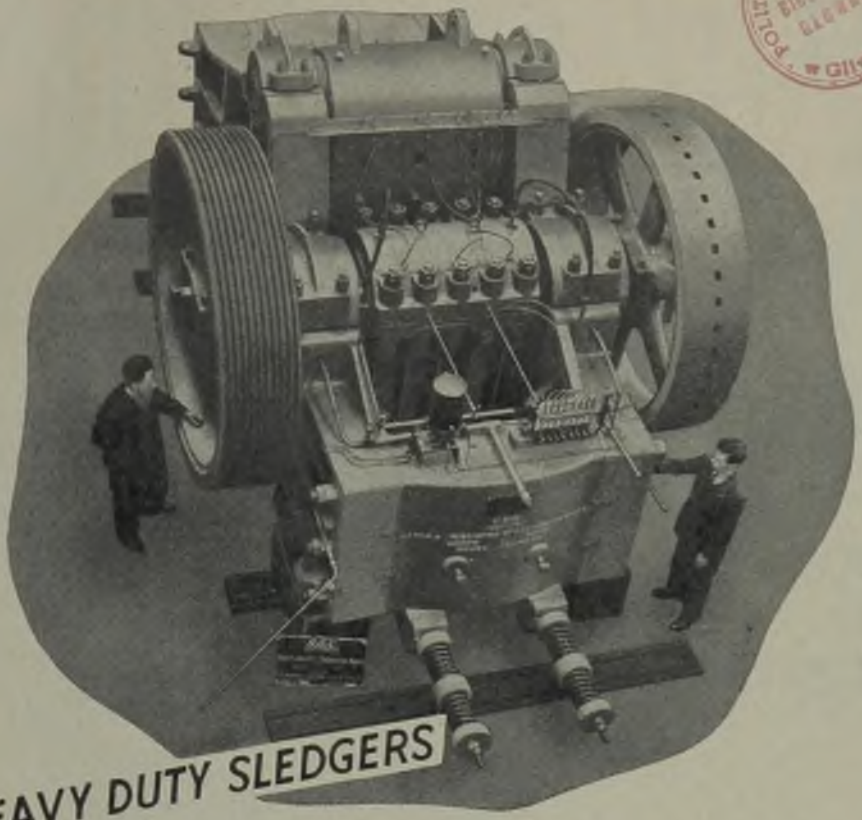
The Mining Magazine

VOL. LXXV. No. 3. LONDON, SEPTEMBER, 1946. PRICE ONE SHILLING



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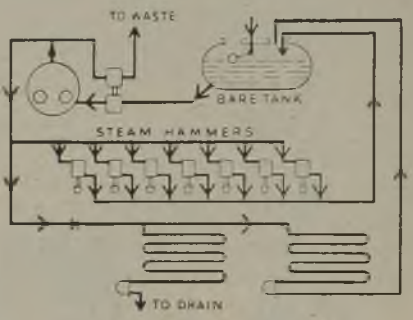

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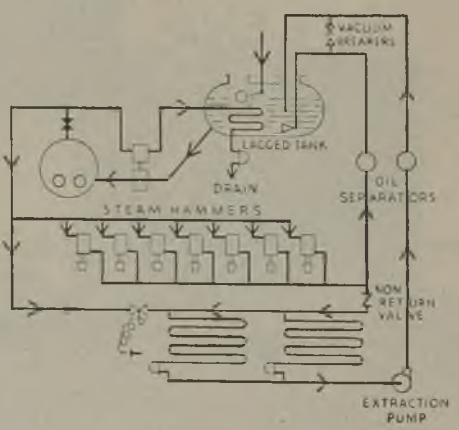

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	18 to 65	**4s. 0d.**	**(instead of 2s. 2d.)**
	65 & over	**2s. 0d.**	(instead of 1s. 1d.)
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Issued by the Ministry of National Insurance

G.E.C.

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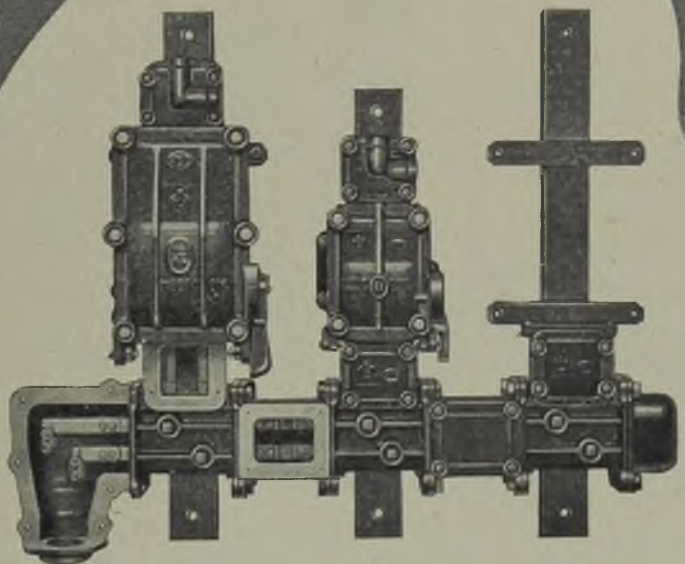

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EDITORIAL

A USEFUL new work has been published during the past month by Mining Publications, Ltd., proprietors of THE MINING MAGAZINE. The author is H. L. H. Harrison and his book is entitled "Examination, Boring, and Valuation of Alluvial and Kindred Ore Deposits." Intended primarily for the man unfamiliar with alluvial testing procedure it also makes a serious contribution to the literature of the subject, particularly in its approach to the question of standardizing boring, sampling, and valuation methods in placer fields. The precise interpretation of boring results assumes greater and greater importance as lower-grade areas enter the ore-field class and a book of this character should find a welcome from engineers concerned with such work.

INCLUDED in a recent control order[1] made by the Board of Trade are ores and concentrates of thorium and uranium, as well as cadmium and cadmium compounds.

BY virtue of the Control of Mercury (No. 12) (Revocation) Order, 1946, which came into force on August 23, the statutory maximum price control of mercury and its compounds was removed.

THE 1946 edition of Skinner's "Oil and Petroleum Year Book"[2] made its appearance last month. This standard work, now in its 37th year of issue, contains concise and up-to-date particulars regarding 566 companies engaged in all branches of the oil industry.

IT is officially announced by the Ministry of Supply that an International Tin Conference has been called by the United Kingdom Government in consultation with the Governments of the United States, Bolivia, Belgium, and the Netherlands Countries. Invitations are to be sent to each of these countries and also to China, France, Siam, and the U.S.S.R. The conference is expected to open on October 8.

[1] Export of Goods (Control) (No. 3) Order, 1946. S.R. and O., 1946, No. 1473. London: H.M. Stationery Office. Price 1d.

[2] London: Walter E. Skinner. Price 15s.

ELSEWHERE in this issue an advertisement gives particulars of a new group of fellowships and scholarships for the advancement of extraction metallurgy about to be established by the Nuffield Foundation. Travelling fellowships and post-graduate scholarships, as well as vacation scholarships, are offered to graduates, staff, and students at approved centres of learning. They are open to all citizens of the Commonwealth and should help to keep younger metallurgists in tune with advancements in the art in other countries.

AS a first move in its attempt to reconstruct the British coal industry the National Coal Board has initiated a series of conferences to be held each week-end throughout the current month and October at various centres in the coalfields. At these meetings speakers "will urge managers and men to pledge themselves to work together, in full recognition of their joint responsibility for the well-being of the industry under the new ownership, to establish the highest possible degree of safety, efficiency, and production, to introduce a new industrial outlook, and to secure friendly discipline in the industry."

BASED on a detailed report prepared while on the staff of the United States Geological Survey V. C. Juan contributes a study of the "Mineral Resources of China" to *Economic Geology* for June–July. This shows that China, with immense coal and moderate iron resources is potentially an industrial nation. The country has considerable oil-shale reserves, but petroleum production is not likely to become important for some time, practically all China's oilfields being largely undeveloped. Manganese resources in the country appear sufficient to meet all requirements and it is rich in gold, although poor in silver. Large exportable surpluses of antimony, tungsten, tin, magnesite, talc, clay, fluorite, mercury, and arsenic appear probable. With adequate water power it is likely that an important aluminium industry can be based on extensive bauxite deposits, while it seems that adequate copper, lead, and zinc will be found for domestic needs.

GERMANIUM, now being produced in America as a by-product of the zinc industry, is closely allied to silica in physical

and chemical properties. A paper recently issued in the United States [1] suggests that the technological application of germanium has been hampered by its association with silicon and points out that although the element is now being produced in commercial quantities it is still largely being used experimentally. Application depends on the developments suggested by recent work. It is stated that traces of germanium had been noted in zinc sulphide ores of the Tri-State district for many years, but that no effort was made to recover the metal until about five years ago. By spectroscopic analyses germanium was found to be concentrated in the cadmium fume produced in sintering the zinc concentrates.

Rand Native Labour

The South African gold-mining industry, beginning slowly to recover from the effects of war-time conditions, seems likely to play a greater part than ever in the Union economy. There is, indeed, a general expectation that the industry's position is finding increasing recognition from the Union Government, particularly as its expansion into the Free State should mean increased revenue, expanding employment, and an extension of ancillary industries into new areas. Although taxation still weighs heavily on mining enterprise in South Africa it is not likely to affect the industry so much as the continued shortage of labour—particularly native labour. With the establishment and growth of secondary industries, all of them, be it noted, dependent on gold-mining for their well-being, there has been an increased demand for labour in the Union and large numbers of natives have left mining for other work. *Mining Survey*, a new periodical review published by the Transvaal Chamber of Mines, in its first number [2] describes native labour as the key to expansion. It points out that in 1941, when 67,255,450 tons of ore was milled by the Rand gold mines, the average number of natives employed was 367,400. In 1945 this number had fallen to 306,600 and the tons of ore treated to 58,897,600. The gold revenues for these two years were £116,978,499 and £101,847,382 respectively. In the past the mines have had to import labour from other parts of Africa and now that, with the likelihood of fresh demands from the developing areas in the Orange Free State, the need is becoming greater steps will have to be taken once again to find fresh sources of supply. So much in South Africa depends on a healthy gold-mining industry that the Government must soon turn its attention to the urgent need in respect of native labour, particularly as the mines must work hard to make good by increased development the ore reserves so heavily drawn upon during the war.

As in so many other parts of the world the labour shortage in the Union has led to unrest. Earlier this year a dispute within the European mineworkers' union led to a virtual cessation of operations throughout the industry for some days and subsequent negotiations between the union and the Transvaal Chamber of Mines resulted last month in fresh wage increases estimated as likely to cost the mining companies some £1,000,000 more annually. In such an atmosphere the Native Mineworkers' Union was unlikely to remain inactive and in the middle of August strike action on its part resulted in a partial stoppage of the industry. The strike was speedily settled, but not before outputs at certain properties had been seriously affected. While labour is scarce the unrest is likely to remain and there is greater need than ever to take every possible step to increase the native labour supply.

In respect of the situation reviewed it is satisfactory to record that the native labour position was regarded with a certain amount of optimism by Mr. C. S. McLean, the retiring president, at the annual meeting of the Transvaal Chamber earlier this year. Mr. McLean said that during 1945 the average labour strength of the industry improved by no less than 10,000 natives. The most pleasing feature, he said, was the upward trend in recruiting results from the Union and High Commission Territories where, for some years, recruiting had been adversely affected by factors arising out of war conditions. Earlier in 1945, Mr. McLean said, there was a heavy wastage of time-expired Portuguese natives and, in spite of a satisfactory recruiting output, fresh arrivals failed to make up the consequent reduction by the end of the year. The results from tropical areas continued to show a steady improvement with a net gain of 4,000 natives during the year. In December

[1] JAFFEE, R. I., MCMULLEN, E. W., and GONSER, B. W. United States Electrochemical Society, Preprint 89–18.

[2] London: A. Moir and Co., London Secretaries, Transvaal Chamber of Mines.

the Chamber was advised that the Nyasaland Government had agreed to increase the quota of natives from that territory from 5,000 to the pre-war quota of 8,500. It had also been advised that the embargo on recruiting in Northern Rhodesia had been raised and that recruiting operations were to be resumed. These are, indeed, steps in the right direction, but if the gold-mining industry is to expand as it should there is every need, as has already been indicated, for the Union Government to work hand in hand with the Chamber in order to maintain the native labour force at as high a level as possible.

Copper in the Transvaal

The ancient workings at Messina, which is situated in the Limpopo River lowlands, at the extreme north of the Transvaal, were first seriously investigated in 1906. Up to 1914 high-grade ore and concentrates were shipped, but during the 1914–18 war the reduction works, newly commissioned, enabled the production of a high-grade matte, which was sent overseas for refining. In 1920 the mines were closed down while a new concentrating plant and smeltery were being erected, production being resumed in 1922. By 1940 some 10,000 tons of copper were being produced annually, the reserves of ore at June 30, 1939, being estimated at 2,811,605 tons, assaying 2·09% copper. The results of a new study[1] of the Messina district are now available and since this throws new light on the reserves and prospects of the area, extended note is taken of it in what follows.

The "Messina Line," on which the three producing mines of the field all lie, is a zone of fissuring extending from the Limpopo southwards to Viskop. This fissure is filled with altered doleritic material, the mineralization with copper minerals being considered as genetically related to the Karroo volcanic period. For structural and petrological reasons the ores have been tentatively assigned to the late Karroo batholith of "augite granophyre" in Rhodesia as source. "It follows that the finding of intrusive igneous bodies of intermediate composition elsewhere in the district may better the chances for striking ore deposits in the surrounding country very considerably. A small outcrop of such rock is found in Hereward 813, but as it is dyke-like in structure, too much significance should not be attached to it. It is thought that irregular intrusive bodies like stocks and chonoliths are more likely to have associated mineral deposits than dykes."

The report considers that an optimistic outlook with regard to the future of the copper-mining industry of the area is fully justified. Since 1936 the reserves for the three producing mines—Messina, Harper, and Campbell—have shown a new peak value every year, partly due to the discovery of the great L lode breccia pipe, but also to steady development in the Harper and Campbell mines. The detailed geological mapping of all underground workings by the geological staff of the Messina Development Company forms a reliable basis for the prediction of ore continuation and new ore-shoots; thereby an ample ore reserve is assured from current workings. Development below the 2,000-ft. level in the Messina and Harper mines met with indifferent results, until the discovery of the large ore-body on the 25th level in Harper, and it is suggested that a further search for ore should therefore be continued in horizontal as well as downward directions. It is thought that the chances for payable ore deposits as yet unknown are fair, the larger prospects on Artonvilla 778, Vogelenzang 814, Hereward 813, and Vryheid 779 meriting thorough investigation before being classified as failures. Other copper occurrences farther away from the Messina belt—*e.g.*, at M'tamba—are regarded with less favour by prospectors because they happen to be farther away from the producing mines. It is pointed out that the size of the hypogene sulphide body cannot be judged solely by the quantity of oxidation products formed at the surface, the L, K.C.F., and E.B.H. lodes in Messina, for example, terminating before reaching the surface. Detailed geophysical investigations might indicate the presence of sulphide ore-bodies. Finally it is emphasized that although circumstantial evidence appears to favour a late-Karroo age for the Messina copper deposits no direct proof can be given. However, a Karroo age implies better chances for the presence of buried bodies of ore, as yet untouched by denudation, since post-Waterberg pre-Karroo mineralization would have against it a long period of very active erosion whereby many shallow-seated ore deposits would have been removed in part or altogether.

[1] SÖNHGE, P. G. The Geology of the Messina Copper Mines and Surrounding Country. S.A. Geol. Surv. Memoir No. 40. Pretoria. Price 21s.

MONTHLY REVIEW

Introduction.—A slump in Stock Exchange prices in America has created a minor recession in London, which, taken in conjunction with the various manifestations of labour unrest in many parts of the world, might be taken as evidence of business uneasiness. Such seems hardly the case, however, in view of the vast unsatisfied demand for commodities and it is likely that any present decline in share prices is purely a temporary one.

Transvaal.—The output of gold from the Rand mines for July was 1,024,830 oz. and from outside districts 22,769 oz., making a total of 1,047,599 oz. for the month. The number of natives employed in the gold mines at the end of July was 299,599, as compared with 305,822 at the end of the previous month.

A strike of native mine workers during August affected outputs at a number of the Rand mines, although it was of short duration.

The liquidator's report to shareholders of Langlaagte Estate and Gold Mining for the period to March 31 last shows a total of 272,000 tons of ore milled and 46,081 oz. of gold recovered. A net loss of £7,458 was largely due to the strike of European miners in March. It is stated that every effort is being made to keep the mine in operation, although all surplus plant and stores are being disposed of as occasion arises.

Clean-up operations at Van Ryn Deep in the period to March 31 last, when 12,037 oz. of gold had been recovered, resulted, according to the report of the liquidators, in an excess of revenue over expenditure of £22,057. It is expected that this work will continue until November.

Sinking at No. 1 shaft of West Driefontein Gold Mining was started in February, 1945, and by June 30 last it had reached a depth of 519 ft. No. 2 shaft, started later, was down 51 ft. The report of the consulting engineer for the year states that the No. 2 level drive from the Blyvooruitzicht property was 170 ft. from the common boundary at June 30.

Shareholders of Glynn's Lydenburg are informed that the ore reserves had been re-estimated at July 31 last and amounted to 283,300 tons, averaging 6·4 dwt. in value over 19·7 in.

At a meeting of Klip Nigel Estate and Gold Mining to be held in Johannesburg later this month it is to be proposed that the capital be increased to £450,000 by the creation of 1,200,000 new 5s. shares and that the company's name be changed to Fixed Properties (S.A.), Ltd.

A further issue of 1,561,650 ordinary shares carrying rights is to be made by Northern Transvaal (Messina) Copper Exploration. The issue price for the 2s. 6d. units is to be 3s. 6d.

At the recent extraordinary meeting of Transvaal Gold Mining Estates held in Johannesburg the creation of 210,000 new £1 shares was approved.

The accounts of Dominion Reefs (Klerksdorp), Ltd., for the year to June 30, 1945, show a profit of £62,215 and a total of £72,371 available. After making necessary provisions £17,875 is required for a dividend equal to 5% and a credit balance of £10,986 carried forward. During the year 270,200 tons of ore was milled and 39,340 oz. of gold recovered. Ore reserves at December 31 last were estimated to be 594,694 tons, averaging 3·30 dwt. in value.

At an extraordinary meeting of Potgietersrust Platinums held on September 10 it was to be proposed that the capital be reduced to £294,375 by reducing the nominal value of the shares from 5s. to 9d.

Apex Mines announced last month that the fire previously reported at the Middelburg steam colliery was spreading and it has been found necessary to abandon the whole of the Station Colliery area. This would result in a further loss of coal and a substantial reduction in the monthly output of the Middelburg steam colliery.

Orange Free State.—An extraordinary meeting of the Free State Development and Investment Corporation was arranged to follow the general meeting on September 12. At this it was to be proposed that the capital of the company should be increased to £550,000

by the creation of 200,000 new 5s. shares, Additional funds, it is stated in a circular to shareholders, are required for the completion of the exploration of properties under option and for the purchase of mineral rights in the Odendaalsrust area. The Corporation reported last month that bore-hole K.K. 7 on the farm Kalkkuil 153, approximately $2\frac{1}{4}$ miles south-east of Odendaalsrust, had intersected Leader Reef at a depth of 5,461 ft., assays showing 20·2 dwt. over 7 in. Basal Reef was intersected at a bore-hole depth of 5,536 ft. and assayed 37·8 dwt. over 6 in. It was subsequently announced that a deflection in this hole had intersected Leader Reef at 5,462 ft., assaying 17·2 dwt. over 7 in. Basal Reef was intersected at 5,534 ft. and assayed 55·6 dwt. over 7 in. In both cases complete recovery of core was obtained.

New Union Goldfields announced last month that drill-hole No. 3 on Theronia 271 had encountered Reef at a depth of 634 ft. with a first assay value of 2·17 dwt. over an uncorrected width of 72 in. The Reef is near the base of the Ventersdorp Agglomerate zone as exposed in the drill-hole. A further Reef was encountered at 777 ft. with a first assay value of 14·7 dwt. over a corrected width of 31 in. The Reef was provisionally correlated as the Leader Reef. A deflection is to be made and the drill-hole continued to the estimated Basal Reef horizon.

Southern Rhodesia.—With a clean-up return valued at £4,226 for August shareholders of Sherwood Starr Gold Mining were informed that milling had ceased on July 25 and that stores and machinery were being disposed of as opportunity occurred.

The report of Thistle-Etna Gold Mines for the year ended March 31 last shows a profit of £20,666 and a total of £32,567 available. A dividend equal to 5% requires £3,712. During the year under review 72,000 tons of ore was mined and 10,731 oz. of gold recovered. The ore reserves at the end of the year were estimated to be 261,280 tons, averaging 3·11 dwt. in value. The plant extension is reported as now in full operation, a capacity of 6,000 tons monthly having been maintained.

Northern Rhodesia.—A general strike of all daily-paid employees at three of the Northern Rhodesian Copper mines last month resulted in a temporary cessation of production in the field. On August 21 an agreement to submit the artisans' demands to arbitration was arrived at and work was resumed on the basis of a new wage scale for daily-paid employees. It was reported earlier this month from Lusaka that the Northern Rhodesian Government was considering an inquiry into the copper industry.

Circulars to shareholders of the Rhokana Corporation, Nchanga Consolidated, and Rhodesian Anglo American sent out earlier this month announced the formation of a new company—Rhodesia Copper Refineries—to take over and enlarge the Rhokana refining plant. The new company is to have an authorized capital of £2,000,000 in preference shares and £500,000 in ordinary shares, all of the latter to be held by the Rhokana and Nchanga companies. The extension of refining capacity resulting will permit the refining of the total estimated production of the Rhokana and Nchanga mines up to the end of 1951 and it is stated that another extension may be necessary to refine the further increase of production from the Nchanga mine which will become operative about 1952. Treasury approval has been given, it is stated, to the issue of sufficient capital to finance the programme.

The accounts of the North Charterland Exploration Co. (1937), Ltd., for 1945 show a profit of £5,352 and a credit balance of £14,380 carried forward.

Gold Coast.—The directors of the London and African Mining Trust, Ltd., announced last month that in connexion with the concessions which they have secured adjoining Nanwa Gold Mines, Ltd., properties, they had entered into an agreement with Mr. Oscar Weiss to carry out an extensive geophysical examination of the whole of the areas comprised in the concessions and the ground owned by and adjoining the mine now being worked by the Nanwa Gold Mines, Ltd.

A progress report recently issued by Nanwa Gold Mines states at July 31 last No. 1A shaft had been repaired and concreted to 112 ft., a total depth of 125 ft. having been cleared. The unwatering of the mine is proceeding.

In the report for the three months to June 30 last shareholders of Konongo Gold Mines were informed that payable values on the 13th level, Odumase, had been entered in the N.E. drive, where 68 ft. averaging 21·3 dwt. per ton over a width of 26 in. were proved, the face still being in ore.

The chairman of Gold Coast Banket Areas, Ltd., in his review accompanying the report and accounts for the year to June 30, 1945, states that development on an enlarged scale

is now proceeding. The intention is to develop additional ore reserves and increase the capacity of the mill to 180,000 tons of ore per annum. He reports that the native labour position is not yet satisfactory, but efforts are being made for the provision of better living conditions and for a regular supply of foodstuffs at reasonable prices which, it is hoped, will lead to a substantial improvement.

Nigeria.—The Bisichi Tin Co. (Nigeria) reports a profit of £14,860 for 1945 and a total of £16,325 available, of which £15,180 is required for a dividend equal to 6%. In the year 326 tons of tin concentrates and 100 tons of columbite were produced.

The accounts of the Kaduna Syndicate for 1945 show a profit of £32,684 and an available total of £60,616, of which £14,300 is required for dividends totalling 54⅙%. The output of tin concentrates for the year totalled 445 tons.

Kaduna Prospectors, Ltd., reports a profit of £5,247 for 1945 and a total of £7,707 available. Dividends equal to 22⅔% require £4,911 of this amount. In the year 65 tons of tin concentrates was produced.

It was announced last month by Gold and Base Metal Mines of Nigeria, Ltd., that the reorganization of the company's capital having become effective it had been decided to issue 400,000 shares of 2s. 6d. each at par to existing holders.

The report of the Nigerian Electricity Supply Corporation for the year ended February 28 last shows a profit of £122,713 and a total of £138,913 available, of which £37,469 is required for dividends and a bonus totalling 12½%.

Kenya.—In the six months to June 30 last the Main shaft at Rosterman Gold Mines was sunk 34 ft. to 1,977 ft. It is stated that a shortage of underground labour is seriously impeding operations at the mine.

Australia.—With the recent dividend notice shareholders of South Kalgurli Consolidated were informed that the profit for the year to March 31 last before providing for taxation was £28,508.

Sons of Gwalia, Ltd., announced that mining and milling operations were resumed at the mine on August 8. The accounts of this company for 1945 show a profit of £34,789 and a total of £54,326 for appropriation, of which £11,172 is required for a dividend equal to 1s. 3d. a share. In the year under review 76,014 tons of ore was treated for a return of 20,792 oz. of gold.

Gold Mines of Kalgoorlie announces that the operating profit for the year to March 31 last, subject to audit, was £44,080.

A profit of £38,291, subject to audit, is reported by the Gold Exploration and Finance Co. of Australia, Ltd., for the year ended March 31 last. This company announced last month that a recent cable from Triton Gold Mines stated that arrangements had been completed for a loan totalling £96,500 (Aust.) for the purposes of financing the reopening of the mine. The reconditioning of workings had been begun and it was hoped the mine would again be in production in March next.

The report of Mount Charlotte (Kalgoorlie) Gold Mines for the year ended November 30 last states the option of Wiluna Gold Mines over the Charlotte and Hannans Hill mines has been extended for an additional period of 18 months. Rights have been secured from the Western Australian Government to carry out an investigation of old workings in the Queen Margaret Reserve, Bulong district.

In order to provide funds for development work Hampton Gold Mining Areas announces that it has been arranged with certain shareholders to subscribe firm for 25,000 unissued 5s. shares of the company at 30s. They have been granted an option for 12 months to subscribe for a further 25,000 shares at 30s. (subject to any necessary Treasury consent being obtained for such further issue). It is intended, it is stated, to register a subsidiary company—Coolgardie and Hampton Gold Mines—and in due course to make an issue to the public. It is also intended to subdivide the existing 5s. stock units into 1s. units and an extraordinary meeting to consider the proposal has been called for September 17.

At an extraordinary meeting of Tindals Gold Mines, Ltd., to be held later this month it is to be proposed that the capital of the company be reduced by writing off 1s. on each of the issued 4,480,000 shares of 2s. each. The remaining 1,520,000 unissued 2s. shares are thereafter to be divided into 1s. units and a further 4,480,000 new 1s. units created to increase the capital once again to £600,000. The object, it is stated, is to obtain further capital to resume active operations.

Malaya.—Shareholders of Rawang Concessions were informed last month that the dredge had completed its trials and started production on July 11. The gravel pump was at work by July 1.

Sione Tin (F.M.S.) reports a profit of £797 for the year to March 31 last and a credit balance of £9,994 carried forward.

The report of Idris Hydraulic Tin for 1945 states that steady progress had been made in reconstruction and that it was expected that production would start at an early date.

India.—The report of Mysore Gold Mining for 1945 shows a profit of £112,050. After adding the sum brought in and making allowances for taxation and other items there was £43,441 available, of which a dividend equal to 5% free of tax requires £30,500. In the year 49,194 oz. of gold was produced from 157,819 tons of ore milled. The payable ore reserves at December 31 last were estimated to be 282,000 tons, of an average grade of 10·3 dwt., in addition to 215,000 tons of probable ore of lower value.

Champion Reef Gold Mines of India reports a profit of £130,738 for 1945. After adding the sum brought in and making allowances for taxation and other items there was £42,257 available, of which a dividend equal to 7½% free of tax, requires £24,375. In the year 82,260 tons of ore was milled and a total of 51,372 oz. of gold produced. The payable ore reserves at December 31 last were estimated to be 554,157 tons averaging 12·32 dwt. in value.

The accounts of the Ooregum Gold Mining Co. of India for 1945 show a profit of £62,581. After making allowances for taxation and other items there was £41,093 available, of which £26,442 was required for dividends, equal to 6$\frac{6}{10}$% on the ordinary shares. During the year 28,069 oz. of gold was recovered from 90,666 tons of ore milled. The ore reserves at December 31 last were estimated to be 180,697 tons averaging 10·05 dwt. in value.

The Indian Copper Corporation reports a profit of £51,240 for 1945. With the sum brought in there was £82,059 available, of which a dividend equal to 10% requires £49,500.

Colombia.—Shareholders of Placer Development and of Oroville Dredging are informed that for three months to August 1, 1946, Pato Consolidated Gold Dredging dredged 2,757,000 cu. yd. for a recovery of 13,444 oz. of fine gold and recovered with its hydraulic units 1,451 oz., the value of the total production being $521,325 U.S. During the same period Asnazu Gold Dredging handled 1,180,600 cu. yd. for a recovery of 5,767 oz. of fine gold, equivalent to $201,845 U.S.

NEW COMPANIES REGISTERED

Anglo-Swedish Minerals.—*Capital :* £120,000 in £1 shares. *Objects :* To carry on business of merchants and dealers in alloys, minerals, etc. *Directors :* M. N. T. Gubbins and O. R. Drakenberg.

Bloemfontein Consolidated Investment Corporation (incorporated in South Africa).—*Capital :* £3,000,000 in 5s. shares.

British Overseas Mining Association.—*Objects :* To take over all or part of the property and liabilities of the unincorporated association of the same name. *Office :* 2 and 3, Crosby Square, London, E.C. 3.

Lead Industries Development Association.—*Objects :* To promote co-operation between individuals and companies interested in white lead, lead oxides, sheet lead, and lead pipes.

DIVIDENDS DECLARED

* Interim. † Final.

(Less Tax unless otherwise stated.)

***Anaconda Copper.**—50 cents.

***Ariston Gold Mines (1929).**—10% and 15%, payable Sept. 30.

†**Bisichi Tin (Nigeria).**—6%.

†**Bushtick Mines (1934).**—2½%, payable Dec. 18.

†**Cementation Co.**—3d., payable Sept. 10.

***Central Provinces Manganese Ore.**—9d., free of tax, payable Oct. 8.

†**Dominion Reefs (Klerksdorp).**—5%, payable Sept. 23.

***Gold Coast Main Reef.**—2½% and 2½%, payable Oct. 16.

†**Gold Exploration and Finance Co. of Australia.**—6d., payable Oct. 1.

†**Gold Mines of Kalgoorlie.**—6d. and 4½d. bonus, payable Oct. 1.

Imperial Smelting Corporation.—Pref. 3¼%, payable Oct. 1.

†**Indian Copper Corporation.**—10%, payable Sept. 25.

†**Kaduna Prospectors.**—5d., payable Sept. 28.

†**Kaduna Syndicate.**—7d., payable Sept. 28.

†**Komata Reefs Gold Mining.**—1½d., free of tax, payable Sept. 30.

***Lake Shore Mines.**—18 cents, payable Sept. 14.

†**Nigerian Electricity Supply Corporation.**—7% and 2½% bouns, payable Oct. 4.

***Noranda Mines.**—$1·00, payable Sept. 14.

†**Phœnix Mining and Finance.**—1s. 3d., payable Oct. 10.

†**South Crofty.**—3d.

†**South Kalgurli Consolidated.**—1s. 1½d. and 1½d. bonus, payable Sept. 19.

†**Thistle-Etna Gold Mines.**—5%, payable Sept. 10.

***Transvaal Gold Mining Estates.**—1s., payable Nov. 7.

†**Witbank Colliery.**—10%, payable Oct. 4.

†**Yarra Falls.**—4½%, payable Oct. 3.

Drilling with Counterflush Continuous Coring

By C. J. Esseling

The author describes a novel system of drilling adopted in oilfield prospecting.

Introduction

Ever since the adoption of the scientific method in prospecting for new oilfields inventors and designers have set themselves the task of perfecting instruments for geophysical prospecting on the one hand and of equipment and tools for prospect drilling on the other. Great as have been the improvements made in geophysical prospecting both as regards methods and equipment, core drilling has advanced but little during the past 35 years. It is true that by mounting rigs as units on motor lorries rigging up and movement from one bore to the next have been facilitated, but the system itself underwent no basic change until very recently.

For the purpose of core drilling, as will be well known, use is made of a string of drill rods to the lower end of which a single or double core-barrel, together with a core bit, is screwed. The whole string is rotated by the rig and flush water is injected through the hollow drill rods to cool the bit and to bring the cuttings up to the surface outside the drill pipes. The core barrel is usually 10 ft. to 20 ft. long and each time it becomes filled with core drilling has to be interrupted in order to raise the core barrel and remove the load.

Counterflush Method

A new method of continuous core drilling has recently been introduced. It eliminates the loss of time caused by the frequent raising and lowering of the core barrel and permits of the recovery of all cores and cuttings drilled. The principle adopted was first introduced by the late Austrian engineer, A. Fauck, at the beginning of the present century, for use with the percussion system of drilling then employed ; the same principle has now been applied to rotary core drilling. The credit for this and for the introduction of the method, which is known as the " Counterflush Method," is due to the initiative of engineers of De Bataafsche Petroleum Maatschappij, The Hague (Royal Dutch Shell), which company made the first trials in the Dutch East Indies some years ago. The counterflush coring method has now been brought to such a high degree of perfection as to warrant the belief that a complete revolution in the methods of core drilling used to-day is about to be witnessed.

The importance attaching to this novel system is indicated by the number of new equipments brought into operation during the few years which have elapsed since its inception. Before the recent war a large number of counterflush plants were already in use in

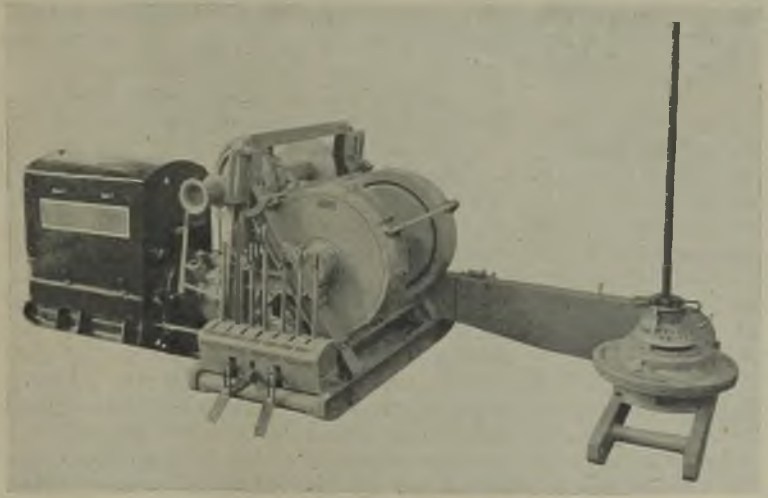


Fig. 1.— Counterflush Rig for a Depth of 3,500 ft.

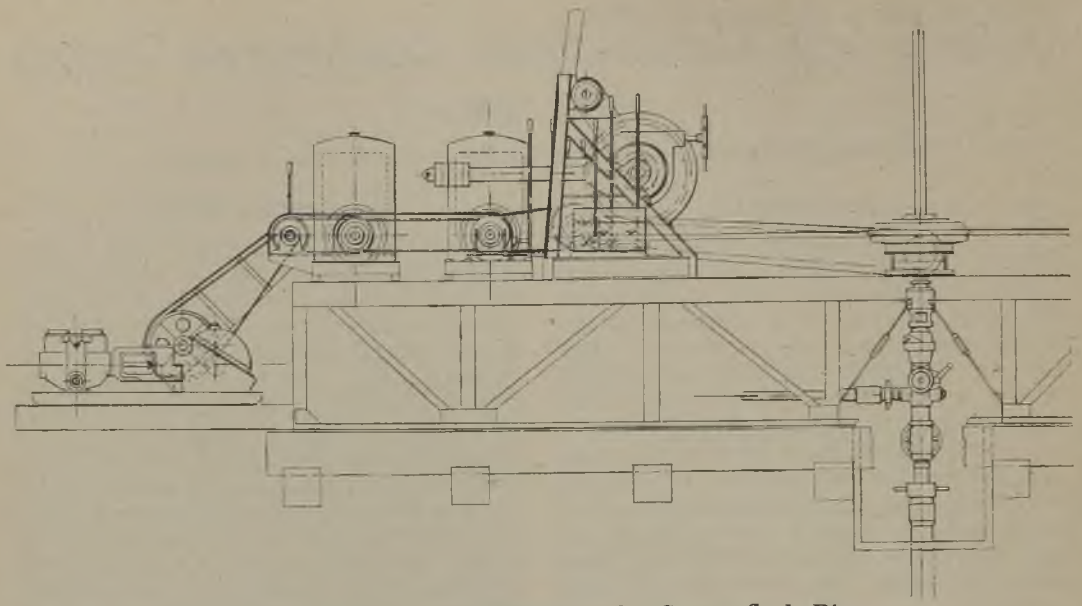


Fig. 2.—Diagrammatic Elevation of a Counterflush Rig.

Borneo, Sumatra, Java, New Guinea, and Rumania, as well as in the oilfields of Austria and Colombia. In addition a large number of bores has been sunk in the north-east of Holland to depths of 3,000 ft. and over solely for the purpose of trying out equipment and tools and for training purposes. Subsequent improvements have enabled crews to make some five times the footage previously obtained, which averages now from 200 ft. to 300 ft. per 22 hours, all work inclusive, whilst even higher figures are quite likely to be achieved.

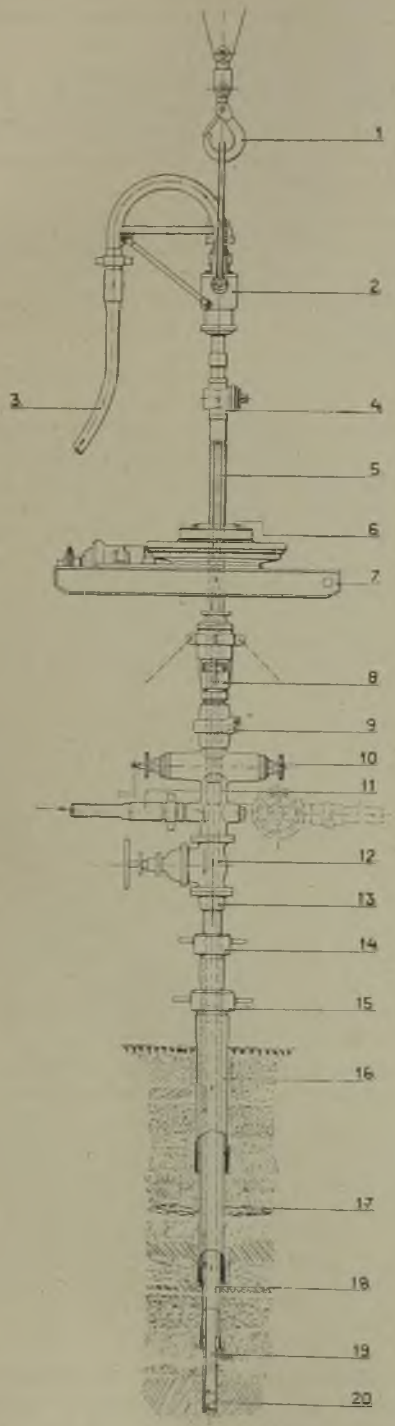
As has already been stated the counterflush system is used only for prospecting purposes—*i.e.*, for drilling intended exclusively for the study of geological formations.

For reasons of economy the initial diameter of such borings is kept as small as possible, no larger than is necessary in order to obtain cores of a final diameter sufficient to enable the geologist to form an opinion. The minimum core diameter is about $1\frac{1}{2}$ in., although in some formations cores of smaller diameter may very possibly be obtained. On the other hand, at the present stage of development of counterflush drilling technique, 4 in. is the largest core diameter which can be raised. The casing programme must therefore take into account these two limits, which permit counterflush bores to be sunk down to 3,000 ft.–3,500 ft.

Equipment

Counterflush equipment differs but little from ordinary rotary outfits. It consists of a derrick, draw-works, rotary table, and one or two mud pumps. In counterflush drilling, however, the mud flush is not injected through the swivel and hollow drill rods; the method is precisely the reverse. After a conductor pipe has been put in place and cemented off, a rotating stuffing-box is fitted for the Kelly, while below the stuffing-box there is fitted a T-junction which is connected to the discharge of the mud pump. The mud flush is consequently directed outside the drill pipe to the bit, cools it, and then carries cuttings and cores on its return journey through the flush-jointed drill rods, the swivel, and the Kelly outlet hose to a hopper ; the cores are then taken from the hopper and arranged in order of succession.

Depths varying from between 1,000 ft. to 2,000 ft. may be drilled before it is necessary to set a second string of casing, depending on the formation being drilled. When the second string of casing has been set and cemented the necessary packing is inserted in the space between the conductor and the casing, a T-joint is connected to the mud pump, and a stuffing-box for the Kelly is also provided. As a rule a complete casing-head control assembly is fitted, in which two or three strings of casing are suspended from slips and packed off with packing rings,



Legend.

1. Casing Hook
2. Counterflush-Type Swivel
3. Core Outlet Hose
4. Kelly-Cock
5. Kelly
6. Kelly Bushing
7. Rotary Table
8. Rotating Stuffing-Box
9. Quick Union
10. Eruption Head
11. Fluid Inlet
12. Master Gate
13. Companion Flange
14. Stuffing Box between First and Second Casing String
15. Stuffing Box between Conductor and First Casing String
16. Conductor Pipe
17. First Casing String
18. Second Casing String
19. Drill Pipe
20. Coring Bit

Fig. 3.—Diagram of the Counterflush Continuous Coring System.

whilst an eruption-head and master-gate are also fitted. Consequently, the eruption-head closes round the counterflush drill pipes and the master-gate shuts it off when no drill rods are in the hole. A Kelly-cock is fitted between the upper Kelly end and the swivel so that if oil or gas is struck the whole system can be shut off to enable the necessary steps to be taken.

Drilling Methods

Two alternative methods of counterflush drilling may be adopted. With the first drilling may be continued, once the conductor has been set, with a casing string used as drill rods, drilling down as deep as possible with them (with this method, the casing string has, of course, to be flush inside). If it is necessary to proceed with a smaller diameter hole the casing string used as drill rods for the first run is left in the hole as the casing; it is caught with the slips in the casing-head or landing flange and the bore is then continued with a smaller casing string used as rods. When employing this method it is necessary to use a coring bit so constructed that the next smaller size of casing string used as drill pipes can pass through it. The employment of casings with sufficient wall thickness and provided with special joints enables them to be used as drill rods with coring bits, since the coring bits only cut away a thin ring and the casing pipes are, in consequence, only subjected to a small torsional strain.

If it is desired to adopt the second alternative method for counterflush drilling a string of drill pipes for coring is used, but they must naturally be flush inside, using full-hole tool joints. The hole is started with a fish-tail bit and, dependent upon the depth scheduled, an 8-in., 6-in., or 4-in. conductor is set and cemented against the rock, after which drilling is continued with the counterflush coring system.

It must be borne in mind that if the diameter of the casing set is too large to permit of drilling the hole to the full desired depth with a counterflush bit, the hole must later be reamed in order to be able to set the next size; moreover a second smaller string of drill pipes, with full hole tool joint connexions, must be available for drilling deeper.

Consequently, the first method described offers the following advantages :—

(1) It is unnecessary to use drill pipes with expensive tool joints.

(2) When using the casing string as a drill pipe the next smaller size will pass through the size previously employed.

(3) If the casing string is used as a drill pipe this enables the employment of bits with a thinner shell; the ring cut away is smaller in consequence and hence the speed of drilling will be increased.

The pressure permissible on the core bits is, of course, appreciably less than that permissible on fish-tail or roller bits. The rigs are therefore equipped with a special control device for adjusting both feed and pressure accurately.

In the early days of counterflush drilling pump pressures of 500 to 600 lb. per square inch were used, but subsequent experience showed that the best results were obtained with a pressure of about 150 lb. per square inch. During drilling the operator thus has to attend to two points—namely, the pump pressure and the pressure on the bit. These two pressures are naturally related to one another for if the pump pressure increases unduly the feed will usually be too rapid—*i.e.*, the pressure on the bit will be too great and vice versa.

A vital item in the counterflush coring outfit is the core bit. Since the system permits of continuous coring one of the chief objectives is to avoid round trips due to the necessity of changing the bit and much experimental work was carried out before a bit was produced which would stand up equally successfully in hard and soft formations. Core bits now in use will drill 1,000 to 2,000 ft. before it becomes necessary to make a round trip to change the bit.

The advantages of the counterflush system may be summarized as follows :—

(1) 100% cores and cuttings are brought to the surface in continuous succession.

(2) Cores can be obtained from formations which would not yield cores with the ordinary coring method. This is due : First, to the fact that the cores are brought up very quickly by the flush flow, which is saturated with the cuttings, so that there is no time for the cores to disintegrate, while, secondly, the composition of the flush itself does not tend to damage the cores.

(3) Owing to the construction and quality of the core bits, a round trip need only be made each 1,000 to 2,000 ft., so that rapid progress is made, while wear of pipe threads, draw-works, and steel wire lines is reduced

to a minimum. Experience has shown that a rig may be in service for many months before an overhaul becomes necessary.

(4) Drill-holes are of small diameter and the outfits may consequently be of small capacity and light in weight, rendering transport possible to regions which are difficult of access. Counterflush equipment of a rated capacity of 2,500 ft. has been transported by aeroplane to regions which could formerly be reached only at very great expense.

Venezuela—The Venezuelan Andes and the Coastal and Interior Ranges

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

(*Concluded from the August issue, p. 87.*)

Communications

Roads.—Because of the nature of the terrain and the many rivers road construction has proved difficult and costly in the Venezuelan Andes. However, the Gran Carretera Andina, or Great Andean Highway, some 700 miles long, is the backbone of the road communication system and extends from Caracas through the States of Miranda, Aragua, Carabobo, Lara, Trujillo, Merida and Tachira. During the wet season (May–October) some sections of the road are frequently blocked by falls of loose gravels or schistose rocks and in the region of Carora the road follows a river valley which often becomes flooded and is impassable for several days at a time. The condition of this highway is being steadily improved and within a reasonably short period should be trafficable throughout the year without any delays due to the above causes. The Venezuelan Andes, however, lack sufficient branch roads into the fertile transverse valleys and these will take longer to make, although new roads are constantly being planned and made. The war has delayed the programme prepared since 1936, because without machinery these projects had to be postponed. Next to this main highway is the good 130 miles long motor road extending from Palmarcjo, opposite the town of Maracaibo, through the oil-fields on the east coast of the lake and joining the Trans-Andean road at Motatán. (See Map No. 9.)[1]

In addition there is also the main road branching off the Gran Carretera Andina at Valencia and passing through Tinaquillo, San Carlos, Acarigua, Guanare and Barinas and continuing as an unimproved dirt road through Pedraza, Santa Barbara, and Santo Domingo to San Cristobal (State of Tachira). Thus the Western Andes is encircled by a high-level and low-level system of road communications, but still lacks short by-roads across the ranges, especially in the State of Merida and the eastern sector of the State of Tachira. There are several mule-trails which are much used by small local agriculturists to bring their produce to the market towns, but these cannot, in most cases, be utilized as a base for conversion to roads for vehicular traffic. The four main transverse roads linking the two trunk highways are :—

(1) The 106-mile long connexion between Acarigua (State of Portuguesa) and Barquisimeto (State of Lara).

(2) The winding road from Biscucuy (State of Portuguesa) through Trujillo to Motatán (State of Trujillo), and the branch road from

(3) Barinas (State of Barinas) through Barinitas to Apartaderos (State of Merida), about 15 miles long.

(4) Pta. Piedras (State of Tachira) through Santo Domingo and Rubio to San Antonio (State of Tachira) on the Venezuelan-Colombian border (136 miles).

Railways.—There are three railways in this region—*viz :*—

(1) The Gran Ferrocarril del Tachira operating between Encontrados, on the Catatumbo River (State of Zulia), and Estacion Tachira (State of Tachira), with a branch line to Cúcuta in the Republic of Colombia. The concession for this line dates from 1896 and the company began its services later in that year. The rail distance between Encontrados and Tachira station is

[1] The Mining Magazine, Aug., 1946, p. 79.

120 kilometres (74·5 miles), the track being of 1·00 metre gauge.

(2) Gran Ferrocarril de la Ceiba, or La Ceiba Railway, extending from La Ceiba to Motatán is 81·3 kilometres (50·4 miles) long and is partly destroyed by floods. This track has a 36-in. gauge and the line was opened for traffic in 1887.

(3) Ferrocarril de Santa Barbara to El Vigia. The station of Santa Barbara is on the Rio Escalante and El Vigia is at the end of a good motor road connecting the central part of the Venezuelan Andes with Lake Maracaibo. The railroad is 60 kilometres (37 miles) long and is of metre gauge. This railway went into service in 1893.

These narrow-gauge railways mainly serve to transport the agricultural products of the Western Venezuelan Andes and adjoining regions of the Republic of Colombia to Maracaibo, where they are loaded on to ocean-going freighters. All of them are in a poor state of preservation and require new rolling stock for efficient operation.

Air.—Because of its rugged mountainous terrain there are very few suitable sites for airports in the Andes. At the present time three are being used by the national air line, L.A.V. They are :—

(1) Near Valera, on the Mesa Carvajal (State of Trujillo),

(2) Adjoining the village of Santa Dominga (State of Tachira), and ,

(3) San Antonio (State of Tachira) close to the Colombian border.

Other places that have landing fields, that are used by oil companies' planes and as emergency landing fields, include : El Vigia and Santa Barbara.

Rivers.—None of the rivers in the region described is navigable.

Regional Geology

The core of the Western Andes, forming the highest peaks and *paramos* consists of metamorphic rocks and granites, flanked on each side by tilted beds of sedimentary rocks ranging in age from Palæozoic to Quaternary. The south-western sector of the State of Tachira includes the area known as the Tachira Depression, which at one time formed a connecting channel between the Lake Maracaibo Basin to the north and the Western Llanos, or Apure Basin, to the south. It formed part of the north Andean geosyncline in Mesozoic-Cenozoic time and in addition to the thick deposit of non-marine Triassic-Jurassic red beds some 5,000 ft to 10,000 ft. of Cretaceous and Eocene marine sediments were added. Considerable movement took place about the end of Eocene time and again during the Pliocene.

Except for alluvium of Quaternary age the youngest sediments exposed in the State of Tachira are those named " sub-andine molasse," of younger Tertiary age, and below these lie the sandstones, arenaceous shales, and shales of Eocene age. These are followed by Upper, Middle, and Lower Cretaceous beds, the latter especially covering a very large area. Below the Tomón formation (Lower Cretaceous) lie the red sandstones and conglomeratic-sandstones of La Quinta (or Girón) formation of Triassic-Jurassic age. In this formation are found sporadic deposits of copper minerals. Very few outcrops of granites are known in the State of Tachira and only a small area of Palæozoic chlorite-schists and quartzites.

The central part of the State of Merida is composed of granites and schists, flanked on the north-west and south-east by a considerable thickness of phyllites, clay-slates, and schists of the Mucuchachí Series, believed to be of Devonian age. Above these, on the south-east flank, lie the red sandstones and conglomeratic sandstones of La Quinta formation, whilst the north-west flank has steeply-inclined beds of Upper to Middle Cretaceous sediments and a considerable thickness of Eocene shales, sandstones, and sandy-shales. To the south-east, between the Colorado " massif " and Mucuchachi, are remnants of unmetamorphosed Palæozoic formations, probably of Ordovician age, cut by the Rios Caparo and Mucuchachi. South of Tino, between the rivers Socopó and Michay, is another narrow strip of the same age. The metamorphics extend into the State of Trujillo in the form of a narrow wedge terminating near Guarico, in the State of Lara. It is not possible to devote enough space in an article of this nature to a detailed description of the geology of the Western Venezuelan Andes, but the accompanying stratigraphic column (Table 40) shows the different formations exposed in these Andean States and the publications listed in the bibliography are recommended to those requiring more detailed information.

Mineral Deposits

During the War there was a search in the Western Venezuelan Andes for mica, crystal

Table 40

STRATIGRAPHIC COLUMN OF THE WESTERN VENEZUELAN ANDES

QUATERNARY	RECENT		ALLUVIUM	Sands, clays, pebbles, and boulders forming alluvial fans and alluvial deposits in the valleys.
	PLEISTOCENE		MESAS	Terraces and Mesas of alluvial and detrital sands, gravels, boulders, and a little clay. Individual terrace heights up to 300 ft.
TERTIARY	PLIO-MIOCENE		GUAYABO SERIES	or "Sub-andine molasse," loosely cemented, conglomeratic sandstones, and mottled clays. Well exposed in north Tachira, N.W. Merida, etc. Possibly same as Parangula formation in Barinas. Thickness 1,600 to 2,200 ft.
	OLIGO-MIOCENE		UPPER SHALE SERIES	Soft, bluish-green, arenaceous shales intercalated with soft grey-white sandstones containing locally quartz pebbles. Top marked by 25 ft. of sandstone, forming base of Guayabo formation, near Uraca and Estacion Tachira, State of Tachira.
	EOCENE	UPPER	SANDY SHALE SERIES [CARBONERA]	Grey, sandy shale with thin sandstone beds and some thin, arenaceous limestones. Some asphalt material present. Exposed near Lobatera and Rio Lobaterita.
		MIDDLE	PAUJI FORMATION	Dark-grey to black, massive shales, thin bedded, sandy, pyritic shales, platy sandstones, and thin layers of limestone.
		LOWER TO	MISOA-TRUJILLO FORMATION (UPPER AND LOWER)	Top of series consists of hard, quartzitic sandstone. (No fossils.) Below this dark shales and shaley sandstones. Maximum thickness of Lower section about 3,300 ft. (Mirador.)
			THIRD COAL HORIZON	Sandy shales and black shales with coal beds.
MESOZOIC	CRETACEOUS	UPPER	MITO-JUAN SHALES	Greenish-grey shale and silty or sandy shale. Seams of discoidal clay-ironstone concretions common. Sand content increases from base upwards. Maximum thickness 1,000 ft.
			COLON FORMATION	Colon shales, dark-grey to black, pyritic and marls with occasional thin limestone beds. Below shales a series of black and grey cherts. Base limestone with intercalated shale. Maximum thickness, including Mito-Juan shales, about 3,000 ft. in Tachira.
		MIDDLE	LA LUNA FORMATION	Alternating dark grey to black limestone and calcareous shales with cherty intercalations. Shales and sandy shales upper section, buff-coloured, non-calcareous shale, often with plant remains in region of Chejende, Trujillo State.
			COGOLLO FORMATION	Massive, hard, grey, crystalline limestone, coarser than La Luna limestone. Formation contains much dark shale. At base 3 to 10 ft. of grey to brownish fossiliferous sandy limestones. Maximum thickness of La Luna and Cogollo formations about 1,580 ft.
		LOWER	TOMÓN FORMATION	Pyritic black shales. Interbedded micaceous grey, yellow, and red sandstones and quartzitic sandstones. Also grey, yellow, red, and purple sandy shales. White, conglomeratic sandstones at base. Maximum thickness about 2,600 ft.
	TRIASSIC JURASSIC		LA QUINTA FORMATION	Brick-red sandstones and conglomeratic sandstones interbedded with soft clayey bands, sandy shales, and shales. In Merida, conglomerates predominate, especially in basal sections. Maximum thickness near Zumbador 11,480 ft.
PALAEOZOIC	CARBONIFEROUS and U. DEVONIAN		PALMARITO SERIES	A series of siliceous limestones, sandy shales, and sandstones. Some cherts and shaly marls. Upper Carboniferous age. Fossiliferous.
			MUCUPATI SERIES	A sandy shale, sandstone, and conglomerate series. No metamorphism. Believed to be Upper Devonian.
	M. ORDOVICIAN		CAPARO SERIES	Sandy shale and sandstone. Non-metamorphosed. Age determined as Middle Ordovician.
	CAMBRIAN DEVONIAN		MUCUCHACHI SERIES	Phyllites, dark-grey to black, generally silky lustre. Quartz, sericite, and graphite major constituents. Locally fine-grained conglomeratic sandstones. Quartz veins common. Maximum thickness 3,300 ft.
ARCHÆAN	?		IGLESIAS SERIES, ETC.	Biotite-gneiss, augen-gneiss, garnet-biotite-gneiss, and garnetiferous mica-schists. Conejos massif typical.

quartz, beryl, and various other strategic minerals and although a number of occurrences were located none proved to be of economic value. However, this work was not sufficient to be conclusive and it is thought that a more intensive search and bulk sampling may reveal commercial deposits of mica, beryl, and some of the rarer minerals—such as columbite, tantalite, and pitchblende.

Mica

Attempts have been made to work occurrences of sheet mica in pegmatites in the States of Trujillo and Merida and the following notes briefly describe these.

State of Trujillo

Boconó.—There are several outcrops of granite pegmatites in the region of Boconó, on the ridge known as Loma Isleta. Some 14 or 15 small cuttings have been made in the hillside at El Rincon on stringers of a pegmatite dyke intruded into a very decomposed granite-gneiss. These workings, which yielded a few tons of scrap mica during 1943 and 1944, are located at an elevation of 5,215 ft. to 5,445 ft. above sea-level. About six hours' mule ride from Tostos, which is about 10 miles S.S.W. of Boconó, there is another pegmatite that was once worked for mica on El Morro del Potrero Grande at a place named Agua Blanca. Samples of mica from this quarry, now buried under a fall of ground, did not exceed 4 in. square in size, were heavily stained, had mineral inclusions, and were cross-grained.

State of Merida.—Four different outcrops of pegmatite dykes have been quarried for mica in this State, *viz.* :—At (*a*) Timotes, (*b*) Chachopo, (*c*) Merida, and (*d*) La Gonzalez.

(*a*) *Timotes* is on the Trans-Andean highway some 320 miles from Caracas and was once the headquarters of the Venezuelan Mica Co.'s operations. This town and the near-by mica concessions are situated in the Distrito Miranda. Near Chachopo, a small town some seven miles S.W. of Timotes, are other mica concessions on which some preliminary work was done in 1935 and 1936. The principal rocks in the region of Timotes and Chachopo are sericite-schists, garnetiferous mica-schists, tourmaline-sericite-schists, and granite-gneiss, which have been intruded by younger granites and pegmatite dykes. In the Rio Motatán valley are the alluvial terraces of Pleistocene age and the Recent alluvial fans and terraces deposited at the mouths of the transverse valleys. The age of the metamorphics and the granites is not definitely known, but the granite-gneiss is probably Pre-Cambrian. (See Map No. 10.)

The quarry of Santa Lucia is situated about a mile N.W. of the town of Timotes, at an elevation of 9,230 ft. above sea-level. The pegmatite dyke has been stripped for a distance of about 200 ft. along its strike and its lower part is hidden by debris thrown down from the quarry face. The width varies from 15 ft. to 20 ft. and there are indications that it is a lenticular body rather than a massive dyke. The average strike of this granite-pegmatite is N. 10° W. and the dip is 70° east.

In addition to felspar and quartz the following minerals are present: (1) Black tourmaline, in radiating crystals or "suns" up to 24 in. in length and up to 4 in. in diameter.

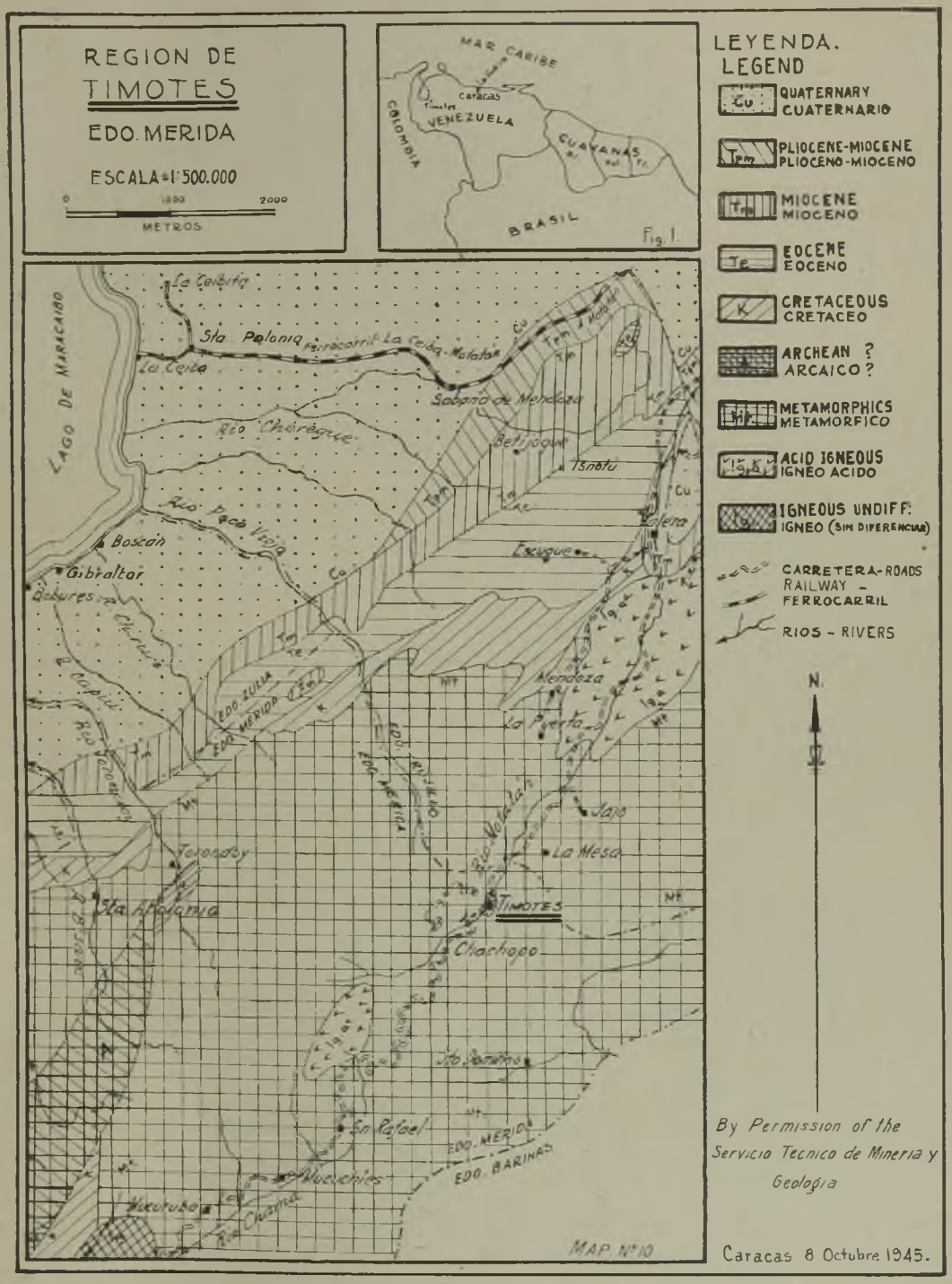
(2) Muscovite mica in books up to 5 in. by by 4·5 in. Most of the mica is found on the hanging-wall side of the dyke within three to six feet of a clay gouge. The leaves of mica have fracture planes which make it difficult to recover sheet mica of commercial size, although the quality is otherwise fairly good.

(3) Small garnets, varying in colour from red through dark brown to yellow, are common near the hanging-wall.

(4) Crystals and nodules of columbite are occasionally found in the dyke near the contact with the country rock. Limonite, hæmatite, marcasite, and pyrite are also found in very small quantities in cavities and fissures penetrating the pegmatite. Some beryl has been reported also, but was not observed at the time of the writer's visit.

(*b*) *Chachopo.*—The Santa Elena pegmatite near Chachopo is located some two miles north-west of this town at an elevation of about 8,600 ft. It has the same strike as the Santa Lucia pegmatite and the principal constituents are the same, but the dyke is very much decomposed. Samples of this soft material were taken and found to contain gold, but not in commercial quantities.

(*c*) *Merida.*—A small quarry was opened on a pegmatite dyke outcropping close to the main highway about a mile north-east of the town of Merida. The quarry is known as El Carmen and lies within the Municipio Millar y Arias of the Distrito Libertador. Some work was done on two outcrops about



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Caracas 8 Octubre 1945.

720 ft. apart and apparently on the same pegmatite dyke. The country rock is a decomposed, grey, biotite-granite containing numerous veinlets of light-green epidote. The pegmatite is of medium grain and contains more felspar than quartz. The books of mica are distributed in a very irregular manner through the pegmatite and vary in size up to 5·5 in. edge and up to 1·25 in. thick. Many of the books of mica are wedge-shaped, much split, striated, and discoloured. A few tons of scrap mica was produced during the war and sold to the oil companies operating in the Lake Maracaibo region. This pegmatite also contains pitchblende and a little beryl.

(*d*) *La Gonzalez.*—Another open-cut working started during the war is situated about $3\frac{3}{4}$ miles south-west of the village of La Gonzalez, in the Municipio de San Juan, Distrito Sucre. The workings, at an elevation of 4,260 ft., may be reached by a steep path up the mountain side in about $2\frac{1}{4}$ hours on mule back. The open-cut has been made along the strike of a pegmatite dyke and three shallow winzes have been sunk S. 34° E. on the dip. The pegmatite consists principally of medium-grained quartz and felspar crystals with scattered books of a greenish-white mica, probably gilbertite. Books were found up to 3 in. in size, but the numerous defects in the sheets precluded their sale except as scrap mica. This dyke was intruded into a grey, fine-grained biotite-granite of which there are several outcrops on the south-east slope of the hill.

Beryl

Many of the pegmatites already described that were examined for commercial sheet mica also contained small amounts of beryl. These included the dykes near Boconó, Timotes, and Merida. In addition other pegmatites near San Rafael and Pueblo Llano (State of Merida) contain small sporadic crystals of beryl.

San Rafael.—The pegmatites of this region are located on Morro Alto of the Paramo de Mucutises, in the Municipio San Rafael of the Distrito Rangel. There have been three concessions denounced in this region, but no more than a little clearing of the outcrops and some sampling have been done. The concession known as B. No. 1 is at an altitude of 14,100 ft. and some five hours' mule ride from the settlement of Barro Negro, north-east of the town of Mucuchies. A pegmatite dyke has been uncovered for about 300 ft. and a small cutting has exposed the pegmatite for a depth of 10 ft or 11 ft. It is composed of about equal parts of quartz and felspar with small amounts of mica and garnet. The beryl reported in this dyke must be very sporadic, because inspection did not reveal the presence of any in the exposed part of the pegmatite.

Concession B. No. 2 is some three miles west of B. No. 1 and at an altitude of 12,100 ft. The pegmatite here is exposed for a length of about 50 ft. and appears to be only 5 ft. wide. A few tons of rock have been broken and contained principally quartz and felspar, but there are also appreciable amounts of muscovite mica, red garnet, and black tourmaline crystals. Some small crystals of beryl have been recovered, but these appear to be few and very sporadic.

The remaining concession, B. No. 3, is close to B. No. 2 and exhibits the same characteristics, but is located in the Municipio of Pueblo Llano of the Distrito Miranda. Analyses of samples of beryl from these pegmatite dykes have ranged from 9% to 12·8% in BeO content.

Pitchblende and Other Radio-Active Minerals

Since 1943 definite occurrences of pitchblende and other radio-active minerals have been found in the Western Venezuelan Andes (9). Samples of radio-active minerals have been collected from the granite-pegmatites of Merida and Timotes and indications of the presence of such minerals have been noted in the pegmatite intrusions near Boconó. These dykes have already been described in the notes on the mica deposits.

(i) *Merida*:—In the quarry of El Carmen, north-east of the town of Merida, about two pounds of pitchblende were collected from the few tons of pegmatite broken whilst quarrying for mica. This mineral occurs in the form of nodules, usually covered with oxidation products and other radio-active minerals—such as, autunite and torbernite. Work was stopped early in 1944 as there was no further demand for scrap mica, so that it was not possible to determine the economic value of this occurrence of radio-active minerals.

(ii) *Timotes*:—Whilst examining the Santa Lucia pegmatite north-west of the town of Timotes the writer also found a small sample of calcio-carnotite which was located in the approximate centre of the dyke. The quartz

Fig. 36.—In the Santa Lucia Quarry, near Timotes.

surrounding it was discoloured and fractured, apparently owing to radio-activity, and it was evident that in quarrying a part of the radio-active mineral had been broken and lost. An analysis of three samples is given in Table 41. Following these discoveries the Government declared the whole of Venezuela to be a National Reserve for deposits of these minerals.

Table 41

	1.	2.	3.
U_3O_8 % . .	1·21	48·15	92·96
U% . .	1·020	40·831	78·365
ThO_2 % . .	Negative	0·34*	Negative
Th % . .	—	0·298	Negative
Pb % . .	N.D.	5·11	2·14
Rare Earths %	N.D.	0·15	N.D.

(1) Calcio-carnotite, hydrated vanadate of uranium and calcium, CaO, $UO_3V_2O_5$. nH_2O (Timotes).

(2) Pitchblende (Merida) Analysis by the National Laboratory, Caracas.

(3) Pitchblende (Merida) Analysis by the National Bureau of Standards, U.S.A.

* Probably most of this is Fe_2O_3.

Columbite and Tantalite

Small fragments of crystals and nodules of Columbite were collected from the pegmatite at Santa Lucia (near Timotes) already described. A sample sent to the National Laboratory in Caracas for assay to determine the Ta_2O_5 content gave 23·4%.

Near the village of Tostos samples of tantalite have been found in the bed of the Rio Burate and others are reported to have been collected higher up this valley near Niquitao, where granite-pegmatites are also known to outcrop. The alluvial deposits of some of these rivers may one day be worth sampling for some of the rare heavy minerals that occur in the pegmatites of the Western Venezuelan Andes.

Urao.—There is a somewhat unusual occurrence of urao, or trona, close to the town of Lagunillas, in the State of Merida. Its existence was known in pre-Colombian times and the Indian tribes of this region used the Urao to mix with the juice of locally-grown tobacco, thus making a thick paste called *chimo*, which they used as a stimulant. The first reference to it in foreign literature is to be found in the collected memoirs of J. Boussingault, published in Paris in 1849 and as far as is known no detailed information on this deposit has yet been made public (10). It is located in an elevated valley about two and a half miles north of the Rio Chama between the alluvial terraces, or *mesas*, that form the right bank of this river and the mountain range of La Culata to the north that forms the south-western extremity of the Cerro del Norte.

The top of the Mesa of Lagunillas is 3,600 ft. above sea-level and from it there is a series of terrace steps down to the valley of the Rio Chama, due south of the trona deposit, which is some 1,640 ft. above sea-level. South of this river the left bank rises steeply to form part of the Cordillera de Merida, with peaks attaining heights of more than 10,000 ft. above sea-level. West of the lake there is a considerable area of typical

" bad land " topography, whilst to the north the mountain slopes end in alluvial fans and cones. The lake itself is situated at an altitude of 3,410 ft. above sea-level in a shallow depression between the low range called the Cerros de La Mesa to the south and the recent alluvial fans at the foot of the mountains to the north. These recent alluvial fans cover the mesa formation of Pleistocene age at the north-westerly end of the lake. A general cross-section is given in Fig. 37.

The maximum surface dimensions of the lake are 3,600 ft. long by 1,300 ft. wide and it is covered in the centre and to the west by a floating mass of vegetation, forming a mat about 3 ft. thick. This makes it appear as if there were two lagoons separated by a sand bar. The amount of water in the lake varies slightly with the season of the year, but the maximum depth of water on the west side is about 10 ft. and on the east 4 ft. This water contains carbonate of soda in solution and is strongly alkaline, the degree of alkalinity varying somewhat with the season of the year. The bottom of the lake is covered with a layer of sandy clay ranging in colour from a pale yellow to a greyish-white when wet.

It is known that some bore-holes drilled during 1942 were extended to 56 ft. below the surface and did not bottom the deposit. An average bore-hole section is 0 ft. to 3 ft., mat of floating vegetation ; 3 ft. to 9 ft., water ; 9 ft. to 15 ft., sandy clay and greyish white mud ; 15 ft. to 24 ft., dark grey mud with crystals of gay-lussite ; 24 ft. to 27 ft., hard capping of whitish colour (1st zone of Trono salt) ; dark greenish-grey to black mud ; below 27 ft., similar conditions to the last section.

There are three minerals found in this deposit :—

(1) *Gay-Lussite*, $CaCO_3.Na_2CO_3.5H_2O$. Found in the form of loose, circular, and needle-like white and yellowish-white crystals.

(2) *Trona*, or *Urao*, NA_2CO_3, $HNaCO_3$, $2H_2O$, found in masses of acicular crystals varying in colour from yellowish-grey to a greenish-yellow.

(3) Hydrated Sodium Carbonate, probably *Natron*, $Na_2CO_3.10H_2O$. The chemical analysis given in Table 42 is typical of several made. Work was suspended in 1945 and the crude treatment plant removed. The small amount of sodium carbonate produced in recent years was utilized in the local chemical and glass industries.

Lead-Silver Ores

The known occurrences of lead-silver ores in the Western Venezuelan Andes are confined to Guarico, in the State of Lara, and to Mucuruba, in the State of Merida.

Table 42

Constituent.	*Dry % [1]*	*Calcined [1] at 180° C.*
Na_2O (including traces of K_2O)	39·49	54·91
CO_2	36·48	37·98
H_2O (including organic substances)	20·04	1·56
Cl	0·16	0·22
F.	0·02	0·03
SO_4	0·01	0·01
SiO_2	2·49	3·46
Al_2O_3	0·39	0·54
Fe_2O_3	0·15	0·21
MnO	0·02	0·03
CaO	0·30	0·42
MgO	0·14	0·20
B_2O_3	0·31	·43

Mineral Composition

Trona (Urao) $Na_2CO_3.NaHCO_3.2H_2O$	94·1%
Carbonate of Soda, Na_2CO_3	92·0%
Other substances [2]	8·0%

[1] Analyses by National Laboratory, Caracas.
[2] By difference.

(*A*) *Guarico* :—A small vein of cupriferous galena was found some years ago on the west side of La Quebrada de Lima, opposite the town of Guarico. This veinlet containing quartz, galena, and some chalcopyrite occurs in a fossiliferous conglomeratic limestone bed. A heavy fall of ground has now buried all trace of the vein and the old workings. This occurrence appears to be very small and while others are said to occur at other points more or less in the same line of strike none is of economic importance. One sample of the ore assayed 33·10% Pb, 2·60% Cu, and contained traces of silver but no gold.

(*B*) *Mucuruba* :—Samples of argentiferous galena were collected from a small vein in the hillside at La Glorieta, opposite the village of Mucuruba, in the Distrito Rangel. The vein was exposed as the result of a small landslide some years ago. Some of the galena recovered was analysed and was found to contain up to 3·4 oz. of silver per ton, traces of gold and 39·10% lead.

A sample of galena in the Museum of Merida is reported to have been discovered at Las Tapias, near Bailadores (State of Merida).

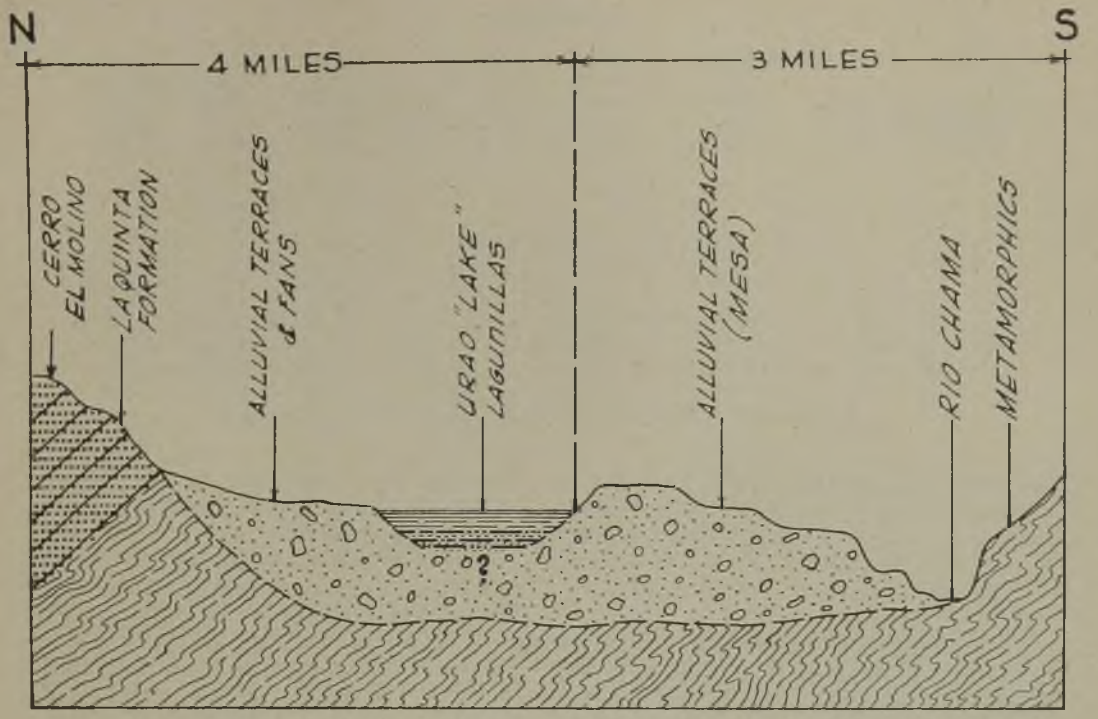

Fig. 37.—Section through the Lagunillas Urao Deposit.

Copper

No commercially-valuable deposits of copper ores are known in this part of the Venezuelan Andes, but sporadic occurrences have been found at several places, amongst the most noteworthy being :—(*A*) El Cobre, (*B*) Seboruco, and (*C*) Trujillo (Rio Mocoy).

(*A*) *El Cobre:*—At a place named Los Mirtos, some 52 kilometres from San Cristobal, small nodules and pebbles of native copper and malachite ores are found in the Triassic-Jurassic red sandstone beds. At this altitude of 7,800 ft. the beds consist of fine to medium-grained sandstone, conglomeratic sandstone, red sandy shales, and some clay. Pebbles of a basic igneous rock, not found *in situ*, were also coated with carbonate of copper.

(*B*) *Seboruco* :—Similar occurrences are known in this area in the district of Jauregui and in Colonial times a quantity of hand-picked nodules of native copper was collected and smelted to make local church bells. This has given rise to a persistent story that there are large copper deposits in this region. Only small quantities of native copper and copper carbonates may be seen in the vicinity of Quebrada de la Mina and El Corozo.

(*C*) *Trujillo* :—A little native copper has been found in various parts of the valley of the Rio Mocoy and this is presumably derived from the red conglomeratic sandstone beds of the La Quinta formation. The most prominent occurrence is that located in the Quebrada Sigusay, a tributary of the Rio Mocoy, east of the village of Soso. Amongst the minerals found are cuprite, malachite, and native copper, the latter mostly in small thin plates and the others as small nodules and thin coatings on pebbles of the conglomerate mentioned. The copper minerals are very sporadic and the occurrence has no economic value.

Asphalt

There is one relatively unimportant occurrence of asphalt in Quebrada La Copé, Distrito San Cristobal, in the State of Tachira. This deposit, situated on the left-hand side of the road 12 miles south of San Cristobal, resulted from seeps of heavy petroleum from Cretaceous-Eocene beds which outcrop in the vicinity. Several small occurrences of this type have been located in the neighbourhood. The crude petroleum

Table 43

	Moisture %	*Volatiles* %	*Ash* %	*Fixed C* %	*S* %	*Calories per kg.*
Sample No. 1	0·90	46·42	1·97	50·51	0·75	6,417
Sample No. 2	8·33	42·64	5·79	43·24	1·31	6,984
Sample No. 3	0·99	39·93	3·29	59·79	0·79	8,100

Table 44

	Moisture %	*Volatiles* %	*Ash* %	*Fixed C* %	*S* %	*Calories per kg.*
Sample No. 1	2·18	52·05	12·13	33·64	3·02	7,379
Sample No. 2	1·75	38·89	11·99	47·37	6·34	6,961
[1] Sample No. 3	1·96	32·74	43·72	21·58	5·30	6,139
[1] Sample No. 4	1·70	39·68	48·84	9·78	4·67	7,083

[1] From Milla. Analyses by the Laboratorio Nacional, Caracas.

has flowed over detrital material and formed a mixture that can be directly applied for making a good road surface and has been used by the local Public Works Department between the towns of San Cristobal and Tariba.

Other small occurrences have been reported from Los Corozos, Agua Dulce, in the District San Cristobal, and near Quinimare. Nothing is known of their extent, but they are believed to be very small and of no commercial value.

Coal

There are numerous outcrops of coal beds and small seams of lignitic and bituminous coal in the States of Tachira, Merida, Trujillo, and Lara, but since the Misoa-Trujillo formation (of Eocene age), including the Third Coal Horizon of Liddle, covers such a large area in the western sector of the State of Tachira there are more occurrences in this State than in the other three.

Tachira :—In the road section from Seboruco to La Fria there are a number of narrow coal seams exposed in the argillaceous sediments of Eocene age, especially between kilometres 91 and 92. Coal has also been reported at Santa Ana, Distrito San Cristobal, near Rubio, Distrito Pozo Azul, Distrito Lobatera, the Aldeas Rivas, and General Salom, Distrito Capacho, etc. Some of these beds have been worked on a very small scale to provide occasional local requirements. In many cases the coal and enclosing beds have been very disturbed by faulting and local earth movements with the result that underground mining would be hazardous and expensive. Early in 1946 some work was done on a coal deposit named San José in the Municipio Lobatera of the District Lobatera. Some typical analyses of these coals are given in Table 43.

State of Merida :—Occasional outcrops of thin beds of coal are seen in exposures of the Misoa-Trujillo formation on the north-west flank of the Andes. One well-known occurrence is at Jaji and another near Milla in the District Libertador. Some representative analyses are given in Table 44.

At the present time there is no commercial exploitation of the coal deposits in the State of Merida and almost the same physical conditions are found in this area as in the State of Tachira.

Trujillo :—Some coal seams have been reported near La Chapa and Escuque, but no information is available regarding their quality and extent.

Lara :—Several samples of a low-grade bituminous coal have been sent to Caracas from the region of Laguneta—a small isolated settlement on the lower foot-hills of the Western Andes some 12 miles S.S.E. of Guarico. An analysis of a reputedly typical sample of coal is given in Table 45. The

Table 45

	Moisture %	*Volatiles* %	*Ash* %	*Fixed C* %	*S* %
[1] Sample No. 1	1·96	32·74	21·58	43·72	5·30

[1] Analysis by the National Laboratory, Caracas.

calories per kg. were 6,139. It is considered unlikely that there will be any attempt made to exploit these coal deposits commercially, but small quantities might easily be produced for local consumption.

Table 46

Location.	CaO %	MgO %	Al_2O_3 %	SiO_2 %	Fe_2O_3 %	Loss on Ignition %
La Concodrida	31·44	1·18	5·38	36·42	0·87	24·80
Barota	51·93	0·46	0·97	5·01	1·38	34·35
Las Adjuntas	49·03	0·58	1·37	9·40	0·90	39·20

Limestones and Clay

Limestones :—There are many exposures of limestone in these Andean States where the Cogollo and La Luna formations occur. In some cases the limestones are highly siliceous, but most of the Cogollo limestone is suitable for making lime or for use in the manufacture of cement. Some of the typical analyses of limestone from Tachira are given in Table 46.

Clay :—There are not many places in the Andes where good-quality brick clays may be found and the only place where bricks and tiles are now manufactured in any appreciable quantity is at Enfadosa.

Other places where small local kilns have been installed from time to time, or where untouched clays are known to exist, include Independencia, San Antonia de Tachira, Michelena, La Grita, and Pregonero—all in the State of Tachira.

Gypsum

Some small occurrences of gypsum are known in the States of Tachira and Merida and may be worked to supply a local cement industry, as the amount required will not exceed 40 tons per mensem.

Localities in the State of Tachira are : The Quebrada San José de la Grita, Distrito Capacho, El Callejon de los Bendidos, on the left bank of the Quebrada Seca in the Municipio Ureña, etc. Gypsum has also been found close to the Quebrada de la Sucia at Jaji, near Ejido, in the State of Merida.

Cement

A cement plant with a capacity of 50 tons (1,200 sacks) per diem is being erected near Palo Grande, about 11 miles from San Cristobal, in the State of Tachira. There is a good supply of Cretaceous limestone (Capacho Series or Cogollo formation) in the vicinity and local shales will also be used, although these are not considered to be of the best quality for the manufacture of Portland cement. It is proposed to produce coal from a bed outcropping near Pozo Azul for use as fuel in the calcination of the raw materials. Small local deposits of gypsum will be worked to supply the limited requirements of this plant. The company has been registered in the State of Tachira as " La Compañia Anonima de Cementos de Tachira " with a capital of Bs. 2,500;000, all of which

Fig. 38.—Trona " Lake," near Lagunillas, State of Merida.

Fig. 39.—West End of Trona Lake, Lagunillas.

is reported to have been subscribed by local people.

Miscellaneous Minerals

In addition to the mineral deposits described in this article there are other occurrences of non-metallic minerals whose economic value is small or as yet undetermined.

In the States of Tachira and Merida there are several occurrences of alunogen ($Al_2(SO_4)_3.16H_2O$), pickeringite ($MgSO_4.Al_2(SO_4)_3.22H_2O$ and what appears to be halotrichite ($FeSO_4.Al_2(SO_4)_3.22H_2O$). These minerals are found as incrustations resulting from the decomposition and leaching of iron pyrites in the black Colon shales of Upper Cretaceous age. As far as is known none of these occurrences is sufficiently large to be of economic importance, although local people are known to collect sufficient quantities to cure hides for their own use.

Alunogen-type salts have been reported near Merida, Ejido, and Mucuchies in the State of Merida, at Santa Ana in the Distrito San Cristobal, and near Capacho in the State of Tachira. A sample of alunogen obtained near Capacho was analysed in the National Laboratory, in Caracas, with the following results :—Al_2O_3, 10·83% ; SO_3, 24·2% ; H_2O_2, 30·09 ; Fe_2O_3, 0·08% ; Insolubles, (by difference), 34·08%.

Bone-Phosphate :—In the south-east sector of the State of Tachira there is a deposit of bone phosphate which has not been studied with a view to commercial exploitation. It is situated near San Pablo, north of the road from San Cristobal to Barrance and west of the Rio Doradas. These phosphatic beds, consisting of fish-bones, lie above the cherty layers of the Upper Cretaceous La Luna limestone. Their areal extent is not known, for only one or two small exposures have been discovered and the average thickness at these places does not exceed 12 in.

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The Flow of Pulp through Spigots

By R. T. Hancock

Expanding an equation previously proposed.

Some years ago it was shown [1] from data published by Robert H. Richards and Boyd Dudley that by putting the Torrecellian equation for discharge through an orifice into the form :—

$$\text{Volume Discharged} = CA\sqrt{2gh}\ (\text{voidage})^{2.5}$$

it would apply not only to the discharge of water alone, where voidage is unity, but also to those cases where the water carries solids.

The original data and the discharge calculated from this equation are given in Table 1.

Table 1

Sand. (*Kg.*)	*Sand and Water.* (*Kg.*)	*Sand by Vol.* (%)	*Water* *Found.* (*Kg.*)	*Calculated.* (*Kg.*)
0·00	9·20	0·00	9·20	9·280
0·45	9·30	1·83	8·85	8·861
1·10	9·35	4·68	8·25	8·232
1·40	9·35	6·08	7·95	7·933
1·90	9·40	8·53	7·50	7·426
1·95	9·40	8·78	7·45	7·375
2·20	9·55	9·92	7·35	7·147
2·25	9·20	10·60	6·95	7·013
2·50	9·05	12·60	6·55	6·627

Derived from the best straight line through the plotted data, the value of $CA\sqrt{2gh}$, no sand being present, is found to be 9·28. A suitable choice of units or change in A, the area of the spigot opening, or in h, the constant head above the spigot orifice, would have made it unity, so we can disregard it in forming the general equations and write :—

$$\text{Volume of water varies as (voidage)}^{2.5},$$

the water being that present in the sand-water mixture passing out of the spigot. The data similarly show that—

$$\text{Volume of pulp varies as (voidage)}^{1.5}$$

the pulp volume being that of the sand-water mixture passing out of the spigot. We also have the relations

$$\frac{\text{Vol. of Water}}{\text{Vol. of Pulp}} = \text{voidage}$$

$$\frac{\text{Vol. of Solids}}{\text{Vol. of Pulp}} = (1 - \text{voidage})$$

Hence :—

$$\text{Volume of Solids varies as (voidage)}^{1.5}\,(1 - \text{voidage})$$

It can be shown by the calculus or by using tables of three-halves and five-halves powers that this expression passes through a maximum when voidage = 60% and solids = 40%.

The weight of solids in a pulp can be found when the specific gravities of the solid and of the pulp itself are known, by means of the equation :—

$$\text{Wt. of Solids} = \frac{\text{s.g. solids (s.g. pulp} - 1)}{\text{s.g. pulp (s.g. solids} - 1)}$$

With quartz at s.g. 2·65 and 40% of solids in the sand-water mixture, the s.g. of the pulp is 1·66 and the equation just given shows that the proportion by weight of quartz in the spigot discharge under conditions implying a maximum is 64% of the weight of the pulp.

The data upon which the foregoing relations are based do not go beyond 13% of solids by volume, so that the figure of 40% involves considerable extrapolation. It is, however, a matter of common observation in the mills and one which can easily be checked with simple laboratory apparatus that the discharge of quartzose material when the spigot carries all the sand it can be given approximates to 64% by weight. It is stated that the maximum percentage of solids by volume which could be discharged in the tests in question was 13, at which figure the spigot choked. Why this should have been the case is not at all apparent.

[1] HANCOCK, R. T., "The Viscosity of Sand Suspensions," THE MINING MAGAZINE, Sept., 1939.

Possibly some foreign body fell unobserved into the experimental tank. The diameter of the spigot was 2·4 cm. and the diameter of the largest particle in the sand was 1·4 mm., so that bridging, which is the usual cause of chokage, could not have occurred.

The fact that a spigot can function as a valve and secure a constant pulp discharge at 40% of solids by volume irrespective of minor changes in the pulp flow behind it in the circuit is of great importance in classifier design and throughout the milling plant.

Estimating Welding Costs on Castings

By H. Seymour

A survey for the benefit of the maintenance staff.

When a careful record is kept of the time spent in preparing and welding a casting and of the value of the gases and supplies used it is comparatively easy to arrive at an accurate cost of the welding job. This information is particularly essential when a value must be set upon the work, as in job welding shops or in cases where the cost of work done is a matter of inter-department accounting. It is often difficult to estimate accurately the probable cost of a welding job before it is done, but often the necessity for such an estimate is quite as urgent as that of accurate costs upon completion of the welding.

Experienced welders can sometimes make a fairly accurate guess of the cost of a job by simply looking at the parts to be welded and mentally comparing the extent of the work necessary with jobs previously done, the costs of which were determined. This method, however, has nothing to recommend its accuracy ; it is so fully dependent upon the estimator that probably very little reliance may be placed upon a figure arrived at in this unbusinesslike manner.

In considering the cost of welding, in comparison with the cost of accomplishing the same results by other means or methods, value factors must be added to the latter to compensate for or offset the savings in time and transportation charges and other economies effected when castings are reclaimed by welding. For such a comparison it is generally necessary to approximate the expenditure required to put a casting into service by employing the oxy-acetylene process.

An approximation made before a job is started of the labour, gases, welding rod, flux, and finishing required to complete it will at least serve as a basis for a valuation of the finished work. The same figure will also decide any question as to the economy of welding as compared with other means of accomplishing the desired results.

A comparison of the estimated cost of welding with the actual cost as evidenced by records of the job will serve as a check upon the practices employed in the execution of the weld. The estimated cost will be based upon work done under ideal conditions. If the actual welding costs are much higher than the estimated cost after an allowance has been made for working conditions this may be an indication that the best practices are not being employed, provided, of course, that the basis for estimate is complete.

The cost of welding will be made up of the costs of preparing parts for welding, the actual welding, annealing, and finishing if this last is necessary. These in turn will be composed of the costs of labour and supplies.

The cost of preparing a casting for welding will include cleaning and chamfering the members and pre-heating. The fuel used in pre-heating must be charged against the welding job, whether a temporary brick furnace or some type of pre-heating torch is used. Included also in the cost figures will be the value of asbestos paper or other material used as insulation, if this is rendered unfit for further use.

The greatest single item of expense for this part of the work on large castings will generally be the time consumed in chamfering. Quite often the labour necessary for this work may be materially reduced by utilizing an oxy-acetylene cutting blowpipe to bevel the edges of parts to be welded.

In the actual welding the labour cost will

often be one of the largest single items. After this will come the cost of the oxygen and acetylene used, the cost of welding rods and flux, and the value of any carbon blocking or other material consumed or spoiled in welding.

The cost of annealing should include the value of any additional fuel added to the pre-heating fire to reheat the casting after welding is completed and that of any additional insulating material used. If it is necessary to finish the weld by machining the cost of labour and materials used will be a logical charge to add to the welding cost.

In most job welding shops and plants where much welding is done complete record of the cost of each job is kept on a cost card or job ticket. These cards are generally ruled with spaces provided for a record of each item of the cost. In some shops these cost records are quite elaborate, their completeness depending upon the requirements of the shop and the cost accounting system in use. In every case an authoritative cost record will prevent the loss of money, if welding is being done for others, through failure to secure sufficient compensation for the work. If the welding is in the nature of production or repair work within an organization accurate costs will permit charging the work against the proper production and maintenance accounts.

The first step in estimating the cost of a welding job will be to determine approximately the amount of pre-heating fuel that will be required to bring the casting to the proper temperature for welding. An idea of this will be gained from the bulk of the casting or the section heated and will be to some extent influenced by the qualities of the fuel to be used. Allowance should be made for sufficient fuel properly to pre-heat the casting and to maintain the heat while the welding is in progress. The cost of the insulating material used and of the fire-bricks for the pre-heating furnace, if these are not part of the equipment of the shop, should be considered.

For the purposes of estimating costs the amount of filler metal needed will be the same as the volume of the open section before welding. To estimate this for any kind of a weld, except one made in round bars, the length of the weld, the width of the weld at the widest part of the vee, and the thickness of the section should be measured in inches. The volume of filler metal needed in cubic inches will be determined by dividing the product of these dimensions by two. If the member is bevelled from both sides add the width of the two vees and divide by two, using the result in place of the vee width as mentioned for the first instance. If the two vees are of the same size the volume of both will be found by multiplying the sum of the two vee depths by the product of the length and the width of the weld and dividing by two.

The volume of metal removed from a round bar may be estimated by multiplying the area of a cross-section of the shaft by the width of the fee at the widest part and dividing by two. To find the area of the cross-section, multiply the square of the diameter by 0·7854, or multiply the square of the radius by 3·1416.

The following formulae may be useful :

Where W = width of vee at widest part, in inches.

L = length of weld, in inches.

D = thickness of section, or diameter of round stock, in inches.

A = area of cross-section, in square inches.

V = volume, in cubic inches.

Flat Stock

For single vee : $V = \frac{1}{2} (L \times D \times W)$.

For double vee ; vees of same sizes : $V = \frac{1}{2} (L \times D \times W)$.

For double vee ; vees not same size : $V = \frac{1}{2} (L \times D \times \frac{W + W^1}{2})$

Round Stock

For single vee : $V = \frac{1}{2} (A \times W)$.

For double vee ; vees same size : $V = \frac{1}{2} (A \times W)$.

For double vee ; vees not same size : $V = \frac{1}{2} (A \times \frac{W + W^1}{2})$.

Cast iron weighs approximately $\frac{1}{4}$ lb. to the cubic inch. Thus by dividing the volume of the vee in cubic inches by four the quantity of filler metal in pounds will be the result. By using the amount of filler metal estimated as a basis the time necessary for welding may be figured from the welding table, this being a basis for arriving at an idea of the labour cost for this operation.

Welding tables issued by equipment makers also give the approximate consumption of oxygen and acetylene per hour and per linear foot of welding for various thick-

nesses of metal. These figures are generally based upon the employment of a neutral flame and may vary if such a flame is not maintained.

The cost of the flux will be a minor item and the amount necessary will vary with the quality and condition of the metal and the quality of the welding rod. For estimating purposes it may be considered that 1 lb. of good-quality flux will be used to deposit 100 lb. of filler metal. This is not accurate enough to serve as a check on the proper use of flux by the operator, but is a value for estimating only.

It may be necessary to add an estimated cost for finishing the weld after the welding. In production welding the expense incurred in this work may be chargeable to another operation and may be disregarded. This is especially true if the castings are being used as machine parts and are finished and painted as a part of the production process. Where it is desirable to add a figure to cover this work to the estimated cost of welding regular machine-shop practices should be applied.

In welding shops where the estimated cost of welding is being used as a basis for the price to the customer cartage or other transportation charges must be added as well as overhead expense. While these are more properly matters of management the fact that they are sometimes not considered in naming a figure to the customer renders their mention expedient. Each job should bear its proper share of the outlay for superintendence, the charges to cover investment and upkeep of apparatus, rent, light, and power; also office, sales, and advertising expenses, and possibly other items not chargeable to any particular job.

Ore-Dressing Notes

(10) *Physics.*

Particle Shapes

What is a particle of ore mineral from the viewpoint of the expert in mineral processing? It has volume, mass, density, shape, surface, and lattices. Weight gives it, so to speak, vertical tractive force *vis-a-vis* the medium in which it is suspended. Weight is related, *via* density, to volume. The dynamic flow of the particle in a vertical direction in the medium depends also on shape and surface. Shape decides the degree of axial perturbation which will arise in moving and hence the braking loss of energy due to the setting up of eddies and currents and the cleaving of the viscous medium. Surface also provides braking restraint by friction between the solid and the fluid medium. Hence, gravitationally, the particle's final course is vectorized by two groups of opposing forces—the gravitational, imparting vertical movement relative to the medium (up or down) and the viscous and frictional braking forces of shape and surface.

Surface is also important, however, in other ways. It is the doorway to the interior of a particle, which may be treated by chemical methods—such as, cyanidation (application of a liquid to the surface to extract gold) or roasting (application of oxygen gas to the surface to extract sulphur). Here the extent of the doorway and the manner in which it is filmed or painted becomes important, for the problem is one of entry and the conditions for successful entry are tightly limited. Again, surface becomes extremely important when the process used is one which seeks to modify it by a mono-molecular film, without penetration or substantial alteration of the chemistry of the particle, as in flotation. The particle now becomes a complex of contending forces, even if it has been so prepared as to contain nothing but a single mineral constituent of the ore. The crystalline aggregation affects the presentation of the lattices and the disposition of the crystal flats. These in turn affect the electronic or ionic exchange between the mobile molecules and near-colloids in the surrounding medium and the unsatisfied electric charges at the particle surface.

It is clear, therefore, that for a process of concentration to reach high efficiency it is first desirable to prepare each particle carefully in accordance with the requirements of the specific process. This is not to be done merely by grinding all the ore to pass a given mesh which has been found to constitute an

Copper Mill in the Transvaal.

acceptable criterion of liberation. Liberation of the constituents of the ore, so that each particle can be directed into the appropriate portion of the product — concentrate, middling, or tailing—is excellent, so far as it goes, but it goes only part of the way. Grinding must not only assure optimum liberation, but it must also limit the amount of -10μ material produced during that liberation. This is demanded by economics, handling, and the concentration process alike. At present enough care is not used in this aspect of milling work, because operators are still not fully alive to the importance of surface control. The minor boom in the sale of infra-sizing machines to the ore-dressing laboratories of North American mines is a most significant pointer to the awakening interest of the man who has to get results. If this Note may venture a prophecy, the verdict of routine infrasizing will be that better grinding is needed as the next major improvement in milling practice.

(11) *Handling.*

Pumping

An interesting paper [1] on the pumping of mill pulp summarizes the author's conclusions thus :—

(1) Velocities of solid-fluid mixtures in pipe-lines must be maintained above the critical point in the discharge line.

(2) Total dynamic heads must be figured accurately.

(3) Sump and pump design must be fitted to the particular problem at hand.

(4) Operation and maintenance procedure must be set up and adhered to.

(5) An installation embodying the foregoing principles is bound to be successful and economical.

The " critical point " or critical velocity referred to in (1) above is that at which solids settle out and varies from 3 to 18 ft./sec. in accordance with particle size, pulp density, and the specific gravity of component sands. The author's experience is that friction factor is inversely as velocity of flow, so that when the speed through a pipe-line is insufficient to keep the solids in suspension a slight increase in both feed volume and speed of pump usually puts things right. Steady volume is most desirable for good pumping and is usually equalized by a feed sump big enough to take care of small surges, but too small to become a settling chamber. Where variations are but slight, a float-controlled valve can be used to add fresh water and maintain volume, without unduly upsetting pumping density, particularly where only tailings disposal is at issue. Trouble in practice is usually found to be due to incorrect estimate of the dynamic head—the sum of static, friction, and suction head, the latter of which is negative where a pump has a " flooded " suction. Under normal operating conditions the frictional resistance due to solids in suspension varies as pulp density and static pressure also is proportioned to the fluid gravity. In most cases this is not of sufficient importance to call for speed variation, but initial calculations must assure that the system is not over-speeded or undue frictional wear will occur, while over-pumping wastes power.

[1] STEPHENSON, W. B. A.I.M.E. Tech. Pub. 2013.

The ideal feed sump is cylindrical, giving a 4-ft. liquid height above the centre-line of the impeller, with perhaps up to 18 in. extra for surge capacity, and the bottom should slope steeply on three sides toward the intake. Baffling should break up any vortex liable to carry air through and a low-level alarm is good practice, since if air is pumped the flow is disturbed and there is risk of a blocked line. For frothy pulp the head should be increased to at least 6 ft., the suction large, and pump oversize run slowly with reduction of pipe diameter at discharge end. Up to $\frac{3}{8}$ in. material is best handled by a pump whose wearing parts are protected by properly-bonded rubber. Above this manganese steel is excellent. Ideally a pump should start up, and stop, on clear water, feed being introduced after the system has been inspected for leaks.

(12) *Sink-Float.*

Handling the Heavy Medium

In a recent paper the author [1] describes the preparation and reconditioning of the galena used at Bunker Hill for sink-float treatment of their lead-zinc ore. New medium is made as required, usually every six days, by recleaning the flotation concentrate from the lead cleaner circuit to upgrade it to 70% Pb. This product has a screen analysis of 0·8% + 100 mesh, 8·5% + 200 mesh, 20·3% + 325 mesh, and 70·4% + 325 mesh. After dewatering to a density of 3·1 its viscosity is 1·2 to 1·4 and its stability $1\frac{1}{4}$ in. in 20 minutes. Viscosity and density of the medium at work in the plant are checked regularly (not less frequently than 3-day intervals) and when they fall away from the figures given the upgraded concentrate is sent to a special hydraulic cone. If the viscosity is too high the cone overflow is bled away to join the mill concentrates, thus reducing the proportion of extremely fine galena in the medium. If, on the other hand, the stability is too low, this indicates a lack of fines in the medium, so spigot discharge is sent to the mill thickener until conditions are correct. High viscosity and low stability do not occur simultaneously.

Owing to the contaminating effect of fine gangue and the degradation of ore and galena during separation it is necessary to clean the medium continuously. Seven tons of sand are removed daily on a 30-mesh vibrating screen through which all the medium circulates and a further 14 tons are taken from the washwater by a drag. Part of the medium is cleaned by flotation, the concentrate going to the sink-float thickener and the tailings to the ball-mill circuit. The cost of preparing new medium is that of running two flotation cells, three pumps, and a cone classifier—some 8% of the operating time of the sink-float plant—without extra labour.

[1] Garber, C. Y. A.I.M.E. Tech. Pub. 1985; *Min. Tech.*, May, 1946.

(13) *Layout.*

Mill Design

A paper on "Mill Design for Labour Economy" by N. Weiss [1] gives three reasons why the mill labour force should be small. First, to reduce wages and welfare services; secondly, to meet man-power shortage, and

[1] A.I.M.E. Tech. Pub. 1997.

Tin Plant in Cornwall.

thirdly, because " many of the shortcomings in design that make necessary the excessive use of labour are . . . not corrected merely by having too many men." The first factor in labour saving the author considers to be the location of the plant, which should not be dominated by the thought of a short haul for the ore, but should suit the functional operations as well. Good design provides for handling supplies and heavy repair jobs efficiently, in buildings planned to support the necessary cranes and hoists. Crushers should be able to get through the day's work in 12 to 14 hours, and should avoid badly-planned handling and loading devices which lead to excessive spillage—a major waster of labour. Mechanical feed to the crusher, with a no-load alarm and interlocked electrical controls frees the attendant considerably. Liberal headroom allows good vertical drops, with avoidance of clogged chutes. Dry timber-free ore is a help to this desirable condition.

Coming to the flotation section the need for processing continuity is stressed and the author quotes a continuous process as—

> One in which all process variables remain constant with time at a given point in the flow path, but vary with distance along the path. . . . In the ideal condition of continuity there is no mixing along the axis of the path, but virtually perfect mixing normal to the axis. Moreover, conditions change in a continuous manner along the axis, rather than by a series of discontinuities . . . discontinuities indicated by harassed workmen coping with chokes and surges instead of going quietly about their duties. . . . process continuity is born in the mill bins and feeders . . . Uniformity of the ore as to metallurgical composition . . . is achieved by good mixing, while uniformity as to tonnage rates is maintained by the correct application of modern feeders and weighers.

From time to time the view has been expressed in these Notes that no other item in mill management and control approaches steady continuity of flow as the basis for consistent results and to get such smoothness most effectively it should be planned before the layout is finally approved. Adequate slopes are essential if smooth transport from point to point is to take care of itself with no threat of choked launders and spilt pulp requiring manual handling from the floor, where, perhaps, it has picked up undesired frothing agents in the shape of lubricants. Clear accessibility and head-room so that heavy parts can be hoisted out for repair, rods swung into their mill in bundles, balls trucked from storage to their mill—these are the criteria of good design, not less than accessible controls on valves, gates, and weirs, with suitable calibration marks to facilitate re-setting. It is time that reagent feeders had some kind of alarm arrangement to give warning when empty or stalled. Pumps, without which the pulp cannot circulate through the veins and arteries of the plant, should be provided in duplicate and so placed as to be convenient for maintenance and safe from flood and splash danger.

Repairs should be anticipated and planned for, from records showing rate of wear of machine parts. The author points out that the equipment should be so constructed by the makers as to allow replacements to be assembled in readiness and should not call for the tedious removal of a host of fiddling little bits and pieces before the job can be done. The author cites as bad examples the need to remove 72 small bolts on a dust cover before a belt and its idlers could be repaired and a fan guarding its wheel with 48 machine screws. To good accessible design might be added the choice of the proper material for each job. Truly efficiency in the modern mill starts at the blueprint stage.

Engineering Log

A lecture recently delivered by Professor G. I. Finch [1] deals scientifically and fundamentally with fires and with the structural and managerial aspects of their cause, control, and prevention. These are all matters which concern us professionally and it is not proposed to summarize a long and closely-reasoned lecture in this paragraph. The rate of growth of a fire influences the method of fighting, rate of evolution of heat, and problem of confining the conflagration.

> For most properties the fire susceptibility depends on the nature, amount, and distribution of the combustible material and its surroundings . . .

Differentiating between fire susceptibility and fire risk the lecturer pointed out that a celluloid collar held in a man's hand could easily be discarded, but that the fire risk was very high when the same collar was being worn. Vegetable matter, with its high content of carbohydrates and cellulose " is by far the most important fuel feeding destructive fire, oils, coals, and explosives being far

[1] *Journ.* Roy. Soc. Arts, Apr. 26, 1946.

less troublesome in practice than wood, paper, and cotton. The rate at which gas is given off from a heated fuel depends mainly on the specific surface, which therefore becomes the chief determinant of ignition and spread of fire. Combustible and incombustible elements in a property are, however, not usually distributed in a uniform pattern, so the development of a fire will be conditioned by the grouping of the fuel elements. In a forest there are three horizontal zones—branches and foliage, undergrowth, and tree-trunks—each having its characteristic behaviour in case of fire. In buildings the combustible matter is grouped and separated by incombustible load-bearing walls vertically and by combustible horizontal floors, the situation being complicated by communicating doors.

In general, the combustible contents of a property lie roughly in one or more horizontal layers. Hence, in the critical initial period of slow burning the fire must grow out horizontally from the centre of inflammability, the area of growth being roughly proportional to the square of the time. This . . . underlines the importance of the early discovery of and attack upon outbreak of fire . . . If two or more neighbouring centres . . . are simultaneously involved the rate of growth is further increased . . . by . . . aeration . . . Growth is checked when the fire reaches the confines of a compartment but usually (accelerates) when doors, windows, etc., give way . . . A fire tends to spread upwards, but may be carried downwards by combustible liquids and melting solids . . .

Firefighting is done by three groups—the man on the spot, the professional fire fighter, and the specialist who copes with technically-unusual fires. Having first saved any endangered persons, the next task is to restrict the material damage and finally to deal with the actual fire. To extinguish flames the gas or its oxidant must be eliminated, the latter usually being oxygen from the air, while the burning gas is probably being liberated by heat. Hence, cooling is one mode of attack, or dilution of the burning mixture with an inert gas, or prevention of further ingress of gas or oxidant. Water as pumped on to the fire cools and then evaporates to form an inert gas, steam. It must be delivered in a cool and compact stream upon its target, the outer edges of the fire area, in the direction of potential spread. If delivered to the centre of the fire the resulting steam may push the burning gases outward. Atomized sprays arrive too hot and transport entrained air to the fire. For special cases a foam blanket, if delivered rapidly and copiously, can seal off the combustibles and foams are increasingly used in specialized cases. The lecturer pointed out the value of co-operative planning to minimize fire risks :

The scientist can point out that the fire-load is no measure of the risk unless the load's fire-growth constant is known ; the architect can secure the lines of escape and erect barriers to delay the spread of fire ; the legislator can check the irresponsible and help the ignorant ; the statistician can preserve our sense of proportion and show us where our efforts are most needed ; the manufacturer can give us steel furniture and woollen night clothes for our children and thereby eliminate the worst fire risks of domestic life ; and the ordinary man can exercise a little more care . . .

* * *

With use engine oils become increasingly acidic through oxidation and this has a corrosive effect on the metal surfaces with which they come into contact, if allowed to go too far. One ingenious method of testing whether a sump should be drained because of acidity of its oil uses a narrow strip of copper which has been electro-plated with lead in a succession of coatings varying from 0·00003 in. to 0·001 in. The strip is immersed in hot oil, either by attaching it to the dip stick or as a beaker test, and after an hour the degree to which the lead has been removed from the copper provides a visual indication of the corrosiveness of the oil.

* * *

From 3,277,000 tons weekly last December Britain's mined coal has risen encouragingly for the first quarter of 1946, to 3,615,000 weekly for March with a useful 157,000 tons of open-cast coal " on the side." Corresponding employment figures were 698,000 in December, 696,000 in January, 697,000 in February, and 698,000 in March, the corresponding absenteeism being 17·03%, 18·93%, 18·58%, and 17·13%. Output per man-shift in March was 2·79 tons at face and 1·04 overall. Last September more than 100,000 of the underground labour force of 710,000 were over 55 years old and the annual wastage was between 35,000 and 40,000, against an intake of 10,000. Absenteeism is worst among new recruits to mining. Statistics make dry reading. Those quoted, when considered against the background of this country's reconstruction needs, export plans, and other schemes for getting us back to a better standard of living, are unpleasant when we remember that all such plans depend on coal. Recent geological pronouncements show that there is plenty still awaiting development, but the weak link in the chain is still the good-will of a happy

and disciplined labour force, skilled and adequate to the demand.

* * *

An improved method of arc-welding studs with speed and great positional accuracy has been developed. The stud is placed in a special tool-holder connected with a 100-volt welding current and is positioned accurately on to the work. Current is initiated through a small pip on the base of the stud which causes the main body of the stud to remain suspended until a molten pool of metal has been formed on the work to which it is being welded. The stud then plunges into this pool, surplus metal solidifying as a collar round the join. The cycle of operations only takes part of a second and proceeds automatically once the circuit is made. Great strength, speed of operation, and simplicity are claimed.

* * *

Industrial alcohol can be produced from several sources and with the return of this important industry to a peace footing a survey of the economics has been made by Dr. Tousley.[1] Ethylene, produced by cracking petroleum hydrocarbons, is probably the cheapest source of ethyl alcohol. Another source is black strap molasses, which is cheaper both in raw material and processing cost than production from grain. Alcohol from the waste sulphite liquor of woodpulp mills has not progressed in America as it has in Europe. The processing of wood waste has also failed to establish itself, since the other raw materials needed are too costly at present, though research is still active.

* * *

The war made amateur gardeners compost-minded and the chemical treatment of plant refuse for the purpose of soil-enrichment by humus is now standard practice in many gardens. In America some up-and-coming cotton farmers are going a step further and are dusting their fields a little before harvest time with a calcium cyanamid compound that kills the leaves, apparently without otherwise affecting the plant's prosperity. The cotton bolls, no longer shaded, ripen better and are easier to pick, while rot due to wet weather is averted. The technique is being tried out with soya beans and tomatoes. Dusting is said to be quick, cheap, and easy to apply.

[1] *Chem. Met. Eng.*, Oct., 1945.

To test the strength of paper sacks one manufacturer, not content with the usual tests, has sent some 50 lb. sacks of flour down the Niagara Rapids and over the Falls. Of three launched one was recovered after 7½ hours' milling round at the bottom of the Horseshoe Falls, intact and with its powder dry. The container consisted of three five-layer sacks of wet-strength paper of stock grade and weight.

* * *

As a result of the interest aroused by an Indian technologist, A. D. Singh, research at the Institute of Gas Technology, Illinois, indicates that cooking gas, smokeless fuel, coal tars, plastics, and motor spirit can be prepared from coal now wasted or left unused. The raw material of the process can be bituminous coal, but it is especially intended to run on lignite carrying 30% to 40% moisture, now but little used in American industry. The process is called "fluidization." Pulverized lignite and bituminous coal are fed by screw conveyor into a gas line which carries the powder to a retort where volatiles are gasified by heat. The issuing stream is stripped of its solids in a cyclone, the cleaned gas then proceeding through condensers which take out tars and light oils. The solids are briquetted into smokeless fuel of good B.Th.U. value. The temperature required for the process is 900° F. to 1200° F. and apart from the feed arrangement there are no moving parts, so the process is not expensive. A semi-pilot plant has been at work for some time and is now able to demonstrate the method on a good scale.

* * *

A new synthetic drug is reported for the treatment of malaria. SN 7618 (the figure refers to the test number which capped four years of research) is said to relieve malaria three times as fast as quinine or atebrin and to produce fewer ill-effects. A weekly dose wards off fever or ends its symptoms abruptly.

* * *

One of the simplest known methods of sustained heavier-than-air flight is provided by the ram jet. Instead of the conventional propeller and motor the "flying stovepipe," as the American Navy's research workers on guided missiles have dubbed it, is just a more

or less empty tube. In fact the first test model had started life as an exhaust pipe and developed 3,000 h.p.—more than that of the aero-engine it originally served. The ram jet is an open pipe. Oxygen is scooped in during flight and compressed by the speed at which the jet is travelling. Fuel is injected into this compressed air, ignited, and exhausted at the tail-end with a tremendous pushing effect. The jet weighs 70 lb. Unlike the German rocket, which must carry its own oxygen supply, it only needs fuel. The snag is that the needful compression does not operate adequately till external methods have speeded the jet up to some 800 m.p.h., which would indicate considerable limitation of its uses in a war-free world.

* * *

An old rule for fixing transport rates was : " What the traffic will bear." This phrase has been developed considerably by modern economists, but it still underlies the theory believed to apply to the final price of all goods and services—the " Marginal Utility Theories " of value and of rent, themselves two aspects of one basic concept. Any good theory of economics must appreciate that modern methods of exploitation can produce a surplus. The way in which marketing is done will determine when this surplus is produced (or how widely the human demand has been satisfied for the goods finally appearing as surplus). It will also, as a corollary, fix the retail selling price and hence the profitable cost of production. These two factors, which determine how much of the goods-purchasing money brought into the market by buyers shall be devoted to a particular item, determine price and so value. The Theory of Rent conditions the price at which the producer can sell and remain in business. It embraces all the items in the selling price charged by the producer except the actual cost of the labour used to do the work of production. G. B. Shaw opens his " Everybody's Political What's What " with the down-to-the-ground statement that " all economic analyses begin with the cultivation of the earth." He then develops a brilliant example of the *modus operandi* of " Economic Rent " and shows that the " all the traffic will bear " axiom boils down in practice to a string of *rentiers* parasitic on the basic producer who, having nobody to rent to, must do the work himself at subsistence level, or starve. Marketing boards, restriction controls, cartels, and restrictive rings were pre-war palliatives. The present invention is to raise standards of living throughout the world, thus providing a much greater consumer market and flow of basic goods. Neither of these devices is complete in itself and it is here, surely, that the fight between state socialism and private enterprise must be fought—not on the farms or in the mines.

News Letters

VANCOUVER

August 5.

Mine Labour.—The strike of the International Union of Mine, Mill, and Smelter Workers, in effect since July 3, differs from most of its predecessors, inasmuch as the union permits its members to take other work. A number of workers on strike have accepted employment with exploration companies and, frequently, are doing the same work at the same pay as formerly within a few miles of the operation for which they refuse to continue. A strange case has arisen in the silver-lead-zinc mines in the Slocan district, where miners have been told it is quite permissible to advance development headings in waste, but cannot obtain a union ruling on procedure if ore is encountered.

Much criticism of the strike, particularly since the loss of 10% gross in the value of gold won, through the equalization of exchange, has been voiced by leaders in the industry. The latest comes from Mr. Victor J. Creeden, general manager of Hedley Mascot Gold Mines, Ltd., who stated at the annual meeting of shareholders that the men at the head of the strike were avowed Communists who were using British Columbia as a testing ground in their efforts to disrupt the Canadian mining industry.

The Pacific Lime Co., Ltd., operator of lime quarries on Texada island, has granted its employees, members of Local 816 of the International Union, an increase of 10 cents per hour and the right to voluntary check-off. No strike was called at this operation.

Chief Justice Gordon McG. Sloan has refused to act as conciliator because the operators would not bargain collectively.

Smelter at Trail.

Mr. George R. Currie, representing the Federal Department of Labour, has since been appointed to conduct negotiations and Justice Sloan has agreed to act in a consulting capacity. As this is written there is no indication of any early solution.

Mining operators in British Columbia are opposing introduction of the 44-hr. week in the metal-mining industry on the following grounds :

(1) A 4-hr. shift cannot be worked in a mine because a work cycle cannot be completed within 4 hr. This is particularly true in development headings.

(2) Not being able to work five 8-hr. shifts *plus* a 4-hr. shift to make up the 44-hr. week, the industry would be faced with three alternatives, none of which would be satisfactory. These are :—

(*a*) The mines could work 40 hr. only. Since, however, the milling operation is a continuous affair, the mill could not be supplied with sufficient ore for a 48-hr. carry-over without providing additional storage capacity at very great cost.

Output could not be maintained without getting a larger crew and providing additional equipment. Larger crews would involve providing additional accommodation, a thing which is impossible at the present time. In order to maintain production, it would be necessary to work a number of additional headings. This would involve the purchase of additional equipment which is not easily obtainable to-day.

Providing additional accommodation and equipment requires large additional outlay of capital.

(*b*) The mines could alternate between a 40- and 48-hr. week, averaging 44 hr. over a stated period. The same objections apply to this as to the above.

(*c*) Mines could presumably obtain permission to work 48 hr. per week, but would have to pay overtime for the additional 4 hr. This is a cost increase which is not justified. The excessive wage demands being made by the unions are already more than the industry can bear.

(3) A third reason for opposing the 44-hr. week in the metal-mining industry is that a great number of men in outlying camps do not want it—that is, their main object is to increase their earnings and not to gain extra days of leisure. This has been made very clear to us during recent negotiations with the Union, during which great emphasis has been placed on the decline in real earnings.

(4) The season for outside exploration work is so short that it is utterly foolish to restrict hours of work on prospects. The men accepting employment on these are invariably willing to work at least 48 hr. per week and in many cases would prefer to work 13 days out of 14. It is impossible to provide recreation on prospects. To add penalty payments for anything over 44 hr. a week is adding an unjustifiable burden to development work.

(5) One of the very real problems in mining camps at present is to provide a means of occupying the leisure time of single employees. Week-ends of 48 hr. simply could not be used to advantage of the majority of these men. Whenever they want a long week-end they can take it under present arrangements.

Portland Canal.—Silbak Premier Mines, Ltd., received net smelter returns of $43,116 from its June production, recovered after the treatment of 5,436 tons of ore averaging 0·22 oz. of gold and 1·57 oz. of silver per ton. The operating loss was estimated at $9,014.

Morris Summit Gold Mines, Ltd., has commenced driving a cross-cut to investigate gold-bearing veins indicated by deep diamond drilling last year. Drilling is to be continued from the upper levels at the same time.

Alberni.—Nitinat Mines, Ltd., has purchased the Havilah mine, adjoining the Black Panther, on which the company is building a 25-ton mill.

Privateer Mine, Ltd., experienced a net operating loss of $27,657 during the fiscal year ended December 31, 1945. Mining was resumed in November last and milling in February, 1946. In the period to May 22 (the date of destruction of the power plant by fire) 782 oz. of gold and 366 oz. of silver were recovered from the 2,288 tons of ore treated. At February 28, 1946, the ore reserves were estimated at 33,956 tons, averaging 0·403 oz. of gold per ton. Progress on the iron and steel project in which Privateer is a partner is reported as follows by Mr. D. S. Tait, the president :

> Good progress has been made under the direction of B.C. Minerals and Resources Development Co., Ltd., with the rehabilitation of the townsite and hydro-electric power development at Anyox. The programme of rehabilitation here is well ahead of schedule and it becomes daily more apparent that this townsite, with its dockage and developed hydro-electric power, constitutes in itself a very valuable asset, in which this company shares equally with the Minerals and Resources company.
>
> We are advised that several large organizations have shown interest in the use of this site and power, and the metallurgical operations which may be undertaken there and it is possible that before the end of this year we may be in a position to announce important developments along that line. This company has already contributed its full agreed share to the acquisition and development of this property and it is anticipated that we will not be called upon to put up further funds in that connexion.
>
> Meantime the programme of exploration and research undertaken by B.C. Minerals and Resources is showing important results in other directions. The company has now acquired the largest and best body of high-grade limestone known on the North Pacific Coast. This commodity is in very strong demand and very short supply, not only in British Columbia but also in the adjoining states of Washington and Oregon. The engineering and other facilities for getting out the material is to be started soon. It appears likely that a highly profitable operation will result. We are informed by the management of the Minerals and Resources company that their intention now is to concentrate upon the development of this limestone deposit until the operation is in full production.

Cariboo.—The June production of the Cariboo Gold Quartz Mining Co., Ltd., was 1,861 oz. of gold from 5,527 tons of ore, averaging 0·337 oz. of gold per ton. Mr. Robert Stevenson, recently on the staff of Noranda Mines, Ltd., has been named general manager, a position held temporarily by Mr. P. N. Pitcher, mine superintendent, since the resignation of Mr. R. R. Rose, managing director.

The June production of Island Mountain Mines Co., Ltd., was 1,213 oz. of gold, valued at $46,775, from 2,752 tons of ore averaging 0·44 oz. of gold per ton.

Burns Mountain Gold Mines, Ltd., has applied for approval of change in name to Cariboo Rainbow Gold Mines, Ltd.

Omineca.—An announcement has been made by Lt.-Col. C. B. North, resident manager, that Duthie Mines (1946), Ltd., has let a contract for a minimum of 5,000 ft. of diamond drilling.

Similkameen.—The Granby Consolidated Mining, Smelting, and Power Co., Ltd., earned a net profit of $27,341 during the second quarter of 1946, after provision of $19,653 for taxes and $49,813 for depletion. During the period 314,575 tons of ore was milled, as compared with 283,103 tons in the first quarter. The operation was hampered by the strike of employees of the Tacoma smelter, destination of the Granby concentrate shipments, which extended from February until May, and it is now shut down as a result of the strike of employees of the Granby company itself.

Osoyoos.—The tunnel from the surface has reached the No. 2 level of the Stemaeindor Mountain mine of Hedley Amalgamated Gold Mines, Ltd., previously reached only by winze from the No. 1 level. A length of 200 ft. of ore of good width and grade was developed on the 2 level in 1938.

During the fiscal year ended December 31, 1945, Hedley Mascot Gold Mines, Ltd., produced 17,181 oz. of gold, valued at $717,395, from 56,503 tons of ore averaging 0·31 oz. of gold per ton ; income from other sources was $2,457. After deducting the operating cost of $673,369 and providing $58,322 for depreciation and $7,447 for taxes the net loss for the year was $19,286. Development work consisted of 2,308 ft. of drives and cross-cuts, 629 ft. of rises, 19,029 ft. of diamond drilling, and 690 ft. of work on the 2,700 incline. The last-named was started from a point 1,800 ft. back of the mill at an elevation of 2,700 ft. and is being driven some 2,600 ft. at an angle of 24° to the 3,700 level ; when completed a surface-and-underground ropeway will connect the top of the incline directly with the mill. During the year the 3,700 level was advanced a further 1,982 ft. into the ore zone of the Nick of Time claim. The company milled 1,764 tons of ore averaging 0·64 oz. of gold per ton from the Good Hope (Wheeler) property, which it holds on option. Dr. Victor Dolmage, the

consulting geologist, describes this ore-body as a replacement in a bed of limestone and states "the limited amount of exploration so far done indicates important possibilities." The annual meeting of shareholders was informed there was little likelihood of an early payment of dividends because all earnings would be required for completion of the major development programme in hand.

Slocan.—The mill of Western Exploration Co., Ltd., was operated for the last ten days of June, during which time the output was valued at $22,000 from ore grading approximately $19 per ton. Although production has been suspended by the miners' strike development work is continuing in the mine.

Kelowna Exploration Co., Ltd., has taken an option on the Ruth Hope and Carnation properties and is conducting geological investigations in the hope of tracing the Silversmith ore-body at depth. The work is being directed by Mr. Paul Billingsley.

TORONTO

July 21.

Gold Production.—During May the gold mines of Ontario milled 630,000 tons of ore and recovered 149,549 oz. of gold and 27,904 oz. of silver, valued at $5,776,929. The month's output figures for the various producing districts were as follows: Porcupine, 340,198 tons milled, 76,029 oz. of gold, 16,902 oz. of silver, value $2,940,215; Kirkland Lake–Larder Lake, 166,217 tons milled 45,484 oz. of gold, 8,174 oz. of silver, value $1,755,994; Matachewan–Sudbury, 37,300 tons milled, 3,676 oz. of gold, 750 oz. of silver, value $141,304; North-Western Ontario, 86,285 tons milled, 24,360 oz. of gold, 2,078 oz. of silver, value $939,416.

The Ontario Department of Mines May gold bulletin states that the output for that month was the highest since March, 1944, with 40 mines reporting production. The output for the first five months of 1946 amounts to $27,635,284, against $24,770,191 for the same period of 1945. The production figures for May include output from the Young-Davidson mine, which resumed operations after the winter, and the production from Magnet Consolidated Mines, Ltd., in the Thunder Bay district, for March, April, and May.

The gold production for the whole of Canada for March totalled 247,918 oz., while the April output was 238,216 oz., valued at $9,171,316. The April figure included 197,092 fine oz. from auriferous quartz mines and 41,124 fine oz. from base-metal mines. The output from auriferous quartz mines and placers rose 6·2% over April, 1945, and production from base-metal mines increased 7·6% in a comparison of the same periods. Employees in producing auriferous quartz mines, including both salaried employees and wage-earners, numbered 18,575 in April, 1946; the corresponding total for active non-producing mines was 669. Employees in non-ferrous metal mines, smelters, and refineries totalled 26,206 during the month under review.

Porcupine.—A three-compartment shaft to be sunk to 435 ft. is planned by Malga Porcupine Gold Mines. The sulphide zone at this

Mine Buildings at San Antonio.

property is estimated to contain 180,000 tons of ore averaging $8·80 per ton and drilling has indicated other potentialities in the area.

During May 10,860 tons of ore was milled by Paymaster Consolidated Mines, the gold output being valued at $101,196.

The Amalgamated Goldfields Corporation completed 5,000 ft. of drilling during 1945, payable ore being indicated in at least three holes. The corporation intends to unwater its mine in Beatty township and to test the bore-hole results by work at the 500-ft. and 625-ft. levels.

Work has been started on the 1,000-ft. shaft to be put down by Porcupine Reef Gold Mines.

Kirkland Lake.—Work at the 525-ft. and 650-ft. levels has been resumed at Armistice Gold Mines.

Amalgamated Larder Mines reports the shaft now down to 650 ft., the objective being 1,000 ft.

North-Western Ontario.—The output of McKenzie Red Lake Gold Mines for 1945 was valued at $486,808, from 63,460 tons of ore milled. These figures compare with $724,956 from 78,279 tons in the previous year, when the labour shortage was not so acute. Operations in 1945 resulted in a loss of $11,691.

The 1945 labour shortage also affected Madsen Red Lake Gold Mines, which reports a profit of $95,536 for the year to February 28 last at a reduced milling rate. Production for the year totalled $981,932 from 98,472 tons of ore milled. At February 28 last the ore reserves were estimated to be 797,290 tons, averaging $7·81 in value per ton.

Little Long Lac Mines reports a profit of $102,741 for 1945, which compares with $123,432 for the previous year. Shortage of labour reduced milling capacity and the reduced output was valued at $815,183.

The report of Pickle Crow Gold Mines for 1945 shows an output valued at $1,291,181, obtained from 64,090 tons of ore milled. The accounts show a profit of $304,410, as compared with $466,769 for 1944. The ore reserves at December 31 last were estimated at 695,095 tons.

Manitoba.—At the recent annual meeting shareholders of Sherritt Gordon Mines were given further information regarding the results of work on nickel-copper prospects at Lynn Lake. To date this work has indicated that several mines may be opened up, since ore intersections on the A, B, and E anomalies have all been good. The company intends to take a mining plant and a pilot mill to Lynn Lake next winter over the winter road from Sherridon, to sink a shaft near the "A" ore-body and to explore this and the adjacent bodies by underground work. This work also will provide ore from the various bodies to be tested in the pilot mill. At the same time diamond drilling is to be continued to investigate other magnetic anomalies and to add to indicated ore reserve. The mining plant at the East mine at Sherridon, where the ore reserves are near exhaustion, will be released in time, it is expected, to provide equipment for the preliminary mining plant at Lynn Lake, while the main plant at Sherridon should be available in time to be incorporated in the permanent production plant.

Quebec.—The gold output of Quebec Province for March was valued at $2,178,099 and that for April at $2,282,357. The total for the four months ended April 30 last was valued at $8,692,530, as compared with $9,247,469 for the corresponding period of 1945. The silver output for the period under review was 568,826 oz., against 768,008 oz., the figures for March and April of this year being 115,675 oz. and 117,743 oz., respectively.

Lamaque Gold Mines reports net earnings of $131,078 for the first four months of the current year. In the period the output was valued at $514,782, from 55,380 tons of ore milled. At April 30 last the ore reserves were estimated to be 2,541,134 tons, averaging $8·14 per ton in value.

A three-compartment shaft is to be sunk to 530 ft. by Goldone Mines to enable exploration work to be carried out at the 200-ft., 350-ft., and 500-ft. horizons.

Sigma Mines reports its May output as $163,060, which compares with $162,257 for April and $162,448 for May, 1945.

The shaft at Golden Manitou has passed the 1,200 ft. mark and work on the new headgear is well under way.

A new mineralized zone has been discovered by Pandora Cadillac Gold Mines in the course of cross-cutting at the 825-ft. level from No. 3 shaft.

At the recent annual meeting of Powell Rouyn Gold Mines shareholders were informed that diamond drilling is being carried out on the E vein, situated to the far east of the property. Low values had been encountered to date, but the structure was thought to be promising.

It is reported by Hosco Gold Mines that

three shifts are now working on the three-compartment shaft and that the first station has been cut on the 200-ft. level. Upon completion of shaft sinking to 550 ft. it is proposed to drive on three levels at approximate depths of 200, 350, and 500 ft. The company has recently completed a financing agreement whereby $250,000 is to be placed in the treasury to assure production by the end of the year.

MELBOURNE

August 20.

State Assistance to Mining.—The Western Australian Government is giving practical assistance toward the advancement of the State's greatest industry. In order to assist prospectors and small operators six light mobile boring units are to be purchased and will be made available to small mines in which their use is warranted. Steps are being taken for the purchase of mobile air-compressors and drilling plants, which will be mounted on trucks as one unit. Such equipment will be a valuable addition to the help already given the small producer in the form of State batteries, of which some 23 are available throughout the large and even the remote goldfields. The plants are designed for the treatment of free-milling ore by amalgamation and have cyanide plants attached for treatment of the battery sands. The ore is treated at a fixed treatment charge per ton and the sands are purchased from the owner on assay value, over a minimum grade slightly over 3 dwt. per ton. It is now proposed to equip one or more of the State batteries for the treatment of sulphide ores.

Activity at Tennant Creek.—Interest is increasing in the Tennant Creek goldfield and the ore available from renewed operations has been sufficient to cause the re-opening of the No. 3 Government mill, which has been closed down since early in the war. The first parcel of ore treated was raised from the Wheal Doria mine, one of the first opened up on the field, and 400 tons are expected to yield an average of 14 dwt. gold per ton. Small producers are reported to have several thousand tons of ore at grass and it is probable that Nos. 1 and 2 Government plants will resume operations.

The only mine here to continue production during the war was the Eldorado, which has its own mill and has reported very good developments at the 300-ft. level, the greatest depth so far reached on the field. Work by the Eldorado company, together with indications obtained by diamond drilling to depths approaching 800 ft. in other parts of the field, are pointing to the possibility of a greater future for the area than was originally thought. The ore occurrences are peculiar, erratic but rich, and careful study of their geology may lead to successful development of a number of mines. Interest is at present centred in the Whippet mine from which the owners have raised 900 tons of ore, which is expected to yield 4 oz. gold per ton. The lode is 40 ft. wide and work has reached a depth of 90 ft. Such values are not unusual on the field, which can be regarded as an attractive exploratory area and the most promising in the Northern Territory.

Tin Mining at Torington.—Before the recent war Torington, in the New England district in New South Wales, was the most important lode-tin producing district in the State. Owing, however, to Federal Government indifference to the provision of labour to a theoretically protected industry ore reserves became exhausted and the two main producers were forced to pass the mines over to tributers.

One company, New Butlers Tin Mines, N.L., was able to carry on limited development with the assistance of the State Government and has reserves of 15,000 tons of ore with an average value of 2% tin oxide. The impossibility of raising capital during the war for the purchase and erection of a mill forced the company on to a tribute basis, but active mining is to be resumed. A milling plant is to be erected ; the necessary units have been purchased and it is hoped to have the mine in production by April of next year. The tin-bearing lodes have been proved for a distance of 1,500 ft. and vary in width from 12 in. to 6 ft. The greatest depth reached in the main shaft workings is 300 ft. from surface, at which depth width and grade are maintained. The country rock is Permian granite, intruded by aplite dykes, which appear to be source of mineralization. The cassiterite is associated with some wolframite. In the wider parts of the lode the principal deposition of cassiterite is near the walls, the central portion consisting of quartz, with occasional low-grade patches of cassiterite and a little galena. Chlorite is a common

Table 1

Period.	*Tons Milled.*		*Concentrates Produced.*	
	Total.	*Average per week.*	*Total.*	*Average per week.*
22 weeks to April 28, 1945	29,412	1,337	84·7	3·8
26 weeks to October 31, 1945	60,106	2,312	349·5	13·4
Totals	89,518	1,865	434·2	9·04

associate of the tin mineral, which is relatively coarse. The concentration plant will consist of tables, vanners, and strakes, with a magnetic separator and a cleaner flotation cell.

It is hoped that with the gradual return of labour it will be possible to obtain the capital necessary for a resumption of exploration and development in the mines of Curnow's Tin Mines, N.L., now worked to a depth of 900 ft., and New England Tin Mines, N.L., which were consistent producers for many years.

Operations at Kalgoorlie.—Paringa Mining and Exploration Co., Ltd., is active in the exploration of abandoned mines of the Kalgoorlie goldfield. The company has explored by diamond drilling the Mount Charlotte leases, over which Wiluna Gold Mines, Ltd., has taken an option. Paringa then became interested in the Maritana group of leases, adjoining on the south, and is carrying out diamond drilling to define the southward extensions of the Mount Charlotte lode channels with encouraging results. The old Brownhill Extended mine is to be examined and John's shaft, which is 800 ft. deep, is to be unwatered and equipped with winding plant. On the old Block 45 mine a small electric winder has been installed, the shaft reconditioned to 400 ft., and ore-bins are to be erected. Within the last 12 months the Federal shaft on the Paringa Extended lease has been sunk from 400 ft. to 523 ft. and ore production has reached 1,200 tons per month. All these mines have been abandoned for many years.

King Island Scheelite.—King Island Scheelite, N.L., which is working the largest known scheelite deposit in the world, earned a net profit from mining of £37,773 (Aust.) in the year ended October 31, 1945. The deposit is worked by open-cut to a depth of 150 ft. by a team of 25 men on a basis of 5½ days of 8 hours per week. Mining plant comprises two Ruston diesel shovels of 2½-cu. yd. capacity, one ⅜-cu. yd. Ruston diesel shovel, and a D 8 caterpillar tractor. During the year a total of 84,443 tons of overburden was removed, in addition to 20,296 cu. yd. of sand, 3,764 tons of waste rock from the ore zone, and 1,398 tons of clayey ore removed from the ore zone to the dump. Crude ore mined and sent to the mill totalled 91,193 tons. The ore was transported by six White 6-ton trucks, with some additional capacity during the summer months. Milling results are shown in Table 1 over two periods : The first, in which large operating losses were incurred mainly in mechanical and metallurgical defects in design ; the second, in which alterations and modifications had largely corrected the difficulties in early operation.

The company has been hampered by shortage of power and by breakdowns to the two generator sets. New sets are to be purchased and when erected will provide sufficient power for the mine requirements. Maintenance has been high, due mainly to the non-provision of wearing parts during the war period and to faulty manufacture. Mill labour was also unsatisfactory, but a marked improvement has taken place toward the end of the period.

Mining in Victoria.—At the annual meeting of the Victorian Chamber of Mines the chairman, Mr. A. H. Merrin, stated that 34 quartz mines were now at work or about to recommence operations. Four gold dredges were producing or very close to resumption. In the previous year operating quartz-mining companies totalled 12. The shortage of explosives, owing to a prolonged strike at the explosive works, had caused some of the mines temporarily to suspend their development work.

Figures issued by the Victorian Department of Mines give the gold production of the State for 1945 as 61,790 fine oz., as compared with 54,085 fine oz. in 1944, which was the lowest production since 1932. Dividends paid in 1945 were £223,125 (Aust.), as compared with £229,875 in 1944. The leading producers last year were as shown in Table 2.

Table 2

Company.	*Fine oz.*
A.1 Consolidated, Gaffney's Creek .	13,347
Central Deborah, Bendigo . .	6,031
Deborah, Bendigo . . .	1,889
Maude and Yellow Girl, Glen Wills	3,418
Morning Star, Woods Point . .	13,583
North Deborah, Bendigo . .	6,973
Wattle Gully, Chewton . . .	5,545

For the past 12 months Victoria Gold Dredging Co., N.L., working on the flats of the Loddon River, at Newstead, dredged very poor ground, with values approximating 1 gr. per cu. yd. A diversion of the river has been carried out and the dredge has crossed the river channel into higher-grade ground. The improvement in results is shown in the report for the fortnight ended July 23, in which 102,535 cu. yd. were treated for the recovery of bullion estimated to contain 485 fine oz. of gold, equivalent to an average grade of 2·3 gr. per cu. yd. For the year ended March 31 the dredging of marginal grade wash resulted in a loss of £3,020 (Aust.), compared with a profit of £12,627 in the previous year. In the financial year for which the report has just been issued, costs increased from 6·06 pence to 7·15 pence per cu. yd. and no dividends were paid. Since commencement of operations in July, 1938, the yardage dredged is 102·2% of that estimated to exist in that portion of the property. The recovery of gold is 87·4% of the total gold indicated by bores.

Gold Mines of Australia, Ltd., in conjunction with the Gold Exploration and Finance Co. of Australia, Ltd., is to float a company next year to dredge leases on the Jim Crow Creek, at Newstead, in the vicinity of the area being worked by Victoria Gold Dredging Co., N.L. The dredge design is being prepared and orders have been placed for items of the equipment. The leases are estimated to contain 10,500,000 cu. yd. of alluvium, with an average value of 2·5 gr. gold per cu. yd. as bored. An area of 4,613 acres on the Stawell goldfield has been examined and on four leases totalling 4,170 acres scout boring has indicated a substantial yardage with an average value of 2½ to 3 gr. gold per cu. yd. Some of the wash is of a clayey nature and tests on the workability of this ground are to be made. On the Guildford leases, in the vicinity of Newsted, the two companies have carried on boring operations which have disclosed 6,000,000 cu. yd. of easily worked wash, similar to that on the area of Victoria Gold Dredging Co., N.L., which adjoins the new ground, the indicated grade being 2·2 gr. gold per cu. yd.

Mining in New Guinea.—Sunshine Gold Development, Ltd., has reported that preparations are being made to resume sluicing on its leases. Water races have been damaged and will take about six months for repairs, as soon as native labour is available. The condition of the races is due, in part, to military operations and some 7,000 ft. of pipe were requisitioned for military purposes, for which orders have been placed. When operations are resumed the mine will have a practically new sluicing plant. The native labour position is unsatisfactory, but some improvement has been reported. Shipping is difficult, for there is, as yet, no regular service from Australia. It is estimated that reserves of ground are sufficient for profitable operations over 15 years. At the time the area was evacuated retorted gold to the value of £1,200 (Aust.) was hidden and has been recovered.

Mount Morgan's Operations.—In the year ended June 30, 1946, ore production at Mount Morgan, Queensland, improved in comparison with the previous year. The gold yield also was better, but the recovery of copper was less. Ore and metal figures for the last seven years are given in Table 3.

Table 3

Year to June 30.	*Ore Treated. Tons.*	*Gold Recovered. Oz.*	*Copper Recovered. Tons.*
1940 .	633,280	65,958	3,770
1941 .	890,800	41,312	4,691
1942 .	863,880	53,891	4,799
1943 .	826,850	51,052	3,972
1944 .	909,200	38,262	3,410
1945 .	549,350	43,400	3,149
1946 .	614,700	48,256	2,935

For the year just closed the average four-weekly profit, before providing for depreciation, was £1,865 (Aust.).

British Guiana

The fourth lecture of the Imperial Institute series covering recent geological work in the Colonies is to be given on Thursday, September 26, at 3 p.m., by Mr. S. Bracewell (Director of the Geological Survey of British Guiana). He will deal with "The Geology and Mineral Resources of British Guiana." The chair is to be taken by Sir Frank Stockdale. The lecture, which will be illustrated,

is to be given in the Cinema Hall of the Imperial Institute, South Kensington, S.W. 7 (East Entrance), and will be followed by a discussion. No tickets of admission are required.

Personal

HENRY BAILEY has retired as head of the Assaying Department at the Camborne School of Mines.

L. C. BALL has retired as Chief Geologist to the Queensland Government.

K. A. BEATSON has been appointed Director of the Waihi School of Mines, New Zealand.

EDGAR BOWLES has left Egypt to take up his appointment as Assistant Professor of Geology at Rutgers University, New Jersey.

JAMES BOYD has been appointed dean of the faculty of the Colorado School of Mines. Since the war Colonel Boyd has been directing industrial operations in the American zone of German occupation.

S. C. BREALEY is returning from India.

FRANK E. BRIBER has resigned as secretary and director of the Denver Equipment Company and its affiliates.

M. L. BROWN is now in Northern Rhodesia.

A. R. BRUHN has returned to Australia.

JOHN GRAY BUCHANAN, chairman of William Jacks and Co., Ltd., this month completes his 60th year of service with the company.

J. V. BULEY has been made a senior field geologist of the Department of Mines of Victoria, Australia.

EDWIN D. CANDLISH is home from the Gold Coast.

M. H. CANNING has been appointed Senior Assistant in the Assaying and Metallurgical Department of the Camborne School of Mines.

ARTHUR ROY CLARK, recently on the staff of Noranda Mines, Ltd., has been appointed instructor in geophysical prospecting at the University of British Columbia.

E. F. DARK is home from Dutch Guiana.

JOHN C. DAVEY is here from Venezuela.

E. B. DAVIES is now in Malaya.

P. A. DELMÉ-RADCLIFFE has left for the Gold Coast.

J. V. N. DORR has been appointed chairman of the Dorr-Oliver Co., Ltd., in place of WILLIAM RUSSELL, who is retiring from that position while continuing as director of the company.

J. A. DUNN is now in Australia, following his retirement from the Geological Survey of India.

DEYMAN EASTMOND is now in the Transvaal.

H. A. ELLIS has been appointed Government Geologist by the State of Western Australia.

FRANK A. FORWARD, head of the department of mining and metallurgy at the University of British Columbia, left on July 25 for Formosa to make a survey of mining and metallurgical plants for an eastern Canadian company. He was accompanied by Dr. PETER PRICE, geologist.

A. E. FRY has been appointed Inspector of Mines in New Guinea.

M. GRATACAP has left Turkey for Venezuela.

DOUGLAS HAY has been appointed Chief Mining Engineer to the National Coal Board. Professor Hay is at present honorary Professor of Mining at Sheffield University.

S. HAYMES is here from India on his way to British Guiana.

JOHN HAYS has left for Northern Rhodesia.

L. HUNTER has left Australia for Malaya.

B. C. KING has been appointed mineralogist to the Nigerian Geological Survey.

D. E. S. KING has returned from Malaya.

L. C. KING has been elected president of the Geological Society of South Africa.

L. J. KRIGE has been awarded the Draper Medal by the Geological Society of South Africa.

J. LATHAM has been appointed Chief Finance Officer to the National Coal Board.

R. B. MCCONNELL has left for Tanganyika.

W. A. NEWMAN has left Colombia for the United States.

L. F. NEWTON is now in Malaya.

H. F. PEARSON is now in Tasmania.

J. W. PERTWEE has left for Holland.

WILLIAM PULFREY is returning from Kenya.

J. D. SAMPSON is now in Kenya.

A. FAIRFAX SCOTT is home from Nigeria.

W. SENIOR is leaving Australia for Nigeria.

EDMONDSON SPENCER, for the past 25 years on the research department of Messrs. Bird and Company, Calcutta, is joining the teaching staff of the Royal School of Mines.

D. STANTON is home from Sierra Leone.

JOHN SUMMERS is now in Gold Coast Colony.

C. TEICHERT is now senior field geologist with the Victorian Department of Mines.

A. L. DU TOIT has been awarded the Jubilee Medal of the Geological Society of South Africa.

F. C. TOMLINSON has started practice as a consulting engineer in Georgetown, British Guiana.

J. W. S. TREEBY has left for Malaya.

G. A. WHITWORTH has been appointed Principal of the Camborne School of Mines, of which he has been Acting Principal since the death of H. STANDISH BALL in 1941.

R. B. WOAKES is leaving shortly for Cyprus.

H. K. WORNER has been appointed Professor of Metallurgy in the University of Melbourne.

ERNEST ALFRED WRAIGHT, who died on August 25 last, aged 67, received his training at the Royal Indian Engineering College and the Royal School of Mines. He received his diploma in 1902 and was then appointed a junior demonstrator in metallurgy, in the following year being awarded the Edward Matthey prize for research into the segregation of silver in argentiferous copper. During 1903 he was Temporary Assistant Assayer at the Royal Mint until he was made senior demonstrator in metallurgy at the Royal School of Mines, as well as a Carnegie Scholar of the Iron and Steel Institute. From this position he was advanced to Lecturer in Assaying, a post he held until 1914, when, joining the Forces, he served first with the Royal Engineers and later the Royal Flying Corps, resigning with the rank of captain from the R.A.F. in 1920. In the period to 1924 " Father " Wraight, as he was affectionately known to many Royal School of Mines men, was engaged in private consulting work, but in the last-named year he became Metallurgical Inspector to the Government of India, which subsequently additionally appointed him Collector of Excise. For his services in India he was made C.I.E. in 1936. Mr. Wraight, who retired from the Indian Civil Service in 1937, was a Member both of the Institution of Mining and Metallurgy and of the Iron and Steel Institute, as well as a Fellow of the Royal Institute of Chemistry.

Trade Paragraphs

Copper Development Association, of Grand Buildings, Trafalgar Square, London, W.C. 2, announce that Sir William Griffiths, chairman and managing director, Mond Nickel Co., Ltd., Mr. H. J. Allcock, British Insulated Callender's Cables Ltd., and Mr. Christopher F. S. Taylor, Rhokana Corporation, Ltd., have been appointed to the management committee of the Association.

British Industries Fair. It is announced that the annual trade fair held in this country in the years before the war is to be revived in 1947. This will take place at Earl's Court and Olympia, London, and Castle Bromwich, Birmingham, from May 5 to 16, the lighter industries being represented at the London exhibitions and engineering and hardware at Birmingham. The organizers are respectively the Export Promotions Department of the Board of Trade and the Birmingham Chamber of Commerce.

R. G. Le Tourneau, Inc., of Peoria, Illinois (London office: 124, Sloane Street, S.W. 1), announce that J. H. Crammond will work in England and Scandinavia with E. R. Galvin, manager of the company's London office. Mr. Crammond formerly served as a member of a Special Detachment of U.S. Engineers who acted as consultants and advisers on airport construction to the Aviation Battalions in England and France. Announcement is also made that A. V. Conrad, who has been with LeTorneau Service and Training Departments for several years, is going out as assistant district representative on the West Coast of South America, to Peru, Colombia, Ecuador, Bolivia, and Chile. He formerly worked with several contracting companies in South America as well as the United Fruit Company. Jerry Mason has rejoined the company to become an export district representative in Turkey. He has just completed several assignments with oil and mining companies in South America and with the Ministry of Fuel and Power on coal stripping in this country during the emergency of 1944–45.

Mine Safety Appliances Co., of Braddock, Thomas, and Meade Streets, Pittsburgh, announce a new 2-page bulletin featuring the M.S.A. goggle-cleaning cabinet with "Fogpruf" for installation in mills, factories, and wherever goggles are used, designed to encourage workers to wear their goggles and to keep them clean. Adapted for convenient wall mounting, the cabinet is equipped with Fogpruf—an efficient lens-cleaning and anti-fogging agent—and optical wiping tissues. The right amount of Fogpruf for proper cleansing is applied to both lenses simultaneously at one turn of the cabinet dial. Optical wiping tissues are pulled from an opening in the bottom of the cabinet and discarded in a waste receptacle in the right-side of the case. A compartment is provided for additional supplies of Fogpruf and tissues. The bottom of the cabinet swings down to make the compartment accessible and may easily be locked with a small padlock. Fogpruf, it is stated, completely frees goggles of dirt and grease and prevents fogging of lenses, permitting clear vision at all times, thereby promoting worker comfort, safety, and efficiency and helping to prevent accidents. Fogpruf is available in liquid or paste form in convenient applicator vials.

British Standards Institution, of 28, Victoria Street, London, S.W. 1, notify an amendment to the Standard Specification for internal combustion engines excluding those of the carburettor type. This revises clause 4, Rated Output and Speed, the basic temperature for the rating of the engine now being raised from 62° F. to 85° F. Figures are given for the reduction of the rated output of the engine if the operating conditions depart from the standard conditions of barometric pressure and ambient (engine room) pressure. A further deduction from the rated output of the engine is provided for where combinations of high atmospheric temperature and humidity agree. The tolerance on fuel consumption as specified in clause 10 of the specification has also been modified. A new specification of which particulars are also announced relates to non-ferrous pipes and piping installations for land boilers. Part 1 applies to the general and detailed construction of the copper pipework connecting a land steam boiler to engine turbine or industrial plant and to all auxiliary pipework, together with individual pipes and fittings forming parts of such installations. It lays down limits of pressure and temperature for the use of copper piping installations and bronze castings used in connexion with such installations.

Allis-Chalmers Manufacturing Co., of Milwaukee (British Office: Commercial Road, Totton, Southampton), have issued a bulletin on rotary dryers and coolers. The dryers described are designed for fast efficient moisture removal from granular materials. Available in a variety of sizes, these units can be stacked up to four high for maximum production output. Good steam circulation and the use of heavy steel sifter blades assure uniform drying, it is stated. With the atmospheric coolers excess heat from dried granular materials can be quickly but safely removed. Multiple stacking is also possible with this unit, permitting a combination cooler-dryer installation. In addition to capacity and dimension tables the bulletin contains recommendations for information required to assure successful application of coolers and dryers. These factors include: Percentage of moisture in material entering and leaving unit, temperature at which dried material can be used, weight per cubic foot, and specific heat of material to be dried. Another bulletin recently released by the company is a buying guide to their products for the process industries. This 16-page booklet, which is well illustrated, features a series of short notes aimed at helping the reader in making preliminary selection of any of a complete range of industrial products including motors, motor controls, power generation and distribution equipment, vibrating screens, feeders, washing equipment, pumps, crushers, grinding and roller mills, pyro-processing machinery, blowers and compressors, V-belt drives, electronic heating, and welding equipment. Leading off with suggestions of primary decisions which must be made by the prospect in narrowing down the problem, each "buying guide" describes how the company is prepared to aid in the proper selection of equipment through the wide range it offers.

Leyland Motors, Ltd., of Leyland, Lancs, in the July issue of their house organ have an article on the scrubbing of exhaust gases. The following are extracts:—Exhaust gas fumes have until now prevented full utilization of motor lorries in mines. At the Mount Morgan gold mine, Queensland, the

difficulty has been overcome and as a result electric locomotives have been superseded by Leyland vehicles operated by Warry Brothers. At 574 ft. below ground level the vehicles operate from an open-cut along a drive 14½ ft. by 12½ ft. and 230 ft. long, to an ore pocket commanding a jaw-crusher 75 ft. below. The first step to keep carbon monoxide down to a minimum was to lay down that oil engines should be employed. Secondly, abundant ventilation was provided, and thirdly, exhaust gas scrubbers were fitted to the vehicles. For ventilation a 3-ft. diameter fan, displacing 56,000 cu. ft. of air a minute, was installed near the ore pocket and in addition a 20-in. diameter multi-vane fan has been provided at the dead end, at right angles to the drive, into which the lorries run to turn. Should the fans fail red lamps hung along the full length of the drive automatically light up and an electric siren sounds.

The basis of the exhaust gas scrubber is a mild-steel cylinder 3 ft. high and 1 ft. in diameter, coned at each end, with a 2-in. diameter exhaust pipe leading out of the top and having a draining plug at the bottom. A 2-in. inlet pipe is led into the bottom of the scrubber through a U-tube section. The scrubber is filled with water to a depth of 12 in., the level being controlled by an overflow plug, and an air space of 2 in. is left over the water. Over the air space is 14 in. of hard furnace coke, compressed between two screen plates with ½-in. diameter holes. When the scrubber was first constructed no top plate was included, with the result that the hand-packed coke broke down rapidly and caused excessive wear on the sides of the cylinder, accentuated by corrosive action. Sisal hemp has since been placed above the top plate further to strain the gases. The top cone of the scrubber is removable to replace the coke and clean the unit. The scrubber is mounted upright at the side or rear of the cab, with the exhaust outlet facing rearwards.

Numerous samples of the scrubbed exhaust gases have been taken under varied conditions of service and tested. The carbon monoxide content has been found to vary between 0·028 and 0·13%. On one occasion as much as 0·21% was found in the case of an engine placed in the workshop for overhaul, thereby proving that the tests can reveal mechanized defects before the carbon monoxide builds up to dangerous proportions. British mine regulations permit a maximum of 0·5% of monoxide in exhaust gas; the U.S. Bureau of Mines permit 0·25%. Men can work unharmed in air containing not more than one part of monoxide in 10,000 parts of air. Tests of the air in the mine have shown a concentration of 0·2 to 0·9 parts, the variation being due to incomplete mixing of the exhaust gases with the circulating air.

United Steel Companies, Ltd., of 17, Westbourne Road, Sheffield, announce the composition of a technical mission to the Caribbean. The mission is under the leadership of Mr. G. R. Bolsover, director and chief metallurgist of Samuel Fox and Co., Ltd. (branch of The United Steel Co.'s Ltd.), and the following are the other members :—Mr. E. E. Allen (Industrial and Engineering Development Association), Mr. D. H. Carter (Head Wrightson Processes, Ltd.), Mr. A. G. Ellison (Yorkshire Copper Works), Mr. E. T. Forestier (Newman, Hender and Co., Ltd.), Mr. E. F. E. Howard (Hayward, Tyler and Co., Ltd., also representing other firms), Mr. F. Kenyon (Wm. Kenyon and Sons, Ltd.), Mr. H. Martin (Murex Welding Processes, Ltd.), Mr. E. Pritchard (British Oilfields Equipment Co.), and Mr. G. H. Thorne (Dawnays, Ltd.). An invitation to visit the oilfields was extended by one of the petroleum companies to the United Steel Co.s, Ltd., who for many years before the war were engaged in special research work for the production of steels to resist the many difficult conditions existing in the drilling and refining of petroleum. Further consideration showed that problems other than metallurgical ones might be encountered during such a visit and convinced the company that the mission should more correctly be made representative of other interested industries. Accordingly member firms of the Council of British Manufacturers of Petroleum Equipment were approached and their co-operation was readily forthcoming. Whilst all the personnel of the present mission are members of the Council the mission is purely a private one organized and financed by the members themselves. It is well known that before the war this valuable business was almost entirely an American monopoly and equipment to the value of many millions of pounds is purchased annually by the oil companies. The importance of the visit, therefore, cannot be stressed too greatly since its successful conclusion must have far-reaching results on our export trade. Every support is being accorded the mission by the Ministry of Fuel and Power and the Export Development Department of the Board of Trade and on arrival in Trinidad a public reception will be held by the Governor-General. The President of Venezuela has also expressed a wish to receive the members.

British Thomson-Houston Co., Ltd., of Rugby, announce that Mr. H. Warren, who is managing director of the company, has received the degree of D.Sc. (*Honoris Causa*) from Birmingham University in recognition of his work in industrial research and technical education. The company also issue some particulars regarding their representation in South America. They state that electrical plant and equipment is expected to be in even greater demand than hitherto throughout this vast continent and that they are now directly represented in Argentina, having opened offices at Avenida Pte. R. Saenz Peña 636, Buenos Aires. These offices, under the charge of Mr. J. G. Boddy, are close to those recently opened in the same city by the Metropolitan-Vickers Electrical Export Co., Ltd., thereby facilitating co-ordination and co-operation between these two subsidiaries of Associated Electrical Industries, Ltd. Under Mr. Boddy's direction the new office will be the focal point of the company's sales organization in Southern South America and from it will be promoted, in course of time, a complete organization for the sales and service of B.T.H. products throughout the whole area. An interesting historical note is that Mr. J. G. Boddy's father, Mr. W. J. Boddy, was responsible, on behalf of the B.T.H. Co. for setting to work one of the earliest railway electrifications in Argentina—*viz.*, the first suburban lines of the Central Argentine Railway to be converted to electric traction. This was followed by many other orders in connexion with the electric power system and industries of Argentina and Uruguay. Mr. Boddy goes to Buenos Aires with a wide practical engineering experience. At the beginning of the war he was loaned by the B.T.H. Co. to Magnesium Elektron, Ltd., in connexion with the big extensions being made to the magnesium plant at Manchester. When during the

war it was decided to build a factory at Las Vegas, Nevada, for the production of magnesium on a scale 10 times greater than the capacity of the plant in England, with the latest extensions to which Mr. Boddy had been associated, he was loaned to the consulting engineers as electrical expert. He was subsequently appointed chief electrical engineer of this undertaking.

National Gas and Oil Engine Co., Ltd., of Ashton-under-Lyne in their *National Bulletin* for July reproduce some notes on self-contained 50-kW. generating sets for overseas. The following are extracts : During the closing months of the German war and since there has been a marked tendency on the part of British Government departments to employ oil-engined plant groups of a self-contained type. These have all accessories, as well as the main engine, carried on a fabricated baseplate ; this permits easy installation in a building constructed by locally available labour and employing a mass foundation block which is a simple weight-bearing cube with no recesses, such as are often needed for lubricating-oil tanks, flywheel races, or pipe channels. One of the latest orders for sets of this type is for 23 generating outfits. The engine is a six-cylinder unit rated at 100 b.h.p. (on the 12-hour basis) at 750 r.p.m. and having aluminium-alloy pistons. It is of the opposed-valve clerestory combustion chamber variety, with the bedplate rigidly mounted at eight points upon bearer rails welded to the main longitudinals of the fabricated baseplate ; the last-named also carries the radiator, generator, and electrical control and instrument board. When facing the front of the engine the radiator is on the left. It contains elements for both cooling water and lubricating oil, with thermometers in the respective circuits, and has a six-bladed fan driven by two V-belts from the free end of the crankshaft. Power is taken from the distribution drive of the engine for the water-circulating pump and by flat belt there is a drive for the Foundrometer combined revolution counter and tachometer. Above the engine is mounted the exhaust silencer, also a Vokes air cleaner. Above the flywheel is the petrol starting engine, which itself is set in motion by hand. The drive to the main engine's flywheel is by gear. On top of the alternator carcass is a platform for the operator, when starting the auxiliary engine. The alternator is rated at 50 kW. (440–220 volts) and is a 50-cycle three-wire machine with a tandem exciter. Above it, supported by angle-steel stanchions, is the 50-gallon fuel service tank and underneath it the tool-box. Tank replenishment is by hand-operated semi-rotary pump, whilst in the outlet from the tank there is a large dirt-collecting sump with a drain cock. In the electrical group on the right-hand end of the set is the Dorman and Smith switchgear and provision for connexion of outgoing cables. A Foster static balancer is mounted on the baseplate at the back of the engine, near to the radiator. Any of these sets can be transported to a working site with comparative ease and needs only seven bolts on each side to secure it to the weight-bearing floor.

Holman Bros., Ltd., of Camborne, have issued a new catalogue describing "Drilrigs." These are available for driving tunnels up to 19 ft. by 15 ft., models for one, two, and four drills being offered. The makers point out that in tunnelling the rigging up of the usual mountings takes considerable time and involves much physical effort. With the new machine both time and labour required are much reduced. The Drilrig is not jacked between floor and roof ; it is merely run up to the face and clamped to the rails. Even with the largest (for four drills) it is possible to commence drilling within a quarter of an hour, compared with some

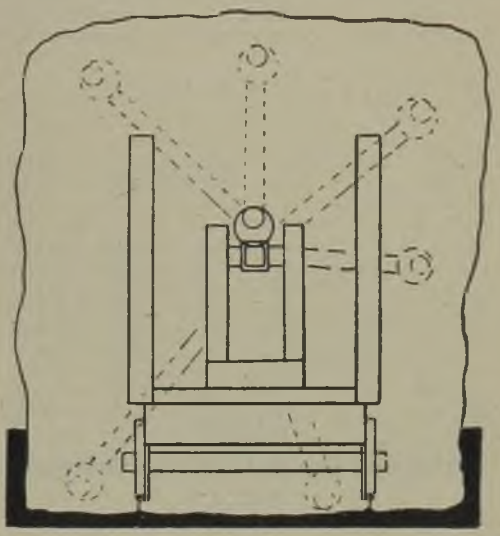


Fig. 1.

two hours which it would take to rig columns etc. in a large heading.

Drilrig-1 (Fig. 1) is suitable for a face up to 8 ft. by 8 ft., the drill recommended being one not exceeding 3½-in. bore. The drill is carried in a centre line mounting which can be rotated around the boom through 360°. The drill clamp itself can also be rotated so that holes may be drilled anywhere in the face when the boom is correctly positioned. When the boom is tilted upwards it is clamped in

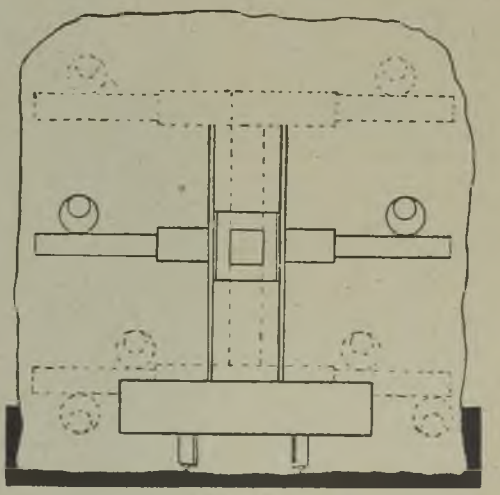


Fig. 2.

position and a bar is inserted underneath it to assist in keeping the drill steady when in operation. The carriage is ready for moving from the face when the boom is adjusted to the horizontal and track clamps and air and water hoses to the main lines have been disconnected.

Drilrig-2 (Fig. 2) is also designed for operation on a face up to 8 ft. by 8 ft., but is for two drills. Standard cradle-mounted drills up to 3½-in. bore

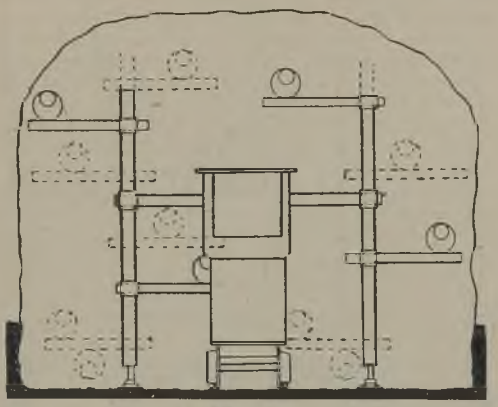


Fig. 3.

may be used, the drills being mounted on a standard cross column carried on the front of the boom. The column can be rotated through 180° to bring both drills under the column. The balanced boom can be dipped or tilted so that the face may be drilled as desired and it can be clamped in any position.

Drilrig-4 (Figs. 3 and 4) is suitable for a face up to 19 ft. by 15 ft. and for four drills. Drifters with a bore up to 4 in. diameter can be efficiently operated. The two extension-type vertical columns secured to the boom by a standard cross column are adjusted so that they rest on the tunnel floor, the drills being carried in standard clamps and cross arms. As will be seen from the illustration (Fig. 4) wooden platforms, mounted on the cross column, are provided for operators of the upper drills. The vertical lift of the balanced boom with columns, machines, and platforms is 3 ft. Mounted on top of the carriage the drill-steel tray is within easy reach of upper and lower operators and is large enough to carry sufficient for a normal round. The unit can be made ready for moving very quickly. The cross column is swung lengthways to the carriage to its full extent; cross arms with drills and hoses connected are also swung in line with the carriage and then hoses to main pipe-lines are disconnected and track clamps released.

International Combustion, Ltd. (Grinding, Screening, and Filtering Division), of 19, Woburn Place, London, W.C. 1, report the following among orders recently received :—Home : Six L.M.13 Lopulco mills and 24 L.M.12 Lopulco mills for grinding coal containing varying moisture contents to an average fineness of 75% *minus* 200 mesh B.S.S. The total capacity of these mills is approximately 250 tons per hour. Mills are equipped with hot air drying in the circuits. Four L.M.12 Lopulco mills, for grinding Morocco phosphate. Moisture, 2% ; feed, ¾ in. down ; fineness, 90% *minus* 100 mesh B.S.S. ; total capacity approximately 90 tons per hour. One 5-roller Raymond mill for grinding lithopone. Feed, 1 in. down ; fineness, 99·97% *minus* 300 mesh B.S.S. ; capacity, 3,000 lb. per hour. One 5-roller Raymond mill for grinding slate to 99% *minus* 300 mesh B.S.S. and seven Raymond laboratory mills. One 6 in. dia. by 36 in. cyl. Hardinge conical ball-mill, with reverse current air classification system for barytes. Moisture less than 0·5% ; feed, ⅜ in. down ; fineness, 90% *minus* 300 mesh B.S.S. ; capacity, 2½ tons per hour. Two 3 ft. by·

Fig. 4.

4 ft. type 38 Hum-mer electric screens ; two 3 ft. by 5 ft. single-surface type 38 Hum-mer electric screens for crushed stone (separation at $\frac{1}{8}$ in.), and one Junior Hum-mer screen. One Ro-Tap testing sieve shaker. Five V.15 Syntron electric vibrators with controllers ; four V.55 Syntron electric vibrators with controllers ; one VP.15 Syntron packer ; one F.1 Syntron feeder ; one F.2 Syntron feeder, and one F.M.1-25 Syntron feeder machine. Two 8-disc Rovac disc filters for ground-nut oil. Three 2-in. Vacseal pumps ; one 2-in. Vacseal pump to deliver pottery slip (28-oz. to the pint) against a total head of 15 ft. ; one 2-in. Vacseal pump to deliver 6,000 gallons per hour of slurry containing 6 tons per hour of sand against a total head of 30 ft., and one 4-in. Vacseal pump to deliver 40–45 tons of sand $\frac{3}{16}$ in. *plus* 20,000 gallons of water per hour against a total head of 60 ft. For abroad : One Baby Raymond roller mill and nine Raymond laboratory mills. Two type B Hardinge constant weight feeders for free flowing chalk having a grain size from 0 to $\frac{1}{2}$ mm. and of a specific gravity of 1·3 and capacity limits of 3 tons per hour maximum to $\frac{3}{4}$ ton per hour minimum. Two Ro-Tap testing sieve shakers ; one V.15 Syntron electric vibrator with controller ; one V.55 Syntron electric vibrator with controller, and one VP.125 Syntron packer. One 2-in. Vacseal rubber-lined pump for 12,000 gallons per hour of metallurgical pulp having a specific gravity of 1·25 against a total head of 20 ft. (solids all *minus* 10 mesh) and one 5-in. Vacseal pump for waterworks.

Metal Markets

Copper.—The copper market has continued to display a rather unsettled aspect during the past month. The strikes of artisans at the big Northern Rhodesian properties, which resulted in the mines being put on a care-and-maintenance basis, have since been settled, although the peace is undoubtedly something of an uneasy one. It was agreed to put the matter in the hands of an arbitrator to be nominated by the Secretary of State for the Colonies and it is to be hoped that a favourable solution to the problem will be reached, since supplies, so far as British consumers at any rate are concerned, are anything but good. As it is, the hold-up in operations in Rhodesia has resulted in something like 15,000 tons of copper being lost. In the meantime, in order to avert as far as possible any crisis in supplies to this country later in the year, the Government has arranged for 148,500 tons of brass scrap and secondary ingots to be shipped to the United States and Canada for refining on a toll basis. Since this material is of the 70/30 type it is to be assumed that around 100,000 tons of virgin metal will ultimately be returned to Britain. With regard to the acquisition of supplies from Chile, the Ministry of Supply is reported to have purchased some 15,000 to 20,000 tons at 15·75 cents per lb. f.o.b. Chile. Calculated on a sterling basis this copper, which is for fourth quarter delivery, will cost about £87 10s. per ton f.o.b. Consumption figures issued recently show that copper consumed in the United Kingdom during July increased over that consumed in June.

United Kingdom official maximum price of electrolytic copper, August 31, £84 a ton, delivered.

Tin.—Despite an announcement that a favourable decision from the Empire producers' point of view regarding tin prices would be published shortly the official maximum quotation in the United Kingdom has remained unchanged throughout the month. An agreement was reached between Bolivia and America on a price basis of 62½ cents per lb. f.o.b., with a retrospective bonus of 1 cent per lb. from January to June and 3 cents per lb. for the remainder of the year, provided yearly output exceeds 17,600 tons. It remains to be seen whether this agreement will have any effect on the price in Britain. It has, however, been stated that the British Government may reach a decision with the Nigerian producers whereby the latter would be paid £337 a ton f.o.b. Nigeria for their output. From the point of view of the consumer in the United Kingdom this would be equal to a delivered price of over £360 a ton. Figures issued by the Ministry of Supply reveal that stocks at the end of July fell to 13,156 tons from 14,419 tons on June 30. Production for the month was 2,706 tons and consumption 2,135 tons. Deliveries totalled 4,037 tons, of which 2,203 tons went to home users and 1,834 tons overseas.

United Kingdom official maximum price on August 31, 1946 : £300 a ton, delivered.

Lead.—The situation in lead has remained as unsatisfactory as hitherto. Consumers have been able to obtain barely 50% of their requirements and with the outlook as discouraging as it is at the moment informed quarters are of the opinion that consumers' needs will not be fully met until two or even three years have elapsed. The United States has negotiated for the supply of over 20,000 tons of Mexican lead, to be spread over three months, at a price of 9·50 cents per lb. f.a.s. On a sterling basis this is equivalent to about £52 15s. per ton.

United Kingdom official maximum price for soft foreign lead, August 31, £55 a ton, delivered.

Zinc.—Consumers of zinc continue to be able to cover their needs fairly adequately, although there is a steady attrition of stocks. The difficulty at the moment is not so much a shortage of concentrates as a limitation in smelting capacity and in this connexion it is encouraging to note that Continental smelters are beginning to get on their feet once again. The present low level of production at the Ruhr coal mines is, however, holding up operations somewhat. Meanwhile world prices continue to display an upward tendency—the American export quotation is now stated to be in the neighbourhood of 10 to 10·50 cents per lb. Gulf Ports, which in the United Kingdom would be equal to more than £60 a ton on a delivered works basis.

Mean United Kingdom price g.o.b. foreign zinc, August 31, £50 a ton, delivered, duty paid.

Iron and Steel.—With rising costs both in rail charges and fuel prices it was for some time apparent that an upward revision in iron and steel quotations was due. This revision was finally made on August 14, when pig-iron was advanced by 4s. 6d. to 6s. 6d. per ton and heavy steel by about 5s. These advances have undoubtedly only gone part of the way in covering steel makers' higher costs of production, so that it will be necessary to institute more efficient working methods in order to meet the new position. In the face of increasing home and export demand, which will be little affected by these moderate price changes, it is unfortunate to note that British steel production during the past month or two has shown a certain falling off.

The average weekly output during July amounted to 226,000 tons, as compared with 239,800 tons in June and 261,800 tons in May. This state of affairs has been enhanced not so much by holiday influences as by a shortage of fuel supplies. All sections of the industry are extremely busy and likely to remain so for some considerable time.

Iron Ore.—There has been little change here during the past month. With home production down imports of good-quality foreign material have had to be maintained, owing to the present strong demand from the iron and steel industry.

Antimony.—The position at the moment is still one in which demand runs ahead of available supplies. Smelters in this country are loth to pay the high prices ruling for ore on the Continent at present and a certain difficulty in ore supplies is evidenced. English regulus is officially held at £125 a ton for 99% material.

Arsenic.—With white arsenic in short supply leading interests have maintained their quotations at about £38 6s. 3d. per ton, ex store, for 99% to 100% in 10-ton lots.

Bismuth.—The current price is unchanged at 9s. per lb. for commercial quantities.

Cadmium.—Sellers in this country continue to ask around 7s. 6d. per lb. for what supplies of cadmium they have to offer.

Cobalt Metal.—Quotations show no change at 9s. to 9s. 1d. per lb.

Cobalt Oxides.—Black and grey oxides continue to be quoted at 8s. 7½d. and 9s. 5½d. per lb. respectively.

Chromium.—Some difficulty in deliveries is reported owing to a tightness in supplies at the moment. For 98% to 99% metal 4s. 5d. to 4s. 8d. per lb., however, remains the current quotation.

Tantalum.—Leading interests in this country continue to quote £18 to £19 per lb.

Platinum.—With the approach of the Christmas buying period in the jewellery trades and as a result of increased prices in America, the platinum quotation in Britain was advanced to £20 15s. per troy oz. about the middle of the month. For what material is available for export about £23 an oz. is asked.

Palladium.—No change has been noted in the palladium price following the advance in platinum and dealers here continue to ask £5 15s. to £6 an oz.

Osmium.—Supplies remain very much on the short side with prices nominal at around £18 to £20 an oz.

Iridium.—For sponge and powder about £34 to £35 an oz. remains the current quotation.

Tellurium.—Steady conditions have prevailed throughout the month with the price unchanged at 7s. per lb.

Selenium.—Leading interests continue to ask 8s. 6d. per lb.

Tungsten Ore.—Following decontrol by the Government the market has once again returned to free trading conditions, although it remains necessary to obtain import licences. For the time being only a moderate interest is being displayed by buyers with the current price in the region of 62s. 6d. to 67s. 6d. per unit of WO_3 c.i.f. for the usual 65% concentrates.

Manganese Ore.—In a world market which is somewhat short of supplies at the moment consumers in Britain appear able to cover their requirements adequately Selling prices in this country are officially held at 1s. 2d. per unit c.i.f. on the basis of pre-war freight and insurance rates. Buying prices are 1s. 2¾d. to 1s. 4¾d. per unit on the same basis.

Aluminium.—Suppliers of aluminium are easily able to cater for the current requirements of consumers, whilst there is also a good deal of secondary material which has to be disposed of, especially in view of the fact that it is no longer possible to export tonnages of the latter. For 99% virgin metal £67 a ton, delivered, remains the current quotation.

Copper Sulphate.—Sellers here continue to quote £33 10s. per ton, f.o.b. less 2%, for 98% to 100% material.

Nickel.—There have been few fresh developments during the past month, demand for nickel from the iron and steel industry having been well maintained. The price remains at £190 to £195 a ton.

Chrome Ore.—Metallurgical ore on the international market remains in somewhat short supply at the moment, but consumers in Britain appear fairly well able to cover their requirements at the ruling official price of £10 a ton for both Rhodesian and Baluchistan metallurgical grades.

Quicksilver.—As from August 23 Government control of quicksilver ceased, although, ostensibly to permit them to dispose of substantial stocks held in the country, the Government has ruled that it will remain necessary to obtain import licences. To date sellers in Britain have made no change in their quotations, which remain at £30 to £31 5s. per flask, ex store, according to quantity.

Molybdenum Ore.—No changes have occurred during the past month and leading interests maintain their price at 42s. 6d. to 45s. per unit of MoS_2, f.a.s.

Graphite.—The current quotation remains a purely nominal one.

Silver.—During August the United States Treasury raised its buying price for domestic silver to 90½ to 91 cents per oz. and that for foreign metal to 90⅛ cents per oz. As a result the United Kingdom quotation was raised from 44d. to 55½d. per troy oz. on August 6.

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)	72	15	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)	20	15	0
Silver		4	7½
Gold	8	12	3
Wolfram (Buying, f.o.b.)	3	2	6
,, (Selling, Delivered)	3	7	6

Statistics

TRANSVAAL GOLD OUTPUTS

	July*		August*	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield oz.
Alpine (Barberton)	5,612	749	—	—
Blyvooruitzicht	34,000	28,874	30,000	25,548
Brakpan	110,000	£189,215	99,000	£165,940
City Deep	95,000	23,512	75,000	18,565
Cons. Main Reef	219,000	29,540	220,000	30,365
Cons. Murchison (T.V.L.)	7,500	£20,627	7,600	£20,840
Crown Mines.....	278,000	60,501	280,000	59,707
Daggafontein	154,000	£368,208	154,000	£368,213
Dominion Reefs	25,000	—	—	—
D'rb'n Roodeport Deep	188,000	34,024	178,000	32,953
East Champ D'Or	30,000	£47,759	27,000	£48,281
East Daggafontein	94,000	£203,884	94,000	£203,742
East Geduld	164,000	45,770	162,000	45,377
East Rand P.M.....	214,000	42,815	216,000	44,040
Geduld.....	110,000	23,284	110,000	23,231
Geldenhuis Deep	67,000	7,351	64,000	7,691
Glynn's Lydenburg ...	10,300	2,742	10,300	2,680
Government G.M. Areas	236,000	£348,761	228,000	£349,978
Grootvlei Proprietary .	168,000	43,267	168,000	43,173
Langlaagte (In Liq.) ..	48,000	£64,722	36,000	£50,483
Luipaards Vlei	88,000	17,965	87,000	18,029
Marievale Consolidated.	57,500	17,256	55,000	16,501
Modderfontein B	62,000	9,346	55,000	8,098
Modderfontein Deep ...	32,500	5,336	30,500	4,989
Modderfontein East ...	134,000	20,101	128,000	19,201
New Kleinfontein	102,000	15,271	96,000	14,722
New Modderfontein....	90,000	11,765	90,000	11,872
New State Areas	115,000	£179,612	117,000	£178,964
Nigel Gold	43,000	10,858	41,000	10,722
Nourse	72,000	13,689	63,000	11,979
Rand Leases.....	186,000	£305,610	182,000	£297,097
Randfontein	372,000	£398,056	365,000	£393,676
Rietfontein Consolid't'd	28,000	5,704	28,000	5,706
Robinson Deep	100,000	19,422	84,000	16,759
Rose Deep	74,000	11,169	72,000	10,975
Simmer and Jack	143,000	25,914	131,000	24,177
S. African Land and Ex.	90,000	£157,221	89,000	£150,600
Springs	123,500	£193,940	122,500	£185,592
Sub Nigel	69,000	34,313	66,500	33,570
Transvaal G.M. Estates	24,000	4,884	24,100	5,358
Van Dyk Consolidated .	103,000	20,419	90,000	16,923
Van Ryn	59,000	£57,051	53,000	£55,567
Venterspost Gold.....	112,000	23,326	112,000	23,420
Village Main Reef	24,500	£34,059	24,700	£34,345
Vlakfontein.....	24,000	10,078	22,500	9,429
Vogelstruisbult.....	76,000	18,096	75,500	18,494
West Rand Consolidated	223,000	£350,350	225,000	£349,748
West Springs	59,000	£107,441	55,000	£91,800
Western Reefs	78,000	£163,134	79,000	£164,981
Witw'tersr'nd (Knights)	82,000	£97,270	82,000	£96,526
Witwatersrand Nigel ..	9,200	£22,656	9,400	£23,176

* Gold at 172s. 6d. per oz.

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	1,047,599
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.
August, 1945.....	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
January, 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
July.....	1,024,830	22,769	1,047,599

NATIVES EMPLOYED IN THE TRANSVAAL MINES

	Gold Mines	Coal Mines	Total
August 31, 1945.....	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
July 31	299,599	27,671	327,270

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.	£
Aug., 1945.	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 5	10 4	2,514,880
Feb.	4,464,000	35 2	25 3	9 11	2,225,680
Mar.	4,224,600	34 6	28 0	6 6	1,364,982
April.....	4,744,400	35 1	25 2	9 11	2,356,640
May	5,007,600	34 11	24 11	10 0	2,506,332
June	—	—	—	—	2,436,942
July	—	—	—	—	2,447,347

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To July 20		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	35,750*	6,002	7,105
Electrolytic Zinc	9,985	614	3,229
New Broken Hill	3,584	387	620
North Broken Hill	37,105	7,094	7,340
Zinc Corp.	38,306	6,413	7,573
Rhodesia Broken Hill ..	—	—	—

* Six weeks to Aug. 10.

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	45,958	7,711
June	46,998	7,772	47,245	7,997
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

	July		August	
	Tons.	Oz.	Tons.	Oz.
Bushtick	—	—	—	—
Cam and Motor	28,800	£42,426	23,000	£42,936
Globe and Phœnix	6,100	3,042	—	—
Rezende	20,900	£20,939	20,300	£20,488
Sherwood Starr	6,200	£7,124	—	£4,226
Thistle-Etna	6,200	898	6,400	883
Vubachikwe	2,900	£5,157	3,000	£5,523
Wanderer Consolidated	35,000	3,078	35,000	3,031

WEST AFRICAN GOLD OUTPUTS

	July		August	
	Tons	Oz.	Tons	Oz.
Ariston Gold Mines	22,000	£63,964	22,000	£64,042
Ashanti Goldfields	16,500	17,345	16,500	17,351
Bibiani	22,500	6,429	22,500	6,430
Bremang	—	1,742	—	—
Gold Coast Main Reef	9,261	3,954	9,118	4,080
Konongo	10,110	4,222	9,910	4,267
Marlu	25,640	2,173	20,965	1,945
Taquah and Abosso	25,000	6,005	25,000	6,008

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	50,987
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 July 23		To August 20	
	Tons	Oz.	Tons	Oz.
Boulder Perseverance	7,204	1,866	9,108	2,433
Central Norseman	9,123	3,845*b*	—	—
Comet Mine	—	—	—	—
G.M. of Kalgoorlie	12,369	3,203*b*	—	—
Golden Horse Shoe	—	—	—	847*d*
Gt. Boulder Prop.	30,129	6,896	32,462	7,293
Kalgoorlie Enterprise	4,063	1,404	4,272	1,458
Lake View & Star	39,960	10,667	46,233	11,095
Morning Star (G.M.A.)	—	—	602	414
North Kalgurli	8,926	2,722	10,946	3,596
Paringa	8,755	1,969	8,473	1,561
Phœnix Mine	—	—	—	—
Sons of Gwalia	4,546	1,374*b*	—	—
South Kalgurli	6,548	1,587	8,570	1,035
Tindals Gold	—	—	—	—
Waronga (Emu)	—	—	—	—
Wiluna	12,438	2,751*a*	—	—
Yellowdine	—	—	—	—

a July. *b* 4 weeks to August 6. *d* August.

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	238,216	9,171,316
May	217,556	8,375,906	240,339	9,253,052
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 $
July, 1945	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
May	630,000	149,549	27,904	5,776,929
June	597,494	149,785	28,436	5,779,609

CANADA'S LEADING MINERAL PRODUCTS

		April.* 1946	May.* 1946
Asbestos	Ton	47,601	52,833
Cement	Brl.	1,002,375	1,535,974
Clay products	$	863,035	1,001,126
Coal	Ton	1,363,552	1,395,599
Copper	Lb.	31,886,954	30,993,228
Lead	Lb.	30,864,007	30,050,050
Nickel	Lb.	18,479,626	14,733,775
Silver	Fine oz.	1,055,917	1,037,921
Zinc	Lb.	41,594,847	40,904,913

* Subject to revision.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA

	July		June	
	Tons	Oz.	Tons	Oz.
Champion Reef	9,890	4,656	9,120	3,434
Mysore	15,958	4,716	10,633	4,715
Nundydroog	13,500	3,662	13,510	3,900
Ooregum	8,113	2,208	8,585	2,051

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	July		August	
	Tons	Value £	Tons	Value £
Blackwater (N.Z.)	1,712*d*	539*	1,464*b*	529*
British Guiana Cons.	—	832*	—	1,022*
Emperor Mines (Fiji)	—	—	—	—
Frontino Gold (Colombia)	7,710	35,055	8,060	37,040
Geita Gold (Tanganyika)	8,570	1,441*	7,431	1,501*
Martha Gold (N.Z.)	10,323*d*	2,387* 23,236†	11,711	2,773* 23,375†
NewGoldfieldsofVenezuela	—	—	—	—
Rosterman (Kenya)	3,800	1,121*	—	—
St. John d'el Rey (Brazil)	—	112,400	—	109,400
Tati Goldfields (Bech'land)	4,700	299*p*	4,800	222*p*
Victoria Gold (Vic.)	—	852**d*	—	1,114**c*
Yukon Consolidated	—	$182,000	—	—

* Oz. Gold. † Oz. Silver.
b Period to Aug. 9. *d* Period to July 20. *p* Profit. *c* To Aug. 6,

OUTPUTS OF NIGERIAN AND OTHER TIN MINING COMPANIES

In Long Tons of Concentrate

	June	July	Aug.
Amalgamated Tin Mines	465	460	540
Bisichi	32	31½	—
Ex-Lands	50	45	—
Fabulosa	—	—	—
Geevor	41	43	—
Gold and Base Metals of Nigeria	—	—	—
Jantar Nigeria	40	42	35
Jos Tin	—	—	—
Kaduna Prospectors	8	7	6½
Kaduna Syndicate	33	—	42
Kagera	—	—	—
Kamunting	—	—	62
Keffi Tin	57	44	53
Naraguta Tin Mines	108*a*	20½	—
Naraguta Karama	50½*a*	16	—
Naraguta Extended	20*a*	7½	—
Nigerian Consolidated	—	—	—
Pahang Consolidated	—	17	—
Rahman Hydraulic	—	—	—
Rawang Concessions	—	37	32½
Rawang Tin	—	—	24½
Ribon Valley	—	—	—
Rukuba Tin Mines	6*a*	1½	—
South Bukeru	30*a*	8½	—
Tin Fields of Nigeria	15	3½	—
United Tin Areas	—	—	—

(*a*) Three months to June 30.

QUOTATIONS OF OIL COMPANIES' SHARES

Denomination of Shares £1 unless otherwise noted

	July 9, 1946			Aug. 7, 1946			Sept. 10, 1946		
	£	s.	d.	£	s.	d.	£	s.	d.
Anglo-Ecuadorian	1	19	3	1	18	3	1	17	9
Anglo-Egyptian B.	4	1	3	4	1	3	3	18	9
Anglo-Iranian Ord.	5	5	0	5	0	0	4	15	6
,, ,, 1st Pref.	1	16	9	1	17	0	1	16	9
,, ,, 2nd Pref.	2	0	0	2	0	3	1	18	9
Apex Trinidad (5s.)	1	13	0	1	12	9	1	12	0
Attock, India	2	17	0	2	12	3	2	11	3
British Borneo Pet. (6s.)	1	3	6	1	5	3	1	11	9
British Controlled ($5)		4	6		4	6		4	6
,, ,, Pref. (,,)		13	9		13	3		13	6
Burmah Oil	3	11	3	3	11	3	3	11	0
,, ,, Pref.	2	3	6	2	3	3	2	1	9
Canadian Eagle Ord.	1	13	9	1	13	3	1	11	9
,, ,, 7% Pref. ($3)		13	3		13	3		13	3
,, ,, 8% Pref.	1	14	3	1	13	3	1	12	6
Kern (3s. 4d.)		5	6		5	3		5	6
Lobitos, Peru	3	8	0	3	5	6	3	5	9
London and Thames Haven		15	6		15	0		17	3
Mexican Eagle Ord. (4 pesos)		13	9		13	3		13	3
,, ,, 8% Pref. (4 pesos)		14	0		13	6		13	6
,, ,, 7% Pref. (,,)		8	9		8	9		8	9
Phœnix Roumania		3	3		3	3		5	9
Premier (Trinidad) (2s.)		—			—			4	3
Royal Dutch (100 fl.)	34	0	0	34	10	0	33	0	0
Shell Transport Ord.	4	13	9	4	13	0	4	10	9
,, ,, 5% Pref. (Units)	1	9	3	1	9	0	1	8	6
,, ,, 7% Pref.	1	18	9	1	18	9	1	18	3
Steaua Romana		5	9		5	3		5	9
Trinidad Central (10s.)	1	5	3	1	2	0	1	3	0
Trinidad Cons. (4s.)		—			—			7	0
Trinidad Leaseholds	5	16	9	5	13	9	5	17	6
Trinidad Pet. Dev.	5	3	0	4	18	0	5	2	6
Ultramar (10s.)	3	16	3	3	14	3	3	8	9
United British of Trinidad (6s. 8d.)	1	6	0	1	6	3	1	9	6
V.O.C. Holding (13s. 4d.)	3	15	0	3	14	3	3	15	6
,, 7% Pref. (13s. 4d.)	3	13	9	3	14	3	3	15	6

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	8½
,, 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:	Aug. 7, 1946.			Sept. 9, 1946.		
SOUTH AFRICA:	£	s.	d.	£	s.	d.
Blyvooruitzicht (10s.)	9	15	0	9	3	9
Brakpan (5s.)		15	0		16	0
City Deep	2	12	6	2	8	9
Consolidated Main Reef	2	5	0	1	17	6
Crown Mines (10s.)	5	17	6	5	15	0
Daggafontein (5s.)	3	6	3	3	2	6
Dominion Reefs (5s.)		5	6		5	6
Durban Roodepoort Deep (10s.)	3	15	0	3	13	9
East Daggafontein (10s.)	2	9	3	2	8	9
East Geduld	9	17	6	9	18	9
East Rand Consolidated (5s.)		15	3		14	6
East Rand Proprietary (10s.)	2	5	6	2	1	3
Geduld	6	10	0	6	15	0
Geldenhuis Deep (15s.)	1	7	6	1	11	3
Government Gold Mining Areas (5s.)	1	5	0	1	3	9
Grootvlei	6	17	6	6	13	9
Klerksdorp (5s.)		6	0		5	9
Lace Proprietary (5s.)	1	5	9	1	4	3
Libanon (10s.)	1	6	3	1	7	9
Luipaards Vlei (2s.)	1	0	9	1	1	0
Marievale (10s.)	1	9	3	1	8	3
Modderfontein B (5s.)		8	6		8	3
Modderfontein East	2	17	6	3	0	0
New Kleinfontein	1	6	3	1	7	6
New Modderfontein (10s.)		8	0		8	3
New State Areas	1	9	6	1	10	0
Nigel Gold (10s.)	1	5	6	1	8	9
Nourse	1	12	6	1	10	0
Rand Leases (10s.)	2	15	0	2	13	9
Randfontein	1	3	9	1	6	3
Rietfontein Consolidated (5s.)		14	0		14	0
Robinson Deep B (7s. 6d.)		14	6		15	0
Rose Deep	1	8	9	1	5	0
Simmer and Jack (2s. 6d.)		11	9		10	6
South African Land (3s. 6d.)	2	1	3	2	1	3
Springs (5s.)		14	0		13	9
Sub Nigel (10s.)	4	17	6	4	13	9
Van Dyk (10s.)		14	9		13	0
Van Ryn (10s.)		15	3		15	0
Venterspost (10s.)	2	6	3	2	2	6
Vlakfontein (10s.)	1	6	9	1	6	3
Vogelstruisbult (10s.)	1	5	6	1	4	0
West Driefontein (10s.)	5	2	6	4	15	0
West Rand Consolidated (10s.)	1	15	0	1	13	9
West Springs	1	3	9	1	2	6
West Witwatersrand Areas (2s. 6d.)	8	1	3	7	8	9
Western Holdings (5s.)	4	8	9	4	12	6
Western Reefs (5s.)	2	3	9	2	0	0
Witwatersrand Gold (Knights)	1	8	9	1	8	9
Witwatersrand Nigel (5s.)		8	0		7	3
RHODESIA:						
Bushtick (10s.)		5	3		4	3
Cam and Motor (12s. 6d.)	1	10	0	1	10	0
Globe and Phœnix (5s.)	1	3	6	1	3	0
Rezende (1s.)		5	9		6	0
Sherwood Starr (5s.)		2	6		3	0
Wanderer		9	0		8	6
GOLD COAST:						
Amalgamated Banket (5s.)		7	3		6	6
Ariston Gold (2s. 6d.)		12	6		12	9
Ashanti-Adowsena (2s.)		2	9		2	6
Ashanti Goldfields (4s.)	3	2	9	3	0	9
Bibiani (4s.)	1	11	6	1	10	9
Bremang Gold Dredging (5s.)		6	0		5	9
Gold Coast Banket Areas (2s.)		3	3		3	3
Gold Coast Main Reef (5s.)		12	6		12	6
Gold Coast Selection (5s.)	1	12	9	1	12	6
Konongo (2s.)		6	6		6	6
Kwahu (2s.)	1	7	6	1	16	3
London & African Mining Trust (5s.)		11	3		10	3
Marlu (5s.)		8	6		7	6
Nanwa		5	0		4	3
Offin River Gold (5s.)		6	0		5	3
South Banket Areas (2s.)		2	9		2	9
Taquah and Abosso (4s.)	1	11	0	1	8	0
AUSTRALASIA:						
Blackwater Mines, N.Z.		11	3		10	6
Boulder Perseverance (4s.), W.A.		9	9		8	9
Gold Fields Aust. Dev. (5s.), W.A.		6	0		5	6
Gold Mines of Kalgoorlie (10s.)		10	3		9	9
Golden Horse Shoe (3s.), W.A.		2	3		2	3
Great Boulder Propriet'y (2s.), W.A.		8	9		8	6
Lake View and Star (4s.), W.A.	1	5	3	1	5	0
Martha Gold (5s.), N.Z.		4	3		4	6
Mount Morgan (2s. 8d.), Q.		7	3		6	9
North Kalgurli (1912) (2s.), W.A.	1	1	0	1	1	0
Paringa (1s.), W.A.		4	3		3	9
Sons of Gwalia (10s.), W.A.	1	8	9	1	7	6
South Kalgurli (5s.), W.A.	1	3	0	1	1	0
Wiluna Gold, W.A.		14	9		13	0

	Aug. 7, 1946.			Sept. 9, 1946.		
INDIA:	£	s.	d.	£	s.	d.
Champion Reef (10s.)	1	5	0	1	5	0
Mysore (10s.)		10	0		10	6
Nundydroog (10s.)		15	0		15	0
Ooregum (10s.)		8	9		8	9
MISCELLANEOUS:						
Fresnillo	2	1	3	1	16	3
Frontino, Colombia	1	8	9	1	8	9
Kentan Gold Areas (10s.), E. Africa		7	9		8	0
New Goldfields of Venezuela (5s.)		1	9		1	6
Rosterman (5s.), Kenya		9	3		8	0
St. John d'el Rey, Brazil	2	1	3	2	3	0
Yukon Consolidated ($1)		9	0		8	0
COPPER:						
Esperanza Copper and Sulphur		2	9		2	3
Indian (2s.)		9	0		7	9
Messina (5s.), Transvaal		18	6		17	0
Mount Lyell, Tasmania		17	6		16	6
Nchanga Consolidated, N. Rhodesia	4	0	0	3	12	6
Rhodesia-Katanga		6	6		4	9
Rhokana Corporation, N. Rhodesia	9	2	6	8	5	0
Rio Tinto (£5), Spain	15	10	0	14	0	0
Roan Antelope (5s.), N. Rhodesia		15	3		14	0
Tanganyika Concessions		14	9		16	0
Tharsis (£2), Spain	1	18	9	1	18	9
LEAD-ZINC:						
Broken Hill South (5s.), N.S.W.	1	6	6	1	7	0
Burma Corporation (9 rupees)		12	6		11	6
Electrolytic Zinc, Tasmania	2	10	0	2	11	0
Lake George (10s.), N.S.W.		9	9		9	0
Mount Isa, Queensland	1	10	0	1	6	3
New Broken Hill (5s.), N.S.W.	1	10	6	1	10	0
North Broken Hill (5s.), N.S.W.	2	10	9	2	9	0
Rhodesia Broken Hill (5s.)		12	6		11	6
San Francisco (10s.), Mexico	1	2	3	1	0	6
Sulphide Corporation (15s.), N.S.W.		9	9		10	9
Zinc Corporation (10s.), N.S.W.	3	18	9	4	1	3
TIN:						
Amalgamated Tin (5s.), Nigeria		13	6		13	0
Beralt (5s.), Portugal		9	3		8	0
Bisichi (10s.), Nigeria		11	0		9	6
Ex-Lands (2s.), Nigeria		6	6		6	3
Geevor (5s.), Cornwall		6	0		5	6
Gold & Base Metals (2s. 6d.), Nigeria		4	9		3	3
Jantar Nigeria (3s.)		8	9		8	6
Jos Tin Area (Nigeria) (5s.)		11	0		10	0
Kaduna Syndicate (2s.), Nigeria		9	3		9	0
Mawchi Mines (4s.), Burma	1	8	6	1	9	0
Naraguta (10s.), Nigeria		9	0		9	0
Nigerian Consol. (2s.)		4	0		4	0
South Crofty (5s.), Cornwall		3	9		3	9
United Tin Areas (2s. 6d.), Nigeria		4	0		4	0
DIAMONDS:						
Anglo American Investment	3	0	9	3	2	6
Consol. African Selection Trust (5s.)	1	15	3	1	13	6
Consolidated of S.W.A. (10s.)	2	7	0	2	11	3
De Beers Deferred (£2 10s.)	21	5	0	20	10	0
West African Diamond (5s.)		2	9		2	6
FINANCE, ETC.:						
African & European	10	0	0	9	8	9
Anglo American Corporation (10s.)	6	5	0	5	17	6
Anglo-French Exploration	1	13	9	1	11	9
British South Africa (15s.)	1	14	3	1	13	0
British Tin Investment (10s.)		15	0		15	3
Broken Hill Proprietary	1	17	6	1	16	3
Camp Bird (10s.)		12	6		12	0
Central Mining (£8)	24	15	0	22	15	0
Central Provinces Manganese (10s.)	2	18	0	2	16	0
Consolidated Gold Fields	4	0	0	3	18	9
Cons. Gold Fields of N.Z. (4s.)		4	6		3	9
Consolidated Mines Selection (10s.)	2	7	6	2	5	0
Eastern Trans. Consolidated (5s.)		9	9		9	9
General Mining and Finance	6	15	0	6	7	6
Gold Ex. and Fin. of Australia (10s.)		12	3		10	6
Gold Fields Rhodesian (10s.)		13	3		13	3
H.E. Proprietary (10s.)	2	6	3	2	1	3
Henderson's Trans. Estates (4s.)		10	0		10	0
Johannesburg Consolidated	4	15	0	4	11	3
London & Rhod. M. & L. (5s.)		6	6		6	0
London Tin Corporation (4s.)		6	3		5	9
Marsman Investments (10s.)		14	3		12	6
Minerals Separation	5	7	6	5	7	6
New Central Witwatersrand (5s.)	1	1	0		19	0
Oroville Dredging (4s.)		19	9		17	6
Rand Mines (5s.)	7	0	0	6	17	6
Rand Selection (5s.)	2	7	6	2	8	9
Rhodesian Anglo American (10s.)	1	7	3	1	5	6
Rhodesian Corporation (5s.)		8	0		7	3
Rhodesian Selection Trust (5s.)	1	2	3		19	9
Selection Trust (10s.)	2	8	9	2	3	9
South West Africa Co. (13s. 4d.)	1	5	0	1	3	9
Union Corporation (12s. 6d.)	14	0	0	13	2	6
Venture Trust (6s. 8d.)		5	9		5	6
West Rand Ind. Trust (10s.)	2	5	6	2	1	9
Zambesia Exploring	1	2	6			

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.

Rockburst Control at Lake Shore

The *Canadian Mining and Metallurgical Bulletin* for July contains an article by W. T. Robson on Rockburst Incidence, Research, and Control Measures at Lake Shore Mines, Ltd., from which the following notes are taken. The author suggests that for an understanding of the mechanism of the problem a knowledge of the factors influencing the occurrence of bursts at Lake Shore is essential. Experience has shown that the most important factors are: (*a*) The nature of the ground, (*b*) the extent of the excavations made by stoping, and (*c*) the geological structure or fracture pattern.

The ore and all the wall-rocks so far encountered are hard brittle types which are resistant up to the point of sudden failure, as compared with the softer schistose types with which release of stress is a more gradual process. Such rocks, under the requisite conditions, are susceptible to bursting.

The ore-bodies are found in steeply-dipping deposits which occur in zones of fractured rock. They are of large extent, particularly those occurring on the foot-wall side of the ore zone, where a section on the plane of the ore-body presents an almost continuous block of ore. Stoping leaves few areas of unmined ground large enough to act as adequate support for the vein walls and, consequently, lacking this steadying influence, subsidence of the hanging-wall country takes place.

The ore-bodies at Lake Shore are found in a branching vein system. Vertically and horizontally this branching structure presents a similar pattern. Some branches roughly parallel each other for several hundred feet and then re-unite, while other strong branches diverge toward the east into the south- or hanging-wall, where many of them join together and resume their former strike.

The ore zone is separated from the country rock by a heavy foot-wall seam, with which is usually associated strong shearing and considerable gouge. In the hanging-wall of the strong foot-wall mud seam is a complex fracture pattern, extending at some horizons across a width of 400 ft. or more. As a result of the fracturing the ore zone is cut up into a great number of large blocks of hard brittle rock. Stoping operations, especially if carried out on parallel or branching ore-bodies, permit the settlement of these large heavy blocks of ground. Unstoped parts of the lode are separated from the country rock on the foot-wall side by the strong mud seam, but are usually attached rigidly to the hanging-wall, where the readjustment of the blocks takes place.

Effect of Structure

Loose rock on the walls immediately surrounding an opening and cracks which are developed along lines of weakness farther within the hanging-wall are evidence that movement takes place. This movement is the result of forces caused by the augmented superincumbent load and unless they are balanced by other forces the effect of the resultant force is to cause the mass to accelerate in the direction of the resultant. Such an opposing of forces takes place when an unmined part of the lode—such as, a pillar, or remnant, or other irregularity in the stope faces—retards the orderly movement of the wall. At Lake Shore it is almost invariably the hanging-wall. The result is that a state of stress is developed and, since a state of stress never causes an acceleration, it cannot be reduced to a resultant force. In other words movement of the walls ceases and the retarding mass must bear the full load of the applied force. In some cases it is incapable of withstanding the load and the result is the violent failure called a rockburst.

If the ground is well schisted the movement of the wall or walls is not retarded and, consequently, a state of stress is not developed and bursts do not take place. Or the retarding mass may be of such size and strength as to enable it to withstand the load, in which case a burst does not result. Or, again, the opposing of forces and the resultant build-up of a state of stress may, and frequently does, take place on a slip developed along a line of weakness well within the hanging-wall of the ore-body. The state of stress is developed by forces which are attempting to produce slippage along the fracture plane, but, since they are opposed by friction, energy is stored up in the rock. If the opposing forces do not remain in balance a slip occurs on the fracture plane, the release of the stored-up energy being accompanied usually by a shock or tremor. In many cases, although the energy released may be great and the tremor severe, no effect of the occurrence can be found underground. In other instances, where the fracture along which the slip takes place crosses a mine opening, the shock may throw down loose and sometimes cause rather severe damage.

The state of stress existing in a mass of rock underground as a result of the opposing of forces cannot be considered hydrostatic in nature, because that term implies that the force causing the stress is applied equally from all directions. A condition of hydrostatic stress would be approximated if the entire rock mass were composed of completely homogeneous matter. This, of course, is far from the fact since the rock mass is not only made up of different rock types which vary within themselves and between each other in granular structure and

strength, but is further removed from the condition of homogeneity by the presence within the mass of marked planes of weakness represented by narrow gouge-filled seams. The effect of these planes of weakness is to separate the rock mass into large angular-shaped blocks of ground, which are free to shift imperceptibly along the seams when stoping provides the necessary space.

This re-adjustment of the hanging-wall takes place, as a rule, with a minimum of crushing or breaking of the rock within the block itself, such effect being confined largely to the development of cracks along the seam on which the slippage takes place. This is well demonstrated by the fact that the walls of cross-cuts, situated in the hanging-wall of the foot-wall ore-bodies, in areas where intense bursting has occurred, exhibit surprisingly little evidence of shattering. Furthermore drives opened parallel to and in the foot-wall of the ore zone, as close as 80 ft. to the strong foot-wall seam, retain their original shape and suffer no disruption, even when stoping is continued on the ore-body.

The compressive stress required to crush Lake Shore wall-rock is several times that which would be present due solely to the weight of the superincumbent load applied hydrostatically, for depths at which severe bursts have taken place. Therefore, the force developed by the straight weight of the rock column must be augmented by the weight of heavy blocks of ground, delimited in the hanging-wall by lines of weakness inherent in the geological structure, to provide a stressed condition of sufficient intensity to cause the ground to burst. The additional force is developed and the rock will burst if the fracturing in the hanging-wall is such as to form a multiplicity of more or less separate blocks which continually shift their points of pressure and providing the bearing surface is too small to withstand the load.

At Lake Shore practically all the wall movement causing rockbursts has been in the hanging-wall, because it is in the area above the strong foot-wall seam that most of the subsidiary fracturing exists. From frequent reference in the literature on the subject to "hanging-wall sag," it would seem that this condition is more or less general in most rock-burst areas. In nearly vertical veins, however, there would appear to be no reason why foot-wall bursting should not be as serious or frequent as hanging-wall occurrences, provided parallel or branching fractures or lines of weakness are well developed in the foot-wall.

Most mines where bursting has reached serious proportions have experienced the violent disruption at depth of masses of ground the large size of which was thought to preclude the possibility of sudden failure. It would appear that the determining factor, in such cases, is not so much the dimensions of the solid ground remaining in the ore-body as it is the size of the mass of rock within the hanging-wall, which is free to shift its position and bring its weight to bear on the solid support remaining in the stoping area. The boundaries of the block are determined by the relative position of the fractures or lines of weakness in the walls. If the partings are such that a mass of ground in the hanging-wall is free to slip toward the excavation made by stoping as a unit or in one more or less solid block over a considerable distance along the strike of the deposit, then all the solid support remaining in that part of the stoping area is subject to bursting conditions and will fail violently if the weight of the moving block of ground exerts a unit pressure greater than the strength of the support.

Effect of Depth

Numerical values for some physical characteristics of Lake Shore wall-rocks have been determined from a reasonably large number of observations. Average values are: Specific gravity, 2·7; compressive strength, 34,000 lb. per sq. in.; Young's modulus, 5,200 tons per sq. in., and modulus of rigidity, 2,100 tons per sq. in.

The effect of the weight of the superincumbent rock is, therefore, equal to a pressure of 1·2 lb. per sq. in. for each foot of depth. At a depth of 28,000 ft. the vertical stress due solely to the weight of the rock column would be 34,000 lb. per sq. in., or just sufficient to crush the rock. At lesser depths the compressive strength of the rock may be exceeded if the mass of the superincumbent rock is increased by partings along lines of weakness in the hanging-wall. Thus, the vertical stress produced by the weight of the hanging-wall to a depth of only 2 ft. in the wall of the ore-body would equal the compressive strength of the rock at a vertical depth of 14,000 ft. The necessary stress would be developed at 2,000 ft. depth by the weight of 14 ft. of hanging-wall and at 560 ft. by the weight of 50 ft. of wall.

With primary stoping bursts are not experienced at shallow depths because the excavations do not, as a rule, disturb the cohesion of the walls to any appreciable depth. Re-entry into old workings to recover a small block of ore may, however, provide the requisite conditions for a burst.

Large-scale closing in of the stope walls at depth is not a common occurrence at Lake Shore, but when it does occur the reason must be ascribed to the settlement, along lines of weakness, of sizeable blocks of loosened rock into the excavation, rather than to convergence of the walls due to the elastic properties of the rock. At a depth of 4,000 ft. the vertical stress would be 4,800 lb. per sq. in. and, with a Young's modulus of 5,200 tons per sq. in., the expansion of the walls would amount to only ½ in. assuming that the zone around the excavation in which expansion takes place extends for 100 ft. within the wall.

Heaving of the track over a pillar is a frequently noted effect of pressure usually associated with mining at depth, but not unknown at shallower horizons in the mine. This phenomenon is not satisfactorily explained by the assumption that the vertical uplift is caused by forces exerted by a zone of increased stress within the wall. The track over a pillar 40 ft. deep may be forced upward, without bursting, as much as 6 to 12 in., which figure is, of course, much too large to be caused by expansion of the solid rock in place. It is apparent, then, that the whole pillar must move upward and in so doing fractures must be developed in the pillar. Thus, since the pillar is no longer part of the solid rock mass, the zone of increased stress in the wall cannot be abutted on the pillar. A slight settlement of the wedge-shaped block of ground, delimited by the hanging-wall fractures, into the excavation made by stoping, will exert an upward-acting force on the unmined ground above the stope. As the pillar, which is already separated from the country rock by the heavy foot-wall seam, is forced upward, fractures are developed on the hanging-wall side and the wall of the drive on the level above is crumpled.

History

The first occurrence in the Lake Shore mine identified as a rockburst occurred in May, 1932, when a floor-pillar burst in a drive on the 1,200-ft. level. During the following year and a half several bursts, mostly of a minor nature, took place, but it was not until 1934 that bursting assumed noteworthy proportions. The experience since then has been one in which periods of more or less severe bursting in certain areas have been separated by times of comparative immunity from bursts. The periods in which the incidence of bursting increased, and also the more severe occurrences which took place in periods of comparative quiet, have been associated with mining in places on which branching hanging-wall fractures tended to concentrate the weight of sagging wedge-shaped blocks of ground.

Four stoping areas in the mine have been particularly susceptible to bursting. In the order in which they were encountered in point of time they are: (*a*) A series of floor-pillars situated on the foot-wall side of the ore zone, in the west half of the mine, on the levels from the 2,200-ft. to the 2,575-ft. horizons; (*b*) an area in the south-east part of the mine where parallel and branching vein structure persists from the 2,700-ft. level to the 3,825-ft. horizon; (*c*) a pillar area in branching vein structure, situated on the foot-wall side of the ore zone from the 3,075-ft. to the 4,325-ft. horizon, about midway in the West half of the property; (*d*) an area located to the east of the main cross-cuts between the 4,575-ft. and the 4,950-ft. horizons, within which a complex fracture system occurs.

In addition to these areas considerable trouble has been experienced from bursting in the main cross-cuts connecting No. 1 and No. 3 shafts on the levels from the 2,575-ft. to the 3,575-ft. horizon and in No. 3 shaft pillar from 1,200 ft. to 2,700 ft. depth.

Bursts in development headings are not easily accounted for by the explanation which is acceptable for bursts in stoping areas. On first thought they might be considered as being caused by inherent tectonic stresses. This is a possibility that might apply in some instances, but, in the few cases experienced at Lake Shore, the following explanation is probably more acceptable.

They are all of a very minor nature and occur almost invariably in the back, but occasionally in the walls of drives or cross-cuts in places where the ground is uniformly textured, fine-grained, and extraordinarily brittle. Following the blast the back slabs off in even curved surfaces, frequently accompanied by considerable snapping. Occasionally there will be a sharp crack and a small piece of rock will be dislodged with considerable violence. After a short period of time this initial flaking or slabbing is arrested, but scaling may cause a temporary resumption of the phenomenon.

The forces which cause this type of minor failure are considered to be the same as those which are responsible for arching along a slip or fault, in places where the rock is not so brittle. The rock is normally under considerable confining pressure due to the superincumbent load and this, possibly supplemented by abnormal local stress due to an unusual arrangement of lines of weakness—such as, a fault or keyed jointing—is further augmented by the blast when a new advance is made in the opening. The excavation tends to work itself into a shape best suited to withstand the load, but in place of the normal, quiet, protracted sloughing which usually takes place at depth, or the more pronounced arching if a slip or fault is present, the process is more rapid due to the brittle uniform nature of the ground. Thus the opening enlarges itself in the form of curved surfaces breaking away in the back accompanied by cracking and snapping.

It is evident that more than straight depth influences the occurrences of bursts in development headings, otherwise their incidence would increase with depth. This is not the case at Lake Shore because certain areas, irrespective of depth, are more susceptible than others—notably, certain parts of the 2,825-ft. horizon, the main cross-cuts on the 3,325-ft., 3,450-ft., and 3,575-ft. levels, and an area on either side of the main cross-cut at the 4,950-ft. horizon. Development openings have been made at much greater depths, including the sinking of a shaft to 6,875 ft. and the driving of the main cross-cut at the 6,825-ft. level, without experiencing this type of ground failure.

More severe bursts occur in drives, rises, or other openings driven in places where the state of stress is already high due to the nearby presence of other large mine openings. At Lake Shore no such bursts have been experienced in foot-wall workings, where new headings can be opened with comparative impunity. In the hanging-wall, however, above the strong foot-wall seam, such bursts, some severe, have occurred.

On a number of occasions bursts have occurred in old workings where no mining has been done for many months or, in some cases, years. An appreciation of the importance of the time factor may provide an explanation for the occurrence of such disturbances. Theoretically the smallest stress is sufficient to produce rupture if applied for a sufficiently long interval. A state of stress, built up in a mass or masses of rock as a result of mining operations, may not be sufficient to cause the immediate rupture of the ground. If, however, the state of stress is maintained for a sufficiently long period of time, the ground may burst without the application of additional stress. Or, as appears quite possible, mining operations, even when carried out in an apparently unrelated part of the mine, may introduce forces which add a little load to the already severely stressed rock-masses, resulting in an eventual burst.

Control Measures

Rockbursts at Lake Shore are the result of a combination of factors. With strong brittle rocks and ore-bodies of great lateral extent and vertical continuity bursts will take place provided heavy blocks of ground, delimited in the hanging-wall by lines of weakness inherent in the geological structure, are permitted to sag and bring their weight to bear on unmined parts of the lode. Unless adequate measures are taken to restrict or control wall movement its effect is cumulative with depth. The condition of instability of the ground, a logical consequence of extensive mining operations carried out at increasing depths, is seriously aggravated if initial movement is permitted to continue unchecked to greater depths, where the cumulative movement may involve large heavy masses of rock.

Control measures, then, should be taken to (1) prevent wall movement as much as possible, and (2) since this is not possible of complete achievement, to provide, by means of an adequate sequence of stoping, an orderly control for such movement as cannot be prevented.

To limit the extent of wall movement demands not only a consideration of the character of the wall support used, but should take into account also the methods of mining used in the ore-body, together with the extent of the movement which has been developed in the past or is now taking place, both in the region where serious bursting occurs and on the levels above. The support of stope walls is discussed first.

Stopes.—Sag begins as soon as an excavation is opened and, unless it is checked, the cohesion of the wall is disturbed to an ever-increasing depth, as the excavation made by stoping is enlarged. The permanent support, therefore, should be placed as soon as possible after the opening is made and as close to the advancing face as mining operations permit.

Most mines, however, when first faced with the problem of rock bursting, have already carried poorly-supported workings to a considerable depth. Sand or other means of backfilling these old workings will not overcome the conditions which cause bursts, although the practice does limit the extent of wall movement which takes place as a result of later mining at the same or lower horizons. Support is, therefore, not a local matter but must be considered in relation to the mine as a whole. For this reason all old workings in the upper parts of the principal ore-bodies at Lake Shore have been completely backfilled.

In all stopes on the main ore-bodies below the 1,600-ft. level cut-and-fill methods of mining have been used exclusively. At first stoping was carried out by means of horizontal cuts taken along the strike direction of the ore-body, but rill stoping was soon adopted when it was realized that a rill face provided more effective support for the walls. One of the principal reasons for this is that the lines of intersection of important vein fractures plunge at low angles in the strike direction of the ore-bodies. A rill face crosses such a line of weakness at a high angle and thus provides more effective support than does a horizontal cut, which might contain the line of intersection for a considerable distance along the stope.

The rill stopes are timbered with standard square-sets, 8 ft. high and 5 ft. 4 in. square. A plank floor is laid from cap to cap and thus is parallel to the stope face and at an angle of 55° with the horizontal. The timber serves a useful purpose in that it restricts, to some degree, initial sag of the immediate walls.

Starting from a vertical rise successive stopes are mined to the level above in sections or panels, each having a maximum length of 65 ft. along the vein. Mining is completed in a section before the next one is started and thus active stoping is confined to a comparatively short length along the ore-body. The stope is mined from the bottom upward, standard practice being to blast one breast on each lift and to drill off but not blast the next one. The rill face is advanced to within 30 ft. of the level above, from where mining is carried as a vertical slice to the sill. Mucking out a completed cut, through a chute constructed at the bottom, is rapid, since the face is advanced one set only. Following the mucking the floor is lifted and re-laid in its new position close to the face, which has already been drilled off for the next cut and the stope filled as quickly as possible. By this method the maximum distance between the fill and the solid face is from 12 to 16 ft., which distance is supported by the stope timber during the short period of time that is taken to muck out and fill the cut.

The filling material used is a mixture of sand and waste rock. As noted above, it is kept close to the working face of the stope and provides the final support of the walls. Care is taken to make sure that the space is completely and thoroughly filled, a necessary condition that is further ensured by the fact that stope blasting is on the floor laid on top of the small amount of fill placed at one time.

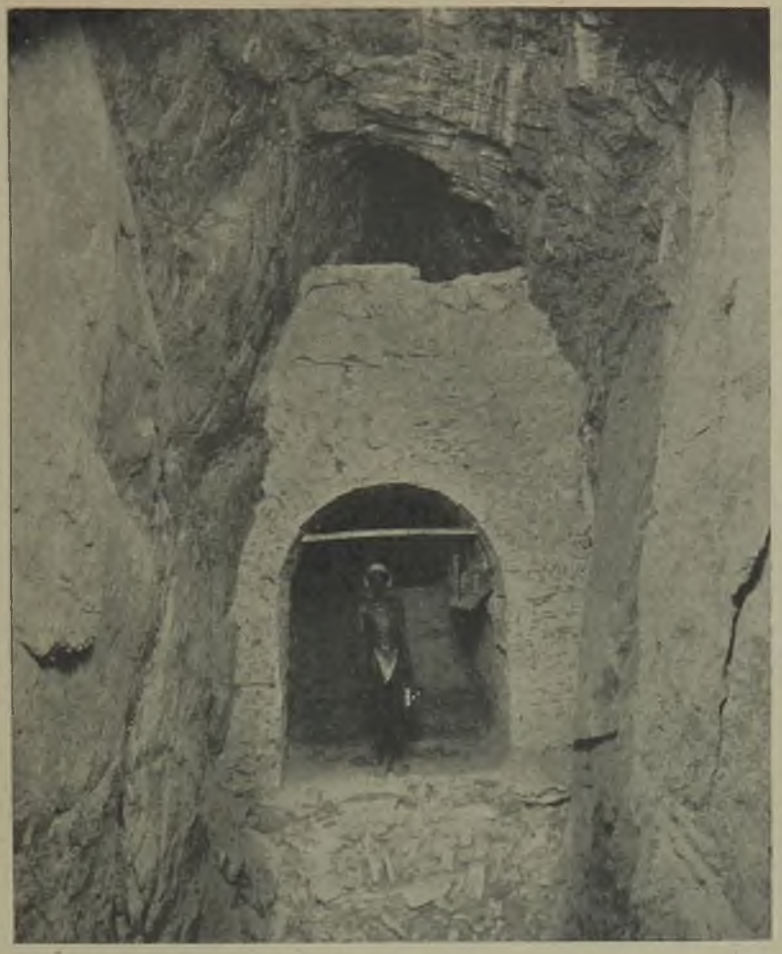
In the principal stoping regions a concrete matte is used as the first fill on stope timbers. The height to which the concrete is carried varies from 8 to 16 ft., depending on the width of the stope. In some cases spaced concrete plugs are placed at the top of the stope to form a sill for the level above. The more rigid support provided by the concrete has a steadying influence on the walls and serves to protect the level opening in the event that a burst takes place.

Many bursts occur simultaneously with, or shortly after, blasting, so it is advisable at blasting time to have the workmen out of those regions which might be affected by a rockburst. For this reason all blasting is done at the end of the shift and electric blasting has been adopted, the charges being detonated in sequence from a far-removed place of safety. The advantages of this practice are that all men are out of the working places at blasting time and thus the tendency of men to blast before the designated time, and in so doing endanger others, is eliminated. It is also possible with this method of firing to reduce the number of delays to a minimum and, by using an excess of explosives, to transmit sufficient shock by blasting to induce a burst if the section is in a critical stage.

Level Openings.—No support is required in driving drives and cross-cuts, but the centre back holes of the round are drilled high to form an arch when blasted. Most parts of the headings stand unsupported, with a moderate amount of sloughing, until stope preparation is started. Over some short lengths, however, where lines of weakness occur in the back, arching takes place. In these places light timber sets, covered with 4-in. lagging, are erected.

In some places, in or near active stoping areas, circular steel sets are used. The rings are 6 or 7 ft. in diameter, made in halves from 65-lb. rail bent with the ball to the inside of the drive. They are placed at 4-ft. centres and are covered with round 4- to 6-in. lagging, the space between the wall and the lagging being filled with sand. They have proved to be quite effective in withstanding the shock caused by a heavy burst.

The drive sets under a stope are set on 12 in. by 12 in. fir sill timbers, placed parallel to the direction of the drive and 20 in. from the track. In the wider stoping sections other sill timbers are placed parallel to these and cribs of slabbed spruce, 6 to 7 ft. long, are built up from them to give greater support to the caps and to help absorb the shock of a rockburst. When a drive cap fails another 12 in. by 12 in. fir cap is placed beside it,



Support in an Indian Gold Mine.

care being taken to make sure that the ends of the new cap are several inches from the wall. It has been found that if drive posts, cribs, and sill timbers are far enough away from the walls, so that no direct shock is transmitted to them when a burst occurs, the drive sets remain standing and the dislodged rock falls harmlessly to the floor.

Sequence of Stoping

The most effective safeguard against the occurrence of bursting at Lake Shore has been the application of a planned sequence of stoping. What constitutes a satisfactory plan for the orderly removal of the ore-bodies in a particular deposit can be determined only after the prevailing physical conditions are known and their relative importance to the problem understood.

To meet with the fullest possible measure of success the extraction of the payable material in an ore deposit must embrace a well-designed long-range plan. The plan must be comprehensive, including in its make-up all phases from the initial development of a new level to the final extraction of the payable material in the ore-shoot, all co-ordinated in such a manner as to permit the unhampered employment of an effective sequence of stoping. This implies a thorough knowledge, understanding, and appreciation of all factors which are involved in the support of the underground workings in the particular mine in question.

Such information is admittedly difficult to obtain when an ore deposit is first opened because many of the relevant conditions are not determined until mining has reached such depths and in such a way as to establish the requisite conditions for bursting. Some of the characteristics, however, are known from the start of mining operations and others can be determined, or allowed for, with a reasonable degree of certainty. The nature of the wall-rocks and the approximate dip of the ore zone are known almost from the start and at shallow depths a reasonably accurate picture of the geological structure can be obtained and the dimensions of the ore-shoots, especially their continuity downward, can be estimated.

The time required to change a system of mining or sequence of stoping found to be inadequate to cope with pressure movements, which invariably take place as mining is carried to depth, may be a matter of years. In this period it is almost

impossible to change over to a planned sequence without cleaning up the irregularities and hazardous situations inherent in the old one. In fact it might, and sometimes does, so happen that the overlapping in time and application aggravates further the situation and a period of time is experienced in which ground movements, violent or otherwise, present an extraordinary problem. The first essential, then, in circumventing the occurrence and the costly, dangerous, and troublesome effects of rockbursts is a thorough understanding of the particular deposit being mined—its geological structure, rock type, size, and continuity of ore-bodies, etc. Of these features geological structure is of paramount importance at Lake Shore.

Starting with the development of a new level, which is opened in such a way as to avoid setting up conditions which, from past experience, have proved to be undesirable, the routine followed in planning the sequence of stoping is designed to present as complete a picture as possible of the relevant conditions. A complete set of level plans is maintained, showing in detail the geological structure. To secure the required information in sufficient detail it was found necessary, when the plans were made up a number of years ago, to re-map most of the underground lateral workings. The plans show vein fractures, faults, slips, and rock types as exposed in the level openings and, with the help of information secured by diamond drilling, indicate the probable positions of fractures in the walls of the workings. They also show ore sections in the drives and possible ore lengths as indicated by diamond-drill holes.

Detailed cross-sections and longitudinal sections are then prepared. The cross-sections are constructed at regular intervals along the ore zone on lines taken 100 ft. apart, but, where considered necessary, the distance between sections is shortened.

Mine models, designed solely for this purpose, are constructed in order to present a three-dimensional view of the underground workings. As much as possible of the detail mentioned above is shown by the models, which are constructed mostly of wood and on a scale of 20 ft. to the inch. Each one takes in all workings over a vertical range of 1,000 ft., the model representing the deeper part of the mine extending to the 6,075-ft. horizon. The deepest stoping is at the 5,200-ft. level, so that the bottom model takes in the levels currently under development and thus makes possible a study of the situation well in advance of stope preparation.

From a continuing study of the plans, sections, and models the development of a new level is directed and the arrangement of stoping sections determined. Drives are driven only on those vein fractures most likely to contain the downward extensions of the main ore-bodies and the formation of parallel drives is avoided as much as possible. The development of branching and close-lying parallel veins consists of testing by diamond-drill holes only, until such time as stoping has been carried through on the main ore shoots.

In the western half of the property, where a major ore-body occurs on the foot-wall side of the ore zone, a sequence has been adopted whereby stoping starts on either side of a vertical rise located at about the middle of the ore-shoot. Stoping is controlled so that each successive section is mined out before the corresponding one below is started. In this way the mined-out area assumes the shape of a triangle resting on its apex, the rate of mining being regulated so as to assure that the stope faces from level to level are kept in alignment, in order to avoid the formation of projections of solid ground jutting into the stoped-out portions of the vein. By this system the number of starting-places is reduced and, consequently, the amount of ore which can be mined from a level in a given period of time is lessened, but the formation of pillars, which are so frequently and definitely associated with rockbursts, is eliminated.

In the middle part of the property on the present lower productions levels two strong vein zones come together to form a complex branching vein structure, resulting in the occurrence of ore in a number of closely-spaced fractures. In this region stoping starts from a vertical rise driven at the junction of the two main zones and is carried along the main ore-shoot before any of the subsidiary side makes of ore are opened up. With this plan no pillars are formed as the stope faces, in alignment from level to level, are carried forward along one plane in the ore zone. The walls are not weakened by excavations opened on branching or parallel fractures and violent failure is held at a minimum.

Another example of planning is illustrated by a situation which is found occurring on the east side of a major fault, which is located in the eastern part of the property. Parallel veins occur here, each containing ore from the fault eastward. The distance separating the ore-bodies is 250 ft. at the 5,200-ft. level, the veins converging on dip to come together at about the 6,075-ft. horizon. At the 5,200-ft. level both veins have been opened by driving, but below that horizon one vein only has been driven on, the other being tested by diamond-drill holes only. Stoping starts at the fault on the vein opened up by driving and will be well advanced on several levels before further driving is carried out on the other vein. In this case stoping starts at a line of weakness represented by the fault and proceeds in one direction, the stope faces being in alignment over a number of levels and thus no pillars are formed.

Examination of the plans and cross-sections of the levels below the 5,075-ft. horizon shows that the ore-bodies occur in places where structural conditions are such as to demand the utmost consideration and respect. It is unlikely that, in mining these ore-bodies, the occurrence of rockbursts can be eliminated, but, from the knowledge and experience gained from the past, it is believed that the further development of these levels and the subsequent stoping of the ore-bodies can be carried out with a minimum amount of disruption from bursting.

Research

Research work of an engineering nature, performed in the investigation of ground failure, includes the following :—

(1) Keeping of a permanent record of all known disturbances caused by rock pressure no matter how minor.

(2) Preparation of plans, sections, charts, and graphs for use in a statistical study of rockbursts.

(3) Preparation of adequate plans, sections, and mine models, to assist in the laying out of a suitable plan of development and sequence of stoping in an attempt to control the occurrence of rockbursts.

(4) Taking accurate measurements of the movements of the wall-rocks adjacent to excavations.

(5) Detailed mapping of the geology as shown in the underground workings, with particular attention being given to a portrayal of the geological structure of fracture pattern as exposed in the workings and by using information secured from diamond-drill holes in the walls of the excavations.

(6) Determination of the most suitable material for backfill. Many experiments have been conducted using mixtures of sand, rock, mill tailing, cement, and bitumuls in various combinations and proportions.

Geophysical research on the rockburst problem at Lake Shore was initiated in December, 1938, when arrangements were made for the installation of a surface seismograph to record the occurrence of rockbursts and their relative intensities. Following the installation of this equipment geophysical rockburst research in the mine itself was organized. An early requirement of the investigation was the construction of a well-equipped electronics laboratory, containing all necessary machinery and testing equipment. In the laboratory instruments and other equipment for use in the work can be built or assembled and their design changed or modified as required by the experience gained in their use.

In addition to the surface installation another seismograph was built and placed in continuous operation on the 3,075-ft. level in a long cross-cut at a place 1,500 ft. in the foot-wall of the ore zone. The sensitivity of the instrument was adjusted so that it did not record ordinary operational disturbances, except heavy blasting. It did, however, register seismic shocks in greater number than the total given by the engineering record of located bursts and this despite that fact that, due to the lowered sensitivity of the instrument, many minor disturbances probably would not be picked up. Such unlocated disturbances, some severe, must originate so deep in the country rock that they do not affect the walls of mine openings.

Much experimental work was done with oscillographs, a seismic prospecting outfit, and other equipment to determine the frequency of vibration caused by bursts and by blasts and other operational disturbances. A marked difference in the frequencies would make possible a modification in the design of the mine seismograph, so that it would record only those vibrations caused by bursts. The sensitivity of the instrument could then be increased and a more complete quantitative record of bursts obtained. The plan had to be abandoned when the experiments showed that, although the frequency of vibration for the burst spectrum was somewhat higher than that for blasts, the two were so slightly separated that it was found impossible to design equipment that would register only bursts. The experiments demonstrated that, with blasting, some vibrations are set up which have frequencies as high as those usually accompanying bursts and that, for bursts originating far away from the seismograph, the higher frequencies are rapidly attenuated and only the lower frequency vibrations reach the pick-up.

Another line of investigation carried out was an attempt to measure the variation of the velocity of seismic waves through rock in place in the mine, presumably undergoing increasing strain. This approach to a solution to the problem failed when experiments carried out underground, using a seismic prospecting outfit, demonstrated the uncertainty of the path followed by the rays. Numerous velocity determinations were secured by laboratory methods on rock samples obtained in the mine, but in the light of the underground experience with the method it does not seem possible that such data are of value in rockburst study.

Considerable work was done with sagmeters and with an electric microgauge, designed to measure and record the deformation which might take place in a diamond-drill hole, drilled into stressed rock. One sagmeter operated for seven months, during which time a number of bursts occurred nearby, the last one closing the drive at the place where the sagmeter was installed. The readings suggested that, in the case of some bursts, the rate of closure was retarded for a period of several days or even weeks prior to the occurrence of the burst, following which the graph rose suddenly. The evidence, however, was too inconclusive to permit any generalization. The microgauge was an extremely sensitive instrument and difficulty was encountered in making it stable under conditions of fluctuating line voltage.

When the methods described above were proved to be unsatisfactory for the purpose it was suggested that the study of very faint sub-audible snaps, called microseismims, that are produced in rocks under pressure, might lead to the development of equipment and techniques which could be used to predict the time of occurrence of a burst, or at least to indicate the location of places under excessive stress. The method, known as the microseismic method, is based on the following assumptions :—

(1) That rock subjected to excessive strain will probably yield microscopically and in so doing will set up minute tremors, which are normally below the range of audibility.

(2) That the snaps can be registered by means of suitable amplifying and recording equipment.

(3) That the rate of snapping will rise as the stress continues to increase.

(4) That if the snapping is localized it will indicate a focus of pressure.

(5) That indicative snapping occurs for an appreciable time prior to the occurrence of a burst.

Equipment was provided for a thorough testing of the microseismic method and, for a period of over four years' duration, the basic assumptions listed above were subjected to large-scale experimental test. Three sets of the equipment, capable of recording in continuous operation the impulses picked up by six geophones, were received in May, 1942. Following preliminary experimentation and testing they were placed in service in the mine late in 1942, in a region situated on the foot-wall side of the ore zone in the middle-west part of the mine on the levels from the 3,825-ft. to the 4,325-ft. horizon. The area selected was one in which stoping had reached the pillar stage in a branching vein structure and hence excessive movement of the hanging-wall was taking place. On January 29, 1943, a heavy burst, followed by another on March 31, brought an end to the observations in this area. The few months in which the instruments were in regular operation in this part of the mine might be considered as a period of experimentation in their use and further development. The excessive movement of the hanging-wall, referred to above, caused successive cycles of intense activity, which

were recorded by the instruments, but no prediction was made.

Following the bursts it was decided to continue the investigation on the east side of the mine from the 4,450-ft. to the 4,825-ft. level. In this part of the mine two strong veins occur, the distance separating them varying from 150 to 250 ft., with the ground between intersected by many strong planes of movement. One set of equipment had been lost in the bursts on the west side, but the remaining two sets, together with three new ones, were installed in the new location. By means of a series of automatic electric switches these five sets were able to service a large number of geophones, placed strategically throughout the area. Regular recordings were made twice daily in the off-shift periods, supplemented by a daily listening period, made before the day shift started work in the morning.

During the time the equipment was installed in this part of the mine 33 located bursts occurred in the region serviced by the instruments. They ranged in severity from ones in which only a small amount of rock was shaken down to others in which several hundred tons were dislodged over an extensive area. Some affected one working place only, others as many as five. As for the time of occurrence 24 of the bursts took place at or close to blasting time, while the remaining nine did not occur with the blasting. In no case did the instruments give warning of an impending burst.

When this type of equipment was first placed underground at Lake Shore in the latter part of 1942 hope was held that, through its use, the time of occurrence of a burst might be predicted. Experience soon proved that this expectation could not be fulfilled and that the most that could be expected from this method, even if it proved to be as successful as could reasonably be anticipated, was that it would indicate places under abnormal stress. That such places do exist goes without saying, but in the great majority of cases the strain is relieved quietly without bursting. Furthermore, pressure movements taking place within the hanging-wall cause rock noises, probably of different types and origins, which reach the pick-up through a wide range of distances and directions. Experience has shown that the determination of the exact, or even approximate, location of a place where excessive stress approaching bursting proportions exists has not been possible with the equipment in use.

In large stoping areas, especially those containing pillars or other irregularities in the alignment of stoping faces, it is to be expected that the breaking up of the ground would be accompanied by the emission of rock noises, both audible and subaudible. Initial failure might be due to bursting or the application of excessive pressure might result in more gradual failure, unaccompanied by violent rupture or bursting.

It is logical to assume that the more rapid the failure the higher would be the count and this is confirmed to some extent by the experience at Lake Shore. Immediately following a burst rock noises or snaps, many times too numerous to count, are reeorded. This intense activity soon quiets down and, as a rule, within a period of time, ranging from half an hour to, say, four hours, the country returns to its normal amount of activity. A similar condition usually occurs after the blasting period.

The activity is caused by the rapid breaking up of the ground following a burst or blast and is to be quite expected. On the other hand there has been no confirmed case, from among the many bursts which have occurred in places serviced by the microseismic equipment, in which greater than normal snapping in significant proportion was detected for an appreciable time prior to the occurrence of a burst. In an area serviced by the instruments there will be times when the activity increases markedly and unusually high counts are recorded. It has not been found possible to associate such a condition with the approaching occurrence of a burst, but rather it seems to indicate that the strain induced by mining is being dissipated by gradual failure. It would seem more logical to suppose that a burst might be expected to occur if such recurrent periods of increased activity failed to appear, since their absence would be an indication that the more or less orderly movement within the hanging-wall had been retarded.

Future Mineral Resources

In an address given before the Colorado Mining Association earlier this year and reproduced in *Mining and Metallurgy* for August the Director of the United States Geological Survey, Dr. W. E. Wrather, reviewed America's future mineral problems in the light of present concern and the certain prospect of increasing demand. He said that past forecasts of ore reserves have often proved ultra-conservative when viewed in the light of subsequent technical and exploratory techniques, but certainly the problem of discovery becomes more exacting as known supplies are depleted. The current estimate of a 10-year proved reserve of high-grade iron ore and a 13-year known supply of recoverable copper may be conservative, he suggested, but in terms of present prices, rising labour costs, and prevailing technology it was to be questioned if there was more than 20 to 25 years of operating life for the mines now producing most of America's lead and zinc.

Dr. Wrather thought that perhaps the trend toward successful exploitation of lower and lower-grade ores will continue by virtue of further improvement of mining, milling, and metallurgical techniques, but as long as competition establishes going prices there will be limits of grade below which they could not go. An alternative to lower-grade ores is to adjust their economy to ever-increasing imports of higher-grade foreign ores, especially when they considered the prospect of rising labour costs.

It was improbable that erosion and structural deformation had exposed all the important ore-bodies in the United States. It was reasonable to suppose that more remained to be discovered beneath barren rocks. To find them they must apply as much ingenuity as they had devoted to mining and extraction methods.

About 25 years ago, Dr. Wrathall said, the petroleum industry had arrived at the point where

mining people found themselves to-day. The demand for petroleum products was increasing at a rapid rate, but the curve of domestic discovery had levelled off and seemed certain to head downward. Wildcat drillers had punched holes wherever oil and gas seepages or recognized surface structures indicated favourable conditions. They were resorting more and more to random drilling on the fringes of known oil-bearing localities and the pessimists were having a field day.

In their extremity the oil companies recruited more and more geologists to locate and map the deep-seated structures that had escaped previous discovery by reason of less evident surface indications. Subsurface geology became a specialized field of study as many important oil-field discoveries were chalked up by geologists. As they resorted more and more to imaginative reasoning they turned for assistance to the magnetometer, the torsion balance, gravimeter, and seismograph as necessary prospecting tools. Working together and checking each other's results geologists and geophysicists made a phenomenal record of petroleum discoveries. With this demonstration of what geology and geophysics can accomplish by teamwork and mental daring it was difficult to accept the idea that they are again running out of petroleum.

He suggested that the example of the petroleum industry might be paralleled by the mining industry. Although the problems are different mineral deposits are geological entities and like petroleum fields their distribution is controlled by geological processes, whose fundamental laws we must understand before the deposits can be found. An illustration of the results of discovery thinking was furnished by the finding of potash in New Mexico.

The United States Geological Survey was unwilling to accept the discovery rate of recent years as a gauge of future expectancy. Although they seemed to be reaching the end of their rope as far as accepted theories and techniques go, they must not accept a status of intellectual bankruptcy. It was time to redouble their efforts if they were to maintain their national supremacy.

It was not reasonable that the mining industry should assume the entire burden of such a task. Individual companies could not undertake to carry the load of fundamental research called for, nor did it seem practicable or desirable for the industry as a whole to assume the burden. Minerals had come to play a stellar role in national economy and defence. Problems relating to mineral resources, therefore, were problems of national concern. Exploration was a matter of public welfare, a public responsibility, and is in large measure a Federal responsibility. The mining industry should and could expect the Federal Government to be cooperative in seeking adequate mineral reserves. The cost of research and the risk of trial experimentation should not be the concern of private industry alone where the national welfare is so vitally involved.

It was the responsibility of private industry, however, to give serious thought and advice in planning.

An Alaskan Tin Mine

In the United States Bureau of Mines Report of Investigations 3902 H. E. Heide gives an account of the Lost River tin deposit, Seward Peninsula, Alaska. The mine was examined in 1942 and as possibilities for developing a significant amount of tin appeared favourable exploration of the orebodies was started in August, 1942.

The Lost River tin mine is on western Seward Peninsula, Alaska, at latitude 65° 28′ N. and longitude 167° 8′ E., about 90 miles north-west of Nome. The property is isolated and the commoner means of communication are entirely lacking. A natural landing field for aeroplanes exists on the east side of Lost River about 1·5 miles below the mine and near the mouth of Tin Creek. Another natural field at the beach, on the west side of Lost River, can be used if necessary. Both fields are only suitable for small planes, but could be improved to land heavy loads. Climatic conditions are severe and as lightering operations can only be carried on in fair weather demurrage may be high.

The approach to the mine from Bering Sea is an area of generally low topographic relief. Lost River Valley is wide and open and the surrounding hills are low and rounded. The district is virtually barren of vegetation.

Experienced labour, both underground and otherwise skilled, is virtually non-existent in this part of Alaska, but it is possible that an adequate supply of unskilled Eskimo labour might be recruited.

Cassiterite was discovered in this area in 1903. In 1907 the Lost River Tin Mining Co. was organized and incorporated by the owners at Nome, Alaska, under the laws of the Territory of Alaska. The owners performed all assessment work and eventually obtained patents to the ground. From 1904 to 1911 intermittent placer operations on Cassiterite Creek are said to have produced 20 tons of tin concentrates. Much of this production was from residual debris at the foot of the Greenstone lode.

The Jamme Syndicate of Seattle took a lease on the property and in 1912 started systematic development. A small pilot mill was erected and intermittently operated until 1915. About 8 tons of tin concentrates are reported to have been produced. In 1916 the lease was abandoned. In 1918 the James F. Halpin interests took a lease on the property and continued development until 1920, when the lease was dropped.

The mine was idle until 1928 when the National Tin Mining Co., a Nevada corporation, took a lease on the property and started development. Operations were continued until 1930, when the lease was terminated. Ownership of the Lost River mine now resides in the Lost River Tin Mining Co.

General Geology

The country rock consists mainly of Ordovician limestone, which has been intruded by two masses of granite and by numerous acidic and basic dykes of several ages. The older faults, which are later than the granitic intrusion, trend somewhat north or south of east. The dykes were later intruded along these faults, but the basic dykes are younger

than the acidic. Both the basic and acidic dykes are displaced by north–south faults and one great fault of this system, which is followed by the valley of Lost River, displaces certain of them horizontally between 3,000 and 4,000 ft.

The tin ores are genetically related to the granitic rocks, but are localized chiefly in and along the acidic dykes. Not all of these dykes, however, are mineralized, nor is any one dyke mineralized throughout its entire length. Instead the tin ores are localized in zones of intense contact metamorphism, which are caused by the presence of underlying cupolas or boss-like protuberances that project upward from a larger underlying mass of granite.

The principal workings of the Lost River mine are located on one of the acidic dykes known as Cassiterite Dike, which is mineralized for about 1,500 ft. along its outcrop.

Diamond drilling by the Bureau of Mines has confirmed the conclusion that the tin-bearing area is underlain by a granite protuberance. The most significant discovery is that the granite is strongly mineralized and may eventually become as important a source of tin as the acidic dykes. This granite apexes several hundred feet below the surface as a narrow ridge or spur trending roughly north–south. Drill holes around the boundary of the granite indicate that it slopes rather gently on its east flank and falls off abruptly on the west. The steep west slope is probably due to north–south faulting with considerable vertical displacement.

Rock specimens of the granite have been obtained only from drill cores. The material from some sections of the holes was so soft and friable, because of alteration, that the original texture and composition could only be surmised. On the contact such material chiefly consists of kaolin and calcite with smaller amounts of topaz, tourmaline, zinnwaldite, and sparse amounts of pyrite, sphalerite, galena, arsenopyrite, cassiterite, and wolframite. Locally variations occur in composition and amount of alteration and mineralization, but in general with increasing depth the granite appears less altered. Harder specimens are essentially quartz, clay, zinnwaldite, and topaz with minor amounts of tourmaline, galena, chalcopyrite, and sphalerite. Felspars in this zone are still too highly altered to be identifiable.

In some places sulphides may constitute up to 4% by weight of the rock, but there is no evidence of any association of sulphides and tin or constant ratio between the quantities of each.

The rocks of the contact zone are comprised of the metamorphosed limestones and dolomites, rhyolite and basalt porphyries, and veinlets. The effects of movement and eruptive forces are pronounced, with the formation of large and small breccia fragments and widespread slickensides. All the rocks have been attacked by solutions, with complete replacement occurring in many places, so that the original rock constituents are scarcely identifiable and the entire zone is a complex assembly of rocks and structures. Because of the many intrusives and periods of faulting, much fragmentation and fracturing has occurred, providing innumerable channels for the entrance of metallizing solutions. Although there are richer concentrations of tin locally, tin deposition has occurred in some degree in all formations. Wolframite, molybdenite, pyrite, chalcopyrite, arsenopyrite, galena, and sphalerite have also been introduced in various amounts, times, and places.

Ore-Bodies

The ore-bodies were sampled by the Bureau of Mines by means of surface trenching, underground sampling in parts of the old workings, and diamond drilling. During the course of the exploration 53 trenches with a combined length of 5,750 ft. were excavated by means of a bulldozer, 22 trenches with a combined length of 1,585 ft. were dug by hand, 251 channel samples were taken across a total length of 1,132 ft., 22 core-drill holes with a total depth of 8,693 ft. were completed, and 1,434 core and sludge samples were submitted for analysis. The Bureau decided that any great increase in ore reserves at the Lost River mine would have to be found in depth and that exploration should be principally in that direction.

Before diamond drilling was settled on as a means of exploration, it was recognized that because of the character of the ore drilling results might not be entirely satisfactory. Mineralization is spotty and generally occurs in small veinlets or seams. Moreover, earlier exploration had shown the enclosing rocks to be greatly altered and softened in the vicinity of concentrated tin deposition. As the cassiterite occurs in hard relatively-coarse grains or crystals, of which probably 90% is *plus* 200 mesh, whereas gangue minerals—such as, kaolin and dickite—occur unconsolidated and easily pulverized, it was expected that an appreciable percentage of the cassiterite might be freed from the gangue in drill sludges. Its high specific gravity would cause the freed cassiterite to lag and become entrapped in the hole.

During drilling in ore formations extreme care was observed in water pressures not to disintegrate cores more than necessary. After each pulling of the core the hole was washed clean for some time in an effort to recover all cuttings for the sample. Good water recovery was demanded at all times, except in a few extreme cases. Whenever the return water was lost, or it was suspected that the hole was sloughing or caving, drilling was stopped and the hole was cemented or cased. In spite of these precautions drill logs indicate that there was an appreciable lagging of cassiterite in the sludges.

Samples from all sources were dried, weighed, and crushed to proper size for splitting on a Jones sampler.

The exploration has shown that tin and tungsten ore reserves exist in the Cassiterite dyke in the granite and in the contact metamorphic zone. Other potential sources of ore are indicated—notably, in Ida Bell dyke near its intersection with Cassiterite dyke, in the Quartz-Porphyry dyke, and in the Intermediate dyke. Information on these latter deposits is too scanty to justify estimating any tonnage or grade.

Beneficiation Tests

Beneficiation tests were made on a representative sample of ore from the rhyolite-porphyry dykes. The sample was tested in the Bureau of Mines laboratories at Rolla, Mo. Satisfactory recoveries were obtained and a flow-sheet designed for a tentative 500 dry-ton daily mine production. The flow-sheet includes a slimes plant similar to that in operation at the Sullivan tin concentrator of the Consolidated Mining and Smelting Co. of Canada. The Sullivan concentrator is treating ore containing 0·065% tin in the tin concentrator and

is making a recovery of 45%. The percentage of recovery should be higher in the Lost River plant. Within the last few years several South American tin producers have successfully operated similar slime plants.

A microscopic examination of a composite sample showed that the ore was composed of numerous minerals. The minerals of economic value, listed in the order of their abundance, were cassiterite, wolframite, scheelite, arsenopyrite, sphalerite, galena, and molybdenite. The gangue was composed chiefly of topaz and zinnwaldite, with lesser amounts of calcite, fluorite, quartz, muscovite, chlorite, beryl, pyrite, oxides of iron, and clay minerals.

The cassiterite occurred mainly in amber to dark transparent and translucent crystal fragments. Most of it was freed by *minus* 14 mesh grinding, but part of the cassiterite remained intimately associated with the wolframite and iron oxides.

The wolframite occurred largely as dark-brown to black platy grains. Some was associated with arsenopyrite, pyrite, scheelite, and calcite. Grinding to *minus* 14 mesh was sufficient to free most of the wolframite.

The chemical analysis of the ore for testing was: Sn, 1·02% ; WO_3, 0·29% ; Fe, 2·79% ; Zn, 0·18% ; As, 0·10% ; Pb, 0·10% ; Mo, 0·03%.

Treatment Procedure

(1) Table concentration.
(2) Flotation of table concentrate.
(3) Magnetic separation of tin and tungsten.
(4) Chemical separation of tin and tungsten.

The flow-sheet for the proposed 500-ton tin-tungsten concentrator for the Lost River deposits involves stage grinding, with intermediate tabling, of the entire feed to *minus* 200 mesh. In the tests made tin and tungsten loss in the flotation concentrate was slight. The overall recovery in the flotation tailing was 75·6% of the Sn and 85·3% of the WO_3. Magnetic separation of the wolframite from the cassiterite in the flotation tailing gave merchantable products, but much of the tungsten remained in the tin concentrate.

To effect better separation of the tin and tungsten in the flotation tailing a series of tests is in progress in which leaching is employed. To date it is apparent that much better results will be obtained by this method than by magnetic separation, though the cost will be substantially higher.

Beneficiation tests are being made on ores in the granite or contact zone. However, the ores are similar in grain sizes and mineral composition to those of the rhyolite porphyry dykes. Possibly a larger amount of slimes would result from treatment of granite ores. This would affect the reclaiming of mill water, but overall recovery of metals should be comparable to recovery from dyke ores.

Tests on a composite sample of reject sludge samples were unsatisfactory, as the material was exceedingly fine ; only 1% of it was *plus* 100 mesh and 78% was *minus* 400 mesh. Additional tests will be made on a composite of diamond drill-core samples from the granite zone.

General

A large volume of fluorite rock is contained in the tin ores. Flotation tests to recover calcium fluorite as a by-product of the tin concentrator were inconclusive, but it is roughly estimated that over 2,000,000 tons of the tin ores, which will average 18% to 20% CaF_2, probably could be treated successfully in an auxiliary plant.

Flotation treatment of the tin-tungsten concentrate would produce a sulphide concentrate containing approximately 25% arsenic and smaller percentages of other metals. Further tests may show the possibility of profitably recovering one or more of these metals.

Development of water power in the Lost River area appears impractical owing to climatic and topographic conditions. No natural fuel resources are known to exist nearer than Candle, about 130 miles from Lost River, where a small amount of coal has been produced. It is doubtful that utilization of this coal for steam power would be cheaper than diesel power.

As the principal products of the Lost River mine would be tin and tungsten the value of the mine depends on market prices of these metals.

It is likely, the report states, that the present price for tin will be maintained several years after the war, as supplies will depend on the rehabilitation of foreign mines. On the other hand high prices for tungsten have stimulated domestic production and development and it is possible that the post-war market for tungsten will be over-supplied.

Magnetometer Work on the Canadian Shield

An address by T. Koulomzine given before a meeting of the Prospectors and Developers Association in Toronto in March last is reproduced in the *Western Miner* for July. In it the author reviews the application of geophysical prospecting methods, particularly magnetometer work, to the Canadian Pre-Cambrian shield. He points out that an overwhelming proportion of the mineral production of Canada comes from the shield. Although most of the ore-bearing Pre-Cambrian rocks have never been submerged and are not covered by sedimentary deposits, a few thousand years ago enormous glaciers forming an ice cap several thousand feet thick covered Canada. This ice cap, similar to that presently known over Greenland and the Antarctic Continent at the South Pole, has not only scratched the surface of the rocks but has also deposited a thin mantle of sand, clay, and boulders. This formation, varying usually between, say, 10 to 300 ft. in thickness, covers an average of 95% of the Pre-Cambrian shield and in some places—like, for instance, in the Eastern part of the Quebec gold belt—well over 99% of the area. The main problem of prospecting in the Canadian shield is, therefore, he says, not the examination of the outcrops, which are few indeed, but rather the securing of information on the rocks underlying the overburden.

The importance of examining the drive-covered areas in search for valuable ore-deposits has become more and more appreciated in the last years. This is clearly seen in the expanding use of the two main

tools for exploration of areas covered by glacial deposits. These tools are : (1) The diamond drill ; (2) geophysical prospecting in all its phases.

The use of diamond drilling has expanded tremendously in the last years. At present the number of drills in operation throughout the Dominion amounts to several hundred and the annual footage drilled certainly exceeds a million feet.

In spite of the fact that diamond drilling is the surest method of exploration it has its limitations. Piping through overburden prior to drilling in rock is exceedingly costly and represents one of the most difficult problems of modern engineering. Furthermore adequate exploration by diamond drilling of, say, a 1,000-acre property, with cross-sections placed at 500-ft. intervals, would necessitate the drilling of some 60,000 ft. and cost close to $200,000, an expense that the average mining company can ill afford in its first stages of exploration.

The main object of geophysical methods of prospecting is to assist the geologist and the mining engineer in their deductions by gathering positive physical facts which may help to decipher the geological structure of the rocks concealed by overburden. Only in certain rare, though spectacular, cases can geophysical prospecting indicate the presence of ore. Generally it is but a geological tool to assist in outlining the structure and thus lead the exploration to the areas where ore is most likely to be located.

Five principal methods of geophysical prospecting are known. They are : Gravimetric, magnetic, radioactive, electric, and seismic. Gravimetric and seismic methods are widely used in oil exploration, but for certain technical reasons their application to conditions prevailing in the Pre-Cambrian shield of Canada is not practical, at least in the present stage of development of the technique of these methods. These remarks could apply to the radioactive method, although this could and has been used in the restricted field of search for radium and uranium ore. Magnetic and electrical methods are widely used in Canada.

The modern magnetometer is an instrument of great precision. The principle involves balancing of the natural magnetic force by gravity—in other words, weighing the magnetic force. Although the instrument is easy to read and any intelligent operator can familiarize himself with the technique within a few weeks of training, it must be pointed out that all makes of magnetometers require constant care and must be serviced at regular and frequent intervals, usually about every two months. This servicing involves knowledge of the physical principles underlying the construction of the instrument. It can be done only by competent geophysicists.

The geological interpretation of magnetometer results is of general interest and the importance and value of this phase of geophysical prospecting can be easily grasped by geologist and mining men. The author gave a few typical examples where geophysical work resulted in valuable information.

Small outcrops of intrusive rocks have long been known to exist in the central part of Bourlamaque township. The two old geological maps—namely, " Dubuisson Sheet " No. 224-A of the Geological Survey of Canada and " Dubuisson-Bourlamaque Area " No. 147 issued by the Quebec Bureau of Mines—show these outcrops but they were considered to form small dykes or other intrusive masses. A magnetometer survey performed by the writer in 1940, for the Central Mining Corporation, over the properties now belonging to East Sullivan, Norseman, and Aumaque, resulted in the discovery of a large complex intrusive mass. Magnetically this mass was not uniform and the interpretation was not simple, with subsequent diamond drilling showing that some of the contacts of the intrusive had to be slightly shifted from their original location determined by the magnetometer results. Nevertheless, the discovery of this intrusive changed the entire geological picture of the township. Diamond drilling was started in the vicinity of the intrusive and on its contacts, important ore deposits have been found at East Sullivan and Aumaque, while at Norseman some gold values were recently encountered.

Similar results were obtained in Vassan township some 10 miles N.W. of Bourlamaque. Here, a magnetometer survey disclosed a large intrusive mass lying under the waters of Lake Demontigny, north-west of Siscoe, astride the boundary between the properties of Western Quebec Mines, Limited, and Snow-Shoe Mines, Limited. Exploratory diamond drilling not only confirmed the presence of the intrusive but revealed numerous commercial grade gold-bearing intersections.

A very interesting example of the application of geophysical methods, the author said, was a survey we performed last spring on part of the Hugh Malartic, Vinray, Bradnor, and Adele properties controlled by the Vincent Mining Corporation. The older geological maps of the district issued by the Geological Survey of Canada—Memoir 222 "Malartic area " by H. C. Gunning—did not indicate any particular structural features in the area covered by the survey. A few years ago Dr. Norman studied again the Malartic area and was able to subdivide the Malartic volcanics into a number of definite rock belts. This interpretation involved great geological skill because it was based on very few outcrops which had to be correlated not only over great distances, but also across the strike when the belts forming the complex have been displaced by faulting and folding. A large displacement of the various belts had been noticed by Norman on Hugh Malartic and Vinray properties and he assumed that this displacement was due to a fault which subsequently has been shown on maps Nos. 43-6A and 42-12 issued by the Geological Survey of Canada. When, last year, Vinray started a programme of diamond drilling to study the ore-making possibilities of this fault nothing of importance was found.

A magnetometer survey was performed at this stage of the development. The interpretation was not easy as numerous rock formations—such as, diorites, talcose, and peridotitic lavas as well as other basic lavas—were found to be strongly magnetic. Nevertheless, due to the large area covered by the survey, it was possible to obtain a picture of the general structure.

Geophysical prospecting, the author concluded by saying, was still in its infancy as far as the application to Canadian mining practice is concerned. Nevertheless its importance is growing fast and it can be estimated that several hundred thousand dollars are spent annually in Canada on geophysical prospecting.

Crushing Underground in New South Wales

A large underground crushing station being installed on the No. 14 (2,000-ft.) level of the New Occidental Gold Mine at Cobar, New South Wales, is described in the *Chemical Engineering and Mining Review* of Melbourne for May 10. The project is expected to be completed by the end of 1946. Output from this mine will then be increased to 9,000 to 10,000 tons monthly, as compared with 7,500 to 8,000 tons monthly pre-war. The only other mine in Australia operating an underground crushing station, it is stated, is the Mount Morgan, Ltd., mine at Mount Morgan, Queensland.

There are two principal reasons for placing the primary crushing station underground at New Occidental. These are :—

(1) To reduce the amount of costly secondary breaking of run-of-mine ore. With the blast-hole open-stope mining method used there is an appreciable number of large pieces of ore which would require " popping " if the crusher were not installed underground.

(2) To increase the capacity of the small shaft dimensions of which are 13 ft. 1 in, by 5 ft. 6 in. With the smaller crushed ore the capacity of the skip will be increased and the difficulties experienced in the past in loading large ore into a small skip will be eliminated.

Along the No. 14 level (1,922 ft.), at present the deepest level of the New Occidental mine, the ore will be transported in Granby self-dumping trucks of 1½-tons ore capacity. The trucks will be arranged in rakes of six and will be hauled by a Mancha electric storage-battery locomotive. From the trucks the ore will fall into a storage bin of 800 tons capacity.

From this bin the run-of-mine ore will be delivered by Ross feeder into a 36 in. by 24 in. Ruwolt jaw-crusher, fitted with self-aligning SKF roller bearings. This crusher has been specially designed to withstand severe operating conditions with minimum servicing and maintenance. It will be driven by an 80-h.p. electric motor, 415 volt, 3 phase, 50 cycle. Crusher product will be 4 in. maximum size and will be discharged to a crushed-ore bin of 80 tons capacity. From this bin the ore will be delivered to a skip measuring pocket of 1½-ton capacity.

Great care has been taken to insure that dust-laden air from the crusher station does not pass into the mine air. Dust will be drawn from above and below the enclosed jaw-crusher through a cyclone fan driven by an electric motor. The fan will discharge through piping to the old stopes in the upper levels of the mine. Coarser dust settling in the cone of the cyclone will be sluiced out periodically and the slurry passed to the crushed-ore pocket.

Crushed ore from the mine cage will be delivered into the surface ore-bin which is incorporated in the shaft headframe. From this bin the ore is transferred by an existing 24-in. conveyor-belt to the 4-ft. Symons cone-crusher, which delivers a ¼-in. product for the cyanidation treatment plant.

New Occidental Ore-body

The main ore-body of the New Occidental mine is 250 ft. long by 60 ft. wide and occurs in a well-defined shear zone at the junction of sandstone and slate. The sandstone forms the eastern wall of the ore-body and the slate the western wall. At the northern end the ore-body is split by a horse of mullock in two legs—eastern and western—which are 250 ft. long and average 25 ft. wide. Overall length of the ore-body is 500 ft.

Little ore, other than remnants, now remains in the New Occidental mine above the No. 11 level (1,116 ft. vertical). In April, 1945, the company decided to cease treatment of New Occidental ore and to concentrate upon a programme of development of which the installation of the crusher station forms a significant part. The position at present is that the No. 12 level (1,484 ft.) has been fully developed and cross-cutting through the ore-body is proceeding at the No. 14 level. The plat at No. 13 level (1,784 ft.) has been cut and the ore-body has been cross-cut and driven north to prepare for sub-level stoping development. Ore will go direct from No. 12 to No. 14 level.

Mining Methods

Ore treatment of New Occidental ore is expected to recommence again in May, 1946. The ore will be stoped between the No. 12 and No. 11 levels and between the No. 14 and No. 12 levels. The method of mining will be by sub-level, using blast-hole diamond drilling. Previous experience with blast-hole diamond drilling has convinced the management that this method will bring lower mining cost. This method involves driving main levels from the main cross-cut at vertical intervals of 200 ft. between No. 12 and No. 13 levels and of 175 ft. between No. 13 and No. 14 levels. At 65 ft. above the level a bell floor is opened out and connected to the main drive by rises spaced at varying intervals depending upon the dimensions of the ore-body. The rises are splayed outward to either wall and between one rise and the next from approximately 60 ft. above the main drive to give a slope of 45° and permit the easy withdrawal of broken ore.

For operation of the blast-hole method a blast floor is opened out 90 ft. below the level above. The blast floor and the bell floor must be connected by a winze, which is then extended across the lode 70 ft. to form a slot, the depth of the block being 90 ft. Diamond drill-holes, 2 in. diameter, are drilled from the blast floor in a vertical direction, the holes in each line being staggered with respect to the holes in the next line. Closely-spaced holes are drilled in each wall to give a clean separation of ore from the walls of the lode.

Boring is being carried out using 2-in. coring diamond drill bits, which allow 90-ft. holes to be bored with little deflection and which have proved superior to non-coring bits with respect to cost and speed of drilling. During experimentation it was found that drilling speed was increased from 9 ft. per shift to 17 ft. per shift when solid bits were replaced by the coring type. The machine in use is a Boyles Bros. Pty., Ltd., Standard J.V. drill, with a speed of 2,300 r.p.m. and compressed air at 85 lb. per sq. in. Rods are made by cutting standard " B " rods into suitable sections for blast-hole work and the bits designed to give the rods a minimum clearance in the holes. The holes are charged with 1¼-in. diameter cartridges, 10 in. long,

of 5% nitrate gelatine dynamite, specially manufactured by Imperial Chemical Industries of Aust. and N.Z., Ltd.

Ore Treatment

During the war period, at the request of the Commonwealth Government, the operating company, New Occidental Gold Mines, N.L., re-opened the Chesney gold-copper mine situated between the New Occidental and New Cobar mines. Ore from the Chesney mine, assaying 1·5% copper and 4 dwt. gold per ton, was treated at the New Occidental flotation plant, together with the New Cobar ore, until January, 1945, when production at Chesney ceased.

Ore from the New Cobar mine, assaying 1·3% copper and 6 dwt. gold per ton, has been treated at the New Occidental plant in a separate flotation section since 1938. It is expected that production from this mine will be maintained at 6,000 tons monthly, the flotation concentrate assaying 16% copper and 2½ to 3 oz. gold per ton being disposed of to a custom's smelter.

New Occidental ore is treated by fine grinding and cyanidation. The feed normally assays 7·5 to 8·0 dwt. gold per ton and a recovery of approximately 90% is made. Difficulty in treatment is occasionally experienced when chalcopyrite and pyrrhotite occur in the feed.

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.

Examination, Boring, and Valuation of Alluvial and Kindred Ore Deposits. By H. L. H. HARRISON. Cloth, octavo, 266 pages, illustrated. Price 30s. London : Mining Publications, Ltd.

Bibliography of North American Geology, 1942 and 1943 : U.S. Geol. Surv. Bull. 949. By E. M. THOM. Paper covers, 460 pages. Price 70 cents. Washington : Superintendent of Documents.

Minerals of the Montmorillonite Group : Their Origin and Relation to Soils and Clays. U.S. Geol. Surv. Prof. Paper 205–B. By C. S. Ross and S. B. HENDRICKS. Paper covers, pp. 23–79, illustrated. Price 35 cents. Washington : Superintendent of Documents.

The Mining Survey, Vol. 1, No. 1, Apr., 1946, Paper covers, 20 pages, illustrated. London : London Secretaries, Transvaal Chamber of Mines.

Nigeria : Ann. Report of the Mines Department, 1944. Paper covers, 20 pages. Price 1s. London : Crown Agents for the Colonies.

Manufactures of the Non-Ferrous Metals in Canada, 1939–1943. Paper covers, 124 pages. Price 50 cents. Ottawa : Dominion Bureau of Statistics.

World Timbers, Vol. II. Ten Timber Leaflets. London : Timber Development Association.

Annales des Mines Statistics, 1945. Paper covers, 63 pages. Paris : Imprimerie Nationale.

Chromite-Bearing Sands of the Southern Part of the Coast of Oregon. U.S. Geol. Surv. Bull. 945–E. By A. B. GRIGGS. Paper covers, pp. 113–150, with maps. Price 55 cents. Washington : Superintendent of Documents.

Nickel-Copper Prospect near Spirit Mountain, Copper River Region, Alaska. U.S. Geol. Surv. Bull. 943–C. By J. KINGSTON and D. J. MILLER. Paper covers, pp. 49–57, illustrated. Price 10 cents. Washington : Superintendent of Documents.

Quicksilver-Antimony Deposits of Huitzuco, Guerrero, Mexico. U.S. Geol. Surv. Bull. 946–B. By J. F. MCALLISTER and D. H. ORTIZ. Paper covers, pp. 49–71, with maps. Price 75 cents. Washington : Superintendent of Documents.

Tungsten Deposits of the Southern Part of Sonora, Mexico. U.S. Geol. Surv. Bull. 946–D. By J. H. WIESE and S. CARDENAS. Paper covers, pp. 103–130, with map. Price 15 cents. Washington : Superintendent of Documents.

Scheelite Deposits in the Northern Part of the Sierra de Juarez, Northern Territory, Lower California, Mexico. U.S. Geol. Surv. Bull. 946–C. By C. FRIES and E. SCHMITTER. Paper covers, pp. 73–101, with maps. Price 25 cents. Washington : Superintendent of Documents.

San José Antimony Mines, Near Wadley, State of San Luis Potosí, Mexico. U.S. Geol. Surv. Bull 946–E. By D. E. WHITE and J. GONZÁLES. Paper covers, pp. 131–153, with maps. Price 40 cents. Washington : Superintendent of Documents.

Developments of Geophysical Prospecting in Germany During the War. B.I.O.S. Final Report No. 334, Item No. 30. Paper covers, 5 pages, typescript. Price 1s. London : H.M. Stationery Office.

Venezuela : Servicio Ténico de Mineria y Geologia, Resumen de sus Actividades 1936–1946. Paper covers, 77 pages. Caracas : Ministerio de Fomento.

Oil and Petroleum Year Book, 1946. Compiled by WALTER E. SKINNER. Cloth, octavo, 200 pages. Price 15s. London : Walter E. Skinner.

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.

13,810 of 1941 (578,475). F. JUELL, Oslo, Norway. Nozzle device capable of accelerating and modifying the bubbles injected into pneumatic cells used for the separation of solid materials in suspension.

1158 of 1942 (578,307). AMERICAN CYANAMID Co., New York. The passage of fluids through suitable resinous materials is found capable of modifying the relative concentration of the ions they contain.

2,002 of 1943 (578,308). BOLIDENS GRUVAKTIEBOLAG, Stockholm, Sweden. Process and apparatus for the full-cell impregnation of timber and similar materials with preservatives.

6314 and 6316 of 1943 (578,694 and 578,695). AMERICAN CYANAMID Co., New York. Reagents applicable to the selective flotation of acidic minerals from other ore constituents.

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

Development, Canada : *Transport, N.W.T.* Transportation in the North. A. M. BERRY, *Western Miner*, Aug., 1946.

Gold, Price : *Trend, Review.* The Future Price of Gold. J. A. CRUMB, *Western Miner*, Aug., 1946.

Production, Canada : *Gold, B.C.* Placer Mining in British Columbia. *Western Miner*, Aug., 1946.

Production, United States : *Helium, Review.* Helium Production in the United States. *Engg.*, Sept. 6, 1946.

Production, United States : *Phosphate, Florida.* Florida Phosphate Mining. *Exc. Eng.*, Aug., 1946.

Resources, Australia : *Coal, Victoria.* The Composition of Victorian Brown Coals. A. B. EDWARDS, *Proc.* Aust. Inst. Min. Met., N.S. No. 140, Dec., 1945.

Resources, China : *Mineral, Survey.* Mineral Resources of China. V. C. JUAN, *Econ. Geol.*, June-July, 1946, Part 2, Supplement.

Resources, Malaya : *Mineral, Survey.* The Relationship of the Geological Survey to the Mining Industry of Malaya. E. S. WILLBOURN, *Bull.* Imp. Inst., Vol. XLIV, No. 2 (Apr.-June, 1946).

Resources, South Africa : *Barytes, Swaziland.* Barytes in Swaziland. A. T. M. MEHLISS, *S.A. Min. Eng. Journ.*, July 6, 1946.

Resources, United States : *Non-Metallic, New Mexico.* Non-Metallic Minerals of New Mexico. F. KUTNEWSKY, *Comp. Air Mag.*, Aug., 1946.

†**Resources, United States :** *Tin, Alaska.* Lost River Tin Deposit, Seward Peninsula. H. E. HEIDE, U.S. Bur. Mines Rep. Inv. 3902.

***Resources, Venezuela :** *General, Andes.* The Venezuelan Andes and the Central and Interior Ranges. J. C. DAVEY, THE MINING MAGAZINE, Aug., Sept., 1946.

†**Resources, World :** *Mineral, Future.* America's Future Mineral Problems. W. E. WRATHER, *Min. Met.*, Aug., 1946.

Geology

Economic, Canada : *Gold, B.C.* Structural Control of Ore at the Surf Point and Edge Pass Mines. A. SMITH, *Western Miner*, Aug., 1946.

Economic, Canada : *Gold, Ontario.* Matachewan Consolidated Mines. D. C. MCLAREN, *Can. Min. Journ.*, July, 1946.

Economic, Malaya : *Work, Survey.* The Relationship of the Geological Survey to the Mining Industry of Malaya. E. S. WILLBOURN, *Bull.* Imp. Inst., Vol. XLIV, No. 2 (Apr.-June, 1946).

†**Economic, United States :** *Tin, Alaska.* Lost River Tin Deposit, Seward Peninsula. H. E. HEIDE, U.S. Bur. Mines Rep. Inv. 3902.

***Economic, Venezuela :** *General, Andes.* The Venezuelan Andes and the Central and Interior Ranges. J. C. DAVEY, THE MINING MAGAZINE, Aug., Sept., 1946.

Mineralogy, Economic : *Earths, Rare.* Cerium and Thorium. E. F. ROOTS, *Western Miner*, Aug., 1946.

***Prospecting, Drilling :** *Coring, Continuous.* Drilling with Counterflush Continuous Coring. C. J. ESSELING, THE MINING MAGAZINE, Sept., 1946.

Regional, Canada : *Yellowknife, N.W.T.* Some Recent Geological Data on the Yellowknife Area. C. RILEY, *Can. Min. Journ.*, July, 1946.

†**Survey, Geophysics :** *Magnetometric, Canada.* Application of Geophysical Prospecting Methods on the Canadian Shield. T. KOULOMZINE, *Western Miner*, July, 1946.

Survey, Geophysics : *Methods, German.* Developments in Geophysical Prospecting in Germany during the War. B.I.O.S. Final Report No. 334, Item No. 30.

Survey, Topographic : *Work, Organization.* Some Suggestions for Speeding up Work on Topographical Surveys. N. B. FAVELL, *Enp. Surv. Rev.*, July, 1946.

Metallurgy

Analysis, Polarographic : *Metals, Review.* Systematic Polarographic Metal Analysis. J. J. LINGANE, *Ind. Eng. Chem.* (Anal. Ed.), July 23, 1946.

Industry, Rare-Metal : *Progress, Germany.* The Platinum Metals Industry in Germany. B.I.O.S. Final Report No. 441, Item No. 21.

Ores, Iron : *Preparation, Germany.* Iron Ore Preparation in Germany. B.I.O.S. Final Report No. 592, Item No. 21.

Smelting, Non-Ferrous : *Progress, Germany.* Copper, Lead, Zinc, Tin, and Antimony Smelting and Refining in North-Western Germany. F.I.A.T. Final Report No. 229.

Machines, Materials

Compressor, Portable : *Plant, Lightweight.* A Lightweight Portable Air Compressor. *Eng.*, Aug. 2, 1946.

Earths, Rare : *Resources, Properties.* Cerium and Thorium. E. F. ROOTS, *Western Miner*, Aug., 1946.

Mains, Pumping : *Chart, Strength.* Strength and Thickness of Pumping Mains. R. MCADAM, *Coll. Eng.*, Sept., 1946.

Mica, Canadian : *Supplies, Uses.* Mica as a Critical War Mineral. H. S. SPENCE, *Can. Min. Journ.*, July, 1946.

Pipes, Steel : *Re-inforcement, Branch.* Reinforcement of Branch Pieces. J. S. BLAIR, *Engg.*, Sept. 6, 1946.

Props, Mine : *Resistance, Measurement.* Measurement of Prop Resistance. W. H. N. CARTER, W. H. EVANS, *Iron, Coal Trades Rev.*, Aug. 2, 1946.

Winder, Coal : *Plant, Automatic.* A Small Automatic Winder. *Coll. Eng.*, Aug., 1946.

Mining

Alluvial, Canada : *Gold, B.C.* Placer Mining in British Columbia. *Western Miner*, Aug., 1946.

Alluvial, Dredging : *Problems, Mechanical.* Solving Mechanical Problems in Dredging. L. L. ROGERS, *Western Miner*, July, 1946.

†**General, Australia :** *Gold, N.S.W.* Crushing Underground at the New Occidental Gold Mine, Cobar. *Chem. Eng. Min. Rev.* (Melbourne), May 10, 1946.

General, Canada : *Gold, Ontario.* Matachewan Consolidated Mines. D. C. MCLAREN, *Can. Min. Journ.*, July, 1946.

Handling, Coal : *Winding, Skip.* Coal Skip-Winding Plants. J. W. WARDELL, *Coll. Eng.*, Sept., 1946.

Handling, Haulage : *Locomotives, Diesel.* The Diesel Locomotive Underground—7. B. REED, *Coll. Eng.*, Aug., Sept., 1946.

Handling, Ropeway : *Installation, Colliery.* Aerial Ropeway at Bolsover Colliery. *Mech. Handling*, Aug., 1946.

Hazards, Coal : *Bumps, Control.* Bumps in the South Staffordshire Thick Coal. *Iron, Coal Trades Rev.*, Sept. 6, 1946.

†**Hazards, Rockburst :** *Control, Canada.* Rockburst Incidence, Research and Control Measures at Lake Shore Mines, Ltd. W. T. ROBSON, *Can. Min. Met. Bull.*, July, 1946.

Hygiene, Silicosis : *Control, Dust.* Dust Suppression in South Wales Coal Mines. J. H. GRIFFITHS, J. C. WEBB, *Iron, Coal Trades Rev.*, Aug. 23, 1946.

Hygiene, Silicosis : *Dust, Sampling.* Sampling and Analysis of Dust in Suspension. D. G. SKINNER, A. G. WITHERS, *Iron, Coal Trades Rev.*, Sept. 6, 1946.

Hygiene, Silicosis : *Therapy, Aluminium.* Aluminium in Silicosis Prevention : A Survey of the Latest Developments. *S.A. Min. Eng. Journ.*, June 22, 1946.

Open-Cast, Loading : *Operation, Shovel.* Shovel Loading. L. DU BOIS, *Exc. Eng.*, Aug., 1946.

***Plant, Maintenance :** *Castings, Welding.* Estimating Welding Costs on Castings. H. SEYMOUR, THE MINING MAGAZINE, Sept., 1946.

Plant, Maintenance : *Lubrication, Underground.* Lubrication of Underground Mining Plant. P. G. TAIGEL, Int. Tech. Congress, Paris, Sept., 1946.

Power, Diesel : *Plants, Australia.* Some Installation, Operational, and Maintenance Aspects of Diesel Engine Power Plant, Gold Mines of Kalgoorlie, Ltd., W.A. A. B. SMITH, *Proc.* Aust. Inst. Min. Met., W.S. No. 140, Dec., 1945.

Power, Steam : *Practice, Boiler.* Modern British Boiler Practice for Power Plants. British Water-Tube Boilermakers' Association. Int. Tech. Congress, Paris, Sept., 1946.

***Sampling, Drilling :** *Coring, Continuous.* Drilling with Counterflush Continuous Coring. C. J. ESSELING, THE MINING MAGAZINE, Sept., 1946.

Support, Ground : *Pressure, Control.* Rock Pressure and Roof Support—5. Z. S. BEYL, *Coll. Eng.*, Aug., 1946.

Ore-Dressing

Coal, Cleaning : *De-Ashing, Germany.* The De-Ashing of Coal by Froth Flotation and Acid Extraction and the Ruhrwerks Coal-Cleaning Process. B.I.O.S. Final Report No. 523, Item No. 30.

†**Crushing, Underground :** *Plant, Australia.* Crushing Underground at the New Occidental Gold Mine, Cobar. *Chem. Eng. Min. Rev.* (Melbourne), May 10, 1946.

***Design, Plant :** *Requirements, Labour.* Mill Design, Ore-Dressing Notes, THE MINING MAGAZINE, Sept., 1946.

Flotation, Coal : *Slurry, Treatment.* Washing Slurry at Grimethorpe Colliery. *Iron, Coal Trades Rev.*, Sept. 6, 1946.

General, Canada : *Gold, Ontario.* Matachewan Consolidated Mines. D. C. MCLAREN, *Can. Min. Journ.*, July, 1946.

Gravity, Jigging : *Corundum, South Africa.* Corundum Concentration in the Field : Tests in Use of Harz Jig. J. LEVIN, *S.A. Min. Eng. Journ.*, July 13, 20, 1946.

***Hydraulics, Flow :** *Spigots, Pulp.* The Flow of Pulp through Spigots. R. T. HANCOCK, THE MINING MAGAZINE, Sept., 1946.

***Size, Particle :** *Behaviour, Pulp.* Particle Shapes. Ore-Dressing Notes, THE MINING MAGAZINE, Sept., 1946.

COMPANY MEETINGS AND REPORTS SECTION

MYSORE GOLD MINING CO., LTD.

Directors : Sir Charles A. Innes (*Chairman*), Sir Frank Noyce, Thomas Pryor, Sydney E. Taylor. *Managers :* Messrs. John Taylor and Sons. *Secretary :* J. A. White. *Office :* 2, White Lion Court, Cornhill, London, E.C. 3. *Formed* 1880. *Capital :* £610,000 in 10s. stock units.

Business : Operates gold-mining properties in the Mysore State, India.

The sixty-sixth ordinary general meeting of the Mysore Gold Mining Co., Ltd., was held at 2, White Lion Court, E.C., Sir Charles A. Innes presiding.

The chairman, in moving the adoption of the report and accounts for the year ended December 31, 1945, said : The results of the year's working are conveniently summarized in the directors' report and I do not propose to say much about them. Shortage both of labour and of materials continued to affect operations and did not permit of a resumption of work below the 76th level. 157,819 tons of ore were milled, rather more than in the preceding year, but the current production of gold dropped from 53,406 oz. to 47,408 oz. The reason for the decrease is that, in pursuance of the policy agreed with the Government of Mysore, we worked a lower grade of ore, the average assay value of the ore milled being only 6·1 dwt., against 7·1 dwt. in 1944. Including the gold obtained by a special clean-up in June, our total production of gold was 49,194 oz. and our sales realized, at an average price of £15 4s. 2¼d., £748,214. In the previous year, 56,673 oz. of gold realized £807,900, but this year our policy of working to a lower grade of ore earned for us a refund of gold duty amounting to £107,320, whereas in 1944 the *ex gratia* payment made to us by the Government of Mysore was only £42,039. On the other hand, there was a further increase of more than £17,000 in our working expenses, the increase being due to the higher cost of labour.

The net result of these and other minor factors is that the amount standing at credit of profit and loss is £128,860, against £140,596 in 1944, but this year we reap the benefit of the action we took last year to square up our Income Tax position and we have had to provide for Income Tax only £32,000, against £72,000 in 1944. We have made much the same provisions for writing down buildings and shaft sinking and for our Provident Fund. We are paying a dividend of 5% free of tax, instead of 5% less tax as in 1944 ; we are making a provision of £27,030 for Special Reserve, the reason for which I will explain later, and we are carrying forward £11,832 to next year.

I explained to you in some detail, in my speech last year, the scheme devised by the Government of Mysore to give us some relief from the very heavy burden of the Gold Duty. The Scheme was introduced in April, 1945. It was an experimental scheme and it was agreed that it should be reviewed and if necessary revised at the end of the year. It was only to be expected, therefore, that initial difficulties should be experienced. The scheme announced by the Government in April did not receive legislative sanction till August, when the Mysore Duty on Gold (Amendment) Act was passed. One important section of the Act was obscure and the obscurity was not cleared up until the Rules under the Act were amended in November. Thus, the year had nearly ended before we knew for certain what relief we should receive when the final settlement was made and this uncertainty made it impossible for us properly to control mining policy and grade. As it turned out, we worked rather too high a grade of ore and this fact explains why the relief received for 1945 was only 38% of the duty paid instead of the 50% admissible under the Amendment Act. Moreover the Rules prescribed that applications for relief must be made to a Reviewing Committee and this Committee was not appointed until November. Now, as you know, the Gold Duty is a very onerous tax. In 1945, we had to pay by way of duty £281,575. The relief scheme contemplated that a considerable part of this levy should be refunded to us, but owing to the delay in setting up the Reviewing Committee, we were compelled to pay over the full amount of the duty for almost the whole of the year. It was not until December that we received our first refund, another instalment was paid in February of the current year and the final instalment was not received till May. At the same time you will remember we were deliberately reducing our output of gold by working to a low-grade policy and moreover we had begun the year in financial embarrassment owing to the calamity of the previous year when the mine was shut down for some weeks owing to an accident to the main Electric Supply Station. The result was that throughout the latter part of the year our cash resources were very seriously depleted—a fact which was a great handicap when in January of this year we were faced by a prolonged strike in the Mine.

Apart, however, from these initial difficulties, our experience of the working of the Relief Scheme in its early stages merely served to confirm the belief which we have always held, that the only real remedy for the situation in which the mines in the Kolar goldfields now find themselves is for the Government to abolish the Gold Duty altogether. The object of the Government, as indeed it is of the Companies themselves, is to prolong the life of the mines. The Relief Scheme does enable us to work a lower grade of ore and thereby ensures a better exploitation of available ore supplies. But it makes no provision for the substantial amounts of capital expenditure that are required for searching for fresh ore and for deepening the mine. In the past it has usually been possible to find the cost of work of this kind out of profits, but even under the Relief Scheme profits are so restricted that nothing is available from this source. It is already a matter of urgent importance that new supplies of ore should be found. Our reserves of payable ore have declined from 453,000 tons in 1940 to 282,000 tons at the end of 1945 and proper mining practice requires that we should resume without delay a programme of vigorous development. We have a number of

schemes in mind. We ought to deepen the mine with the object of discovering a new ore-shoot. From the mining point of view the prospect of making such a discovery warrants a thorough programme of exploration. Moreover the large area of reef round Edgar's shaft pillar is known to contain valuable ore in quantity. The ground is difficult, but the great advance that has been made in mining methods enables us to work it. But projects of this kind are expensive; moreover it will take time to carry them out and in the early stages the expenditure will be unproductive. It is here that we come up against two main difficulties. In the first place, the effect of the Gold Duty and of the limitation, under the Relief Scheme, of refunds of the Gold Duty to 50% of the amount of duty actually paid by the company must be to reduce the attractiveness of such projects for the company. And secondly, our profits are so restricted even under the Relief Scheme that we are unable to finance the capital expenditure involved.

Accordingly it was decided that Mr. Sydney Taylor should pay another visit to the Fields in the beginning of this year when, as I have just told you, the Relief Scheme was due for review. We thought it important that he should himself submit to the Government the conclusions we had arrived at as the result of our experience of the working of the scheme between April and December. Part of his duty was to establish our claim for Relief for 1945 and to suggest practical improvements in the detailed working of the scheme and these tasks were successfully accomplished. In particular, arrangements have now been made for periodical payments of Relief, subject to final adjustment at the end of the year. Mr. Taylor was also able to persuade the Government to agree that the maximum dividend ordinarily payable under the scheme should be 7½% free of tax instead of 10% less tax and also that the bonus which we earn under the scheme if the grade worked is below a certain figure might be added to the dividend at our discretion, irrespective of the above maximum. We owe our thanks to the Government for meeting us in these matters. But Mr. Taylor was also instructed again to press for the abolition of the Gold Duty and the substitution for it of a tax based on profits, or failing this, for the removal of the 50% limitation on refunds. I may remark in passing that our case for abolition had been strengthened by the fact that a similar impost in Southern Rhodesia had recently been removed on the strong recommendation of a Commission appointed to inquire into the Gold Mining Industry in that country. In Mysore we were not so fortunate and the Government found themselves unable to agree to either request. No doubt they have their own difficulties, but I confess that their decision came as a disappointment to us.

Mr. Taylor, however, was able to bring home to the Government the urgent need for the initiation of a vigorous programme of development with the object of discovering fresh supplies of ore and I am authorized to make the following announcement :—

" Conversations have been in progress for some time with the Government of H.H. The Maharaja of Mysore regarding financial ways and means for the post-war rehabilitation of the Industry in harmony with a policy of longevity, which is being examined sympathetically by the Government of Mysore. Negotiations have reached an advanced stage for the obtaining of a loan at a low rate of interest for financing the Capital Expenditure for the current year according to an approved programme. It is hoped to be able to make a fuller and more detailed announcement on the subject in the near future when the negotiations have been finally concluded, but it can now be said that the information contained in this notice is published with the knowledge and approval of the Government of Mysore."

You are aware that in May and June, 1945, there was a strike on the fields. We took precaution of obtaining the approval of the Government to the terms which we decided to offer. The men refused to accept the terms and again came out on strike in January of this year. On the advice of Mr. Sydney Taylor, who fortunately was in the Fields, and of our committee there we offered further concessions. These terms were accepted and the men returned to work on March 22.

I am afraid that there is no doubt that the strike was a great misfortune. All production of gold at the mine ceased for more than two months just when Indian gold prices were at their peak. Our cash resources, which as I have already told you were depleted at the end of 1945, were further reduced and still constitute a difficulty. This is one reason why we have thought it wise to limit the dividend to 5% free of tax and to make a beginning with the building up of a special reserve fund.

Mr. Taylor will tell you of mining developments during the year 1945. I will merely say that though we must wait till the reef has been proved in more detail before we can estimate the full significance of the discovery, we do seem to have discovered a rich ore-shoot in the 43rd level. Our prospects for the current year have of course been adversely affected by the strike, but the price of gold in India remains high and if these high prices continue, I am hopeful that the financial results will approximate to those of 1945. I need not remind you that the Mine is a high cost mine and that future prospects depend very largely on the maintenance of a high price of gold in India.

Mr. Sydney E. Taylor, in reviewing the mining developments, said : Progress in the year 1945 would undoubtedly have shown a marked improvement over 1944 had it not been for the strike which caused a complete stoppage of all work for a month. The development work accomplished during 1945 totalled 8,273 ft., only 109 ft. more than in 1944. As labour has continued to be in short supply throughout the year it was not possible to resume development of the bottom levels of the mine, work was therefore confined to the middle and upper levels. The discovery of rich ore in the 43rd level north of Ribblesdale's No. 1 winze, reported a year ago, was followed down to the 44th level and up to the 42nd and 41st levels. This ore-shoot, which was 233 ft. long at the 43rd level, was only 58 ft. long at the 44th level, being cut off by faulting at the north end.

The scheme of relief from Gold Duty by which £107,230 was refunded out of £281,575 paid made it possible to reduce the grade of ore treated by 1 dwt. per ton.

The report was adopted.

INDIAN COPPER CORPORATION, LTD.

Directors : Sir Godfrey B. H. Fell (*Chairman and Managing*), Robert Annan, Capt. Hugh Vivian, H. R. Mackilligin, D. S. Warren. *Consulting Engineers and Technical Managers :* New Consolidated Gold Fields, Ltd. *General Manager in India :* E. R. Dempster. *Secretary :* A. Shelley. *Office :* 49, Moorgate, London, E.C. 2. *Formed* 1924. *Capital issued :* £900,000 in 2s. shares.

Business : Operates copper-mining properties in the Singhbhum district, Chota Nagpur, India.

The twenty-second ordinary general meeting of Indian Copper Corporation, Ltd., was held on September 11 at the Institute of Chartered Accountants, London, E.C.

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.

Accounts.—The net proceeds of sales and adjustment of stocks on hand amounted to £945,036, an increase of £20,770 over last year. Interest and sundry receipts were also higher by £12,545, mainly on account of the resumption of shipments of kyanite to the Continent after the war. The total increase of £33,315 was, however, offset by heavier operating costs of £32,034, with the net result that the profit was only £1,280 higher than last year.

Capital Expenditure.—You will note from the balance sheet that there was an overdraft at the bank of £52,000 at December 31, 1945. As foreshadowed in my address last year we have embarked on a large expansion programme. We have ordered a 4,000-kW. turbo-alternator electric generating set and a 4-high cold rolling mill, together with accessories and spares, for which payments have been made on account, necessitating recourse to the bank. It is estimated that a sum of £250,000 in all will be required for these items, including the sinking of the new vertical shaft recommended by Dr. Pelletier. Proposals are submitted for your approval at this meeting to increase the capital by creating 1,000,000 new shares of 2s. each, for issue by the directors on such terms and conditions as they may determine, to provide in part the finance required for this programme.

Development.—Good development results are reported at Mosaboni, chiefly on the North Badia Section, in which some 50% of the development during the year was carried out. At Badia, however, we are entering a poor zone, but it is reasonable to expect that some improvement will take place in depth.

Ore reserves have shown a steady improvement during the past few years. Present ore reserves of 2,126,343 short tons are sufficient to maintain milling operations at their existing level of 350,000 tons per annum for five years.

Ventilation problems will soon become acute and emphasize the necessity of undertaking, as soon as practicable, the sinking of the new vertical shaft.

New Refinery.—A new refinery-cum-foundry has been successfully brought into operation since the close of the year. The whole layout was designed by our works manager, Mr. H. C. Robson. It consists of two refining furnaces, so arranged for tilting that molten refined copper can be poured into a ladle rotating on a pivoted arm serving two electric furnaces, into which the refined copper can then be transferred in its molten state, thus eliminating solidification and re-melting. Handling is reduced to a minimum, resulting in a considerable saving in the costs for copper refining and brass casting.

General.—Since the close of the year under review the import duty on unwrought copper has been abolished, with the result that we now have to compete on equal terms with copper imported from other countries, where the grade of ore from which their copper is won is much higher than ours. For the present, with the high world price of copper, we can still compete ; but if and when the world price falls this may cease to be possible. We might even be forced to close down our mines, resulting in throwing some 3,700 men out of employment and confine our future activities to the treatment of imported blister copper, unless the Government of India afford us assistance, either by re-imposing the duty or by granting a subsidy. We have recently approached the Government of India with the request that they will give us an indication of their probable attitude towards our application for assistance, should this necessity unfortunately arise, and we gratefully acknowledge the sympathetic hearing which they have given us.

We have also been fortunate in securing a relaxation of the controls exercised throughout the war, which *inter alia* limited the price at which our products might be sold, either to the Government, the principal buyer, or to the market, to a figure which would enable us to earn only an agreed profit on the capital employed.

A maximum figure has now been agreed and within this limit we may sell our products without having to submit our operating costs to the scrutiny of Government accountants and to refund, as hitherto, any sum by which the ascertained profits exceeded a certain figure.

Shareholders will no doubt be anxious to know what effect the proposed grant of complete independence to India may have upon the fortunes of this Corporation. The political situation in India is still so fluid and uncertain that anything in the nature of prophecy would be rash in the extreme. Like all well-wishers of India I can only hope that the communal differences will before long be reconciled and that India, under a Government of its own choosing, will progress steadily towards its goal—namely, to become a great and prosperous country with industries so developed as to provide additional employment for its rapidly increasing population. I believe that British co-operation can contribute materially towards this end, and I know that it will be readily forthcoming. We for our part will do our best to ensure that our undertaking—the only one of its kind in India—will continue to operate at maximum efficiency and thus be in a position to meet, for many years to come, a large part of India's demand for Y.M. brass and copper producers.

KADUNA SYNDICATE, LTD.

Directors : Sir Godfrey Fell (*Chairman*), J. W. Anderson, Charles Leach, H. R. Muckilligin, Fredk. Lee. *Secretary :* Fredk. Lee. *Office :* 78, Highlands Heath, Putney, London, S.W. 15. *Formed* 1910. *Capital issued :* £48,000 in 2s. shares.

Business : Operates alluvial tin areas in Northern Nigeria.

The thirty-fifth ordinary general meeting of the Kaduna Syndicate, Ltd., was held on September 12 at River Plate House, London, E.C.

The following are extracts from the chairman's review, which was circulated with the report and accounts for the year ended December 31, 1945 :—

The net profit for the year, £32,684, is more than £5,000 higher than in 1944, and the amount received from the Ministry of Supply for 1944, under the Supplemental Agreement, the nature of which was explained in my last year's review, is also higher by some £6,000. An interim dividend at the rate of 25%, less tax, was paid in May last and, though at that time your directors considered that the final dividend was not likely to exceed that rate, they have decided, subject to your approval, to pay a final dividend at the rate of 29½%.

In my last year's review I gave the figures of output for the five years 1940–1944 inclusive, which averaged 543 tons per annum. The corresponding figure for 1945 was 445 tons.

The negotiations with the Ministry of Supply regarding the terms of the proposed new contract in place of the war-time contract which, at the instance of the Ministry, was terminated on December 31, 1945, have dragged on for a long period. The Nigerian Chamber of Mines, on behalf of its Members, informed the Ministry in January, 1946, that it could not recommend acceptance of the Ministry's proposed price of £300 per ton of metallic tin. It is probable that the terms of an agreement may be known at an early date—possibly before this review is in the hands of shareholders—and it is hoped that they will be found more in consonance with present costs of production. These costs show no signs of decreasing, while the cost of native wages, social services, etc., increases and there is the further risk of heavy additional burdens being placed on the industry in respect of increased compensation for disturbance of land and the replacement of the overburden removed in the course of mining operations.

The present policy of the Nigerian Government appears to be to require retrospective payment, for six years, of compensation for disturbance and, as it is not possible to estimate what this charge may amount to, your Directors have considered it advisable to set aside £3,000—by creating a Contingencies Reserve Account—to meet this and other liabilities that may be imposed under the new Minerals Ordinance.

At December 31, 1945, the ore reserves, proved and indicated, were estimated by the general manager at 1,160 tons.

KADUNA PROSPECTORS, LTD.

Directors : Sir Godfrey Fell (*Chairman*), J. W. Anderson, Brig.-Gen. Lord Esmé Gordon-Lennox, Charles Leach. *Secretary :* Fredk. Lee. *Office :* 78, Highlands Heath, Putney, London, S.W. 15. *Formed* 1913. *Capital issued :* £18,000 in 3s. shares.

Business : Operates alluvial tin properties in Northern Nigeria.

The thirty-first ordinary general meeting of Kaduna Prospectors, Ltd., was held on September 12 at River Plate House, London, E.C.

The following are extracts from the chairman's review, which was circulated with the report and accounts for the year ended December 31, 1945 :—

A profit of £1,173 was realized from the sale of tantalite ore. These concentrates were urgently needed during the war, but there appears to be very little demand at the present time. Production has ceased owing to the known sources of supply on the company's areas having become exhausted. The net profit for the year is higher, at £5,247, compared with £3,679 for the previous year. An interim dividend at the rate of 8⅓%, less tax, was paid in May last and it is now proposed, subject to your approval, to pay a final dividend at the rate of 13⅓%, less tax, at 9s. in the £.

Last year dividends totalled 16⅔%, less tax, and in my address at the last annual general meeting I said that whether it would be possible to pay dividends at a similar rate for 1945 would depend largely on the output of tin concentrates for the remainder of that year. Output was actually 65 tons and the profit on realizations amounted to £3,565, as compared with £2,873 in 1944.

The negotiations with the Ministry of Supply regarding the terms of the proposed new contract in place of the war-time contract which, at the instance of the Ministry, was terminated on December 31, 1945, have dragged on for a long period. The Nigerian Chamber of Mines, on behalf of its members, informed the Ministry in January, 1946, that it could not recommend acceptance of the Ministry's proposed price of £300 per ton of metallic tin. It is probable that the terms of an agreement may be known at an early date.

Last year I issued again a grave warning about the approaching exhaustion of the company's properties. Another year has passed and the situation remains unchanged. In spite of such prospecting work as the limited staff has been able to undertake, no new deposits of interest have been discovered. Our ore reserves at the close of the year under review were estimated to amount to 260 tons. Whether, having regard to higher costs of labour, social services, and the further obligations which may be imposed under the new Mining Ordinance, the company can continue to operate at a profit, depends largely on the outcome of the negotiations with the Ministry of Supply.

We are not without hope that we may yet find a property to replace that in Nigeria when finally worked out, but there is nothing definite to report on this subject.

SONS OF GWALIA, LTD.

Directors : Capt. A. H. Moreing (*Chairman*), Capt. N. W. Diggle, J. C. Gardner, W. M. Kirkpatrick, E. A. Loring. *General Managers :* Messrs. Bewick, Moreing, and Co. *Secretary :* G. Anderson. *Office :* 20, Copthall Avenue, London, E.C. 2. *Formed* 1898. *Capital issued :* £162,500 in 10s. shares.

Business : Operates gold-mining properties on the North Coolgardie goldfield, Western Australia.

The forty-ninth annual general meeting of Sons of Gwalia, Ltd., was held on September 10 at 20, Copthall Avenue, E.C., Capt. A. H. Moreing presiding.

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

Although the war against Japan ended in August, 1945, shareholders will realize that war conditions prevailed for the rest of that year and, while there has been some improvement, the mine is still far from operating on a normal basis.

The balance of profit carried to the appropriation account is £34,789, as compared with £41,333 in the accounts for 1944. The difference is accounted for by a reduction of output by 5,362 tons and a small drop in the grade of ore mined. With the balance of mining profits brought forward from 1944 of £19,537, the amount available for appropriation is £54,326. The directors have provided for the estimated amount of the taxes due in respect of 1945 and have appropriated £5,000 for depreciation. It was not considered necessary to make any further additions this year either to the general reserve or the reserve for internal shaft and development. The balance to be carried forward, after payment of a dividend of 12½%, 1s. 3d. per share, and making all provisions, is £23,655.

Development work at the mine was greatly affected by the shortage of labour and totalled 925 ft., as compared with 1,224 ft. in 1944. The south-west branch ore-body has continued to open up satisfactorily at the No. 30 level and, while values at the No. 31 level are slightly lower than those in corresponding sections on the levels immediately above, it is estimated that the new ore developed in this branch ore-body at these two levels during the year is over 33,000 tons, averaging 5·5 dwt. Driving and cross-cutting at these levels has given further indications that the South Gwalia series may again contribute a substantial supply of ore to the mill.

As the result of detailed study of the geological conditions at the mine it was decided to initiate, as soon as circumstances permitted, a diamond-drilling programme and the first two holes have been drilled.

While it is too early to say anything definite the results that have attended this diamond-drilling campaign so far can be regarded as encouraging. The ore reserves at the end of 1945 were estimated at 702,483 tons, averaging 5·7 dwt., compared with 731,048 tons of the same grade at the end of 1944.

The report and accounts were adopted.

Professional Directory

BANKS, Charles A.,
Royal Bank Building, Vancouver, B.C., Canada,
and
23rd Floor, Russ Building, San Francisco, Cal.,
Cables: Bankca. U.S.A.

Tel.: Clerkenwell 4956/9.
BEWICK, MOREING & Co.,
62, London Wall, London, E.C. 2.
Cables: Bewick.

BOISE, Charles W.,
Mining Engineer,
Selection Trust Building, Mason's Avenue,
Coleman Street, London, E.C.2.
Cables: Kukeha, London. No professional work entertained.

Tel.: Flaxman 8085.
BOTSFORD, R. S.,
Mining Engineer,
246, Old Brompton Road, Earl's Court,
London, S.W. 5.

Tel.: Mansion House 1155.
BROADBRIDGE, Walter,
341/4, Salisbury House, London Wall,
London, E C. 2.
Cables: Rillstope, London.

CALLOW, M. J.,
BRITISH-GECO ENGINEERING CO., LTD.
Consulting Metallurgical Engineers
(Ore Dressing, Testing, and Plant Design).
Adelaide House, London Bridge, London, E.C. 4.
Tel.: Mansion House 8921. Cables: Gecoring.

CHRISTOE, W. H., & SONS,
Assayers and Analysts
Truro, Cornwall.
Metals, Ores, etc.
Tel.: Truro 2152. Cables: Christoe, Truro.

DAVEY, John C.,
Consulting Mining Engineer and Geologist,
Apartado 1573, Caracas, Venezuela.

DEGENHARDT, W. R., Tel.: Royal 7921.
Mechanical Engineer,
Mining Plant Design and Purchasing.
49, Moorgate, London, E.C. 2. Usual Codes.

DORR, John V. N.,
President, The Dorr Company, Inc.,
Metallurgical, Chemical, and Industrial Engineers,
570, Lexington Avenue, New York.
Abford House, Wilton Road, Victoria, London, S.W. 1.

GILL, Donald, Tel.: Monarch 3818.
Mining Engineer,
c/o Pellew-Harvey & Co., 59a, London Wall, E.C. 2.
Code: Broomhall's

Tel.: Kelvin 4080/2.
HIGGINS, A. Howard,
Consulting Metallurgist.
Ore Dressing and Flotation Processes of Concentration.
10, Old Jewry, London, E.C.2.

Tel.: Western 4927.
HITCHEN, C. Stansfield,
Consulting Geologist,
2, De Vere Cottages, London, W. 8.

Tel.: Worthing 6694.
HODGSON, Victor,
Mining Engineer,
4, George V Avenue, Worthing, Sussex.

Tel.: Elgar 5202.
HOLLOWAY, George T., & Co., Ltd.
Metallurgists & Metallurgical Engineers,
Atlas Rd., Victoria Rd., Acton, London, N.W. 10.
Cable: Neolithic, London. Code: Bedford McNeill.

JOBLING, Charles E.,
Consulting Mining Engineer,
61, Moorgate, London, E.C.2.

KINGAARD, Alexander R.,
Mining Engineer,
The Pacific Southwest, Mexico, Central
and South America.
321, Spruce Street, San Diego, Calif.

LAGRANGE, J. M., & Associates,
Consulting Mining & Economic Geologists,
P.O. Box 8989 Johannesburg Tel. 34 1429
Office: 128, Cullinan Building, Johannesburg, South Africa.
Cables: "Geoscopist." Codes: Broomhall, Marconi, McNeill.

LEDOUX & Co.,
Assayers and Samplers,
155, Sixth Avenue, New York, U.S.A.

LORING, E. A., Tel.: Clerkenwell 4956/9.
Bewick, Moreing & Co.,
62, London Wall, London, E.C. 2.
Cables: Ringlo.

LUNDBERG, Hans,
Geological and Geophysical Surveys,
Toronto, Canada, Victory Building.
New York: 26, Beaver Street.

R. E. BINNS. Tel.:
McCARTHY & BINNS, London Wall 5756.
Mining Engineers,
Friars House, 39/41, New Broad Street,
London, E.C. 2.

Nuffield Foundation Fellowships and Scholarships for the Advancement of Extraction Metallurgy

With the object of advancing research and training in extraction metallurgy, the Nuffield Foundation is offering a limited number of Fellowships and Scholarships, for which citizens of Great Britain, the Commonwealth and Empire are eligible to apply.

Travelling Fellowships are offered to men who are members of the teaching staff of universities and approved schools of mines and metallurgy.

Travelling Postgraduate Scholarships are offered to junior members of the profession who are graduates of universities and approved schools of mines and metallurgy.

Vacation Scholarships are offered to mining and metallurgical students at universities and approved schools of mines and metallurgy.

Full particulars and application forms may be obtained from the Secretary, Nuffield Foundation, 12–13, Mecklenburgh Square, London, W.C. 1.

THE CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA, LIMITED.

SIX PER CENT. SECOND PREFERENCE SHARES.

DIVIDEND No. 71.

NOTICE IS HEREBY GIVEN that the TRANSFER BOOKS and REGISTER OF MEMBERS of the Six per Cent. Second Preference Shares of the above-named Company will be CLOSED from the 2nd to 4th September, 1946, both days inclusive, for the purpose of balancing the books for payment of the Dividend for the half-year ending 30th September, 1946, payable 1st October, 1946.

AND NOTICE IS ALSO HEREBY GIVEN to Holders of Share Warrants to Bearer of the above-mentioned Second Preference shares that in order to obtain payment of the dividend they must either :—

(1) Surrender their Share Warrants at the address mentioned below for registration of the shares in the names of the holders, free of charge, or

(2) present their Share Warrants to the Company's Bankers, Midland Bank, Limited, at the New Issue Department, Poultry, London, E.C. 2, for marking, five clear days before payment will be made.

Income Tax at the rate of 9s. in the £ will be deducted from this dividend.

By Order,
R. CARR TAYLOR, *Secretary.*

REGISTERED OFFICE :
49, MOORGATE, LONDON, E.C. 2.

16th August, 1946.

BUYERS' DIRECTORY.

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Denver Equipment Co., Ltd. .. 26
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Air Receivers
Consolidated Pneumatic Tool Co., Ltd. ..... *
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Allis-Chalmers Manufacturing Co. 15
Fraser & Chalmers Eng. Works 3
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Dorr-Oliver Co., Ltd. 16
Huntington Heberlein & Co., Ltd. 29
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Davies Magnet Works, Ltd. .... *
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Denver Equipment Co., Ltd. .. 26
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Knapp and Bates, Ltd. 48
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Allis-Chalmers Manufacturing Co. 15
Hadfields, Ltd. 40
Pegson, Ltd. 4
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Dunlop Rubber Co., Ltd. 19
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Allen (Edgar) & Co., Ltd. 21
Allis-Chalmers Manufacturing Co. 15
Fraser & Chalmers Eng. Works 3
Hadfields, Ltd. 40
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Denver Equipment Co., Ltd. .. 26
End Runner Mills Co., Ltd. 50
Knapp & Bates, Ltd. 48
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Andre Rubber Co., Ltd. ..... *
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Ruston & Hornsby, Ltd. ..... *
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English Electric Co., Ltd. 2
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Tecalemit, Ltd. ..... *
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Davies Magnet Works, Ltd. .... *
Fraser & Chalmers Eng. Works 3
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Hadfields, Ltd. 40
Head, Wrightson & Co., Ltd. .. 31
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Allen (W. H.) Sons, & Co., Ltd. *
Belliss & Morcom, Ltd. ..... *
Blackstone & Co., Ltd. ..... *
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English Electric Co., Ltd. 2
National Gas & Oil Engine Co., Ltd. *
Robey & Co., Ltd. 23
Ruston & Hornsby, Ltd. ..... *
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Consolidated Pneumatic Tool Co., Ltd. ..... *
Holman Bros., Ltd. 1, 56
Mather & Platt, Ltd..... 35
Pegson, Ltd. 4
Ruston & Hornsby, Ltd. ..... *
Uskside Engineering Co., Ltd. *
Worthington-Simpson, Ltd..... *

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Allen (W. H.) Sons, & Co., Ltd. *
Blackstone & Co., Ltd..... *
Ruston-Bucyrus, Ltd. 11

Pumps—Sand
Consolidated Pneumatic Tool Co., Ltd. ..... *
Denver Equipment Co., Ltd. .. 26
Fraser & Chalmers Eng. Works 3
International Combustion, Ltd. 39
Stokes (R. O.) & Co., Ltd..... *
Wilfley Mining Machinery Co., Ltd. *

Railways—Light
Hudson (Robert), Ltd. 26

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Rolls—Crushing
Allen (Edgar) & Co., Ltd..... 21
Allis-Chalmers Manufacturing Co. 15
Fraser & Chalmers Eng. Works 3
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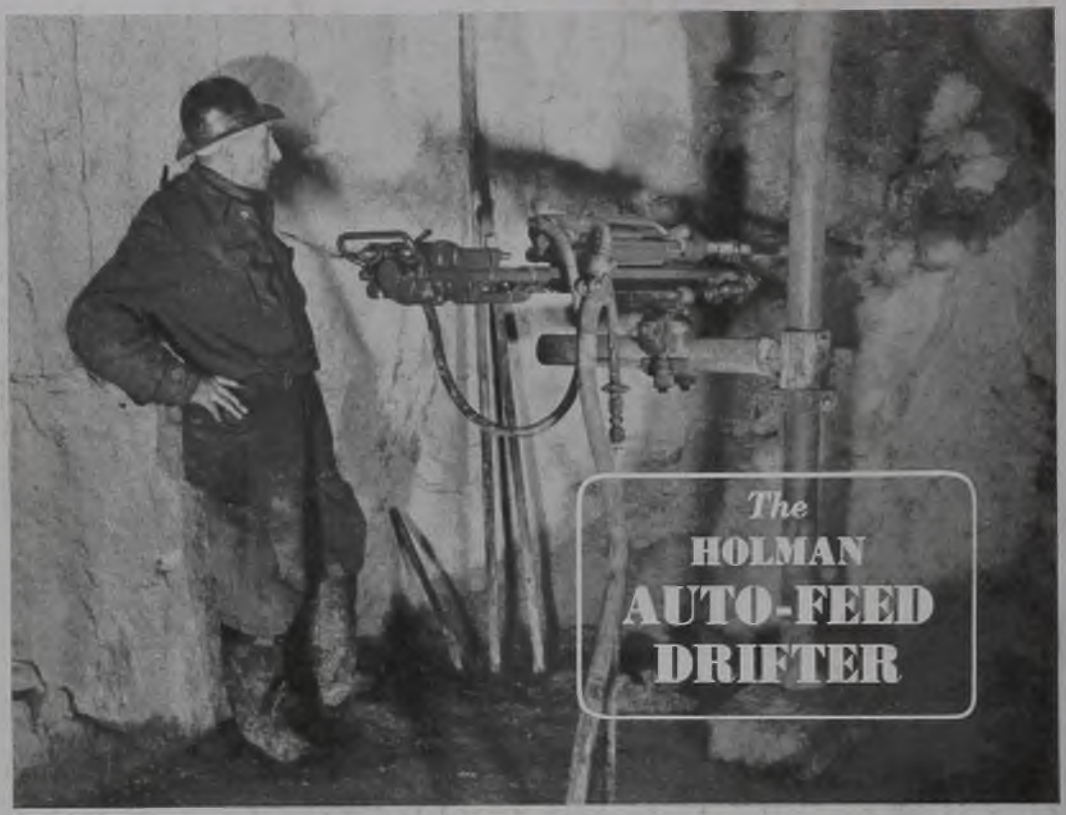

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