good the loss.

* * *

An interesting technique has been developed for putting America's reserve weapons into storage. They are enveloped in a moisture-proof plastic film. First, the sharp angles are covered with tape and a tape network is stretched from point to point to form a founding network. On this a sort of cobweb is placed. Next, the plastic cover, in liquid form, is sprayed on to the web by compressed air. It floats down and solidifies as it grips the network, several coats being applied if necessary. Finally, the original air is replaced through a sealing point with hot air and desiccant inserted before sealing.

* * *

The Railway Committee appointed in 1944 to review the position of London's railway services has put forward a scheme costing £230,000,000. This, if adopted, will add over 100 miles of new tunnels to the existing railways and will link up southern and northern systems by tunnels under the

Thames, doing away with some of the present unsightly bridges. The scheme will take at least 30 years to complete. In May the Government's road plan for the whole country was announced. The programme is in three stages, covering ten years. The first (two-year) stage is chiefly concerned with rehabilitation and improvement of places with the worst accident records. Next, three years of major improvement, bridge strengthening, and bottleneck relief, with some work on new roads is planned. Finally, five years of radical reconstruction of the chief roads and the building of new and exclusively motor traffic routes is envisaged.

* * *

At the end of the 1914–1918 war farming accounted for 44% of Canada's total production, with manufactures some 28%. By 1939 farming yielded 28% and manufactures 39%. Under the urge of war both expanded their output and in 1943 they were respectively 20% and 54% and the reconversion to peace has set Canada (now the fourth nation in the air, third in sea power, and fourth in munitions making) the problem of wisely preserving its trained industrial labour. Conversion of industry is well advanced, over £200,000,000 having been allocated for turning over " from swords to ploughshares." Responding large-heartedly to Britain's need, agriculture has expanded and now ships bacon, cheese, beef, poultry, and eggs in increasing quantity, as well as its regular food exports. All this is reflected in the rise of production from $5,495,000,000 in 1939 to $11,359,000,000 in 1945.

* * *

According to a recent definition Radar (Radio Detection And Ranging) is " the art of detecting by means of radio echoes the presence of objects, determining their direction and range, recognizing their character, and employing the data thus obtained in the performance of military action." Its ground applications in war included aircraft warning, gunlaying, searchlight control, guidance of interceptor planes, and tactical " recco " work in the actual fighting. At sea parallel activities were undertaken and air-borne radar also overcame bad visibility over target and at base. These are but some of the activities to which various types of radar instruments have been adapted, but the fundamentals in each case are the same. A pulsed output of high-power electromagnetic energy of extremely short life is sent out and the resulting echo is registered, all at such a *tempo* as to permit continuity of record, usually in a cathode-ray valve. There must be a timer to fix signal rates, a transmitter to generate the pulses, an aerial system both to radiate the pulses and receive the echoes, a receiver to amplify the echoes, an indicator to render the signal visible, and a source of power. Since the velocity of radio frequency energy is known the " slant range " or direct distance between instrument and target can be measured. Direction in azimuth is measurable as an angle, as is elevation. These three measurements give the location of the target. In long-distance searching no great precision of beam is needed, but for such work as gun-laying high accuracy is achieved by " conical scanning." In some instruments the radar beam can follow its target automatically. Recognition of the nature of the target is not yet as well developed.

* * *

A simple signalling device for use in lifeboats, rafts, and on lifebuoys develops the principle of the mirror heliographing the sun's rays. Using it, the signaller aims a dim image of the sun at the target whose attention he desires to arouse, and the optical system does the rest.

* * *

Two methods of extracting alumina from clays and high-silica bauxites have been evolved as American war-time research projects. In one, extraction with NaOH and NaCl is used to produce sodium aluminate comparatively uncontaminated with silica, which precipitates as soda-like in the presence of salt, instead of becoming the more soluble sodium aluminium silicate hydrate. An extraction of over 90% from high-silica bauxite is claimed. The other technique starts by sintering the aluminous material with limestone at 1300° C., the resulting calcium aluminate being extracted with Na_2CO_3 and NaCl to give a recovery from clay of 95% of the alumina.

* * *

Salvage of sunken aircraft is made easier by the use of globular pontoons which can be inflated after divers have attached them to the submerged wreck. The biggest recorded

bag was elongated, 10 ft. by 26 ft., and made of waterproof canvas with a rope netting to cover it. Inflated, it could lift 50 tons. Relief valves release part of the pressure as the bag nears the surface. The spheres developed by American naval salvors range in diameter from 5 ft. to 7 ft. and have a unit buoyancy of from two to five tons. Small compressors on the salvage boats supply the air, once divers have secured the collapsed globe in position, and they distribute air through a manifold so as to keep the rising wreck properly trimmed.

* * *

Electricity's " five-year plan " announced in June promises, as an alternative to nationalization, that supply will be extended, tariffs and voltage standardized, and d.c. abolished as regards domestic users. The gas industry is similarly stimulated by the threat of socialized public services. Competition of this sort should benefit the public without increasing cost.

* * *

The Assouan dam was the greatest structure of its kind in the world when first built in 1902. Since then its original height of 357 ft. has been twice raised—to 374 ft. in 1912 and 403 ft. in 1933. If current plans go through it will rise to 439 ft. and impound over 7,000,000 acre-feet. In lower Egypt the Nile runs up to 14 ft. above the land during exceptional floods and 20 ft. above Cairo. A cyclic period of high floods is now due. The " Baker space " method of increasing the thickness of the dam is again to be used. This ties the new masonry to the old across a 6-in. gap by steel rods and after time for settlement grouts the two into a single structure. Extra run-off storage is proposed in the new scheme by channelling from Assouan reservoir to the depression of the Wadi Rayan.

* * *

Soggy ground presents no difficulty to oil geologists and geophysicists working in the swamps of the southern United States. They can now equip themselves with a " marsh-buggy "—a tractor, with four balloon tyres 10 ft. high and 66 in. in diameter mounted on hollow aluminium drums which allow the vehicle to travel overland at 20 m.p.h. and in water at 4 m.p.h.

* * *

A quick war-time method of obtaining silt-free sand for concrete work should carry over into peace-time use. It is obtained from running streams simply by stirring up the river bed with perforated pipes carrying compressed air. Mud then washes away with the flowing water leaving behind a washed sand ready for extraction and use.

* * *

A giant electron accelerator in the American G.E. Co. research laboratories can develop 100,000,000 volts, according to information now released. This electron stream is opening a new field of atomic research. The chief part of the machine is a 130-ton electromagnet 9 ft. high, 6 ft. wide, and 15 ft. long, built of laminated silicon steel. In the heart of the betatron is a vacuum tube of moulded and tempered pyrex glass, of toroid shape, with silvered inner surface. Electrons are fired into this tube and accelerated round and round the magnetic field, gaining about 400 electron-volts on each circuit. They can be taken out at any stage of build-up, from two to 100,000,000 volts. The betatron uses alternating magnetic force, thus differing in principle from the cyclotron which applies high voltages in a unidirectional field to " kick " the racing electrons into greater velocities.

* * *

The atom-bomb has provided America with new problems in connexion with the now vulnerable Panama Canal. Three expensive alternative proposals are under consideration. The new locks, partly finished when work was stopped at the end of the war, could be completed, but they are too close to the present ones to be entirely safe against a massed air attack and they depend on water from Lake Gatun which only preserves its 85-ft. head of water by an earth dam which could easily be destroyed. Second, a sea-level canal is possible, at enormous cost, but the 85-ft. cut needed might start huge earth and rock movements in the surrounding hills. Third, a new canal could be cut, again at great cost, at some other location.

* * *

Details of British and Allied war inventions continue to be released. Among those published this year are the Duplex-Drive

Tank—the "swimming tank" which led Germans on the D-day beaches to think that our Valentines and Shermans were small boats, until a few seconds after their emergence on to land, they shed their canvas screens and became tanks. Another amphibian was the "Neptune," carrying a 4-ton load. It was propelled at sea by a 285-h.p. engine driving "paddle-wheel tracks" and could land in heavy surf and then go ashore. Another British invention, the "Swiss Roll," is a flexible pier made of canvas and wood, to which a tension up to 30 tons is applied to stretch it from ship to shore, allowing a loaded lorry to be driven over it. It can then be hauled aboard and rolled out when again needed. "Wireless Set No. 10" worked on centimetric waves and allowed direct speech communication with full secrecy between G.H.Q. and Downing Street. Among American inventions was the "snake," a pear-shaped flexible head with two aluminium bodies 400 ft. long. It was got into place by a light tank and its 4,800-lb. charge was then exploded to clear a path through a minefield. "Torpex" is a British explosive mixture of T.N.T. and aluminium powder used in "block-buster" bombs. The L-delay fuse, twice the size of a fountain pen, was much used in underground sabotage work. At sea the "foxer" was our antidote to the acoustic mine, making a noise which attracted the enemy mine to the point at which it was towed astern of our ships. The "hedgehog" was a large mortar throwing 24 projectiles a furlong ahead of our ships and detonating only on contact with the submerged U-boat. The American Sono-Buoy was dropped in the sea by aircraft. Its hydrophone picked up submarine sounds and radioed them to a watching aeroplane.

* * *

Breakfast food is not the only processed material that can by sudden decompression, be "shot from guns." Wood waste, chips, and sawdust are put into sealed containers and steamed up to 1,000 lb./sq. in. The pressure is suddenly removed and this loosens the lignin, breaks the fibre, and puffs out the wood. This "synthetic" lumber can then be compressed to desired size, shape, and densities; it can be fireproofed or otherwise doped at the same time. Being synthetic it is not limited in width or length, except by the capacity of the moulding machinery.

News Letters

VANCOUVER

July 5.

Mine Labour.—The International Union of Mine, Mill, and Smelter Workers called its members at most of British Columbia's hard-rock mines out on strike on July 3 after several ineffective attempts at conciliation in which the operators, union, and Provincial Department of Mines participated. The union is demanding an eight-point programme, which includes: A 40-hour week; a minimum increase of 29 cents per hour for miners and corresponding adjustments and increases for all other workers; overtime pay at 1½ times the regular rate, and full pay for six stipulated statutory holidays; off-shift differential rate of 5 cents per hour for afternoon shift, 7½ cents per hour for night shift, and 10 cents per hour for graveyard; vacations with pay of one week for each worker with one year seniority and two weeks for all with seniority of two years or more; sick-leave pay of up to two weeks each year to accumulate if not used to a total of 90 days and to be available in any later year; severance pay of one month for each employee with seniority of one year, and two months for all employees with two years or more service, and guaranteed annual work or wage equivalent of not less than 1,900 hours per year.

The operations of The Consolidated Mining and Smelting Co. of Canada, Ltd., are not affected, the union having previously negotiated an agreement with the management. One or two remote operators are also continuing work, but, in the main, the gold-, silver-lead-zinc-, and copper-mining properties are idle. Some 2,500 men are affected. The Federal Department of Labour has appointed Mr. Justice Gordon McG. Sloan to consider the dispute as a commissioner.

It is understood that the operators are prepared to make some concession in the matter of wages, but are unyielding in their refusal to consider negotiating on a Province-wide basis or to accepting "union security," which may be interpreted to mean a great deal more than the apparently harmless words suggest.

Atlin.—Taku River Gold Mines, Ltd., has advanced $200,000 to its wholly-owned

subsidiary, the Polaris-Taku Mining Co., Ltd., to re-imburse it for expenditures made in preparing the Polaris-Taku mine for new production. Approximately one-third of the amount was paid for adjoining mineral claims which are known to carry the extension of the mine's productive veins. Milling was again in progress before the end of June.

Portland Canal.—Silbak Premier Mines, Ltd., received net smelter returns of $52,603 from its May production, recovered after the treatment of 5,834 tons of ore. Operating loss was estimated at $898 before write-offs.

A tunnel being driven by Stewart Canal Gold Mines, Ltd., has intersected an ore-body at a depth of 150 ft. below any previous development.

All the assets of the Indian Mines Corporation, Ltd., have been acquired by the newly-incorporated Indian Mines (1946), Ltd., in consideration of Corporation shareholders receiving one share of the new stock in return for each four shares of the old stock surrendered. The new company is capitalized at 3,000,000 shares, of which 1,000,000 shares are to be sold to net the treasury $120,000 for development of the silver-lead property adjoining the Silbak Premier mine.

Skeena.—Surf Inlet Consolidated Gold Mines, Ltd., has obtained an interesting diamond-drill intersection of 1 ft. of ore assaying 1·28 oz. of gold per ton at a distance of more than 1,000 ft. from any previously-developed ore.

Alberni.—Spud Valley Gold Mines, Ltd., is to resume development, to be followed shortly by production, as soon as labour is available at its Zeballos property. A new adit is to be driven to open the Big Star vein 300 ft. below any previous work.

The newly-incorporated Nitinat Mines, Ltd., has acquired the Havilah mine and a lease and option to purchase the Black Panther mine on Vancouver Island. The company, capitalized at 3,000,000 shares, also holds a silver-lead group in the Slocan mining division. A 25-ton mill is currently in the course of construction at the Black Panther.

Victoria.—Power has been turned on again at the Mount Sicker properties of Twin " J " Mines, Ltd. and, unless halted by the labour-strike situation, development work will be commenced at once with a view to resuming production in the near future. In addition to rehabilitation of the Tyee mine and the initiation of a large-scale diamond-drilling programme it is proposed to drive from the 500-ft. level of the Richard III mine to the South ore-body in the Tyee mine, traversing a section in which the presence of an extensive ore-body has been indicated by preliminary work.

Nanaimo.—The development programme of the Marble Bay Mining Co., Ltd., will be considerably accelerated as a result of new financing recently obtained. The company will proceed to unwater the shaft and workings of the full 17 levels to permit exploration at depth, as suggested by Dr. Victor Dolmage, the consulting geologist. The new capital is represented on the board by Mr. Marcus H. Cunningham.

Lillooet.—For the first time in more than a decade Bralorne Mines, Ltd., has failed to pay its regular quarterly dividend to shareholders. The directors, in passing the disbursement, were of the opinion that the company's resources should be conserved in the face of an imminent strike of employees.

During the fiscal year ended March 31, 1946, Pioneer Gold Mines of B.C., Ltd., produced 4,317 oz. of gold and 843 oz. of silver, valued at $166,719, from 10,624 tons of ore averaging 0·414 oz. of gold per ton; other income was $53,490. After all operating costs of $425,400 and the provision of $18,720 for depreciation, $7,740 for depletion, and $30,679 for exploration and prospecting, the net loss for the year was $262,329, reducing the surplus account to $74,752. Development work at the Pioneer mine included 1,511 ft. of driving, 227 ft. of rising, 566 ft. of cross-cutting, and 6,288 ft. of diamond drilling. At the end of the fiscal year the ore reserves were estimated at 187,940 tons, averaging 0·427 oz. of gold per ton. Mining was suspended for five months to permit repairing and re-timbering of shafts and ore pockets, replacement of water supply pipe-line, and reconditioning of buildings on the townsite, in preparation for larger-scale operation in the following year. The company participated in the development of gold-silver claims in the Omineca district, of gold-copper claims on Texada island, as well as in gold prospects in Manitoba, Quebec, North-West Territories, Brazil, and Fiji.

Congress Gold Mines, Ltd., has obtained ample funds for the development programme currently in progress at its Bridge River property by granting an option on the balance of its treasury shares to Sheep Creek Gold Mines, Ltd., which company has agreed to advance $77,000 during 1946.

Mt. Milligan from the Nation River Bridge.

(Photo: H. S. Fowler)

It is proposed to increase the capital structure of the Congress company to 5,000,000 shares and also to grant Sheep Creek an option to purchase the additional treasury shares.

Cariboo.—The May production of Cariboo Gold Quartz Mining Co., Ltd., was 2,305 oz. of gold, valued at $88,723, from 6,775 tons of ore averaging 0·34 oz. of gold per ton. During the first four months of the current fiscal year production was valued at $362,893. The operating profit was $36,654, resulting in a net profit of $2,848 after provision for depreciation and depletion. Exploration and development work during the period amounted to 1,693 ft. and diamond drilling to 3,949 ft.

The May production of Island Mountain Mines Co., Ltd., was 1,583 oz. gold, valued at $60,961 from 3,419 tons of ore treated.

Bralorne Mines, Ltd., has taken an option on the Motherlode group of Cariboo Crescent Gold Mines, Ltd. If exercised $100,000 will be provided to prepare the property for production, together with such additional sums as may be deemed necessary, the further loan to become a charge against first production.

Omineca.—The Hudson Bay Mountain property of Duthie Mines (1946), Ltd., is under development with a view to resuming production in the near future. Lt.-Col. C. B. North has been appointed resident engineer in charge of operations and a number of key men has been engaged. The property is equipped with a 70-ton mill and was formerly an important producer of silver and lead.

Osoyoos.—Shareholders of Hedley Basin Mines, Ltd., have approved conversion of the present authorized capital of 25,000 shares of $1·00 par value to 50,000 shares of 50 cents par value. A further resolution authorized public participation and increase in the capital structure to 2,500,000 shares of a par value of 50 cents each, with each shareholder receiving 50 shares of the company as enlarged for every share held in the original incorporation. The company holds a promising gold property at the foot of Nickel Plate mountain.

Greenwood.—Pilot Gold Mines, Ltd., former Bridge River operator, has taken an

Taku River, near the Polaris-Taku Mine.

(Photo: H. Townsend)

option on the Fry group of six silver claims across the valley from the Highland-Bell mine, recently purchased by Leitch Gold Mines, Ltd., and associated companies.

Dentonia Mines, Ltd., has discovered a strong ore occurrence on the bottom level of the Jewel mine, 160 ft. lower on the dip than a strong ore-body on the No. 1 level. At one place the vein averaged 2·74 oz. of gold and 16·24 oz. of silver per ton over a width of 2½ ft.; it subsequently widened to twice that size, but values reduced considerably.

Nelson.—Sheep Creek Gold Mines, Ltd., is to pay a quarterly dividend of 1½ cents per share on July 15.

Mr. Lewis P. Larsen, of Spokane, president of Pend Oreille Mines and Metals Company, has announced that the Reeves MacDonald mine, situated in the Nelson mining division of British Columbia, will be equipped with mining and milling facilities to provide for a daily output of 1,000 tons as soon as labour and materials are available.

Slocan.—Shares of Silver Ridge Mining Co., Ltd., have been called for trading on the Vancouver Stock Exchange.

Slocan Charleston Mining Co., Ltd., plans to re-open work at the Keystone group of silver-lead claims.

Yukon Territory.—The annual report of the Yukon Consolidated Gold Corporation, Ltd., shows 1945 production valued at $918,442, together with other income of $26,723 from power sales, $17,835 from interest on investments, and $390 from miscellaneous sources. After operating expense of $613,669, administrative costs of $48,330, interest on debentures of $6,423, and provision for depreciation of $188,991, the net profit for the year was $105,978. Three dredges mined 2,682,743 cu. yd. at a cost of 21·79 cents per cu. yd. to obtain recovery valued at 34·14 cents per cu. yd. At the end of the fiscal year proved gravel reserves were estimated at 109,328,933 cu. yd. containing gold valued at $39,307,949 (Au at $35), not including ground ahead of dredge No. 4 on Bonanza Creek, which is estimated at 34,424,188 cu. yd. Five dredges are to be operated in 1946 for the full season and one other for part of the time, while stripping is to be carried on in six situations and thawing in five. A new dredge is to be constructed to replace No. 5, destroyed by fire in 1943. A lease has been granted to Yukon Alluvial Gold, Ltd., a McRae-Patty company, on the 144 claims owned on Henderson Creek, a tributary of the Yukon River, whereby Yukon Consolidated will receive 10% of the value of gross production, *plus* the return of $34,459 expended on prospecting and development work.

TORONTO

June 20.

Gold Production.—During April the gold mines of Ontario milled 594,266 tons of ore and recovered 141,230 oz. of gold and 16,673 oz. of silver, valued at $5,449,639. The month's output figures for the various producing districts were as follows: Porcupine, 338,201 tons milled, 74,962 oz. of gold, 5,984 oz. of silver, value $2,891,201; Kirkland Lake-Larder Lake, 159,074 tons milled, 41,984 oz. of gold, 7,841 oz. of silver, value $1,621,701; Matachewan-Sudbury, 19,945 tons milled, 2,330 oz. of gold, 690 oz. of silver, value $90,234; North-Western Ontario, 77,046 tons milled, 21,954 oz. of gold, 2,158 oz. of silver, value $846,503.

The value of the bullion produced by the Ontario gold-mining industry in the first four months of the current year amounted to $21,858,255, against $19,871,859 for the corresponding period in 1945.

Porcupine.—Porcupine Reef Gold Mines is to sink a shaft to 1,000 ft. Work is to be directed by Broulan Porcupine Mines and any ore produced is to be treated by that company.

The operations of Buffalo Ankerite Gold Mines for 1945 resulted in a net loss of $133,656, as compared with a profit of $39,508 for the previous year. The output for 1945 was valued at $1,253,829 from 197,691 tons of ore milled. The ore reserves at the end of the year were estimated at 244,556 tons. The company is now opening up fresh ore on the newly-acquired Wright claims.

Coniaurum Mines reports a profit of $285,829 for 1945, as compared with $220,089 for the previous year. During 1945 the ore milled totalled 98,120 tons and the recovery $1,013,678.

The accounts of Bonetal Gold Mines for 1945 show a profit of $43,426. The ore treated amounted to 23,992 tons for an output valued at $168,826. The company plans a diamond-drilling programme for the current year.

The report of Broulan Porcupine Mines for 1945 shows a profit of $39,354, as compared

Beresford Lake, Manitoba.

with $107,231 for the previous year. During 1945 the ore milled amounted to 89,392 tons and the recovery to $653,917. At the end of the year the ore reserves were estimated to be 245,000 tons averaging $6·93 per ton in value.

Kirkland Lake.—A profit of $938,381 is reported by Kerr-Addison Gold Mines for 1945, as compared with $889,419 for the previous year. During 1945 the ore treated totalled 430,065 tons, recovery amounting to $3,122,706. The ore reserves at the end of the year were estimated to be 8,379,951 tons averaging $7·60 per ton. The company plans to increase the capacity of the treatment plant to 4,000 tons a day.

The report of Teck-Hughes Gold Mines for 1945 shows a profit of $580,512, against $790,262 for the previous year. The ore milled in 1945 totalled 106,006 tons, the recovery being valued at $1,098,532. The ore reserves at the end of 1945 were estimated to be 281,472 tons averaging $13·22 per ton.

Macassa Mines reports a profit of $85,461 for the first three months of the current year. In the period 20,569 tons of ore was treated for an output valued at $336,211.

Matachewan - Sudbury. — Falconbridge Nickel Mines reports a profit of $637,690 for 1945, as compared with $959,907 for the previous year. The ore reserves at the end of 1945 were estimated as 13,682,000 tons, averaging 1·72% nickel and 0·93% copper.

As a result of its 1945 operations Young-Davidson Mines reports a profit of $216,779. Production for the year was valued at $752,171, from 206,556 tons of ore milled.

The accounts of Matachewan Consolidated for 1945 show a profit of $67,928, which compares with a loss of $20,851 suffered in the previous year. During 1945 the ore milled totalled 161,361 tons and the recovery $602,951. At the end of the year the ore reserves were estimated to be 811,127 tons averaging $4·23 per ton.

North-Western Ontario.—A profit of $234,090 is reported by Leitch Gold Mines for 1945. In the year 20,086 tons of ore was milled for an output valued at $683,452.

The new ore discovery between the 5th and 6th levels is reported by Hard Rock Gold Mines. The company reports a loss of $349,923 for 1945, during which the mill was operated for some six weeks only.

In the first three months of the current year Madsen Red Lake Gold Mines milled 24,315 tons of ore for an output valued at $259,693.

Manitoba.—In the period from January 1 to February 26 last San Antonio Gold Mines produced gold worth $277,965 from the 22,366 tons of ore milled.

The report of the Hudson Bay Mining and Smelting Company for 1945 shows a profit of $5,897,844. In the year 1,822,628 tons of ore was milled, metal production amounting to 80,195,057 lb. of copper, 94,936,880 lb. of zinc, 131,239 oz. of gold, and 1,694,184 oz. of silver. The ore reserves down to the 3,250-ft. level are estimated as 26,000,000 tons averaging 2·99% copper, 4·24% zinc, and 0·089 oz. of gold and 1·25 oz. of silver per ton.

Goldbeam Mines announces that its shaft reached its objective at 500 ft. in April. Exploration work is now in hand at the 150-ft., 300-ft., and 450-ft. levels.

Quebec.—The gold output of Quebec Province for February was valued at $2,000,537 against $2,231,537 for January. Silver production in February totalled

155,789 oz., as compared with 179,619 for January.

Noranda Mines reports a profit of $9,000,135 for 1945, when production totalled 102,323,546 lb. of copper and 226,095 oz. of gold. At the end of the year the reserves of sulphide ore averaging over 4% copper were estimated as 5,127,000 tons, in addition to 15,228,000 tons averaging 0·68% copper and 0·197 oz. of gold per ton and 853,000 tons of siliceous fluxing ore grading 10% copper and 0·107 oz. of gold per ton.

The accounts of Stadacona Rouyn (1944) Mines for 1945 show a profit of $65,533. In the year bullion valued at $835,073 was produced from 125,937 tons of ore milled. The ore reserves at December 31 last were estimated to be 539,341 tons averaging $6·23 per ton. In the current year exploration of the Pelletier Lake shear zone is to be undertaken.

The report of East Malartic Mines for 1945 shows a profit of $25,935, against a loss of $41,356 for the previous year. The ore milled in 1945 totalled 304,890 tons and the recovery $1,538,499. At the end of the year the ore reserves were estimated at 2,665 813 tons, averaging $7·76 per ton.

Sullivan Consolidated reports a profit of $155,998 for 1945, against $144,869 for the previous year. Reserves of ore at March 31 last are given as 653,305 tons grading $9·72 per ton.

The Normetal Mining Corporation reports a profit of $424,449 for 1945, as compared with $206,965 for 1944. In the year under review 204,067 tons of ore was treated, the reserves at the year end being estimated at 1,399,000 tons, averaging 7·04% zinc, 3·53% copper, and 0·032 oz. of gold, and 2·53 oz. of silver per ton.

MELBOURNE

July 20.

Gold in Western Australia.—The annual report of the Chamber of Mines of Western Australia, for 1945, shows a decrease in both tonnage of ore treated and yield of gold in comparison with the figures for 1944. Despite rise in costs and other disturbing factors, it was possible to maintain a grade of ore very close to that worked in immediately preceding years. Progress of the industry in recent years is summarized in Table 1 and compared with the State's peak year, 1903. The figures in Table 2 are those for dividends paid, wages and store disbursements, and employment.

Table 1

Year.	*Ore Treated. Long Tons.*	*Gold Recovered. Fine Oz.*	*Average Grade. Dwt. per Ton.*
1903	2,160,637	2,335,425	21·62
1929	628,400	377,176	12·00
1930	645,344	417,518	12·93
1931	982,163	510,572	10·39
1932	1,327,021	605,561	9·12
1933	1,588,979	637,207	8·02
1934	1,772,931	651,338	7·35
1935	1,909,816	649,049	6·80
1936	2,492,034	852,421	6·77
1937	3,039,608	1,007,289	6·62
1938	3,759,120	1,172,950	6·24
1939	4,095,257	1,188,286	5·80
1940	4,291,680	1,154,843	5·38
1941	4,210,774	1,105,477	5·25
1942	3,225,704	845,774	5·24
1943	2,051,011	531,747	5·18
1944	1,777,128	472,588	5·32
1945	1,736,592	469,906	5·41

Table 2

Year.	*Dividends Paid. £ (Aust.).*	*Wages, Stores. £ (Aust.).*	*Men Employed.*
1903	2,024,152	7,896,096	20,176
1929	65,607	1,536,535	4,108
1930	31,250	1,833,192	4,452
1931	53,125	2,945,012	6,344
1932	320,584	4,083,058	7,983
1933	842,843	4,043,431	10,165
1934	991,275	4,567,598	12,523
1935	1,124,918	4,577,231	14,692
1936	1,101,967	6,271,572	15,329
1937	1,213,529	7,580,104	15,845
1938	1,103,244	9,300,822	15,083
1939	1,338,111	10,257,110	14,961
1940	1,059,936	11,246,880	14,368
1941	830,032	10,981,957	12,929
1942	423,712	8,414,605	8,033
1943	630,046	4,926,715	5,048
1944	814,715	4,151,736	4,584
1945	458,479	4,564,816	4,786

The advance in the technical side of the industry, in the treatment of ore of steadily decreasing grade, and the value of the industry as a whole to the State is clearly shown by the summary. The decline is entirely due to war conditions and although progress in 1946 has been slower than was hoped there is improvement in output despite slow return of labour to the mines and strong indifference on the part of the Federal Government to the future of the industry. The State Government, on the other hand, is doing all possible

in the circumstances to assist the upward curve of gold mining. The price for gold, after deductions for Commonwealth gold tax, from June 10 to December 31, 1945, was £9 17s. 7½d. (Aust.). Industrial relations in the State were, generally, good during the year. Increase in operations by many companies was difficult or impossible through uncertainty and impossibility of obtaining necessary stores and machinery and this condition still obtains. The minimum wage payable in the industry at the close of the year was 21s. 2d. per shift, or £6 7s. (Aust.) per week, exclusive of district allowances; the highest rate for mine employees on wages was 30s. per shift, or £9 (Aust.) per week. The leading producer was Lake View and Star, Ltd., which treated 279,579 long tons of ore for a recovery of 88,340 fine oz. of gold and employed 512 men, followed by Great Boulder Proprietary Gold Mines, with 276,778 tons for 71,560 fine oz. and 587 men; Wiluna Gold Mines, Ltd., 334,638 tons for 38,016 fine oz.; North Kalgurli (1912), Ltd., 107,737 tons for 31,064 fine oz., and Gold Mines of Kalgoorlie, Ltd., 109,334 tons for a recovery of 25,357 fine oz. of gold.

Gold in Victoria.—An improvement is shown in the State production of gold for the first five months of the current year, in comparison with the same period of 1945, the increase in output being from 21,693 fine. oz. from January to May, compared with 30,772 fine oz. in the same months of 1946. The month of May recorded the highest yield, 7,894 fine oz., since 1942. Many idle mines on the Bendigo and other fields are resuming work, but expansion is hindered by Government restrictions on share-market dealings, through the imposition of ceiling prices and the necessity under regulations of holding shares for five months before resale is permitted. In addition, the restriction of capitalization of new companies to £10,000 is proving fatal to many new enterprises of promise. The record year in Victorian gold production was 1906, when production was 3,053,744 fine oz. to the value of £12,214,976 at the price of gold ruling at that period, which was between £3 17s. 6d. and £4 per oz.

Aberfoyle Tin Mine.—The leading tin mine in Tasmania is Aberfoyle Tin, N.L., which, since 1926, has milled 190,586 tons of ore for a total production of 3,904 tons of tin concentrate and 492 tons of wolfram concentrate, having a gross value of £906,025 (Aust.). Average operating costs over the period have been £3 7s. 2d. per ton; the net profit has been £1 7s. 11d. per ton milled and dividends have been paid amounting to £182,880 (Aust.). The mine is working several lodes varying in width from a few inches to 7 ft., which occur in a zone of Cambro-Ordovician rocks intruded by Devonian granite. Payable veins extend for distances along the strike up to 1,400 ft., the width of the tin-bearing zone being 400 ft. The mineral-bearing series of rocks is covered by Permiam sedimentaries and was exposed by faulting. The vein minerals are quartz, sericite, and pinite, with pyrite, arsenopyrite, pyrrhotite, marcasite, galena, sphalerite, chalcopyrite, tetrahedrite, stannite, and the economic minerals cassiterite and wolframite. The cassiterite and wolfram are coarse with little intergrowth.

The mine is worked from a vertical shaft, 12 ft. by 5 ft. in section, and the lowest level is at 627 ft. from surface. Trucks of 10-cwt. capacity are hoisted in cages by an electric winder at a rope speed of 600 ft. per minute. Cost of shaft sinking from 405 ft. to 641 ft., between the years 1943 and 1944, was £29 8s. 2d. (Aust.) per foot. The ore reserves are: Positive ore, 50,495 tons; probable ore, 18,636 tons. The ore mined and developed is equivalent to 705 tons per vertical foot. Horizontal cut-and-fill stoping is practised, the width of stopes being from 4 ft. to 18 ft. depending on the width of the individual veins and their distribution. A stoping party consists of two men who receive £3 5s. (Aust.) per fathom. Tests are being carried out with ring drilling and shrinkage stoping has been considered and abandoned. Mining costs are shown in Table 3. Costs of shaft sinking

Table 3

	Wages.	*Other Costs.*	*Total.*
	s. d.	*s. d.*	*s. d.*
Stoping	17 10	6 6	24 4
Development	3 7	1 8	5 3
Haulage	4 5	1 3	5 8
Totals	25 10	9 5	35 3

and driving main cross-cuts are not included. The mill has a capacity of 10 tons of ore per hour and the average grade of the ore treated is 1·5% Sn; 0·2% WO_3. Final concentrates represent 2·1% of the total mill products.

The ore is crushed in jaw and gyratory

crushers and rolls in closed circuit with a $\frac{3}{8}$-in. screen; the various fractions are separated by cataract screens, Hum-mer screens, and a Fahrenwald sizer. Coarser fractions pass to jigs and the finer sizings to Wilfley tables. Coarse middlings are reground in a rod-mill, 2 ft. diameter and 4 ft. long, and are returned to the circuit. Sand middlings are reground in a Hardinge mill, 36 in. by 4 ft. 6 in., and are then floated in M.S. cells to produce a sulphide froth containing 1·2% Sn, which is discarded, the flotation tailings being returned to the circuit. Classifier overflows are collected in a Dorr thickener, 25 ft. diameter and 7 ft. deep, and the thickened pulp is tabled. Slime table concentrate is cleaned by flotation, the sulphides are returned to the float cells in the sand section, and the slime table middlings join the sand middlings for re-grinding and flotation. Bulk concentrate is dried and magnetically separated to yield final tungsten concentrate and a non-magnetic product, which after cleaning produces final tin concentrate. The cleaning is effected by flotation and the float froth is returned to the cells in the sand section. Slime concentrate is marketed separately from coarse concentrate. Recovery of cassiterite is 86%.

Assay value of the concentrate is: Tin concentrate, firsts, 74·5% Sn, 0·7% WO_3; seconds, 63·0% Sn, 0·5% WO_3; slime, 65·0% Sn, 5·0% WO_3; the wolfram concentrate assays, 0·5% Sn, 73·0% WO_3. The assay value of tailings is: Coarse, 0·12% Sn; sand, 0·12%; slime, 0·7%; sulphide tailings, 1·2%. A substantial part of the sulphide tailings loss is in the form of stannite. Reagents used in sulphide flotation are: Copper sulphate, 0·5 lb.; sodium ethyl xanthate, 0·2 to 0·4 lb.; amyl xanthate and sodium silicate have also been used. Jigs treat four separate sizings: $-\frac{3}{8}$ in., $-\frac{1}{4}$ in., $-\frac{1}{8}$ in., and $-\frac{1}{16}$ in. Costs will approximate 7s. 6d. per ton, distributed as follows: Supervision, 10%; operating labour, 40%; maintenance labour, 10%; power, 12½%; stores, 27½%. Electric power consumption is 17·2 kW. hr. per ton.

A 1 Gold Mine.—The A 1 Consolidated Gold Mine at Gaffney's Creek, Victoria, continues to mine and mill high-grade ore. Reports state that this ore is being mined over increasing widths in the south workings and prospects for continuance are considered to be good. The mine has now been developed to a depth of 1,500 ft. from surface and increasing attention is to be given to the south end of the bulge in the diorite dyke in which the quartz reefs occur. The last return reported is 360 tons of ore milled for a recovery of 815 oz. of gold, an average of 45·3 dwt. per ton, and in addition, three tons of sulphide concentrate was recovered from tables and strakes. Returns for the three previous fortnightly periods were 30·4 dwt., 29·7 dwt., and 21·1 dwt. gold per ton. A dividend of 4s. per share, totalling £18,000 (Aust.), has just been paid, making the total dividends paid £328,500 or 73s. per share. A sum of 13s. per share has been distributed since the beginning of the year.

Development Possibilities at Kalgoorlie.—There are prospects that a large area north of the operating mines at Kalgoorlie, Western Australia, may prove to contain ore-bodies of importance. Much work was carried out to shallow depth in the early years of the field and a considerable amount of gold was recovered from areas now held by Mount Charlotte Gold Mines and Maritana Gold Areas. The former is held under option by Wiluna Gold Mines, Ltd., and the last named is being prospected by Paringa Mining and Exploration Co., Ltd. This company has put down what diamond-drill bores were possible during war-time with the object of locating the southward extension of the ore-bodies which had previously been located by drilling in the Mount Charlotte leases. Results have been generally satisfactory and give encouragement to further exploration. Four bores, put down from surface, have given the following results:—No. 1 bore-hole intersected ore between 800 ft. and 825 ft. from surface, which gave 5·21 dwt. gold over a width of 58 in. and 5·25 dwt. over 153 in.; No. 2 bore, between 685 ft. and 800 ft., returned values of 4·79 dwt. over 75 in., 4·17 dwt. over 103 in., and 7·29 dwt. over 74 in., the measurements being true widths. No. 3 bore intersected ore at much shallower depth; true widths have not been reported, but 2 ft. of core at 165 ft. assayed 5·29 dwt. and 13½ ft. of core at 350 ft. assayed 3·04 dwt. per ton. No. 4 bore has produced 18 ft. of core from a depth of 435 ft., with an assay value of 3·27 dwt. per ton. The company will, no doubt, carry out further drilling, the results of which will be watched with interest. There is approximately a mile of country on the same line, which has been worked to shallow depths only and contains development possibilities.

Personal

T. St. H. Acland is returning from New Zealand.

R. J. Agnew is expected from Western Australia.

H. E. Allen is returning from South Africa.

A. J. Baeyens is leaving for the Belgian Congo.

G. C. Barnard is now in Kenya.

G. H. Beatty has retired from his position as joint general manager of the Johannesburg Consolidated Investment Company.

J. G. Berry is leaving for India.

H. O. Berryman is now with the Mines Department, Tanganyika Territory.

C. W. F. Bond has left for the Gold Coast.

H. A. Cochran is home from Nigeria.

W. S. Coombes has left for Malaya.

W. Dunn is now in Germany.

W. J. Dyack is now with the Nairobi District Council as engineer.

D. Eastmond has left for South Africa.

P. P. Edwards is returning from India.

W. E. Everitt has left for Malaya.

J. L. Farrington has left for Nigeria.

E. Ferreyros has left Peru for the United States.

V. L. Gasper is home from Germany.

A. G. Glenister has been re-elected chairman of the Council of the Malayan Chamber of Mines.

F. R. H. Green is here on leave from British Guiana on his way to take up the position of Chief Inspector of Mines, Sierra Leone.

D. W. J. Grey is home from Brazil.

A. C. Harrison is leaving for Burma.

C. A. Hart has been awarded the Royal Geographical Society's Murchison Grant for 1946 for his work on the application of radar to mapping.

G. L. Hatherly has left for South Africa.

F. T. Ingham has left for Malaya.

R. F. Lethbridge is back from Malaya, where he has joined the firm of Park and Francis of Kuala Lumpur with E. F. Elkan.

R. I. Lewis is here from Portugal.

D. H. McCall is shortly returning from India.

G. B. MacKenzie is now in Sierra Leone.

J. B. Mackie has returned to Malaya from New Zealand.

J. H. M. McNaughton has left for Northern Rhodesia.

P. B. Marriott is on his way to Malaya.

R. Murray Hughes has left on a short visit to Yugoslavia.

G. Maxwell Norman is now in Venezuela.

H. J. D. Penhale is here from Fernando Po.

T. Pickering, now released from the Forces, is in England.

H. C. Reis is now working on the Scottish hydro-electric scheme.

R. S. H. Richards is here on leave from Portugal.

Kenneth Richardson has been appointed general manager to the Johannesburg Consolidated Investment Company.

H. C. Robson is home from India.

R. H. Skelton has returned from Australia.

J. Spalding has returned from India.

N. A. Stacey is returning on leave from the Gold Coast.

T. J. Thomson has left New Zealand for Malaya.

C. W. Walker is now in Gold Coast Colony.

D. A. B. Watson has been appointed consulting engineer in South Africa to the Johannesburg Consolidated Investment Company.

H. J. R. Way is home from South Africa.

A. S. W. Wood has left for Sierra Leone.

James Park, whose death in New Zealand at the age of 89 is reported, was born in Aberdeen and received his training at the Royal School of Mines between 1872 and 1874. In 1878 he was appointed assistant geologist to Sir James Hector of the New Zealand Geological Department. Some ten years later he became Director of the Thames School of Mines and Superintendent of the Government Experimental Metallurgical Works. In the period from 1896 to 1901 he acted as consulting engineer to various companies interested in New Zealand mining, but in the last-named year he was appointed Professor of Mining and Mining Geology at Otago University. Professor Park became Dean of the Mining Faculty at Otago and on his retirement in 1932 he was appointed Professor Emeritus. A man of wide experience and the author of many papers and several standard text books of mining, mining geology, and metallurgy Professor Park was a former Governor of the New Zealand Royal Society and an Honorary Member of the Institution of Mining and Metallurgy.

THE INSTITUTION OF MINING AND METALLURGY

Elections and Transfers

Member.—Gerald Chad Norris (*Tarkwa, Gold Coast*).

Associate to Member.—Frank Tinley Ingham, Ph.D., A.R.C.S., B.Sc. (Geol.) (*London*), D.I.C. (*Exmouth, Devonshire*); Alan John Walker Legge, A.R.S.M. (*Entebbe, Uganda*); Donald Asire MacKay, A.R.S.M. (*Penang, Straits Settlements*); Sydney Herbert Shaw, A.R.S.M., B.Sc. (Min. Geol.) (*London*) (*Jerusalem, Palestine*).

Associate.—Ranganatha Rao Subba Rao Batni, A.I.S.M., B.A. (*Mysore*) (*Robertsonpet, Mysore State, S. India*); Martin Keough (*Que Que, S. Rhodesia*); Arthur Liston Lloyd (*Mount Morgan, Queensland, Australia*); William Mackenzie (*Silos de Calañas, Huelva, Spain*); John Henry Polglase, A.C.S.M. (*Sungei Besi, Selangor, Malaya*).

Student to Associate.—Oscar Julius Blau, B.E. (Min. Metall.) (*Sydney*), (*Sydney, N.S.W., Australia*); James Cameron, B.Sc. (Geol.) (*Aberdeen*) (*London*); Ronald Arthur Cave, A.C.S.M., B.A. (*Cambridge*) (*Burnley, Lancashire*); Joseph Chynoweth, Jnr., A.C.S.M. (*Ipoh, Perak, Malaya*); Thomas Frederick Bridgewater Spencer (*Pilgrim's Rest, Transvaal, S. Africa*); Brian Antony Tregay, A.C.S.M. (*Royal Navy*); Austin Gerald King, A.C.S.M. (*Nkana, N. Rhodesia*); Richard Oxley-Oxland (*Johannesburg, Transvaal, S. Africa*).

Trade Paragraphs

Huntington, Heberlein, and Co., Ltd., of 114, Cromwell Road, London, S.W. 7, have received an order from Dorman, Long, and Co., for a complete sintering plant—Dwight Lloyd continuous sintering machines.

Ruston-Bucyrus, Ltd., of Lincoln, in the *Digger* for January–June have the second and final part of the company's war history. This deals with activities of the company's staff in the Home Guard, Civil Defence Services and National Fire Service, and Royal Observer Corps.

High Speed Steel Alloys, Ltd., of Widnes, in *Alloy Metals Review* for June have an article on developments in low alloy steels for welding constructions and a number of abstracts. Among these are one on the German steel industry and another on refractory metal composition by powder metallurgy.

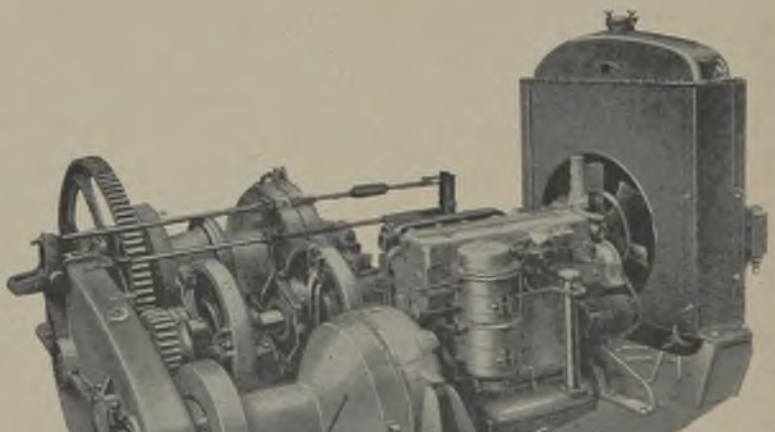
Mond Nickel Co., Ltd., of Grosvenor House, Park Lane, London, W. 1, in the *Nickel Bulletin* for June have extracts on nickel catylists in synthetic fuel production, nickel-iron alloys for magnetic circuits, determination of copper and of titanium in corrosion-resisting steels, and photometric estimation of silicon in steel.

British Export Trade Research Organization, of Premier House, 48 Dover Street, London, W. 1, announce that Mr. Ivor Cooper (Lever Bros. and Unilever, Ltd.) completes his year of office as chairman of the Council this month, and the deputy chairman, Mr. Leslie Gamage, joint managing director of the General Electric Co., Ltd., has been elected chairman for this ensuing year. Mr. Leslie Gamage is succeeded as deputy chairman by Mr. C. Percy Lister of R. A. Lister and Co., Ltd.

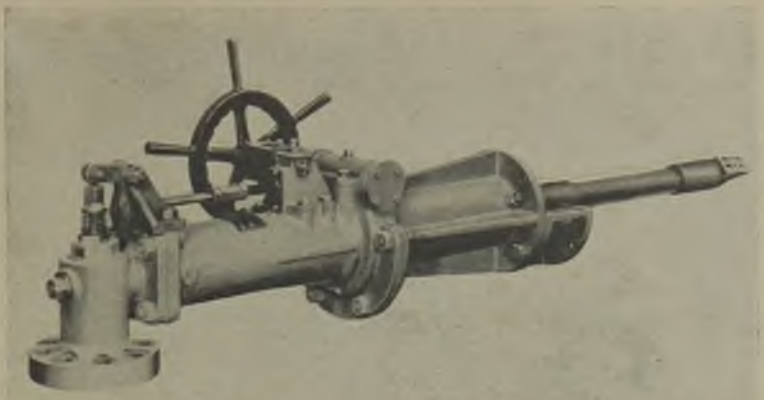
Visco Engineering Co., Ltd., of Stafford Road, Croydon, have compiled a new air filter catalogue. An introduction recalls that the Visco filter was first introduced in 1921 and was the first all-metal filter using oil-film covered surfaces for the removal of dust from air and gases. The surfaces are in the form of small ferrules and these are packed in suitably-shaped frames with wire covers, the frames being readily detachable for cleaning. Many examples of the arrangement and application of installations are illustrated in the new catalogue, which also gives particulars of small filters, pressure filters, self-cleaning filters, and " dry " filters.

Wild-Barfield Electric Furnaces, Ltd., of Elecfurn Works, Watford By-Pass, Watford, Herts, announce the formation of the Société Anonyme Wild-Barfield, 165, Rue Belliard, Brussels. This new company has been formed to handle the sales and service of Wild-Barfield furnaces in Belgium, Holland, and Luxembourg, and to represent also the associated company, G.W.B. Electric Furnaces, Ltd., in the same territory. The company state that, in keeping with their general policy, the aim is to give to customers in those territories the same complete service as the organization in this country offers to users over here and to this end engineers trained in the design, construction, and application of Wild-Barfield and Gibbons-Wild-Barfield furnaces are on the staff of S.A. Wild-Barfield to deal with all technical matters. The full resources of the research and development departments are available to the new company when required. They also announce that Dr. R. H. Barfield is joining the research and development staff. This appointment has been made with a view to strengthening still further the team of specialists in various branches of science and engineering with which the company's widening field of activities comes into contact.

Ransomes and Rapier, Ltd., of Ipswich, have produced a new catalogue devoted to the Rapier 423 excavator, which is a ⅜ cu. yd. machine available as a shovel, dragline, grab, crane, trencher, skimmer, and pile driver, with interchangeable equipment. The power unit, which is illustrated, comprises a diesel or petrol-paraffin engine of 57 b.h.p. and a fluid coupling is strongly recommended. The advantages of this are given as :—(1) Greater outputs are obtainable as full engine torque is delivered to the bucket right up to the moment, and even after, the bucket may have become stalled in the



Rapier 423 Power Unit.



Hopkinson's Single-Nozzle Soot Blower.

cut. (2) Shock loads and snatch are almost entirely eliminated. This results in longer life of all wearing parts, particularly ropes. (3) The engine cannot be stalled or badly over-loaded.

Hopkinsons, Ltd., of Huddersfield, have made available some notes on soot blowers, from which the following is taken :—As a means of increasing the efficiency and availability of water-tube boilers, as well as effecting economies in fuel consumption, the soot blower is now widely recognized as an important adjunct to power plant. Careful attention to the automatic synchronization of the opening and closing of the steam valve with the movement of the blower discharge tube and special consideration in designing the nozzle and internal parts have minimized steam consumption. In addition, the ease and quickness of operation, together with facilities for the remote control of soot-blowing equipment, have reduced operating costs to a marked degree. These requirements are characteristics of the latest type of manually-operated soot blowers manufactured by the company which are of two general types—the single-nozzle retractable type and the non-retractable rotary type, which is also available as a single-nozzle or multi-nozzle unit. The single-nozzle retractable blower is recommended for installation whenever space is available for its efficient operation, particularly where high gas temperatures are experienced—such as, in combustion chambers or near superheaters. The nozzle is automatically withdrawn from the influence of the hot gases when not in use, thereby avoiding damage by burning and the necessity for frequent nozzle replacement. The multi-nozzle rotary type of soot blower generally serves multi-tube boilers, where the flue gas temperatures permit the permanent installation of the multi-nozzle element. It is generally fitted in the last passes of water-tube boilers and for cleaning economizers. A special feature is the patent flexible fluid-tight coupling which permits differential expansion between the blower head and the element. The single-nozzle rotary type is similar in design to the above blower, a single nozzle being substituted for the multi-nozzle element. This type of blower is suitable for location where the gas temperatures are below 1,650° F. and where space is available for its efficient operation. All these blowers open anti-clockwise and close clockwise. Special features include automatic integral valves with positive opening and closing, valves and seats of " Platnam ", and visual " On-Off " indicator gear. The nozzles are of special heat-resisting material and all mechanism is totally enclosed and dustproof. In addition, the company have standardized a range of electrically-operated and automatic sequence-controlled soot blowers.

British Thomson-Houston Co., Ltd., of Rugby, have compiled an illustrated booklet devoted to the war achievements of the company. The following are extracts from the introduction :—Although many of the company's peace-time products were indirectly required to meet the emergency very many widely different mechanisms and devices for war purposes were developed and used with marked success. A vast amount of direct armament production was carried out by utilizing to the fullest extent the entire resources—research, technical, and manufacturing—of the company and by close collaboration with various Government departments. Most engineers are familiar with BTH products, from the largest steam turbines to the smallest electric motors and lamps, but they have not known of the part BTH has played in devising cunning apparatus for the detection of clouds, guns, aircraft, ships, and submarines ; complex equipment for the remote control of aerials, searchlights, and gun turrets, or for the destruction of mines at sea. Secrecy also forbade any mention of new radio valves, receivers, and transmitters ; of aircraft electrical equipment, aircraft engine ignition, and of aircraft themselves ; of anti-aircraft shells and of anti-flying-bomb devices ; of electric torpedoes, and of the greatest secret of all, kept successfully for eight years, the development of the Whittle gas turbine.

The BTH research laboratories were increased to three times normal proportions, about three times as many factories were operated, and 4,000 employees were released for Government services. Refrigerator and switchgear shops were ruthlessly dismantled and turned over to shell lines, control gear shops to Radar, and lamp assembly areas to small special valves and large mines. Cinema equipment shops were transformed into aircraft equipment areas and small assembly shops converted into aircraft wing building shops, while cutting-tool manufacture made way for special projectiles. All this had to be done in order to produce the new and widely varied range of armaments for which BTH was responsible, entailing an enormous amount of work in connexion with the layout, tool design,

testing arrangements, and many other factors involved in the inauguration of different manufacturing sections. Although the extensive Rugby works of the company required only a small increase in floor area it was necessary to acquire many other factories in different parts of the country—notably, at Peterborough, Northampton, Leicester, and in the north—in order to cope with the great demand on the company's developmental and manufacturing resources. At Rugby, as at other BTH factories, the capacity was increased by the introduction of a large night-shift, which for the first time included women.

The booklet deals in turn with work done in the Research Laboratory, radar, jet propulsion for aircraft, the anti-acoustic mine device, electrically-propelled torpedoes, predictors, activities of other BTH works, and other war-time activities—such as, power station equipment and mobile power plants, lamps, and further work on the gas turbine. The publication has been produced primarily for distribution overseas and very few copies are available in this country.

Bristol Aeroplane Co., Ltd., of Filton, Bristol, issue detailed notes regarding their Type 170 Freighter and Wayfarer, which is described as Britain's first post-war aircraft to be built entirely to a civil specification and is designed to fulfil the need for a simple and reliable twin-engined aeroplane capable of operating from small landing grounds with a payload of five tons or carrying up to 40 passengers. Two distinct versions are being produced—the Freighter and the Wayfarer—the first for cargo services, for which low cost of operation is essential, and the second for passenger travel. The Freighter is a twin-engined high-wing monoplane of all-metal construction with a fixed undercarriage. The cargo hold has been specially designed to facilitate rapid loading and unloading through the nose, fitted with large doors opening sideways, which allow unobstructed access to the full width of the hold. A three-ton lorry may be driven up a ramp straight into the hold. The main floor is constructed of light-alloy beams and inter-costals with a wooden floor, which will support a unit load of 200 lb. per sq. ft.; two strips 16 in. wide built into each side permit the carriage of wheeled vehicles having a maximum wheel loading of 5,000 lb. The freight doors and trailing edge flaps are operated by hydraulic jacks energized by an electrically-driven pump. The Freighter is powered with two Bristol Hercules 131 14-cylinder sleeve-valve engines rated at 1,675 b.h.p. for take-off. This engine is a transport purpose version of the Hercules engine used in the Bristol Beaufighter and many other military aircraft, which has operated with consistent and outstanding success in every command of the Royal Air Force. The Hercules 131 has a single-speed supercharger, giving maximum power at 7,000 ft., and is designed for long service between overhauls under transport conditions. Four-bladed Rotol constant-speed feathering propellers are fitted, having large spinners, and cooling fans may also be supplied for tropical use.

The Wayfarer is of the same basic construction as the Freighter, but the large doors in the nose of the aeroplane are replaced by a fixed nose (Fig. 1). A non-structural forward bulkhead is added and the cargo compartment is fully equipped for passengers. Seating for up to 40 passengers can be arranged, but the standard design caters for 32 persons in 16 double seats facing forward. These seats are placed eight on either side of a central gangway, and adjacent to each pair of seats is a large window, which allows, in conjunction with the high wing, an unrestricted range of vision. The minimum headroom in the compartment is 6 ft. 8 in. and the distance between the seats is 40 in.

Utilization of the 170.—The company is prepared to discuss with operators the provision of such specialized equipment as de-icing, ski or float undercarriage, mail pick-up and dropping devices, and the installation of containers or specialized racks. The large stowage capacity of the aircraft permits adaptation to a wide range of purposes and the constructors suggest that by co-operation at an early stage of development the fullest use of the design versatility may be made. Some of the possible uses of the aeroplane are: Freighter, standard cargo version for: (*a*) Scheduled services; (*b*) Bush operation; (*c*) Exploration work. Wayfarer, 32-seat passenger version for short range and feeder services. Combined freighter/passenger version, with readily detachable seats, for scheduled services. Medical services (operating theatre, dentistry, etc.). Photographic survey (with complete processing facilities). Regarding supplying remote projects the makers state that the carriage of various kinds of bulky articles, especially of machinery or vehicles, would therefore seem to offer a particularly fruitful sphere in the employment of the Freighter. Mining projects, bridge-building, and track-laying work in remote and inaccessible regions provide unlimited opportunities for making use of the advantages exclusive to cargo-carrying aircraft (Fig. 2). For the rapid

Fig. 1.

Fig. 2.

delivery of supplies, food, machinery replacements, and vehicles, and for the carrying of personnel between base and location, the cargo aeroplane offers a unique service. The Freighter has been designed to operate under arduous conditions; no region can be entirely inaccessible to it and, its maintenance needs being small, the Freighter will operate safely and economically over the wildest countryside with very little attention. Loading and unloading constitute no problem, an important consideration on any task where a quick "turn-round" is necessary and particularly so on any project where a constant stream of supplies is a routine essential.

Metal Markets

Copper.—The official maximum price of electrolytic copper in the United Kingdom has shown no change during the month, but despite the appreciable advance made at the beginning of July it is still somewhat lower than the world level. Consumption of virgin metal at the moment is running at something in the neighbourhood of 25,000 tons monthly, while stocks, which have been steadily eaten into, are now insufficient to cover more than a month or two's requirements. The news of a settlement of strikes in both America and Chile was well received and it was hoped that some improvement in world copper supplies would become apparent as a result, but the announcement was quickly followed by an intimation of labour troubles in the big Northern Rhodesian properties of Mufulira, Rhokana, N'Changa, and Roan Antelope.

An item of major interest was the abolition of the American Office of Price Administration on June 30 and while producers there made no move to advance their selling price from the hitherto official "ceiling" of 14·375 cents per lb. the world price has stiffened to fully 16 cents. It has recently been announced that the Reconstruction Finance Corporation has suggested to the re-installed O.P.A. that it raise the copper "ceiling" to 16 cents per lb.

Tin.—The attention of interested quarters has continued throughout the month to be focused on the possibilities of an advance in the official maximum United Kingdom quotation. At the time of going to press, however, no change has taken place, but current world indications are such that it is difficult to see how the price can be pegged down for much longer. The British Government has held discussions with a view to arranging a more equitable quotation for tin, while in a recent debate in the House of Commons on Malaya the Secretary of State for the Colonies stated that "a very important decision" relating to tin prices would be reached before long. Negotiations between America and Bolivia regarding tin ore supplies from the latter country were reported to have reached a measure of agreement—the Bolivians have been demanding 66 cents per lb. f.o.b.—but with the change of Government resulting from the recent revolution the outlook has once again been obscured.

United Kingdom official maximum price: £300 a ton, delivered.

Lead.—The past month has seen no fresh developments in the lead producing and consuming industries and world supplies have remained very much on the short side. The Minister of Supply has stated that this country has been obtaining its fair share of what supplies are available, but a good deal of dissatisfaction has continued to be expressed among consuming industries. The lead pipe and sheet manufacturers in particular have been unable to meet anything like their requirements and a good deal of recourse has been made to scrap in an effort to maintain output. In the United States the price has been temporarily forced back to a "ceiling" of 8·25 cents after being 9·50 cents per lb.

United Kingdom official maximum price for soft foreign lead, £55 a ton, delivered.

Zinc.—In both Britain and America supplies of raw zinc have been adequate for current requirements, although a good deal of eating into stocks has been evident; in the last-named country doubts regarding the future price, following on the temporary abolition of the O.P.A., has had a quietening effect on business in zinc generally. United Kingdom June imports amounted to a mere 5,199 tons, against 14,037 in June, 1945, and made a total for the year so far of 11,466 tons, compared with 63,915 tons last year.

Mean price g.o.b. foreign zinc: £50 a ton, delivered, duty paid.

Iron and Steel.—Activity in the iron and steel industry has remained as feverish as hitherto and output has been well maintained, although a certain amount of falling off has been evident as a result of Whitsun, V-Day, and annual holidays. Production of pig-iron, whilst adequate for current requirements, could usefully be increased if more supplies of fuel were forthcoming; as it is, however, a shortage of coke is preventing the lighting of further furnaces. Steel makers and rollers all have very full order books and new business is confined to first and second quarter 1947 delivery. Recent advances in rail charges, both to and from the works, together with higher fuel charges lend strength to the steel-makers' demands that official prices should be advanced and Government circles are believed to be not unsympathetic with this view.

Iron Ore.—Demand for high-grade ore, as a result of the intense demand for iron and steel, has been well maintained throughout the month. Imports of good-quality foreign ore have continued as home

output has fallen off, although consideration has had to be given to the question of foreign exchange.

Antimony.—Demand has been well maintained throughout the month, but with ore supplies none too plentiful a certain amount of difficulty is experienced by producers in meeting current needs. Meanwhile the official price for English 99% regulus is unchanged at £125 a ton.

Arsenic.—White arsenic has been somewhat on the short side during the month and as a result prices are firmer at around £38 6s. 3d. per ton, ex store, for 99% to 100% material in 10-ton lots.

Bismuth.—For merchant quantities 9s. per lb. has continued to be quoted by sellers in this country.

Cadmium.—There is an undoubted shortage in world supplies of cadmium at the moment. Following decontrol of the metal by the Government towards the end of June the market has not really settled down and it remains difficult to name a firm price. Small lots have, however, changed hands recently at 7s. 6d. per lb. In the United States it has been decided, following the reformation of the O.P.A., to leave cadmium and its compounds a free market.

Cobalt Metal.—Around 9s. to 9s. 1d. per lb. remains the current price.

Cobalt Oxides.—For black oxide 8s. 7½d. per lb. continues to be asked and 9s. 5½d. per lb. for grey.

Chromium.—For 98% to 99% metal 4s. 5d. to 4s. 8d. per lb. remains the current price.

Tantalum.—No change has been noted throughout the month, with the price maintained at about £18 to £19 per lb.

Platinum.—Dealers continue to report a good demand for platinum, but with supplies decidedly short more interest tends to be shown in palladium. Leading interests here now quote about £17 per troy oz. for the home market and nominally £20 for whatever is available for export.

Palladium.—With platinum in short supply a better inquiry for palladium is apparent. Current quotations, however, show no change at £5 15s. to £6 per troy oz.

Osmium.—Nominally £18 to £20 per troy oz. is being asked by sellers.

Iridium.—Leading interests currently quote about £34 per troy oz.

Tellurium.—The market has remained quietly steady at 7s. per lb.

Selenium.—A steady demand has been noted at the ruling price of 8s. 6d. per lb.

Tungsten Ore.—Consumers in this country have continued to be able to cover their requirements adequately. Imports during the first six months of the year have totalled 2,590 tons, of which 1,610 tons came from Portugal. The United Kingdom official selling price has recently been reduced and is now 70s. per unit, delivered.

Manganese Ore.—Few fresh developments have been noted throughout the month, with users here able to obtain whatever supplies they required. Transport difficulties have, however, resulted in certain countries being unable to buy sufficient tonnages to cover their needs. There has been no change in the United Kingdom official selling price, which remains at 1s. 2d. per unit c.i.f., on the basis of pre-war freight and insurance rates; buyers quote from 1s. 2¾d. to 1s. 4¾d. per unit, on the same basis.

Aluminium.—With effect from August 1 Government war-time control of the purchase of aluminium and light alloys has been relaxed. Owing to a contract which the Ministry of Supply has entered into with Canada for the supply of 215,000 metric tons of virgin aluminium for 1946–7 delivery the Government will continue to be the sole buyer and seller of virgin metal.

Copper Sulphate.—The ruling quotation remains unchanged at £32 5s. per ton f.o.b., less 2%.

Nickel.—There has been no falling off in the demand for nickel and with steel production likely to remain considerable for some time the tone of the market is decidedly firm. According to quantity, the current price is £190 to £195 a ton.

Chrome Ore.—While users appear able to obtain sufficient tonnages there is an undoubted shortage of high-grade metallurgical ore. The current official price for both Rhodesian metallurgical and Baluchistan chemical grades is £10 a ton.

Quicksilver.—There is no shortage of quicksilver in the world at the moment and price tendencies are downwards. Whilst a certain amount has recently changed hands at £22 10s. a flask, f.o.b., the open market quotation is more in the neighbourhood of £20. In Britain the official maximum price remains at £30 to £31 5s. per flask, according to quantity.

Molybdenum Ore.—Sellers here continue to quote around 42s. 6d. to 45s. per unit of MoS_2, f.a.s.

Graphite.—The price of graphite is nominal and remains largely a matter of negotiation.

Silver.—Consumers in this country continue to obtain sufficient supplies from official stocks at the current price of 44d. per troy oz. In America the price for domestic produced silver is now 90½ cents per oz., with foreign produced material 90⅛ cents.

METAL PRICES

Aluminium, Antimony, Copper, Lead, Nickel, Tin, and Zinc per Long Ton; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	67	0	0
Antimony (Eng. 99·6%)	125	0	0
„ (Crude 70%)	100	0	0
Copper (Electro)	84	0	0
Lead (Soft Foreign)	55	0	0
Nickel (Home)	£190–£195		
Tin	300	0	0
Zinc (g.o.b.)	50	0	0
Platinum (Refined)	17	0	0
Silver		4	7½
Gold	8	12	3
Wolfram (Buying, f.o.b.)	3	10	0
„ (Selling, Delivered)	3	10	0

Statistics

TRANSVAAL GOLD OUTPUTS

	June*		July‡	
	Treated Tons.	Yield oz.	Treated Tons.	Yield Oz.
Alpine (Barberton)	5,957	906	—	—
Blyvooruitzicht	30,000	24,041	34,000	28,874
Brakpan	106,000	£187,560	110,000	£189,215
City Deep	89,000	22,676	95,000	23,512
Cons. Main Reef	212,000	28,377	219,000	29,540
Cons. Murchison (T.V.L.)	7,300	£20,036	7,500	£20,627
Crown Mines.....	260,000	57,539	278,000	60,501
Daggafontein	161,000	£385,811	154,000	£368,208
Dominion Reefs	23,000	3,375	—	—
D'rb'n Roodeport Deep	175,000	32,390	188,000	34,024
East Champ D'Or	29,000	£45,382	30,000	£47,759
East Daggafontein	94,000	£204,018	94,000	£203,884
East Geduld	151,000	43,204	164,000	45,770
East Rand P.M.....	204,000	40,566	214,000	42,815
Geduld.....	102,000	21,584	110,000	23,284
Geldenhuis Deep	64,000	11,396†	67,000	7,351
Glynn's Lydenburg ...	10,000	2,800	10,300	2,742
Government G.M. Areas	212,000	£339,929	236,000	£348,761
Grootvlei Proprietary .	158,000	49,685	168,000	43,267
Langlaagte (In Liq.) ..	48,000	£67,066	48,000	£64,722
Luipaards Vlei	84,000	17,559	88,000	17,965
Marievale Consolidated .	53,500	16,053	57,500	17,256
Modderfontein B	62,000	9,483	62,000	9,346
Modderfontein Deep ...	30,000	5,086	32,500	5,336
Modderfontein East ...	128,000	19,212	134,000	20,101
New Kleinfontein	101,000	15,491	102,000	15,271
New Modderfontein....	84,000	16,164†	90,000	11,765
New State Areas	110,000	£181,069	115,000	£179,612
Nigel Gold	41,000	10,113	—	—
Nourse	71,000	13,561	72,000	13,689
Rand Leases.....	181,000	£299,404	186,000	£305,610
Randfontein	360,000	£383,322	372,000	£398,056
Rietfontein Consolid't'd	26,000	5,472	28,000	5,704
Robinson Deep	94,000	18,532	100,000	19,422
Rose Deep	75,000	11,050	74,000	11,169
Simmer and Jack	139,000	25,087	143,000	25,914
S. African Land and Ex.	91,000	£162,752	90,000	£157,221
Springs	125,000	£199,140	123,500	£193,940
Sub Nigel	64,500	33,156	69,000	34,313
Transvaal G.M. Estates	24,200	4,705	24,000	4,884
Van Dyk Consolidated .	98,000	19,359	103,000	20,419
Van Ryn	58,000	£57,374	59,000	£57,051
Venterspost Gold.....	102,500	22,131	112,000	23,326
Village Main Reef	24,200	£33,648	24,500	£34,059
Vlakfontein.....	23,000	9,683	24,000	10,078
Vogelstruisbult.....	73,000	17,996	76,000	18,096
West Rand Consolidated	221,000	£346,276	223,000	£350,350
West Springs	59,000	£107,647	59,000	£107,441
Western Reefs	77,500	£158,598	78,000	£163,134
Witw'tersr'nd (Knights)	79,000	£93,395	82,000	£97,270
Witwatersrand Nigel ..	8,600	£21,476	9,200	£22,656

* Gold at 172s. 3d. per oz. ‡ Gold at 172s. 6d. per oz.
† Includes 4,000 and 5,000 respectively, as Special Declarations.

COMPARATIVE TRANSVAAL GOLD FIGURES

	1943	1944	1945	1946
	Oz.	Oz.	Oz.	Oz.
January.....	1,074,754	1,029,398	1,029,384	1,016,458
February....	1,011,672	969,017	965,569	946,577
March	1,108,789	1,038,414	1,036,443	877,449
April	1,075,363	995,915	1,028,544	994,988
May.....	1,096,195	1,058,875	1,030,990	1,049,195
June.....	1,064,572	1,038,331	1,024,796	1,018,543
July	1,089,708	1,039,851	1,032,717	—
August.....	1,059,932	1,053,954	978,097	—
September...	1,054,980	1,024,341	1,002,716	—
October	1,060,198	1,024,574	1,058,283	—
November ..	1,056,979	1,006,986	1,020,990	—
December ...	1,046,879	997,572	1,005,016	—
Total ...	12,800,021	12,277,328	12,213,545	—

PRODUCTION OF GOLD IN THE TRANSVAAL

	Rand	Elsewhere	Total
	Oz.	Oz.	Oz.
July, 1945.....	1,009,518	23,199	1,032,717
August	953,280	24,817	978,097
September	982,537	20,179	1,002,716
October	1,032,907	25,376	1,058,283
November	999,212	21,778	1,020,990
December	981,168	23,848	1,005,016
Januarv, 1946	996,175	20,283	1,016,458
February.....	923,468	23,109	946,577
March	855,832	21,617	877,449
April	974,434	20,554	994,988
May	1,026,007	23,188	1,049,195
June	995,767	22,778	1,018,543

NATIVES EMPLOYED IN THE TRANSVAAL MINES

	Gold Mines	Coal Mines	Total
July 31, 1945.....	303,686	27,316	331,002
August 31.....	303,479	27,498	330,977
September 30	303,642	27,159	330,801
October 31	301,366	26,944	328,310
November 30	298,406	27,195	325,601
December 31	292,408	27,028	319,436
January 31, 1946	298,756	27,533	326,289
February 28	306,719	27,640	334,359
March 31	310,446	27,746	338,192
April 30	310,923	28,012	338,935
May 31	307,190	27,768	334,958
June 30	303,822	27,695	333,517

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.	£
July, 1945.	5,066,800	34 0	23 8	10 8	2,632,027
Aug.	4,758,300	34 2	23 7	10 5	2,148,785
Sept.....	4,897,800	34 4	25 1	9 1	2,517,628
Oct.	5,104,300	34 4	24 1	10 3	2,758,873
Nov.....	4,926,100	34 8	23 6	10 10	2,622,409
Dec.	4,780,500	35 1	24 1	10 7	2,526,770
Jan., 1946 .	4,884,100	34 9	24 6	10 7	2,514,880
Feb.	4,464,000	35 2	24 5	10 4	2,225,680
Mar.	4,224,600	34 6	25 3	9 11	1,364,982
April.....	4,744,400	35 1	28 0	6 6	2,356,640
May	—	—	—	—	2,506,332
June	—	—	—	—	2,436,942

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To June 22		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	22,640	3,515	4,286
Electrolytic Zinc	9,989	670	2,959
New Broken Hill	3,723	362	725
North Broken Hill	38,267	6,343	6,954
Zinc Corp.	—	895*	1,660†
Rhodesia Broken Hill ...	—	—	—

* Lead. † Zinc.

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1945		1946	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	47,829	7,444	45,261	7,961
February	46,009	7,518	42,089	7,440
March	48,166	8,547	44,969	8,094
April	49,072	8,622	45,982	7,156
May	47,797	7,554	—	—
June	46,998	7,772	—	—
July	47,972	8,705	—	—
August	47,666	7,846	—	—
September	47,995	8,100	—	—
October	47,550	8,471	—	—
November	45,567	7,687	—	—
December	45,620	7,707	—	—

RHODESIAN GOLD OUTPUTS

	June		July	
	Tons.	Oz.	Tons.	Oz.
Bushtick	12,100	1,791	—	—
Cam and Motor	24,100	£45,255	28,800	£42,426
Globe and Phœnix	6,000	3,014	—	—
Rezende	20,100	£20,518	20,900	£20,939
Sherwood Starr	7,300	£7,456	6,200	£7,124
Thistle-Etna	6,100	883	6,200	898
Vubachikwe	2,900	£4,709	—	—
Wanderer Consolidated	34,500	3,127	35,000	3,078

WEST AFRICAN GOLD OUTPUTS

	June		July	
	Tons	Oz.	Tons	Oz.
Ariston Gold Mines	21,500	£63,957	—	—
Ashanti Goldfields	16,500	17,358	16,500	17,345
Bibiani	22,500	6,454	22,500	6,429
Bremang	—	1,912	—	—
Gold Coast Main Reef	9,230	3,861	—	—
Konongo	8,580	4,227	—	—
Marlu	17,680	1,983	25,640	2,173
Taquah and Abosso	25,000	5,986	25,000	6,005

WESTRALIAN GOLD PRODUCTION

	1944	1945	1946
	Oz.	Oz.	Oz.
January	36,796	41,508	42,471
February	33,196	35,947	37,523
March	38,885	38,855	39,855
April	26,806	35,134	41,297
May	37,762	34,202	46,312
June	40,973	36,591	44,527
July	36,582	39,861	—
August	60,193	59,414	—
September	39,475	33,578	—
October	37,331	34,108	—
November	36,156	41,590	—
December	42,107	39,760	—
Total	466,362	468,548	—

WESTRALIAN GOLD OUTPUTS

	4-Week Period			
	To May 28		To June 30	
	Tons	Oz.	Tons	Oz.
Boulder Perseverance	6,356	1,687	6,577	1,891
Central Norseman	8,558	3,067	8,456	2,701*d*
Comet Mine	—	—	—	—
G.M. of Kalgoorlie	11,274	3,139*b*	12,386	3,552*d*
Golden Horse Shoe	—	763*a*	—	—
Gt. Boulder Prop.	28,722	6,544	29,814	6,775
Kalgoorlie Enterprise	3,854	1,184	4,019	1,338
Lake View & Star	42,118	10,796	50,845	12,263*a*
Morning Star (G.M.A.)	—	—	—	—
North Kalgurli	8,067	2,618	8,385	2,477
Paringa	7,150	1,458	7,590	1,691
Phœnix Mine	—	—	—	—
Sons of Gwalia	7,608	2,054*b*	—	—
South Kalgurli	5,933	1,410	6,189	1,605
Tindals Gold	—	—	—	—
Waronga (Emu)	—	—	—	—
Wiluna	11,244	2,231	—	—
Yellowdine	—	—	—	—

a June. *b* 4 weeks to June 11. *d* 4 weeks to July 9.

PRODUCTION OF GOLD IN CANADA

	1945		1946	
	*Output oz.	*Total value $	*Output oz.	*Total value $
January	233,210	8,974,350	238,450	9,180,325
February	212,351	8,175,513	229,099	8,820,311
March	228,687	8,804,450	248,403	9,563,516
April	223,737	8,613,875	—	—
May	217,556	8,375,906	—	—
June	212,163	8,103,086	—	—
July	210,209	8,093,046	—	—
August	211,754	8,152,529	—	—
September	211,529	8,143,866	—	—
October	229,550	8,837,675	—	—
November	220,755	8,499,067	—	—
December	239,749	9,230,337	—	—
Total for Calendar Year	2,651,250	102,004,700	—	—

* Subject to revision.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
May 1945	498,258	127,173	22,583	4,898,332
June	505,448	121,217	18,796	4,673,033
July	481,596	119,151	16,276	4,593,064
August	482,402	119,407	28,130	4,607,639
September	492,626	122,175	18,394	4,709,952
October	539,554	130,320	20,458	5,023,191
November	556,671	136,974	19,724	5,279,708
December	589,792	145,493	51,752	5,622,718
January, 1946	589,148	144,509	22,600	5,574,375
February	551,813	134,485	21,155	5,190,366
March	623,827	146,055	27,229	5,643,975
April	594,266	141,230	16,673	5,449,639

CANADA'S LEADING MINERAL PRODUCTS

		March,* 1946	February,* 1946
Asbestos	Ton	36,305	29,614
Cement	Brl.	603,811	273,379
Clay products	$	801,126	684,258
Coal	Ton	1,593,556	1,638,333
Copper	Lb.	34,374,946	28,208,803
Lead	Lb.	31,287,569	30,477,148
Nickel	Lb.	15,677,068	12,450,659
Silver	Fine oz.	1,179,862	1,045,448
Zinc	Lb.	42,957,226	39,784,315

* Subject to revision.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA

	June		July	
	Tons	Oz.	Tons	Oz.
Champion Reef	9,440	4,546	9,890	4,656
Mysore	14,149	3,422	15,958	4,716
Nundydroog	13,110	3,694	13,500	3,662
Ooregum	9,052	2,349	8,113	2,208

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	June		July	
	Tons	Value £	Tons	Value £
Blackwater (N.Z.)	—	—	1,712*d*	530*
British Guiana Cons.	—	644*	—	832*
Emperor Mines (Fiji)	32,723	10,591**b*	—	—
Frontino Gold (Colombia)	7,820	35,889	—	—
Geita Gold (Tanganyika)	9,470	1,851*	—	—
Martha Gold (N.Z.)	10,211	2,642* / 21,001*	10,325*d*	2,387* / 23,236†
New Goldfields of Venezuela	—	—	—	—
Rosterman (Kenya)	4,400	1,302*	—	—
St. John d'el Rey (Brazil)	—	103,800	—	112,400
Tati Goldfields (Bech'land)	4,300	158*p*	—	—
Victoria Gold (Vic.)	—	925**c*	—	852**d*
Yukon Consolidated	—	$153,000	—	—

* Oz. Gold. † Oz. Silver.
b Period to June 5. *d* Period to July 20. *p* Profit. *c* To June 11.

OUTPUTS OF NIGERIAN AND OTHER TIN MINING COMPANIES

IN LONG TONS OF CONCENTRATE

	MAY	JUNE	JULY
Amalgamated Tin Mines	625	465	—
Bisichi	33¾	32	—
Ex-Lands	45	50	—
Fabulosa	—	—	—
Geevor	50	41	—
Gold and Base Metals of Nigeria	60	—	—
Jantar Nigeria	33	40	42
Jos Tin	—	—	—
Kaduna Prospectors	8	8	—
Kaduna Syndicate	45	33	—
Kagera	—	—	—
Kefn Tin	33	57	—
Naraguta Tin Mines	—	108*a*	—
Naraguta Karama	—	50½*a*	—
Naraguta Extended	—	20*a*	—
Nigerian Consolidated	8	—	—
Pahang Consolidated	—	—	17
Rahman Hydraulic	17	—	—
Ribon Valley	14	—	—
Rukuba Tin Mines	—	6*a*	—
South Bukeru	—	30*a*	—
Tin Fields of Nigeria	—	15	—
United Tin Areas	12	—	—

(*a*) Three months to June 30.

QUOTATIONS OF OIL COMPANIES' SHARES

Denomination of Shares £1 unless otherwise noted

	JUNE 6, 1946	JULY 9, 1946	AUG. 7, 1946
	£ s. d.	£ s. d.	£ s. d.
Anglo-Ecuadorian	1 18 3	1 19 3	1 18 3
Anglo-Egyptian B.	4 3 9	4 1 3	4 1 3
Anglo-Iranian Ord.	4 18 9	5 5 0	5 0 0
,, ,, 1st Pref.	1 18 0	1 16 9	1 17 0
,, ,, 2nd Pref.	2 0 6	2 0 0	2 0 3
Apex Trinidad (5s.)	1 12 3	1 13 0	1 12 9
Attock, India	1 15 6	2 17 0	2 12 3
British Borneo Pet. (6s.)	1 4 0	1 3 6	1 5 3
British Burmah (4s.)	9 0	10 0	10 0
British Controlled ($5)	5 0	4 6	4 6
,, ,, Pref. (,,)	14 9	13 9	13 3
Burmah Oil	3 17 6	3 11 3	3 11 3
,, ,, Pref.	2 2 6	2 3 6	2 3 3
Canadian Eagle Ord.	1 16 6	1 13 9	1 13 3
,, ,, 7% Pref. ($3)	13 3	13 3	13 3
,, ,, 8% Pref.	1 16 6	1 14 3	1 13 3
Kern (3s. 4d.)	5 0	5 6	5 3
Lobitos, Peru	3 6 0	3 8 0	3 5 6
London and Thames Haven	16 6	15 6	15 0
Mexican Eagle Ord. (4 pesos)	14 9	13 9	13 3
,, ,, 8% Pref. (4 pesos)	14 9	14 0	13 6
,, ,, 7% Pref. (,,)	8 9	8 9	8 9
Phœnix Roumania	3 6	3 3	3 3
Royal Dutch (100 fl.)	36 10 0	34 0 0	34 10 0
Shell Transport Ord.	4 13 9	4 13 9	4 13 0
,, ,, 5% Pref. (Units)	1 9 6	1 9 3	1 9 0
,, ,, 7% Pref.	1 19 0	1 18 9	1 18 9
Steaua Romana	6 0	5 9	5 3
Trinidad Central (10s.)	1 6 3	1 5 3	1 2 0
Trinidad Leaseholds	5 13 9	5 16 9	5 13 9
Trinidad Pet. Dev.	5 7 6	5 3 0	4 18 [illegible]
,, ,, ,, 6% Red. Cm. Pf.	1 2 9	1 2 9	1 3 0
Ultramar (10s.)	4 2 6	3 16 3	3 11 3
United British of Trinidad (6s. 8d.)	1 4 6	1 6 0	1 6 3
V.O.C. Holding (13s. 4d.)	3 17 6	3 15 0	3 14 3
,, 7% Pref. (13s. 4d.)	3 17 6	3 13 9	3 14 3

Prices of Chemicals

Chemical stocks and prices are generally under control and the figures given below represent those last ruling.

		£ s. d.
Acetic Acid, 40%	per ton	25 12 0
,, ,, 80%	,,	49 10 0
,, ,, Glacial	,,	59 0 0
Alum	,,	16 0 0
Aluminium Sulphate, 17 to 18%	,,	11 10 0
Ammonia, Anhydrous	per lb.	2 0
Ammonium Carbonate	per ton	42 0 0
,, Chloride, 98%	,,	22 10 0
,, Nitrate	,,	19 0 0
,, Phosphate (Mono- and Di-)	,,	69 0 0
Antimony, Sulphide golden	per lb.	1 11
Arsenic White, 99/100%	per ton	32 0 0
Barium Carbonate (native), 94%	,,	6 5 0
,, Chloride	,,	19 10 0
Barytes	,,	9 3 6
Benzol	per gal.	2 6
Bleaching Powder, 36% Cl.	per ton	11 5 0
Borax	,,	30 0 0
Boric Acid (Comml.)	,,	52 0 0
Calcium Chloride, solid, 70/75%	,,	5 15 0
Carbolic Acid, crude 60's	per gal.	3 9
,, ,, crystallized	per lb.	11
Carbon Bisulphide	per ton	39 0 0
Citric Acid	per lb.	1 9
Copper Sulphate	per ton	32 5 0
Creosote Oil (f.o.r. in Bulk)	per gal.	6
Cresylic Acid, 98%	,,	4 2
Hydrofluoric Acid, 59/60%	per lb.	1 1
Iron Sulphate	per ton	3 17 6
Lead, Acetate, white	,,	60 0 0
,, Nitrate	,,	55 0 0
,, Oxide, Litharge	,,	59 0 0
,, White	,,	72 0 0
Lime, Acetate, brown	,,	19 0 0
,, ,, grey, 80/82%	,,	23 10 0
Magnesite, Calcined ex W'h'se	,,	20 15 0
,, Raw	,,	9 7 6
Magnesium Chloride, ex W'h'se	,,	22 0 0
,, Sulphate commL	,,	13 0 0
Methylated Spirit Industrial 66 O.P.	per gal.	3 0
Nitric Acid, 80° Tw.	per ton	25 0 0
Oxalic Acid	,,	62 10 0
Phosphoric Acid (S.G. 1·750)	per lb.	1 1
Pine Oil	per cwt.	4 7 0
Potassium Bichromate	per lb.	7½
,, Carbonate (hydrated)	per ton	57 10 0
,, Chlorate	per lb.	Nominal
,, Chloride, 96%	per ton	16 10 0
,, Amyl Xanthate	per lb.	1 3½
,, Ethyl Xanthate	,,	8
,, Hydrate (Caustic) solid	per ton	65 10 0
,, Nitrate	per cwt.	3 16 0
,, Permanganate	,,	7 19 3
,, Sulphate, 90%	per ton	Nominal
Sodium Acetate	,,	41 0 0
,, Arsenate, 58–60%	,,	Nominal
,, Bicarbonate	,,	11 0 0
,, Bichromate	per lb.	6½
,, Carbonate (crystals)	per ton	5 7 6
,, ,, (Soda Ash) 58°	,,	8 0 0
,, Chlorate	,,	36 0 0
,, Cyanide 100% NaCN basis	per lb.	8½
,, Hydrate, 76/77%	per ton	16 4 0
,, Hyposulphite, commL	,,	14 15 0
,, Nitrate	,,	15 5 0
,, Phosphate	,,	22 10 0
,, Prussiate	per lb.	9½
,, Silicate	per ton	8 10 0
,, Sulphate (Glauber's Salt)	,,	4 10 0
,, ,, (Salt-Cake)	,,	4 11 0
,, Sulphide, flakes, 60/62%	,,	20 17 6
,, Sulphite, commL	,,	13 0 0
Sulphur, American, Rock (Truckload)	,,	12 10 0
,, Ground	,,	16 15 0
Sulphuric Acid, 168° Tw.	,,	6 12 6
,, ,, free from Arsenic, 140° Tw.	,,	4 11 0
Superphosphate of Lime	,,	5 10 0
Tartaric Acid	per cwt.	15 8 0
Tin Crystals	per lb.	Nominal
Titanium white, 70%	per ton	37 10 0
Zinc Chloride	,,	20 0 0
,, Dust, 95/97%	,,	Nominal
,, Oxide (White-Seal)	,,	45 15 0
,, Sulphate	,,	25 0 0

Share Quotations

Shares are £1 par value except where otherwise stated.

GOLD AND SILVER:	July 9, 1946. £ s. d.	Aug. 7, 1946. £ s. d.
SOUTH AFRICA:		
Blyvooruitzicht (10s.)	10 3 9	9 15 0
Brakpan (5s.)	15 9	15 0
City Deep	2 12 6	2 12 6
Consolidated Main Reef	2 6 3	2 5 0
Crown Mines (10s.)	6 2 6	5 17 6
Daggafontein (5s.)	3 6 9	3 6 3
Dominion Reefs (5s.)	5 9	5 6
Durban Roodepoort Deep (10s.)	3 16 3	3 15 0
East Daggafontein (10s.)	2 10 0	2 9 3
East Geduld	10 6 3	9 17 6
East Rand Consolidated (5s.)	16 6	15 3
East Rand Proprietary (10s.)	2 10 6	2 5 6
Geduld	6 12 6	6 10 0
Geldenhuis Deep (15s.)	1 2 6	1 7 6
Government Gold Mining Areas (5s.)	1 6 9	1 5 0
Grootvlei	6 17 6	6 17 6
Klerksdorp (5s.)	6 9	6 0
Lace Proprietary (5s.)	1 6 3	1 5 9
Libanon (10s.)	1 7 9	1 6 3
Luipaards Vlei (2s.)	1 3 0	1 0 9
Marievale (10s.)	1 12 3	1 9 3
Modderfontein B (5s.)	8 9	8 6
Modderfontein East	3 0 0	2 17 6
New Kleinfontein	1 9 6	1 6 3
New Modderfontein (10s.)	8 0	8 0
New State Areas	1 10 6	1 9 6
Nigel Gold (10s.)	1 10 0	1 5 6
Nourse	1 15 0	1 12 6
Rand Leases (10s.)	2 16 3	2 15 0
Randfontein	1 8 9	1 3 9
Rietfontein Consolidated (5s.)	15 6	14 0
Robinson Deep B (7s. 6d.)	15 9	14 6
Rose Deep	1 8 9	1 8 9
Simmer and Jack (2s. 6d.)	12 0	11 9
South African Land (3s. 6d.)	2 5 0	2 1 3
Springs (5s.)	14 9	14 0
Sub Nigel (10s.)	5 2 6	4 17 6
Van Dyk (10s.)	15 0	14 9
Van Ryn (10s.)	15 0	15 3
Venterspost (10s.)	2 8 9	2 6 3
Vlakfontein (10s.)	1 8 9	1 6 9
Vogelstruisbult (10s.)	1 6 6	1 5 6
West Driefontein (10s.)	5 8 9	5 2 6
West Rand Consolidated (10s.)	1 16 9	1 15 0
West Springs	1 3 9	1 3 9
West Witwatersrand Areas (2s. 6d.)	8 5 0	8 1 3
Western Holdings (5s.)	4 12 6	4 8 9
Western Reefs (5s.)	2 5 0	2 3 9
Witwatersrand Gold (Knights)	1 8 9	1 8 9
Witwatersrand Nigel (5s.)	8 9	8 0
RHODESIA:		
Bushtick (10s.)	5 9	5 3
Cam and Motor (12s. 6d.)	1 12 6	1 10 0
Globe and Phœnix (5s.)	1 4 6	1 3 6
Rezende (1s.)	6 3	5 9
Sherwood Starr (5s.)	2 9	2 6
Wanderer	9 3	9 0
GOLD COAST:		
Amalgamated Banket (5s.)	7 9	7 3
Ariston Gold (2s. 6d.)	13 3	12 6
Ashanti-Adowsena (2s.)	2 9	2 9
Ashanti Goldfields (4s.)	3 5 0	3 2 9
Bibiani (4s.)	1 13 0	1 11 6
Bremang Gold Dredging (5s.)	6 3	6 0
Gold Coast Banket Areas (2s.)	3 6	3 3
Gold Coast Main Reef (5s.)	13 0	12 6
Gold Coast Selection (5s.)	1 15 3	1 12 9
Konongo (2s.)	6 3	6 6
Kwahu (2s.)	1 16 3	1 7 6
London & African Mining Trust (5s.)	12 3	11 3
Marlu (5s.)	8 9	8 6
Nanwa	5 3	5 0
Offin River Gold (5s.)	6 6	6 0
South Banket Areas (2s.)	3 3	2 9
Taquah and Abosso (4s.)	1 11 9	1 11 0
AUSTRALASIA:		
Blackwater Mines, N.Z.	13 0	11 3
Boulder Perseverance (4s.), W.A.	10 0	9 9
Gold Fields Aust. Dev. (5s.), W.A.	7 3	6 0
Gold Mines of Kalgoorlie (10s.)	10 6	10 3
Golden Horse Shoe (3s.), W.A.	2 6	2 3
Great Boulder Propriet'y (2s.), W.A.	9 6	8 9
Lake View and Star (4s.), W.A.	1 7 3	1 5 3
Martha Gold (5s.), N.Z.	4 9	4 3
Mount Morgan (2s. 8d.), Q.	6 3	7 3
North Kalgurli (1912) (2s.), W.A.	1 1 9	1 1 0
Paringa (1s.), W.A.	4 9	4 3
Sons of Gwalia (10s.), W.A.	1 10 0	1 8 9
South Kalgurli (5s.), W.A.	1 3 3	1 3 0
Wiluna Gold, W.A.	6 6	14 9

	July 9, 1946. £ s. d.	Aug. 7, 1946. £ s. d.
INDIA:		
Champion Reef (10s.)	1 5 6	1 5 0
Mysore (10s.)	10 6	10 0
Nundydroog (10s.)	16 3	15 0
Ooregum (10s.)	10 0	8 9
MISCELLANEOUS:		
Fresnillo	1 18 3	2 1 3
Frontino, Colombia	1 10 0	1 8 9
Kentan Gold Areas (10s.), E. Africa	8 9	7 9
New Goldfields of Venezuela (5s.)	1 9	1 9
Rosterman (5s.), Kenya	10 3	9 3
St. John d'el Rey, Brazil	2 0 0	2 1 3
Yukon Consolidated ($1)	9 6	9 0
COPPER:		
Esperanza Copper and Sulphur	2 9	2 9
Indian (2s.)	8 0	9 0
Messina (5s.), Transvaal	19 6	18 6
Mount Lyell, Tasmania	17 6	17 6
Nchanga Consolidated, N. Rhodesia	4 0 0	4 0 0
Rhodesia-Katanga	5 6	6 6
Rhokana Corporation, N. Rhodesia	9 15 0	9 2 6
Rio Tinto (£5), Spain	17 5 0	15 10 0
Roan Antelope (5s.), N. Rhodesia	16 0	15 3
Tanganyika Concessions	16 9	14 9
Tharsis (£2), Spain	1 18 9	1 18 9
LEAD-ZINC:		
Broken Hill South (5s.), N.S.W.	1 6 9	1 6 6
Burma Corporation (9 rupees)	12 6	12 6
Electrolytic Zinc, Tasmania	2 11 3	2 10 0
Lake George (10s.), N.S.W.	10 9	9 9
Mount Isa, Queensland	1 12 6	1 10 0
New Broken Hill (5s.), N.S.W.	1 13 0	1 10 6
North Broken Hill (5s.), N.S.W.	2 10 9	2 10 9
Rhodesia Broken Hill (5s.)	13 3	12 6
San Francisco (10s.), Mexico	1 3 6	1 2 3
Sulphide Corporation (15s.), N.S.W.	8 9	9 9
Zinc Corporation (10s.), N.S.W.	4 1 3	3 18 9
TIN:		
Amalgamated Tin (5s.), Nigeria	12 9	13 6
Beralt (5s.), Portugal	8 3	9 3
Bisichi (10s.), Nigeria	10 6	11 0
Ex-Lands (2s.), Nigeria	6 9	6 6
Geevor (5s.), Cornwall	6 3	6 0
Gold & Base Metals (2s. 6d.), Nigeria	3 0	4 9
Jantar Nigeria (3s.)	8 3	8 9
Jos Tin Area (Nigeria) (5s.)	11 0	11 0
Kaduna Syndicate (2s.), Nigeria	9 3	9 3
Mawchi Mines (4s.), Burma	1 8 0	1 8 6
Naraguta (10s.), Nigeria	9 0	9 0
Nigerian Consol. (2s.)	4 3	4 0
South Crofty (5s.), Cornwall	4 0	3 9
United Tin Areas (2s. 6d.), Nigeria	5 3	4 0
DIAMONDS:		
Anglo American Investment	3 1 9	3 0 9
Consol. African Selection Trust (5s.)	1 16 3	1 15 3
Consolidated of S.W.A. (10s.)	2 6 9	2 7 0
De Beers Deferred (£2 10s.)	21 5 0	21 5 0
West African Diamond (5s.)	2 9	2 9
FINANCE, ETC.:		
African & European	10 10 0	10 0 0
Anglo American Corporation (10s.)	6 11 3	6 5 0
Anglo-French Exploration	1 15 0	1 13 9
British South Africa (15s.)	1 17 0	1 14 3
British Tin Investment (10s.)	15 9	15 0
Broken Hill Proprietary	1 17 6	1 17 6
Camp Bird (10s.)	13 3	12 6
Central Mining (£8)	25 15 0	24 15 0
Central Provinces Manganese (10s.)	2 17 0	2 18 0
Consolidated Gold Fields	4 6 3	4 0 0
Cons. Gold Fields of N.Z. (4s.)	6 0	4 6
Consolidated Mines Selection (10s.)	2 13 9	2 7 6
Eastern Trans. Consolidated (5s.)	12 0	9 9
General Mining and Finance	7 2 6	6 15 0
Gold Ex. and Fin. of Australia (10s.)	13 3	12 3
Gold Fields Rhodesian (10s.)	13 9	13 3
H.E. Proprietary (10s.)	2 8 3	2 6 3
Henderson's Trans. Estates (4s.)	11 0	10 0
Johannesburg Consolidated	5 10 0	4 15 0
London & Rhod. M. & L. (5s.)	6 6	6 6
London Tin Corporation (4s.)	5 6	6 3
Marsman Investments (10s.)	15 3	14 3
Minerals Separation	4 13 6	5 7 6
New Central Witwatersrand (5s.)	1 2 6	1 1 0
Oroville Dredging (4s.)	1 1 0	19 9
Rand Mines (5s.)	7 7 6	7 0 0
Rand Selection (5s.)	2 11 3	2 7 6
Rhodesian Anglo American (10s.)	1 9 3	1 7 3
Rhodesian Corporation (5s.)	8 6	8 0
Rhodesian Selection Trust (5s.)	1 3 6	1 2 3
Selection Trust (10s.)	2 12 0	2 8 9
South West Africa Co. (13s. 4d.)	1 5 0	1 5 0
Union Corporation (12s. 6d.)	14 13 9	14 0 0
Venture Trust (6s. 8d.)	6 6	5 9
West Rand Inv. Trust (10s.)	2 8 0	2 5 6
Zambesia Exploring		

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Aids for the Modern Prospector

In a paper presented at the annual meeting of the British Columbia section of the Canadian Institute of Mining and Metallurgy held in October last and reproduced in the *Western Miner* for June R. G. Gayer reviewed "Mechanical Aids to Prospecting." The author suggests that in the near future an increase in mining activity may be expected, due largely to the exploration of areas recommended by the geologist-prospector. In order to compete in this new field, he says, the individual or group interested in carrying on successful prospecting ventures must avail themselves of all the aids modern science can develop. It is unfortunate that proper equipment will add greatly to the cost of equipping such ventures. However, under proper management, increased results should more than offset this factor.

The first and best known of the modern aids to the prospector is the aeroplane. For years the aeroplane has been giving remarkable service in the mining areas of Canada, though its chief use has been in the field of transportation. It has been definitely proved that the aeroplane can compete with mule and horse transport over rough country, and that the advantages of load, rapidity, assurance of delivery, and flexibility give the plane a definite superiority. While most up-to-date prospecting parties make full use of the plane for purposes of transportation, its potential use as a method of prospecting has, with few exceptions, scarcely been developed.

Aerial Photography

Aerial photography as an aid to prospecting has not, suggests Mr. Gayer, been brought to its peak of usefulness. Perhaps the reason for this can be attributed to the small amount of publicity given to this practice combined with a lack of suitable equipment. Prior to the war two large aerial survey companies were operating in the United States, but their services were, on the whole, only in limited demand among the mining companies. With the modern improvements in aerial photography equipment and technique developed during the recent war the value of this aid will be increased manyfold.

A new Canadian company, Aero Surveys, Ltd., has been formed, staffed by former R.C.A.F. photographers and observers highly trained in the use and application of the latest types of equipment. Estimates of costs based on aerial mapping of 15 square miles in an interior mining district gave a cost price of approximately $40·00 per square mile for an aerial photographic map on a scale of 1 in. to 500 ft. Larger-scale prints can be made at only slightly higher cost. From photographic prints an accurate contour map can be prepared at a cost of approximately $65·00 per square mile. Such a map accompanying the aerial photographs would be of inestimable value in detail geologizing and prospecting of the area. In addition to the above costs rental charges for the aircraft used must be added.

The interpretation of aerial photographs for geological purposes is an able tool in the hands of the trained prospector or geologist. Photographs frequently reveal geological information not procurable by other methods. They provide a sufficiently accurate map of any particular area and record the most minute of physical detail.

The use of aerial photographs for prospecting purposes speeds the work and permits a more rapid and accurate study of an area. This in turn reduces the cost and permits further concentration on areas of greatest interest. In considering the cost it must not be forgotten that the photographs provide a permanent record which can be re-examined at will by others; that topographical maps can be made from them; that much other information *re* water power, soils, vegetation, road locations, communications, etc., is available.

It is true, the author says, that in some cases aerial photographs show so little geology that they are valuable only as good detailed maps of the country to be worked, but even under such circumstances they are far superior to any other type of map, as minute details of topography and vegetation shown in the photographs enable the trained prospector to locate himself at all times with great accuracy.

Lines of faulting expressed in topography may often be more readily followed in an aerial photograph than on the ground, while faults that bring rocks of different types into juxtaposition are also easily observed. Dykes, veins, or other sharply-defined rock masses are usually readily discernible in photographs.

An application of aerial photography not in common use, but which might well be employed in relation to lakeshore deposits, is the photographing of areas covered by water. Offshore oil structures have been observed by this method and hard reefs and outcrops are readily discernible where they protrude above the sandy bottom of a lake or sea.

While aerial photographing of an area to be prospected is strongly recommended for one reason

or another, such an expenditure may be somewhat of a deterrent. However, even though photography is not to be used, direct aerial observation of the area in question should be made by the party or parties who intend to work it. With the relatively low cost of a chartered plane trip from any of the many local airports throughout British Columbia this can, Mr. Gayer says, usually be arranged easily and economically. Such a reconnaissance can, in most areas, save many days of tedious ground search and will quickly locate sections of particular interest. These can be noted on a large-scale map and examined in detail by parties on foot. As the season's work progresses, and certain limited areas are under detailed study, occasional air views can reveal much to the trained eye of the prospector which is not readily discernible from the ground. It is also interesting to note that the prospector himself can take pictures of the area from the plane with an ordinary camera. While such pictures are not suitable for mapping many such pictures record in great detail and clarity ground and geological features, veins, dykes, etc.

In contemplating the use of small chartered aircraft the following figures may be used as a guide: Small two-place land planes capable of landing and taking off from small fields and pastures can be chartered in British Columbia for as low as $8·00 an hour of actual flying time, where the individual intends to fly himself. The same type of aircraft with a pilot will cost from $12·00 to $13·00 an hour. These aircraft cruise between 80 and 90 miles an hour, so that an approximate idea of the cost of a particular trip can be readily computed if the airline distance *plus* 20% for short flights of 50 to 100 miles and 10% for longer flights to allow for landings and take-offs be divided by the average cruising speed of the aircraft chartered and the result multiplied by the hourly charter rate.

Small two-place planes equipped with floats for water landings and takeoffs cost approximately $12·00 an hour without the pilot and $16·00 an hour with a pilot. Charter rates for larger craft are from $10·00 to $18·00 an hour in addition to the rates quoted above for each extra passenger-carrying capacity of the aircraft chartered; a plane equipped with floats capable of carrying a pilot and two or three passengers would charter for approximately $45·00 an hour.

As more and more aircraft come into use these prices will undoubtedly be lowered considerably. One manufacturing company has already started production on an amphibious craft which will carry a pilot and three passengers or the equivalent in freight. This craft can land on either land or water and will probably operate for charter at 30% to 40% less than the hourly rates at present charged for planes of equivalent capacity.

Two comparatively recent developments in the aeronautical field, the author goes on to say, are of considerable interest to the mineral exploration field. One is the helicopter, a special type of aircraft capable of vertical takeoffs and landings and of hovering in mid-air. The other is the delivery of freight *via* parachute.

The helicopter, like every other recent revolutionary invention, has been greatly over-rated by the public and many wild claims have been made for its performance. However, when analysed in the light of proved performance the helicopter will have a very definite place in the field of mining and prospecting. First costs of these craft will be high, probably in the neighbourhood of $16,000 to $18,000 for two-place craft and $40,000 to $50,000 for 4- and 5-place machines, although several manufacturers insist that when their plants reach full production on these types they will be equivalent to and in some cases lower in price than similar capacity conventional aircraft.

Transportation direct to any point is one of the greatest features of the helicopter. Hovering over deserts, mountains, and along rivers or heavily wooded areas is no problem. With the improved stability characteristics of the latest helicopters hovering over or lowering slowly into canyons, crevices, mountain gorges, or small clearings in heavy timber is easily accomplished. Another feature is that motor failure, weather or winds have little effect on the helicopter and float-equipped models will be able to land on water or land. The helicopter hovering over mineral areas at any desired elevation would enable the prospector or geologist to study in great detail the territory beneath him; then as various features indicated that they should be given further investigation the craft could be brought to earth at these points and normal methods of sampling etc. could be followed.

As helicopters become more common the day of the pack horse will be over, for the more remote and inaccessible an area might be the greater the saving of aerial transportation and freighting costs will become over other means.

One of the leading helicopter manufacturers in the United States, the author says, has announced that his firm is preparing to manufacture a 5-place helicopter, powered with a 450-h.p. engine capable of carrying a total useful load of 1,445 lb. Assuming the first cost of this craft to be $60,000, and giving it an operating and maintenance cost of 30% in excess of similar cost on conventional aircraft, the author, in conjunction with an aeronautical expert, calculated the hourly cost of this type of craft, allowing full depreciation charges etc. Using this figure and the rated performance it was estimated that over a 9½-mile haul between a freight terminal and an isolated mining property all supplies could be flown in at a cost of ¾ cent per pound. The cost of bringing in freight and supplies by truck and pack train over the same length of haul cost 2 cents a pound and up. In addition the helicopter would make an average of 8 to 10 round trips a day carrying pieces of freight up to 1,000 pounds total weight, whereas the maximum practical load for a pack horse is in the neighbourhood of 250 lb. and all machinery and equipment must be amenable to dismantling to pieces small enough to be packed by horses. In places further from the source of supply the relative difference between helicopter freighting and truck and pack train haulage will be many times greater.

The dropping of supplies from aircraft is not new and several mining companies have used this means of obtaining supplies with varying degrees of success. An example at one of B.C.'s northern prospects was a dismal failure; another more recent example occurred in 1944, when a year's supply of traps and supplies were flown into the inaccessible Elaho River country and dropped in a small meadow from a height of about 300 ft. All packages were packed in bundles of moss, old newspapers, etc., and even glass jars of pickles were dropped with only one failure when a poorly-aimed package missed the meadow and landed among the rocks at the river's

edge. The cost of bringing in these supplies in this manner was estimated to have been a saving of 400% over back packing and horses. While this method of dropping supplies is suitable for non-friable articles—such as, small pieces of hardware, tools, canned foods, dry foods, bedding, dynamite, fuel oil, etc.—equipment such as gas engines, diamond drills, and diamond-drill rods, small compressors, etc., would not withstand the jar of the necessary drop and the packing would make too bulky a package to be handled by aircraft suitable for such work.

During the war paratroopers received their supplies *via* "paradropping" and, from this use and the experience gained, has come a new form of air express. A "bush" pilot with many hours of service flying and leader of the air-supply section of the recent "Muskox" operation reports that after a few preliminary troubles a highly satisfactory system of dropping all manner of supplies by parachute was set up. In all a total of 345,000 lb., or over 172 tons of supplies, ranging from 1,300-lb. automoble engines, sleighs, and 400-lb. fuel drums, to cases of fresh eggs and photographic equipment were dropped by parachute to the Muskox expedition. The overall loss amounted to 2·4%. In contemplating delivery of supplies *via* "paradropping" the following pointers will help as a guide. A dropping zone (cleared area, preferably soft meadow land or snow free of rocks), 50 by 200 yd., is sufficient. Fragile items must be properly packed with the best size package weighing approximately 300-lb. Pieces weighing over 300-lb are dropped with two or more chutes attached. The aircraft used should have a large cargo space with a wide accessible door so that parcels can be dumped out quickly and easily. Experience has shown that the best dropping height is from 200 ft. to 300 ft., giving the chutes time to open and check the descent but not allowing excessive drift.

Earth Movers

The second mechanical aid to be considered is the "cat" or bulldozer. The applications of the equipment can be broken into four headings:

(1) Transportation.
(2) Trail and road construction.
(3) Stripping.
(4) Auxiliary power.

In the field of transportation and in trail and road construction the uses to which a "cat" can be put are well known. The use of a bulldozer to strip veins and to aid in tracing them beneath overburden is a somewhat newer application. In the future the use of the "cat" will naturally be confined to areas where roads or open country permit reasonable access. A considerable amount of prospecting will take place in or near old mines and mine camps. This means that in general there is available some means of access by car, truck, or "cat" without undue difficulty.

Most stripping, trenching, etc., has been carried out by hand means in some favoured locality. Water has been employed either through small monitors or by ground sluicing to remove overburden. However, on the whole, hand methods have been the simplest and cheapest.

The use of a bulldozer has its greatest application where the overburden is relatively heavy—say, from 4 to 12 ft. deep—and where the veins or mineral exposures are of a substantial width. When judged from a pure unit cost angle it will be found that in most instances the "cat" will effect a substantial saving. Judged on a yardage basis, however, particularly when tracing narrow veins, the "cat" will remove several times the amount of overburden as would be required in the case of stripping by hand methods and consequently it will be found that in such cases the over-all cost of stripping may equal or even be somewhat higher than the over-all cost of hand methods. This factor is offset considerably by the fact that the large area uncovered will give a much better opportunity to examine the exposure and wall rocks and permits of cleaner and more accurate sampling.

In considering the use of the bulldozer it is of interest to note that "cats" equipped with a bulldozer blade and winch drum can be used to strip veins outcropping on hillsides with slopes as great as 30° and steeper.

In the matter of auxiliary power the "cat" equipped with a power take-off is an extremely flexible source of power for all sorts of needs around a camp or prospect. It has been used to operate small crushers, pilot mills, generators, portable sawmills, camp lighting, compressors, diamond drills, etc.

Portable Drills

A third aid to the prospector is the small portable diamond drill designed for horseback or even back-pack transport and capable of drilling holes up to 200 ft. with ⅞-in. core. Such equipment is of inestimable value to crews operating in mineralized areas where outcrops are numerous and surface values not conclusive. Too often outcrops that give negligible assays are overlooked and not tested at depth due to the cost involved in sinking or tunnelling operations. A few short holes will test these showings to a depth of 100 ft. or more at a small fraction of the cost of a shaft or tunnel. Other factors contributing this may often bring to light results sufficient to indicate that further exploration is warranted. While the prospector or geologist cannot expect to obtain information from diamond drilling sufficiently accurate to warrant large capital outlays for plant and equipment, it will give a very good guide as to the nature and potential grade of the formation drilled and in the event that values are encountered will give excellent information upon which to base further exploration by sinking, driving, and cross-cutting.

Mechanical Gold Plan

A fourth mechanical device is mentioned here, although its field is limited to that of the placer prospector. This is the mechanical gold pan, a machine, equipped with a small petrol motor and using a scientifically arranged series of screens, pans, and amalgam plates, which has a capacity varying in the smallest type of 1½ to 2 cu. yd. of sand and gravel per hour to the larger types which handle up to 6 cu. yd. per hour. The smallest of these compact units has a shipping weight of 675 lb. and can be broken up into easily-transported parts.

Geophysical Appliances

A fifth aid to the prospector can be generalized in the application of geophysics. This, however, is a highly specialized field. In a newspaper article appearing March 9, 1946, it was reported that Hans

Lundberg, the well-known geophysicist, had purchased a 4-place Sikorsky helicopter and was planning to equip it with a generator, oscillograph, two electric coils, a transmitter, and two motion picture cameras. The two synchronized coils rotate in the earth's magnetic field, cutting across the lines of force, and the differences of magnetic intensity are shown on the gridded scan of an oscillograph. One camera, focused on the scan, provides a continuous recording of the readings. The second, an aerial type, will be synchronized with the first to provide a record of the terrain so that any anomaly indicated by the oscillograph can be found again on the ground.

Conclusion

Modern developments and the application of them to prospecting will within a few short years undoubtedly bring about a new impetus in the location of new properties. Groups and individuals contemplating prospecting ventures are strongly urged to investigate and apply, under scientific direction, as many of these new aids as it is possible to bring to bear on their contemplated project.

Up-Grading a Zinc Concentrate

Describing the process of de-leading zinc concentrate at Golden Manitou Mines, Quebec, in the *Canadian Mining and Metallurgical Bulletin* for June, D. A. Livingstone, the Mill Superintendent, says that the aim of all operators of base-metal concentrators is to raise the grade of their concentrated product by the elimination, to the greatest practical extent, of all constituents for which no payment is made by the buyer. The removal of these undesirable constituents is usually accompanied by increased operating costs, capital expenditure, and/or some sacrifice in recovery. Such factors, he says, must be carefully considered in taking steps to improve the grade of a concentrate. To mention briefly a few of the methods customarily employed :

(1) Grinding control—involving the economic limit of the separation of the mineral constituents of the ore.

(2) Reagent control—the type and quantity of reagents used and the points of addition.

(3) Density control in the flotation circuit.

(4) Manipulation of flotation cells to give the desired arrangement and capacity of the cleaner section.

There is the further consideration, he then says, that the concentrate may contain minerals or metals which must be considered as contaminants in the concentrate in question, but which may be economically separated into one or more lesser concentrates of marketable quality. At Golden Manitou this last-named condition was found to exist. His paper describes briefly how the zinc concentrate has been successfully re-floated to produce a marketable silver-bearing lead concentrate and at the same time an up-graded zinc concentrate, an improvement which has led to a net return of more than a dollar per ton of ore milled, currently 800 tons daily, from a capital investment of less than $8,000.

The zinc concentrate produced at Golden Manitou prior to the installation of the de-leading circuit in September, 1945, contained, as major impurities, lead, insoluble matter, and iron of the order of 4%, 3·5%, and 2% respectively. In addition, there was silver running seven to ten ounces per ton of concentrate, which by weight was a negligible impurity, but which represented one-third of the silver in the mill feed. Governed by the terms of the contract with the zinc smelter, zinc was the only metal paid for and this on a basis of the zinc content of the concentrate. In other words, the presence of lead and silver in this concentrate not only represented a metal loss but also reduced the per pound value of the contained zinc.

In the early stages of milling operations at Golden Manitou the presence of lead, representing three-quarters of one per cent. of the mill feed, was purposely overlooked in favour of more pressing metallurgical considerations. However, when the time arrived to tackle the problem of up-grading the zinc concentrate, records showed that about 60% of the lead in the mill feed reported in the final zinc concentrate. The problem then was this : Could a marketable lead concentrate be economically produced and, if so, at what point in the mill flow-sheet ?

Some concept of the nature and treatment of the ore at Golden Manitou prior to the adoption of the de-leading scheme will be helpful. A typical analysis of the mill feed is as follows :

Gold, 0·05 oz./ton, closely associated with pyrite.

Silver, 3·00 oz./ton, native, associated with galena, and as argentiferous tennantite-tetrahedrite.

Zinc, 5–6%, as sphalerite.

Lead, 0·6–0·8%, as galena.

Iron, 12–15%, chiefly as pyrite.

Copper, 0·2–0·3%, as chalcopyrite and tennantite-tetrahedrite.

Arsenic, 0·03%, chiefly as arsenopyrite.

The flow-sheet, following grinding, was : Flotation of a primary gold-silver concentrate, predominantly pyrite, for cyanidation, followed by flotation of a zinc concentrate from the combined primary flotation tailing and cyanide residue.

Theoretically the lead could be removed by flotation at any of four points in the mill circuit—namely :—

(1) From the new feed, preceding primary flotation.

(2) From the primary concentrate, preceding cyanidation.

(3) From the cyanide residue, preceding zinc flotation.

(4) From the zinc concentrate.

A de-leading operation at point No. 2 was operated with some measure of success for about six months in the winter of 1943–4, but was discontinued in order to requisition the equipment thus used for additional cleaning capacity in the zinc circuit.

Table 1

METALLURGICAL SUMMARY

	Amount. (Tons).	*Gold. oz./t.*	*Assay. Silver. oz./t.*	*Zinc. %*	*Lead. %*
De-leading circuit head (zinc cleaner concentrate)	7,259·5	0·020	14·57	56·78	4·98
Lead concentrate	599·5	0·084	139·90	16·90	54·54
Lead tail (de-leaded zinc concentrate)	6,660·0	0·014	3·29	60·37	0·52

Ratio of concentration 12·11 : 1.

Table 2

PRODUCTION AND COST SUMMARY OF DE-LEADING OPERATION
(October, 1945, to January, 1946, inclusive)

ORE MILLED			78,260 tons
LEADED ZINC CONCENTRATE :			
Amount produced			7,259·5 tons
Zinc content			56·78%
Value (less duty on lead)			$229,246·30
DE-LEADED ZINC CONCENTRATE :			
Amount produced			6,660·0 tons
Zinc content			60·37%
Value			$246,959·46
Increase in value of zinc output due to de-leading			$17,713·16
LEAD CONCENTRATE :			
Amount produced			599·5 tons
Assay : Gold	0·084 oz./ton		
Silver	139·90 ,,		
Lead	54·54%		
Copper	2·01 ,,		
Payment for : Gold		$1,844·42	
Silver		62,290·26	
Lead		29,908·02	
Copper		541·30	
			$94,584·00
Freight and smelter charges			16,828·43
Net value			$77,755·57
Add increase in value of zinc output (see above)			17,713·16
			$95,468·73
Less mill operating costs for de-leading			5,965·09
Net dollar return after all charges and deductions			$89,503·64
Net profit per ton of ore milled, due to de-leading			$1·14

NOTE : All dollar values are in Canadian funds. Tonnages and assays are mine estimates, subject to adjustment according to smelter settlement.

On the basis of laboratory work the feasibility of economically de-leading the zinc concentrate was demonstrated in 1943, approximately one year after milling operations commenced. At that time, it was established that 60% of the lead and more than 30% of the silver in the mill feed reported in the final zinc concentrate and that, by the use of a single zinc depressant—namely, sodium cyanide—approximately 50% of the lead and silver could be re-floated in a marketable lead concentrate and the grade of zinc concentrate thereby increased by about two units.

At a later date investigation of the de-leading of the zinc concentrate was resumed, this time with the aid of a home-made flotation unit of the pneumatic type, including conditioner, rougher, and cleaner cells. With this equipment, capable of handling about 1,200 lb. of zinc concentrate per hour continuously, metallurgical date comparable with full-scale operation were obtained and equipment requirements were anticipated with greater certainty. It was furthermore discovered that the use of zinc sulphate and sodium sulphite in addition to sodium cyanide (the only reagent used in earlier

test work) stepped-up recoveries of the lead and silver from the previous figure of 50% to approximately 85% and 75% respectively. It appeared probable that about 2% of the total zinc would be lost in the operation, but this would be more than offset by the appreciation in grade and value of the resulting de-leaded zinc concentrate.

On the basis of the earlier laboratory work and even more from the results obtained with the pilot unit in the plant, it was possible to predict with reasonable certainty that the following benefits would accrue from the installation of a de-leading circuit :

(1) The overall silver recovery would be increased from somewhat less than 40% to about 60%.

(2) Lead, not presently being recovered, would be recovered to the extent of about 40% of the mill-feed content of the metal.

(3) The grade of zinc concentrate would be increased by about 2½ units.

(4) Some payment, though small, would likely be received from the lead smelter for gold and copper.

(5) The flotation of lead in the presence of low iron presented operating advantages over alternative de-leading schemes.

(6) In an already crowded mill building the minimum of space and equipment required to de-lead zinc concentrate, less than 100 tons per day, would be a desirable feature.

With this encouragement the necessary new equipment to effect a full-scale de-leading operation was purchased and installed, consisting of two 6 ft. by 6 ft. conditioners, one six-cell flotation machine (12 cu. ft. per cell), and one automatic sampler. In addition a 14 ft. by 3½ ft. thickener, a 2-in. diaphragm pump, a 4-ft. disc filter, and a sand pump—which were already on hand—were utilized to complete the set-up. Installation of this equipment, at a total cost of $7,800, was completed in September, 1945, at the same time, by coincidence, that the price of silver in the United States advanced from 44·75 cents per oz. to 70·75 cents.

In brief, the operating details of the de-leading circuit are as follows : The cleaned zinc concentrate, which formerly was de-watered and loaded for shipment, is now conditioned for approximately 75 minutes with sodium cyanide, zinc sulphate, and sodium sulphite, using about two pounds of each per ton of zinc concentrate. Of the six flotation cells four are roughers, allowing ten minutes' flotation time, and the remaining two are cleaners, arranged for single- or two-stage cleaning. The lead rougher tail is the final de-leaded zinc concentrate. The lead concentrate is stored in a thickener, from which it is filtered out and loaded into box cars at convenient intervals.

The pertinent data covering the de-leading operation for the first four full months of operation, commencing October, 1945, are given, the metallurgical results in Table 1 and the economic results in Table 2.

Of the metals present in the feed to the de-leading circuit, the following proportions were recovered in the lead concentrate (in percentages) : Gold, 35·2 ; silver, 79·3 ; zinc, 2·5 ; lead, 90·5. These recoveries represent the following percentages of the total amount of these metals present in the mill head : Gold, 1·5 ; silver, 29·6 ; zinc, 2·2 ; lead, 51·2.

The Climax Molybdenum Enterprise

The issue of *Mining and Metallurgy* for June contains a series of articles devoted to the various branches of the Climax Molybdenum enterprise. In one of these W. J. Coulter, F. S. McNicholas, and A. D. Storke review " The History and Trend of Mining at Climax " and the following notes are taken from their article. The authors note that in the early days of Colorado mining between 1880 and 1900, when Leadville, Kokomo, and Robinson were boom mining camps, the entire area around Climax for a matter of 15 miles was overrun with prospectors, so the mineralized outcrop at Climax was not unknown. The principal interest in minerals during this period was in gold, silver, and lead and since the Climax outcrop showed none of these it drew little attention. Geology played an important part, they say, in bringing prospectors to the very edge of the Climax deposit. The Mosquito fault, which crosses near the base of Bartlett Mountain, continues as an important geological structure, at least as far as Leadville, some 12 miles distant, and at the base of Bartlett Mountain the vertical throw on the fault is estimated to be between 2,000 and 5,000 ft. The sedimentary beds known to the Leadville district are all present on Bartlett Mountain to the north of the Mosquito fault, which cuts them off abruptly and exposes the Pre-Cambrian rocks that underlaid them, so the prospectors, who were searching for gold, silver, and lead in the sediments common to Leadville, Kokomo, and Robinson, did not prosecute their prospecting with the same vigour beyond this fault in the older Pre-Cambrian rocks.

The basin between Bartlett Mountain and Ceresco Mountain is an old glacial cirque ; the receding glacier from this cirque scoured off the capping of the ore-body and some of the rich molybdenum ore and deposited them in moraines down the Ten Mile Valley as far as Kokomo and also down the Arkansas Valley for some distance. Many of these boulders would to-day be classed as high-grade, both the oxide and the molybdenite being plainly visible, and the geologists those days had little if any doubt where they came from. As the glacier receded from this cirque it scoured off both hillsides, particularly on the Bartlett Mountain side, leaving cliffs exposing both molybdenum oxide and molybdenite plainly visible.

However, not until sometime between 1900 and 1905 was the mineralization recognized as molybdenite, but only a very small amount of molybdenum was then being used in the entire world and

there was virtually no market for it. In spite of this the ground was staked and prospectors did some open-cut work and tunneling. The rich gold mines of the Alma district were only some five or six miles distant in an air line over Democrat Mountain and these early prospectors believed that this extensive mineralization indicated the possibility of finding gold, silver, and lead and encouraged them to prospect intensively for those minerals.

When the 1914–1918 war broke out something was known about molybdenum as an alloying element, particularly as a replacement for tungsten in alloy stee's. It being known that the Climax deposit contained molybdenum this property drew the attention of the present officials of the Climax Molybdenum Co., who became interested in the economic production of molybdenum from this deposit in 1916. Development of the mine was started, a crushing plant built at the mine, a Leschen rope-way a mile long was built, and a 200-ton flotation mill erected. Put in operation in 1918, the plant produced molybdenum concentrate up to March, 1919, when it was closed down, the war being over, with no further demand. The plant remained closed until 1924 by which time a modest domestic demand for molybdenum had been developed.

Mining

With this foreword the authors suggest that the development of Climax from 200 tons per day in 1918 to more than 20,000 tons per day in 1943 and 1944 is an interesting story. The mine was opened up on the Leal level on the South side of Bartlett Mountain at an elevation of 12,000 ft. on a basis to produce 200 tons per day. A 6 by 8-ft. tunnel 700 ft. long was driven under the outcrop and three shrinkage stopes 25 ft. wide by 200 ft. long with 25-ft. pillars between them were developed. Rising and stoping was done with stoper drills and the ore was broken fine enough to be drawn directly through chutes without grizzlies. Chutes with openings of 2 ft., operated by arc gates, were spaced at 25-ft. intervals and the ore was loaded into one-ton mine cars and trammed by hand over 18-in. gauge track with 16-lb. rail to ore-bins at the portal of the tunnel. Thence the ore was conveyed by a jig-back tram down the hill some 800 ft. to a bin behind the crushing plant where it was put through an 18 by 24-in. jaw-crusher, then conveyed to ore-bins behind the tramway which in turn carried it to the mill bins by aerial tramway.

Prior to the beginning of mill operations very little was known about the structure or size of the ore-body. Hayward and Brown, who made the first comprehensive report, believed it to be a magmatic segregation in which molybdenum was a primary constituent of the granite magma and was deposited with quartz in shrinkage cracks in that portion of the igneous mass which solidified first against the intruded sediments and that the mineralized zone would be of limited thickness and the ore-bodies would be irregular in both form and grade. Little evidence existed on which to base an opinion as to the extent of the mineralization. They estimated 100,000 tons of proved and probable ore carrying about 1% MoS_2.

The Leal level was the main operating level. The White level 200 ft. below the Leal was driven in 1917. No commercial ore was found in this tunnel and a rise was put up to the Leal. This did not strike ore until it was within 60 ft. of the Leal level. This seemed to confirm the belief that ore was confined to a shallow zone at the top of the intrusive granite. Further confirmation of this appeared in 1924, when, after removal of some 400,000 tons, the economic limits of the original ore-body were reached. An intensive drilling and exploration programme was then started to prove a theory advanced by A. D. Storke that a series of faults had cut off the ore. As a result of this work new ore was found and for the first time a clearer picture of the structural features of the mineralization was developed.

Cross-cuts were driven into the new ore-bodies from the White level and five shrinkage stopes 50 ft. wide and 400 ft. long with 40-ft. pillars between were opened up. Chutes were installed on each side of the drive on 50-ft. centres and equipped with 2-ft. openings and arc gates. Chute rises were driven to a grizzly level 25 ft. above, where grizzlies were installed with 12-in. openings; each grizzly had four draw points, one belled out from each corner, so that draw spacing was on 25-ft. centres under the shrinkage stopes. Undercutting of the shrinkage stopes was started 30 ft. above the grizzly level and advanced from one end of the stope to the other by breast drilling with Leyner drills. Drilling was done from machines mounted on an arm off a 16-ft. post. In advancing down the stope a machine was set up near the pillar line on each side of the stope. Holes 22 ft. long were drilled and rounds were usually four rows wide and four rows high along the line of the pillar. Both machines reached out for from four to six holes per side into the centre back.

It took two to three shifts to finish the drilling from one of these set-ups and it was common to break as high as 1,000 tons per set-up. The rock was hard, but brittle and highly fractured, so that each hole easily took care of a burden of 6 ft. or more. A substantial overbreak would accompany blasting of the two lower rows of holes. In this practice the back of the stope ahead of the drills was close to broken ore. This type of mining naturally developed large boulders that made the grizzlies a necessity ahead of chute drawing. Ore was drawn into 5-ton Granby side-dump cars and trains of four or five of these cars were handled with 3½-ton storage-battery locomotives. The track was a 2-ft. gauge with 20-lb. steel. Up to 1,500 tons per day was produced from this level. The ore was dumped into a bin from which it was conveyed to a 24 by 36-in. jaw-crusher from which it passed to a 4-ft. gyratory crusher, then over a screen, the oversize of which passed through a set of 54-in. Garfield rolls. Screen undersize and the roll product were conveyed to ore-bins behind the tramway. By 1930 the demand for molybdenum had so increased that the mine was producing 1,500 tons per day.

As the shrinkage stopes on the White level were brought up to the Leal level a recovery of pillars was undertaken and at the same time consideration was given to recovering not only the pillars but all of the ore between the White level and the surface by a caving method. A retreat system for recovering pillars was adopted. The method selected for recovering the first pillar was as follows: Small coyote drives were driven from one end of the pillar to the other, spaced at 20-ft. vertical intervals; from these coyote drives powder tees were driven on each side of the drive at 12-ft. intervals. Powder tees were

loaded with bag powder and blasted electrically or with Cordeau. The result of blasting the first pillar was satisfactory, but as most of the pillars had been badly robbed and the company dealing with an area some 400 by 600 ft. the ground caved above the whole area without further effort. Some 600,000 tons of ore came in as a result of this caving, most of it being recovered from the White level.

While this development and mining work was progressing on the White level an intensive diamond-drilling programme was inaugurated, giving considerable information as to the horizontal and vertical extent of the ore-body and indicating substantial ore reserves.

By 1929 the increasing demand for molybdenum indicated the need for a still lower level designed to handle tonnages substantially in excess of anything that could be produced from the White level and handled over a tramway.

The Phillipson level was started in May, 1929, at the elevation of the bins of the new crushing plant. This level is 465 ft. below the White level and was driven straight into the nose of Bartlett Mountain for 2,900 ft. where the north-westerly rim of the hanging-wall of the ore was encountered. A large tonnage of low-grade ore involving upwards of 100,000,000 tons containing 6 to 7 lb. of recoverable molybdenum per ton had been proved and, as production and treatment of even lower-grade ore was possible from above the Phillipson level, a layout for the economical handling of large tonnages was decided upon. It was anticipated that drainage would have to be provided to take care of the spring run-off and surface drainage from the slopes of Bartlett Mountain, Ceresco Mountain, and the glacial cirque basin, so it was important to provide a ditch to take care of this under extreme conditions. A 3-ft.-square flume was installed in the floor on the south side of the adit. The tunnel is 9 ft. high by 12 ft. wide clear of timber with a grade of 0·4% to meet maximum water run-off through the flume. This has been found none too large. This main-line single-track adit has 36-in. gauge track which was originally laid with 60-lb. rail. As production increased the 60-lb. rail in the tunnel was replaced with 90-lb. rail. Tonnage as high as 24,000 tons in 24 hours has been handled over this haulage system.

From the start of operations on the Phillipson level 19-ton haulage locomotives have handled trains of between 20 and 25 cars. The cars are 10-ton Granby side-dump type and over the years average around 8·5 tons of live load. After handling some 45,000,000 tons the company is still using the original cars.

The first 2,500 ft. of this tunnel up to the Mosquito Fault was driven through the Leadville series of sedimentaries and igneous sills. Ground for most of this distance was heavy, requiring top and side spiling for a good portion of the distance. Sets of 12-in. squared timber were spaced at a maximum distance of 5-ft. centres, but in some sections it was necessary to install them side by side. For a number of years maintenance of this adit was expensive but in later years it has been nominal, perhaps because the area has been drained and ground movements and pressure surrounding it have been stabilized.

Neither the foot-wall nor the hanging-wall of the ore-body have sharp definite limitations, but values gradually grade off. On the foot-wall this gradation normally extends 25 to 50 ft., whereas on the hanging-wall values between 0·4% and 0·2% MoS_2 may extend as far as 200 ft. beyond the present established economic ore limit. The original haulage drives on the northern and western side of the ore-body were laid out for extraction of ore by the chute-and-grizzly system.

As a result of experience and study of the caving characteristics of the highly-fractured ore on the White level it was indicated that a caving method was applicable to this ore-body, so it was decided that, since a large tonnage of low-grade ore was involved and a large production was needed, the Phillipson level would be laid out for panel caving using the chute-and-grizzly method.

The sill development on the Phillipson level was by conventional foot-wall and hanging-wall fringe drifts connected by parallel loading drifts, spaced on 100-ft. centres. Double chutes were installed at intervals of 100 ft. in the loading drifts and were opposite each other. These chutes were 6 ft. wide at the cap and 4½ ft. wide at the lip and were operated by finger gates controlled by air lifts hung in the centre of the drive so that one lift could serve the finger gates on the chute on either side of the drive. Branch rises were driven from each chute to grizzly chambers on the grizzly level 60 ft. above the haulage level. The grizzly level was developed by foot-wall and hanging-wall fringe drives connected by parallel grizzly manway drives on 100-ft. centres directly over the loading drive. Entries on 50-ft. centres from these drives gave access to the double grizzly chambers which discharged into the branch rises from the chutes on the haulage level. The original grizzlies were double, each 12 ft. long, made of specially-rolled heavy crane-rail sections weighing 270 lb. per yard and installed with a 30-in. opening. The centre support for these was a 14 by 16-in. built-up I section. The original grizzly rails proved insufficiently strong to stand the service, so were replaced by a rail of Keystone section weighing about 350 lb. per yard.

It was believed that the same practice could be followed on the Phillipson level as used on the White level—that is, draw points from each corner of the grizzly chamber could be carried up to the mining level to establish draw points at 25-ft. centres, but this proved to be in error, principally because the ground on the Phillipson level was below the water table and had different characteristics from that on the White level. The heavy bulldozing necessary to bring down hang-ups in these fingers resulted in shattering the ground between the fingers so that it soon failed, resulting in only one draw point at the end of the grizzly. As drawing progressed the same thing occurred with the pillar over the centre of the grizzly chamber so that the entire grizzly was sometimes lost. Naturally this condition, which involved safety, high maintenance cost, and small tonnages, had to be corrected.

Grizzly chambers with only one draw point at each end of the double grizzly were tried and were unsatisfactory as in many instances the ground over the grizzly chambers could not be held, resulting in flooding of the grizzly chamber. Blocking of the grizzly entry was common ; at times the entire grizzly was lost and a serious safety hazard was always present. This experience led to development of a single-end grizzly which, though somewhat more expensive, gave greater safety, better ventilation, higher recovery of ore, less maintenance, and lower operating cost. Maintenance of these grizzlies in weak rock was high, often requiring concreting of the chamber.

Slushing

An experiment in the handling of ore with slushers was conducted on a small scale on the White level above. Results were so promising that it was decided to try the slushing method on the Phillipson level on a large scale whereby a direct comparison could be obtained between this and the chute-and-grizzly method. If the slusher method proved practical it offered the following comparative advantages :

(1) Safety.

(2) Larger recovery of the horizontal pillar above the level. The chute-and-grizzly system required approximately 100 ft. between the haulage level and mining level, whereas with the slusher method this distance was reduced to approximately 50 ft. Any ore not recovered on this level would be charged with hoisting expense.

(3) Closer spacing of draw points.

(4) Better control of the ore drawn from each draw point.

(5) Less development work.

(6) Better ventilation.

(7) Concentration of work on one level.

(8) Reduction of cost.

Development of the slusher system, however, presented many problems. Slusher drives were driven 9 ft. wide by 11 ft. high, normal to the haulage drive on 75-ft. centres. The bottom of the slusher drive was at the elevation of the top of the cap of the haulage drive, so ore could be scraped directly into cars and fingers were driven on both sides of the drive. These slusher drives were 100 ft. long and slushing was done alternately on either side by a hoist maintained in the back of the haulage drive ; thus in this system it was only necessary to drive a haulage drive on 200-ft. centres instead of on 100-ft. centres as required in the chute-and-grizzly system. The first slusher drives were not timbered and as with the grizzly chambers the ground did not stand up. Use of timber and steel sets also proved unsatisfactory, so it was found necessary in all cases to concrete these drives and the lower portion of the finger raises from them.

Various arrangements and spacings were tried for finger rises feeding directly on to the bottom of the slusher drive. Experience has led the company to space these openings on 33⅓-ft. centres on one side only of the slusher drive, which results in draw-point spacing of 50 by 33⅓-ft. centres.

The original hoists were 150 h.p. with a rope speed of 325 ft. per min. both ways, which proved too fast for digging, so the hoists were changed to 100 h.p. with rope speed of 250 ft. per min. The original scraper was a cast manganese hoe-type with 6-ft. digging blade. This was superseded by a cast manganese semi-box type with 5-ft. digging blade and then by the present cast manganese hoe-type with a 6-ft. folding digging blade. The ore is scraped directly into the 10-ton Granby-type cars.

Handling of ore by the slushing system has proved so much more satisfactory and efficient than by the chute-and-grizzly system that the latter has been discontinued and all new work is being laid out for the slusher system. Approximately 75% of the ore now produced is being handled by slushers and the fact that the company has attained as much as 45 tons per man shift for all underground employees speaks for the efficiency of this method of handling ore.

The first stope laid out for caving on the Phillipson level was predicated upon the characteristics of the ore-body as it was known on the White level. An area approximately 600 ft. long and 400 ft. wide was undercut on the hanging-wall side of the ore-body. Horizontal pillars were left on the mining level between the draw points driven up from the grizzly level, vertical cut-off stopes along the hanging-wall with substantial pillars between them were driven for 250 ft. above the mining level, and coyote drives and powder tees were driven horizontally over the mining level on 30-ft. centres. All pillars and powder tees were blasted with delay caps in the final removal of all support of the undercut area. This required large blasts. In one case 110 tons of powder was used in the blasting of the pillars and powder tees, which was the largest amount of powder used underground in one blast up to that time. The breaking and caving results were satisfactory and over 2,000,000 tons of ore was drawn from this area. At the time of this big blast tonnage was badly needed and for several months thereafter 2,000 tons per day was drawn from three chutes, indicating that the caving method was working satisfactorily and that the grizzlies and chutes were also functioning as planned. Mining and development work then proceeded easterly, westerly, and toward the footwall from this initial caved area.

Approximately 100,000,000 tons of ore has been developed above the Phillipson level and about half of this has already been recovered. A great deal has been learned about the characteristics of the ore-body, the strength of the ground, the height of the backs, or the most desirable vertical distance between the levels, the importance of and the best means of providing for and supervising draw control, the best methods of undercutting and handling, the most satisfactory type and size of haulage equipment, and the best system of ventilation and dust control applicable to this mine ; in all of this the elements of safety and health hazards have been given serious consideration.

An extensive study of caving and draw as shown by a scale model has indicated, confirmed, and crystallized ideas regarding recovery, draw-point spacing, draw control, cut-off procedure, etc. The study and mapping of the caving characteristics of the ore-body also promises to be an important aid to future planning.

Caving practice at Climax differs from conventional caving methods in :

(1) Concreting of working places.

(2) Mining by caving of foot-wall inclined areas over a vertical distance of 700 to 800 ft.

(3) Practically 100% use of slusher system.

(4) Large spacing of draw points made possible by caving characteristics of ore-body.

(5) Under-cutting on a muck slope (40°), so material from undercuts flows by gravity to fingers and leaves maximum pillar over slusher drive to protect it.

(6) Pillar removal by electrical blasting of a large number of pillars simultaneously where indicated.

(7) Continuous retreat panel caving followed by continuous retreat panel draw of ore with no pillars left between panels or blocks.

A new level, 300 ft. below the Phillipson level, from which approximately another 100,000,000 tons of ore should be recovered, has been carefully planned and laid out.

Report on a Californian Copper Deposit

An account of exploration work carried out by the United States Bureau of Mines on a copper property in El Dorado County, California, is given in Report of Investigations 3896 by R. H. Bedford. The El Dorado mine is situated in the foot-hill copper-zinc belt of California, which traverses the western slope of the Sierra Nevada with unusual persistence from Butte County to Kern County—a distance of more than 300 miles. Although this area contains such important past producers as the Penn mine, Union, and others, a great part of the current production has been derived from smaller properties, which depend largely on premium metal prices for economic operation. The El Dorado mine is in the latter group, which constitutes an important source of metal in a national emergency.

Exploration by the United States Bureau of Mines by means of eight diamond-drill holes indicated narrow intermittent lenses of copper ore along structures 600 ft. in length. The copper occurs in massive sulphides composed of chalcopyrite, pyrite, pyrrhotite, and minor quantities of bornite. The sulphides have evidently replaced tuffs, which are interbedded with the Mariposa slates and shales. In December 1944 an engineer of the Bureau of Mines visited the mine and recommended the project work undertaken. The purpose was to aid the owners in bringing the property into production of copper and zinc, which at that time was critically essential to the war industries.

The country shows the characteristics typical of the western flanks of the Sierra Nevada at 2,000 ft.—an elevation transitional between foothills and mountains proper. Situated on the south slope, just below the divide between the middle and south forks of the American River, the area is one of rolling hills separated by gently-sloping valleys that plunge below into rugged ravines of the South Fork. Summers are hot and dry and the winters are moderate, with about 40 in. of rainfall and at times a transient fall of snow. Conditions are ideal for efficient all-year operations and housing facilities and board for a small crew are available within a radius of 5 miles.

The Deposit

From Kern County in the south to Butte County in the north, mineralization in the Sierra Nevada, from its western flank to its summit, shows the zoning characteristics described by Emmons and other geologists. In the foothills along the west flank a line of copper and copper-zinc deposits follows in direction the main north-west-striking axis of the batholith that constitutes the backbone of the range.

Typical "West Belt" copper-zinc deposits are marked by an inconspicuous gossan, below which may be expected a tabular or lenticular ore-shoot that dips steeply, usually to the east. Although the average lense is small in some places—such as, at the Penn mine in Calaveras County and the Big Bend mine in Butte County—ore reached a thickness of 30 ft.

The El Dorado mine is a member of the West Belt family and departs from the typical only to the extent that the host rock is slate of the Mariposa formation instead of the schist that is usual in the others. As seen at the El Dorado mine, the Mariposa formation comprises an alteration of dark slate and shale as the dominant constituents and minor amounts of an interbedded grey rock believed to be tuff.

Ore is indicated by narrow zones of gossan striking N. 27° W. and dipping 60° to 70° to the west. The massive sulphides, consisting mostly of chalcopyrite, pyrrhotite, and pyrite, have evidently replaced the stratum of the tuffs, which seems to have been more susceptible to replacement than either the slate or shale, both of which are barren. Although the tuff has a thickness of as much as 10 ft. only narrow beds showed complete replacement. The thicker bands showed no more than scattered specks of mineral, an incipient replacement that did not rise to the level of protore. The reason for the complete replacement of thinner strata and virtually no replacement of the thicker is not apparent.

Underground exploration consisted of a 173-ft. adit driven as a cross-cut for 46 ft. and as a drive on the vein structure for 127 ft. and a 48-ft. shaft that connects with the adit 128 ft. from the portal. The shaft bottom is 8 ft. below the adit, which was driven near ground-water level, as shown by the oxidization of the vein to that horizon. The exposures in the adit suggest ore-shoots that have but little strike length. At the point where the shaft intersected the adit, sampling by a Bureau engineer showed 3·24% copper across 3 ft. on the foot-wall side and 4 ft. of 13·24% ore on the hanging-wall side. A sample across the middle 4 ft. assayed 0·75% copper. Zinc assays ranged between 0·5% and 0·6%. Gold values ranged from a trace to 0·025 oz. per ton, whereas silver values ran from 0·25 to 1·10 oz. per ton. The foot-wall band showed some quartz containing bornite. This ore extends from a few feet south of the shaft to a few feet north, at which point it dies out and re-appears as a 12-in. vein of solid sulphides 5 ft. from the present face.

In addition to the underground work there are numerous old surface cuts and pits, which are evidently the work of prospectors in their search for gold.

Work by the Bureau

The base map showed surface evidence of two approximately parallel veins, one in the north and the other in the south portion of the Roosevelt claim. The gossan outcrops are not continuous and are now marked by old open-cuts, shallow pits, and the main shaft. Eleven drill holes aggregating 1,613 ft. were drilled. Holes 1, 2, 3, 4, 5, 6, 10, and 11 explored the southerly vein and holes 7, 8, and 9 explored the northerly one. Where not in ore all holes showed barren or only slightly mineralized Mariposa formation consisting of interbedded slates, shales, and tuffs.

Because the southerly structure was both more extensively developed and promising it was selected as the target for the first two drill holes, which were designed to explore in depth the ore found at the intersection of the shaft with the adit. The holes showed narrow bands of ore at two horizons, 60 and 130 ft. below the adit, respectively. The ore consisted of massive sulphides containing much chalcopyrite.

Holes 3 and 6 were drilled parallel to holes 1 and 2 about 90 ft. to the north to explore for the possible

extension of the ore-body in that direction. This location was midway between the main-shaft gossan and that showing 180 ft. north of it. To test the foot-wall hole 3 was continued to a depth of 165 ft. without finding any ore, although at 162 ft. it did show 4 in. of slightly-mineralized tuff.

Holes 4 and 5 were drilled to explore below the gossan 180 ft. north of the shaft and both of them intersected narrow widths of ore similar to that found in the shaft section.

At this stage two small shoots of ore were indicated in the southerly section. Holes 7 and 8 were then drilled to explore below the northerly gossan. Hole 7 did not intersect the vein below the oxidized zone and small specks of native copper appeared in the core between 62 and 72 ft. Hole 8 showed solid sulphide ore from 110 ft. 8 in. to 111 ft. 9 in. This ore was the same type as found in the southerly lenses.

Three more short holes, 9, 10, and 11, explored for lateral extension of the ore-shoots indicated. Hole 9, drilled 65 ft. north of 7 and 8, showed scattered mineral in tuff between 118 to 122 ft., but was otherwise in barren slate. Hole 10, drilled 65 ft. north of sections 4 and 5, intersected 1 in. of pyrite at 87 ft., but was otherwise barren of mineralization.

At 75 ft. south of holes 1 and 2 hole 11 was barren except for a little scattered pyrite between 84 and 86 ft.

In its final results drilling indicated in the sections of holes 1 and 2, 4 and 5, and 7 and 8, three shoots of ore of limited lateral extent. The average thickness of ore in the three lenses where cut by the drill holes is 1 ft. Persistence in depth was not determined, but in the West Belt the Penn mine has ore to a depth of at least 2,800 ft., Copperopolis to 1,800 ft., and the Newton has ore below 900 ft.

Electrostatic Tests on Queensland Beach-Sand Concentrates

The Australian Council for Scientific and Industrial Research Investigation Report No. 292 issued by the Metallurgical Laboratory of the University of Melbourne reviews tests on the electrostatic separation of zircon and rutile from gravity concentrates produced from beach sands at North Burleigh, Queensland. The authors, J. G. Hart and H. H. Dunkin, state that one of the samples marked "MDS Red" had been magnetically treated on the Southport treatment plant for removal of ilmenite and other magnetic minerals. It consisted of zircon and rutile *plus* minor minerals and residuals from the tabling and magnetting operations. The sample marked "MDS Black" was a straight table concentrate and therefore contained zircon, rutile, and ilmenite *plus* minor minerals and residual quartz. The investigation was to determine whether electrostatic separation of the zircon could be applied either on the magnetted or unmagnetted concentrates.

In assaying the test products from this investigation a microscopic count of "white" (zircon), "black" (rutile and ilmenite), and "others" (quartz, garnet, etc.) was made, the figures given being weight percentages. At first all minerals were counted separately, but it was soon found that some of the rutile appeared black under the microscope and reported as ilmenite. This "black rutile" is feebly magnetic and therefore probably contains some iron; however, it contains over 95% of TiO_2. It was then decided to count all rutile and ilmenite as "blacks"—that is, as they appear to the eye unaided. Chemical analyses for TiO_2 were also carried out on the products.

Apparatus

Electrostatic work was carried out using a 6-in. brass-coated roller as the rotating electrode; this was earthed to the positive side of the rectifier, roller speed being 430 r.p.m. The separating electrodes were steel wires placed 2 in. from the roll at positions corresponding to 1, 2, 3, and 4 o'clock, as viewed from the end showing clockwise rotation. The separating electrodes were connected to the negative side of the rectifier. Direct current was supplied by a valve-type rectifier with choke circuit, the voltage used being of the order of 20,000. Mineral was heated to 200° F. for the treatment.

Under these conditions rutile and ilmenite threw towards the separating electrodes and were taken off as a "concentrate". Zircon attached itself to the roll and was removed by a brush wiper at a position of 8 o'clock, giving the "tailing." "Middlings" was the material falling between the concentrate and tailing.

The United States specification for rutile calls for a minimum of 85% TiO_2 for "metallurgical" grades and a minimum of 95% TiO_2 for "welding" grade. Zircon specifications vary depending on the buyer of the mineral, but impurity limits are extremely small and it is safe to say that zircon must exceed 98% pure mineral before it is saleable.

Sample MDS Red

This material had been magnetically treated at the company's works, it was therefore a product consisting mainly of zircon and rutile. It was given several passes over the electrostatic roll, the results of the treatment being shown in Table 1.

In assaying by particle counting sufficient fields must be counted to give statistical accuracy; also spreading of samples on the slides must be done in such a way that segregation of the minerals does not occur. The first of these is tedious and the second is difficult, consequently the particle counts are of doubtful accuracy. Cases occur in Table 1 such as that marked—where the TiO_2 figure by chemical analysis is higher than the total of rutile *plus* ilmenite; this is the direct result of the two factors mentioned *plus* a third—*viz.*, that leucoxene, a titanium-bearing mineral, reports in the particle count among "other minerals."

Table 1

Product.	%	Assays %					Distribution %.				
	Wt.	W	B	TiO_2	O	M	W	B	TiO_2	O	M
Rutile	45·1	4·5	84·6	91·5	10·9	0·6	5·1	74·7	74·1	50·0	36·6
Middling	16·7	32·7*	56·6*	61·7	10·7	0·3	13·8	19·3	18·5	18·2	6·7
Zircon	38·2	84·2	7·6	10·7	8·2	1·1	81·1	5·9	7·3	31·8	56·7
Composite	100·0	39·6	48·9	55·6	9·8	0·7	100·0	99·9	99·9	100·0	100·0

W = White; B = Black; O = Others; M = Monazite.

Table 2

BS Screen.	Aperture, inches.	% Weight. Zircon.	Rutile.	Ilmenite.
+ 72	0·0083	0·3	—	6·5
+ 100	0·0060	10·9	26·2	30·9
+ 150	0·0041	72·6	66·7	50·7
+ 200	0·0030	16·2	7·1	11·7
— 200	—	Nil	Nil	0·2

Table 3

Electrostatic

Product.	%	Assays %					
	Wt.	W	B	TiO_2	O	M	Cr_2O_3
Rutile-Ilmenite	43·0	1·7	93·7	67·9	4·7	0·13	1·43
Middling	20·4	37·7	45·7	47·4	16·6	0·2	1·6
Zircon	36·6	75·0	10·0	9·7	15·0	0·95	0·7
Composite	100·0	35·9	53·3	42·4	10·9	0·44	1·2

Magnetic

Ilmenite	55·7	0·5	95·7	47·4	3·8	Nil	2·24
Rutile	44·3	3·1	91·1	93·7	5·8	0·3	0·41
Composite	100·0	1·7	93·7	67·9	4·7	0·13	1·43

The most significant point about Table 1, the authors say, is that the amount of other minerals present in the concentrate reaches 9·8%. These other minerals (quartz etc.) control to a large degree the quality of the finished zircon and rutile. Thus the rutile produced contains only 91·5% of TiO_2, while the minor minerals are present to the extent of 10·9%, as indicated by a particle count, if these were absent rutile grade would exceed 95%. The zircon produced is far from pure due to contamination by minor minerals and by "blacks"; further processing would be needed to produce pure zircon.

The presence of minor minerals in the original sample calls for strong comment. It means that the simple single-stage tabling used to concentrate the heavy minerals is quite inadequate to give both high recoveries and clean silica-free concentrates. Some modification of this treatment seems desirable as an initial step in the production of pure zircon and rutile.

Zircon and rutile distributions in the various electrostatic products are about what may be expected—that is, there is a loss of 5·1% of the total zircon in the rutile concentrate and a loss of 7·3% of the TiO_2 in the zircon concentrate. The middling would in practice be returned, thus distributing its mineral contents between the zircon and rutile products.

Sample MDS Black

This sample was the bulk table concentrate without any further treatment. Like the previous sample it contained too much minor minerals and this was reflected in the grade of zircon and rutile finally produced. It was repassed on the electrostatic roll in a similar manner to that used for the previous sample. The electrostatic concentrate was then magnetted to separate it into rutile and ilmenite; the results of the treatment are shown in Table 2.

As in the case of the previous sample the rutile containing 93·7% of TiO_2 is diluted with 5·8% of minor minerals, while the zircon, containing only 75% of zircon, is diluted with 15% of minor minerals and 10% of blacks. It is interesting that the black content of the electrostatic middlings is almost entirely rutile, indicating a preferential separation of ilmenite. Monazite has thrown mainly with the zircon from where it could be removed by high-intensity magnetic separation. Chromite (or spinel) has gone mainly with the rutile-ilmenite and finally into the magnetic product. Screen tests on rutile, ilmenite, and zircon are recorded in Table 2.

Summary

The testing showed that it is unimportant whether electrostatic separation is applied before or after removal of ilmenite from concentrates such as those submitted. The work showed up clearly the major effect on purity of final products of the minor minerals and residuals likely to be present in such concentrates.

It is clear from the work that closer attention should be paid at the plant to securing concentrates as free as possible from such residual minerals. This must be the pre-requisite step to production of reasonably pure grades of zircon and rutile.

Ore Reserves in the United States

In an article in the *Mining Congress Journal* for May the position of the United States regarding future ore reserves is reviewed by G. M. Fowler. The author's discussion is confined to copper, lead, zinc, gold, and silver. He says that undoubtedly many new important discoveries will be made outside established districts and in them beyond the inferred extensions of known ore-bodies. Numerous small to very large areas in many parts of the United States where little or no work has been done must be explored for their ore possibilities. These areas are exclusive of even larger tracts where sufficient geological work has been done to demonstrate that only negative results can be expected.

Before the 1914–1918 war the reserves of some of the common minerals—such as lead and zinc—were thought to be ample for many years, but recent surveys indicate their alarming decline. Many factors contributed to this situation. The volumes of these ores were adequate for current needs and there was little incentive from any source to augment them. Few mining companies deemed it necessary to stimulate their ore search efforts until the recent war demonstrated the urgent necessity for metals. Many vigorous prospecting campaigns are now in progress and it seems certain that some of them will be successful.

The major production of the minerals mentioned from the beginning of the United States domestic industry to the present, came from relatively few districts. For several decades more than 90% of their production came from less than 40 districts, nearly all of which will continue for many years to be important sources of mineral wealth. Also, numerous new ore discoveries will be made in these districts, as few have been explored to their lateral and vertical limits.

Among recognized essentials for hypogene ore deposition are :

(*a*) Source material ;

(*b*) Channelways through which the source material may travel, and

(*c*) Reservoirs in which this material may be deposited.

The adequacy or inadequacy of any of these essentials is a definite limiting factor in any ore deposit. The volumes of the deposits are directly related to the quantities of the source materials and the cubical contents of the ore reservoirs. The optimum conditions require abundant source materials, adequate channelways, and favourable host conditions.

The close relationship of hypogene ore deposits to structural deformation has long been recognized. All the major mining districts are localized in favourable zones in large centres of regional disturbance. This is also true where the host formations are all igneous, all sedimentary, and in many cases a combination of both.

A little progress has been made in determining the reasons for the localizations of some of the mining districts as units, but much additional factual evidence is necessary. The three-dimensioned structural patterns within some mining districts have been determined with sufficient accuracy to delineate many of the important ore-bodies. Practically nothing is known regarding the structural relations that may exist between two or more districts. Serious studies to this end, the author says, should be undertaken in many parts of the country. Partial to complete answers regarding these conditions would materially increase our ore reserves and our knowledge regarding ore deposits.

Prospecting of Concealed Deposits

Nearly all the past ore discoveries resulted from surface observations and prospecting of visible outcrops. New ore discoveries will show few if any surface manifestations and many of these deposits are concealed by barren formations from a few feet to many hundred feet in thickness. To date only limited attempts have been made to find concealed deposits. The oil industry faced a similar situation a few years ago, then new methods and new instruments were developed.

In the revived ore-search campaign surface exposures or manifestations that may indicate ore at depth are being re-appraised in the light of present knowledge. Zones of structural deformation, stratigraphy, and rock formations in general and in detail are being studied with renewed emphasis. Soil analyses have been tried extensively in some areas and will have a place in future investigation.

In some parts of the United States, where surface exposures are non-existent, churn or diamond drilling campaigns have been in progress for years. The stratigraphy is determined from drill cuttings or cores and structure contour maps are prepared and interpreted in order to delineate ore-bodies that may exist there. This work is being extended to many new areas in which little or nothing is known regarding the ore possibilities. Geophysical prospecting has given valuable preliminary information in some mining localities and it is probable that it will gradually be extended in the search for these hidden ores.

Fertile fields for prospecting for concealed ores at relatively shallow depths include large areas in the Mississippi Valley, areas in the eastern states, and parts of many of the inter-mountain valleys in the western states. Clues regarding hidden ore deposits in the western valleys may be revealed in some cases by interpreting the geological structure and strata of the exposed contiguous mountain-sides.

The search for ore in the past in many cases has been a hit or miss proposition with few organized plans except in the known districts. Nearly all the important ore discoveries were made by prospectors or by accident. The United States Geological Survey and a few State surveys have pioneered in general geological studies in many parts of the country and contributed valuable data, but their funds and personnel have been too limited to undertake intensive ore-search campaigns.

For several decades technically-trained personnel in the established districts have made remarkable strides in outlining development which has yielded large returns in ore reserves. Few of them have undertaken real prospecting campaigns in regions outside these districts. The successful investigators of the future who will work in these regions will be much better prepared as they will combine the efforts of the geologists, geophysicists, geochemists, and all others who are interested in ore deposits. When the new techniques are intensively and extensively applied throughout the country, undoubtedly many important ore discoveries will result.

Exploring Canadian Asbestos

The drilling methods used at the Jeffrey mine, Asbestos, Quebec, to explore the deposits and to forecast production are described by G. K. Foster and C. D. Borror in the *Canadian Mining and Metallurgical Bulletin* for March. At this property operations were started in 1881 on outcrops on a hill, as a side-hill cut, followed by a second and third cut. This development was the forerunner of the present large open-pit operations, the mine now ranking as the largest open-pit asbestos mine in the world. Operations were first carried on by hand, then by horse-power, and later by stem cableways. By 1914 the derrick spans, 2,000 ft. or more long, became unwieldy. To overcome this and also to eliminate hand labour as much as possible, steam shovels and railway haulage were introduced. The steam shovels were replaced in 1928 by larger electric shovels of the full-revolving type.

The ore-body is a serpentinized peridotite rock mass. The chrysotile fibres form a network of veins throughout, varying from microscopic width to two or more inches measured across the veins. These veins may be continuous for a few or many feet; they may increase or decrease in width within a few feet. The veins in which the fibres occur perpendicular to the veins are known as cross fibre. Those in which the fibres lie parallel to the veins are known as slip fibre. The cross fibres are of better quality and more in demand. The majority of the fibre occurring in the Jeffrey mine is of the cross-fibre type. The chrysotile fibre and the serpentine rock mass are of practically the same chemical composition and for this reason no chemical analysis or assay will determine the value of the ore. This must be determined by visual examination.

The first core drilling was commenced in 1920, using company-owned shot drills cutting a $3\frac{1}{4}$-in. core. These cores were easily read, but penetration was slow, with comparatively high costs. This type of drilling was soon discontinued except for relatively shallow holes. The first diamond drilling was started in 1922, by contractors using machines that cut a $1\frac{5}{16}$-in. core. These were found to be too small to retain the fibre veins and so did not furnish accurate information. In 1928 drilling by contractors using *AX* equipment was begun. This size of core was found to be satisfactory and was adopted as standard. A system of logging was introduced whereby each cross-fibre vein $\frac{1}{32}$-in. thick or thicker is measured and counted. The type of serpentine rock is also recorded. The ore classification is by comparison with known ore faces whose mill recoveries are on record. This classification having been made, the fibre recoveries can be forecast by using an empirical formula that has been derived from daily operating data kept over a number of years. The logging is recorded on a suitable sheet and a committee composed of engineers and mine and mill operating men then classifies the rock as "good," "medium," or "poor" mill ore, or waste. This information is then transferred to a rod model.

With the yearly demand forecast before them, the engineers draw up a yearly mining schedule showing quantity and grades of fibre that may be expected from each mining area. It is then the task of the operating departments to mine this rock in such a way that the mill will be supplied with an even flow of rock, blended to produce the grades of fibre desired.

RECENT PATENTS PUBLISHED

☞ A copy of the specification 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.

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2,507 of 1944 (578,023). A. G. E. ROBIETTE and P. F. HANCOCK, Birmingham. Metals are melted in a vertical shaft furnace using a controlled supply of gaseous fuel.

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8,629 of 1944 (578,136). M. J. UDY, Niagara Falls. Recovery of the elemental sulphur produced by the reaction between hydrogen sulphide and sulphur dioxide.

13,401 of 1944 (578,069). E. I. DU PONT DE NEMOURS AND CO. and N. F. BLACKBURN, Wilmington, Delaware. Electrodeposition of metallic tin from a plating bath containing an aqueous solution of an alkali metal stannate, the anode being a tin alloy with an alkali metal.

NEW BOOKS, PAMPHLETS, ETC.

☞ Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C.2.

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Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary Technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

Economics

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COMPANY MEETINGS AND REPORTS SECTION

MINING TRUST, LTD.

Directors : Earl Castle Stewart (*Chairman*), E. P. Andrae, G. F. Laycock, H. J. Fisher, Mrs. Leslie Urquhart, D. P. Mitchell, H. Quennell. *London Manager and Secretary :* C. H. Self. *Office :* Adelaide House, London, E.C. 4. *Formed* 1929. *Capital issued :* £5,945,988 in £1 shares.
Business : Finance and development of mining ventures in various parts of the world.

The seventeenth ordinary general meeting of the Mining Trust, Ltd., was held on July 26 at Winchester House, E.C., Earl Castle Stewart presiding.

The following are extracts from the statement by the chairman, which was circulated with the report and accounts for the year ended December 31, 1945 :

Cash at bankers on December 31 stood at £391,850. At to-day's date our liquid resources amount to £830,577, comprising £366,075 cash at bankers, £64,502 temporarily advanced to Britannia Lead Company against metals and £50,000 advanced on short-term to Mount Isa and £350,000 Government securities. The profit of £43,140 has been applied to the reduction of the debit balance on income and expenditure account.

Mount Isa.—Net profit for the year ended June 30, 1945, amounted to £126,236 (Aust.) after deducting from gross profit the sum of £197,426 (Aust.) for interest on debentures and loans and £133,382 (Aust.) to cover depreciation on buildings, plant, and machinery. Earnings from copper production based on actual receipts from metal sales amounted to £251,391 (Aust.), which would have been insufficient to service the debentures and in addition provide for reasonable depreciation ; but certain supplementary earnings from the sale of lead and zinc products became available during the year and these largely accounted for the net profit as stated of £126,236 (Aust.) after covering interest and depreciation.

The reserves of developed and prospective lead-zinc ore remain unchanged at 7,116,740 tons, containing an average of 7·7 oz. silver, 8·6% lead, and 8·5% zinc. At June 30, 1945, copper ore reserves were 2,754,500 tons containing 3·96% copper.

It had been hoped that the company would be able to revert from copper production to the production of lead-silver bullion and zinc concentrates on January 1 this year, but owing to a shortage of man-power and difficulties connected with the supply of coal, the resumption of the production of lead bullion was delayed until the month of May. Whilst it is clearly to the interest of the company, in view of the present market prices of lead and silver, to resume the production of lead-silver bullion and zinc concentrates, it is not possible to proceed simultaneously with the production of copper. Before copper production can be resumed it will be necessary to make arrangements for the separate handling of copper ore in the mine and to construct an additional unit for the mill, a copper smelter, a converter, and other auxiliary equipment. Designs and estimates for the cost of construction of the new plant are now being made and the methods whereby the new finance required should be provided are being studied.

With regard to the prospect of dividends from Mount Isa, it must be borne in mind that during the year ending June 30, 1946, the company was for ten months engaged in the production of copper only and did not benefit from the large and rapid rise in the prices of lead and silver. Therefore, although the company will probably show a favourable balance on profit and loss for the year ending June 30, 1946, such profit is not likely to be large enough to provide the cover necessary to safeguard the Queensland Government's guarantee of the Third debenture and therefore it is unlikely that the company will be able to pay a dividend in respect of that year. But it is hoped that if production can be maintained at 3,000 tons of lead bullion per month and if costs and selling prices remain at roughly present levels, Mount Isa might be able to earn sufficient to justify a modest maiden dividend for the year ending June, 1947.

Other Interests.—There is little that I can add with reference to our interests in the gold properties at Big Bell Mines, in New Guinea and in Saudi Arabia, to the information which is contained in the directors' report, but we are confident that when normal production can be resumed at these properties we shall receive substantial dividends upon our share holdings.

Future Policy.—Several shareholders have from time to time put forward the view that the capital structure of Mining Trust should be reorganized and the debit balance at profit and loss and other losses should be written off. At the annual general meeting last year your directors promised that this matter, which has been under consideration for some time, should not be lost sight of. With regard to this year the position is this : Since, as I have stated above, Mount Isa is unlikely to declare a dividend for the year ending June, 1946, the income of Mining Trust is not likely to be such as to warrant the distribution of a dividend even if the company was reconstructed during the course of this year. But if, during the remaining months of this year and the early part of next year, it were apparent that Mount Isa were earning profits at such a rate as to warrant a distribution for the Mount Isa financial year ending June 30, 1947, then it might well be both practicable and desirable that the reconstruction of Mining Trust should be carried through. If this were done there is a possibility that a small maiden dividend might be paid in respect of the year ending December 31, 1947. I cannot at the present moment add anything more to this somewhat general statement because until the amount of the new finance required for Mount Isa has been determined and until we have a clearer picture of the result of the resumption of the production of lead-silver bullion, it is not possible to forecast the earnings of Mount Isa or of Mining Trust with even tolerable accuracy. But in general it may be said that over the past few years the prospects of the Mining Trust have greatly improved, there is a very substantial balance of cash and Government securities amounting to over £800,000 in hand and if metal prices should continue at their present levels the outlook is distinctly promising.

The report and accounts were unanimously adopted.

JOHANNESBURG CONSOLIDATED INVESTMENT CO., LTD.

(Incorporated in the Union of South Africa.)

Mining Companies' Reports for Quarter Ended June 30, 1946.

GENERAL REMARKS.—The revenue from gold has been calculated on the basis of gold at £8 12s. 3d. per ounce fine. In determining the payable development footage gold has been taken at £8 12s. 3d. per ounce fine. The development figures are the actual results of the sampling of development work on reef; no allowance has been made for modifications which may be necessary when computing the ore reserves.

6, Lothbury, London, E.C. 2. *July 29, 1946.*

Government Gold Mining Areas.

Issued Capital - - - £1,400,000

Crushed 642,000 tons; yielding 122,563 oz.

		Per ton.
Revenue from Gold	£1,055,573	£1 12 10
Working Costs	875,800	1 7 3
	£179,773	£0 5 7
Sundry Revenue	11,547	
Profit for Quarter	£191,320	

Working costs per fine oz. gold produced **£7 2s. 11d.**

Government's share of profits for quarter estimated at **£37,647.**

Expenditure on Capital Account **£2,187.**

DIVIDEND No. 58 of 20% (**1s.** per **5s.** share) has been declared in Union of South Africa Currency.

DEVELOPMENT FOOTAGE sampled **8,205** ft. **Payable, 2,780** ft., having average value **6·3** dwt. over **43** in. **Unpayable, 5,425** ft., having average value **2·1** dwt. over **41** in.

New State Areas.

Issued Capital - - - £1,514,037.

Crushed 334,000 tons; yielding 64,042 oz.

		Per ton.
Revenue from Gold	£551,564	£1 13 0
Working Costs	370,340	1 2 2
	£181,224	£0 10 10
Sundry Revenue	4,236	
Profit for Quarter	£185,460	

Working costs per fine oz. gold produced **£5 15s. 8d.**

Government's share of profits for quarter estimated at **£95,416**, and taxation for the six months ended June 30, 1946, at **£44,767.**

Expenditure on Capital Account **£2,654.**

DIVIDEND No. 43 of 7½% (**1s. 6d.** per share) has been declared in Union of South Africa Currency.

DEVELOPMENT FOOTAGE sampled **6,704** ft. **Payable, 2,580** ft., having average value **19·7** dwt. over **14** in. **Unpayable, 4,124** ft., having average value **3·2** dwt. over **17** in.

Randfontein Estates Gold Mining.

Issued Capital - - - £4,063,553.

Crushed 1,057,000 tons; yielding 134,712 oz.

		Per ton.
Revenue from Gold	£1,160,203	£1 1 11
Working Costs	1,011,084	0 19 1
	£149,119	£0 2 10
Sundry Revenue	10,059	
Profit for Quarter	£159,178	

Working costs per fine oz. gold produced **£7 10s. 1d.**

Taxation for the six months ended June 30, 1946, estimated at **£17,056.**

Expenditure on Capital Account **£63,428.**

DIVIDEND No. 37 of 2½% (**6d.** per share) has been declared in Union of South Africa Currency.

DEVELOPMENT FOOTAGE sampled **10,405** ft. **Payable, 4,930** ft., having average value **5·6** dwt. over **38** in. **Unpayable, 5,475** ft., having average value **2·1** dwt. over **38** in.

East Champ d'Or Gold Mining.

Issued Capital - - - £259,875.

Crushed 90,000 tons; yielding 16,081 oz.

		Per ton.
Revenue from Gold	£138.501	£1 10 9
Working Costs	108,966	1 4 2
	£29,535	£0 6 7
Sundry Revenue	614	
Profit for Quarter	£30,149	

Working costs per fine oz. gold produced **£6 15s. 6d.**

Taxation for the six months ended June 30, 1946, estimated at **£13,377.**

DIVIDEND No 19 of 10% (**3d.** per **2s. 6d.** share) has been declared in Union of South Africa Currency.

DEVELOPMENT FOOTAGE sampled **1,780** ft. **Payable, 965** ft., having average value **17·4** dwt. over **15** in. **Unpayable, 815** ft., having average value **2·2** dwt. over **38** in.

ZINC CORPORATION, LTD.

Directors : J. R. Govett (*Chairman*), Sir Clive L. Baillieu, F. A. Crew (*Manager*), Capt. A. H. Moreing, L. B. Robinson, W. S. Robinson (*Managing*). *Consulting Engineers :* Bewick, Moreing, and Co. *Chief General Manager of Mines and Works :* A. J. Keast. *Joint Secretaries :* J. B. R. Challen and J. R. Francis-Smith. *Office :* 8, Basinghall Street, London, E.C. 2. *Formed* 1911. *Capital issued :* £1,534,045.

Business : Operates lead-zinc properties in the Broken Hill district, New South Wales.

The thirty-fifth ordinary general meeting of the Zinc Corporation, Ltd., was held on August 5 at 95, Gresham Street, E.C.

The following are extracts from the statement by the chairman circulated with the report and accounts for the year ended December 31, 1945 :—

Since the termination of hostilities men have been returning steadily. But for the war and its effect on our operations, I have little doubt that we would have now been producing over 550,000 tons of ore per annum for the Zinc Corporation alone and a total with the New Broken Hill Consolidated added of over 700,000 tons. The combined visible reserves in the two mines would probably have reached over 5 million tons.

Our policy of Joint Working with the New Broken Hill Consolidated had perforce to be turned into a policy of concentrating the joint working forces of the two mines into one force for the production of metals from the Zinc Corporation.

We have for a considerable time past carried on an increasingly intensive survey of the possibilities of extending the mining and associated activities of this Corporation and its associates. We are preparing a Geological and Geophysical organization which we intend to use to determine as far as possible the prospects of major additions to the ore resources of the Broken Hill district as a whole.

British industry cannot be expected to recover and progress unless Britain is in the forefront of the search for and development of raw materials within the Empire. The search for minerals, even with the aid of the latest scientific developments, must be recognized as a venturesome business and one which probably involves large expenditure. We do not, therefore, intend to risk the stability of the producing mines—the Zinc Corporation and New Broken Hill Consolidated—by entering into any extensive commitments on their behalf, and we will shortly we hope be able to announce the formation of an organization which will deal with this extension of our work.

On April 30 and May 1 last Broken Hill was greatly honoured by a visit from H.R.H. the Duke of Gloucester, the Governor-General of Australia. This, the first visit of a member of the Royal Family to the city, aroused great enthusiasm and was deeply appreciated by not only the citizens of Broken Hill but throughout the west of the Darling country.

In conclusion I desire to express the utmost confidence in the future, not only of the Zinc Corporation, but of the Broken Hill field and its associated industries.

NEW BROKEN HILL CONSOLIDATED, LTD.

Directors : J. R. Govett (*Chairman*), Sir Clive L. Baillieu, L. B. Robinson, W. S. Robinson. *General Managers :* Zinc Corporation, Ltd. *Consulting Engineers :* Bewick, Moreing, and Co. *Joint Secretaries :* J. B. R. Challen and J. R. Francis-Smith. *Office :* 8, Basinghall Street, London, E.C. 2. *Formed* 1916.

Capital issued : £507,884 in 5s. stock units.

Business : Developing lead and zinc properties in the Barrier district, New South Wales.

The tenth ordinary general meeting of New Broken Hill Consolidated, Ltd., was held on August 7, at 95, Gresham Street, E.C.

The following are extracts from the statement by the chairman circulated with the report and accounts for the year ended December 31, 1945 :—

Our general manager now reports that his manpower requirements are for the time being well supplied. We are now making good progress with our development and equipment programme, which perforce had to be dormant during the war.

The mine is now producing at the rate of 1,000 tons of ore per week. This should increase steadily and our total production for this year will, I expect, be between 45,000 and 50,000 tons. The grade will continue low—say, about 8·6% lead, 15% zinc, and about 2 oz. silver per ton—until the mine is opened up to permit us to draw on the high-grade lead lode. Next year we expect the output to run between 75,000 and 100,000 tons of higher-grade ore.

Work on the conversion of the present Downcast Airway to a haulage shaft to a depth of 50 ft. below the No. 22 level (3,213 ft.) of the Zinc Corporation is making good progress. This circular shaft, 13 ft. 6 in. in diameter and concrete lined, will, on completion, be equipped with steel sets giving two compartments suitable for 10-ton skips. The sinking of a new service shaft, 20 ft. in diameter and concrete lined, has been commenced 50 ft. east and 90 ft. south of the haulage shaft. It will be equipped with steel sets with suitable compartments for two 100-men double-decker cages, a small runabout cage, ladderway, and cable and pipe compartments. Development of both the zinc and lead lodes will be carried out from these shafts below the No. 18 level. Levels above the No. 18 level will be worked from the Zinc Corporation openings.

A considerable amount of development work preliminary to stoping has been carried out during the last six months. Diamond drill-holes to test the Western lead lode ore-bodies were put out at the No. 17 level. One disclosed a width of 156 ft. of 13·8% lead, 2·9 oz. silver, and 7·3% zinc, and another a width of 62 ft. of 9·8% lead, 2·3 oz. silver, and 5·2% zinc. On the No. 16 level boreholes put out to test the zincy ore-bodies disclosed important widths of both high-grade lead and zinc ore.

Drilling to test the character of the ground for an additional main shaft to be situated approximately 3,000 ft. south of the Zinc Corporation boundary is in progress.

CONSOLIDATED TIN SMELTERS, LTD.

Directors : Don Simon I. Patino (*President*), Ernest V. Pearce (*Chairman and Managing*), John C. Budd, J. van den Broek, Lord Marchwood, Don Antenor Patino R. *Secretary :* W. H. Monier-Williams. *Office :* Princes House, 95, Gresham Street, London, E.C. 2. *Formed* 1929. *Capital issued :* £3,257,931.

Business : Owns interests in tin-smelting operations in various parts of the world.

The seventeenth ordinary general meeting of Consolidated Tin Smelters, Ltd., was held at 95, Gresham Street, E.C. 2, on July 31, Lord Marchwood presiding.

The chairman, who delivered Mr. E. V. Pearce's speech moving the adoption of the report and accounts for the year ended June 30, in his absence, said : When I addressed you last year I expressed the hope that we should shortly be able to obtain some definite information regarding the condition of the works of our subsidiary—Eastern Smelting Company, Ltd.—in Penang. That hope has now been fulfilled. As you will have gathered from the report of the directors, the plant was not as seriously damaged as might have been anticipated. The first contingent of our staff arrived in Penang early in November of last year. Reports received from Mr. Mackay indicated that the Japanese had operated the plant during their occupation and that he found it in a reasonable state of repair on his return, so much so that smelting operations on a modest scale were resumed on April 6 last. While we have a capacity ready for smelting a large tonnage of concentrates, that capacity can be made use of only as supplies become available from the mining companies and this in turn depends upon the rate at which rehabilitation of the mining industry can be effected.

Regarding our other assets in the East, reports received indicate that our staff houses have been almost entirely denuded of furniture and fittings. Our most serious loss, however, has been incurred by the compulsory abandonment of the stocks of tin and concentrates at the works, in transit, and at our agencies throughout Malaya at the time of the evacuation of Penang in December, 1941. Our ultimate loss in these directions will depend upon the compensation we receive as a result of our claims upon the Government.

Regarding the future of tin, I see no reason to abate in any respect the optimism which I expressed last year. Supplies are gradually increasing and will continue to do so as a result of the efforts which are being made to re-establish the mining industry in Malaya and the Netherlands East Indies. It is certain, as far as anything can be certain in these days, that every ton of tin which can be produced for some considerable time will find a ready market.

One great need of the tin industry to-day is a world price and the sooner this can be established, preferably by the re-opening of the London Metal Exchange, the better it will be for all concerned.

The report was adopted.

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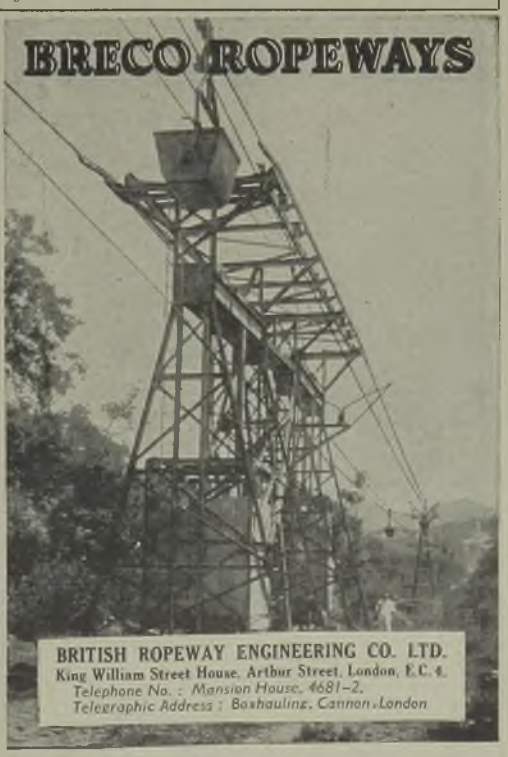
BUYERS' DIRECTORY.

BUYERS' DIRECTORY (*continued*).

* July issue. † June issue.



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