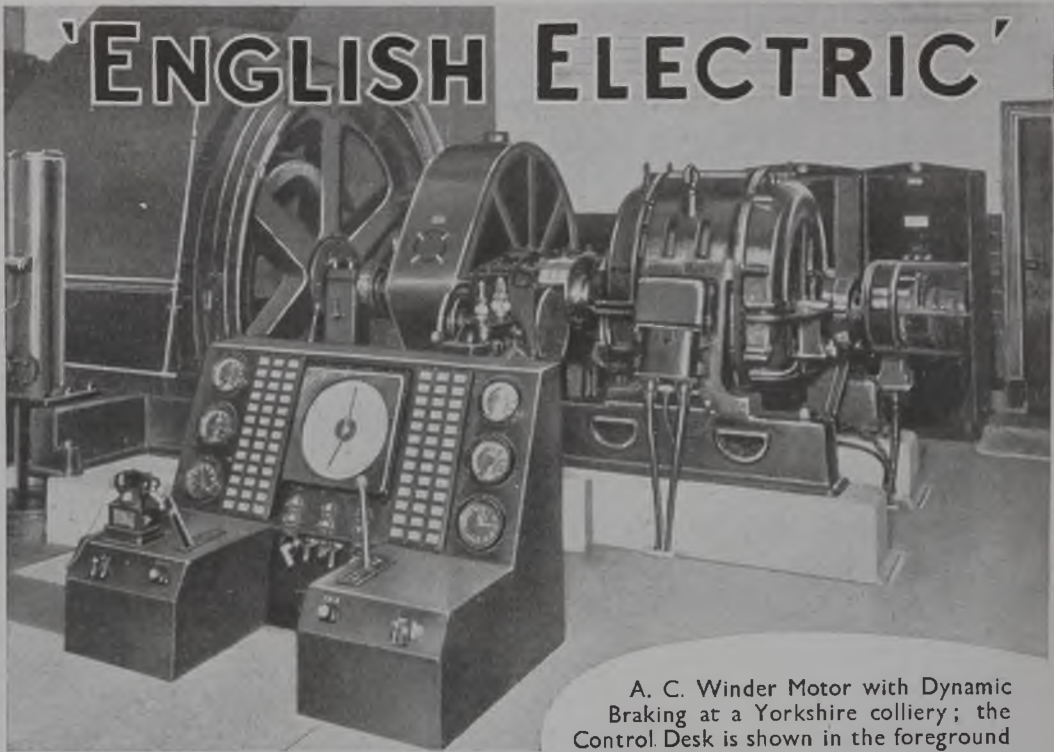
The Mining Magazine

VOL. LXXV. No. 5. LONDON, NOVEMBER, 1946. PRICE ONE SHILLING



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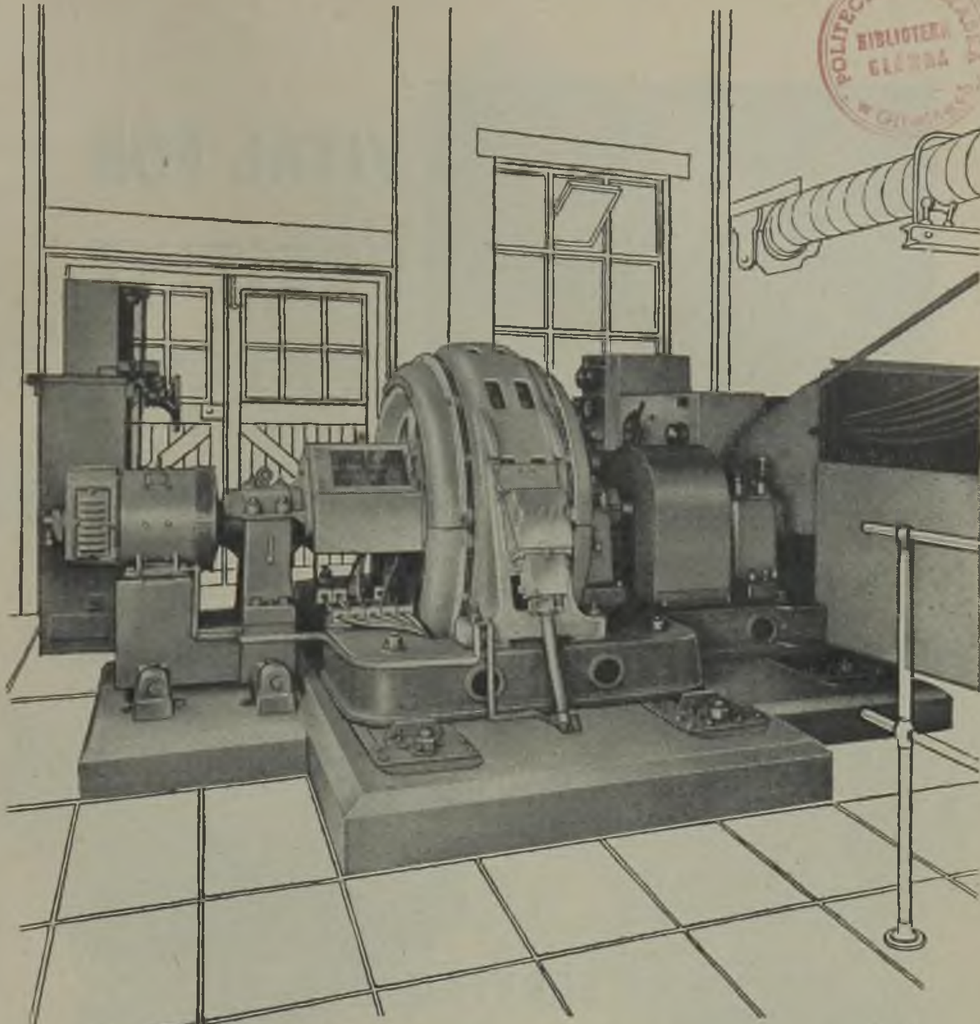

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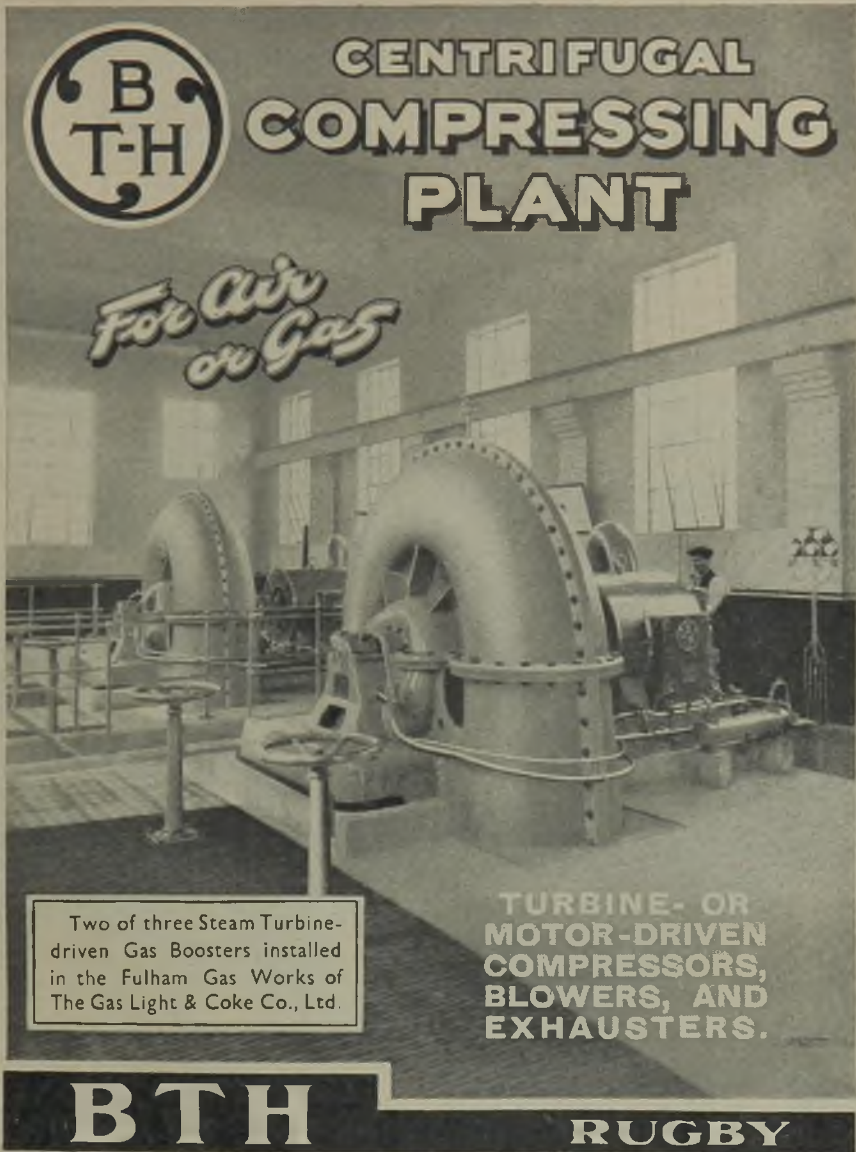
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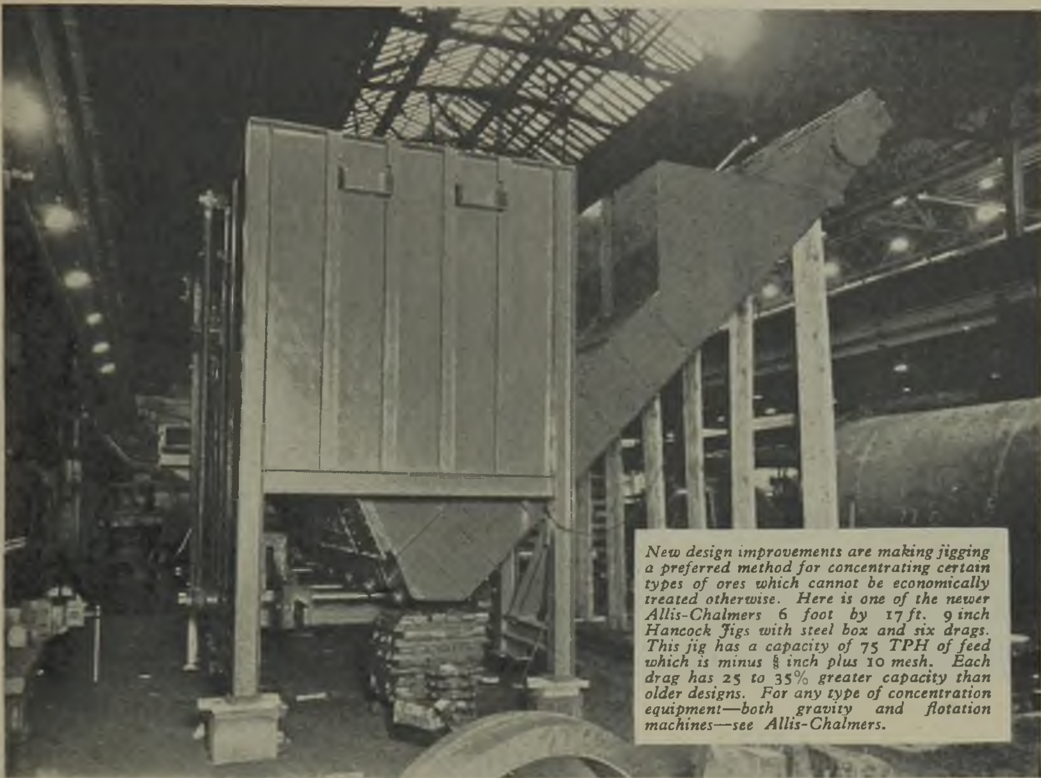

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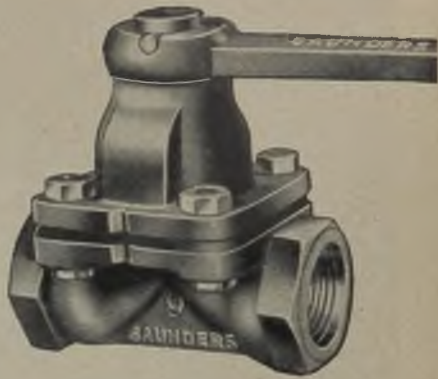
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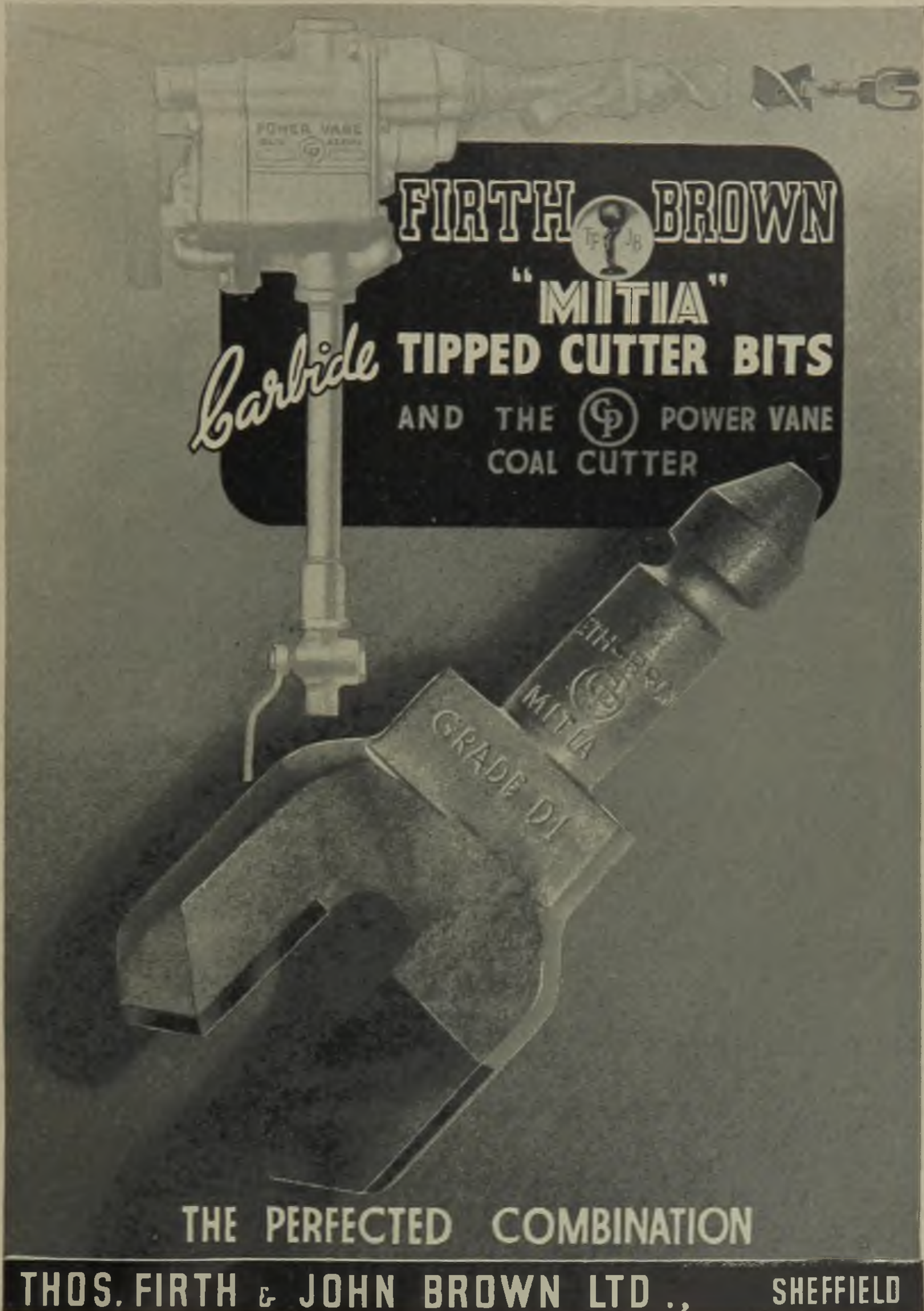
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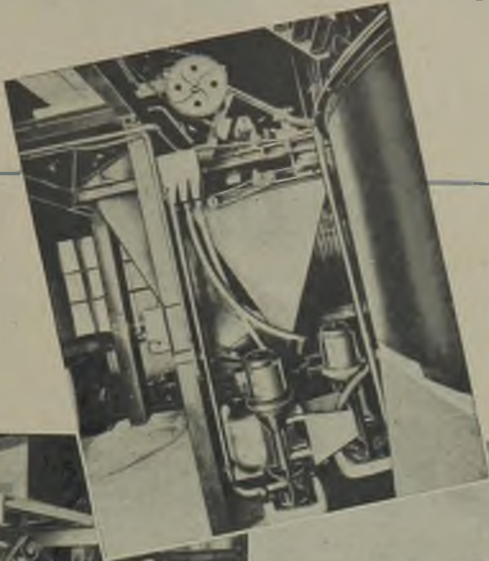

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Gravity
Concentration

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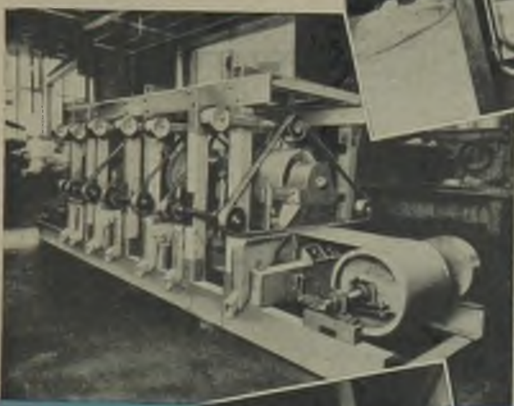

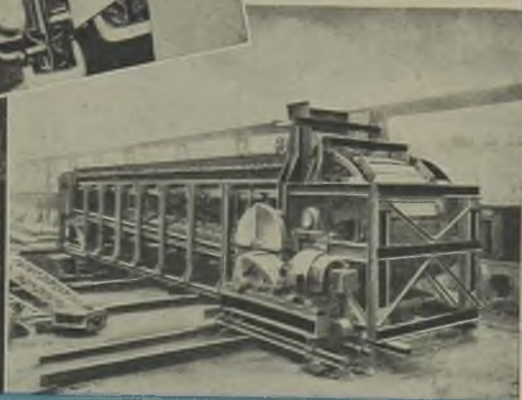

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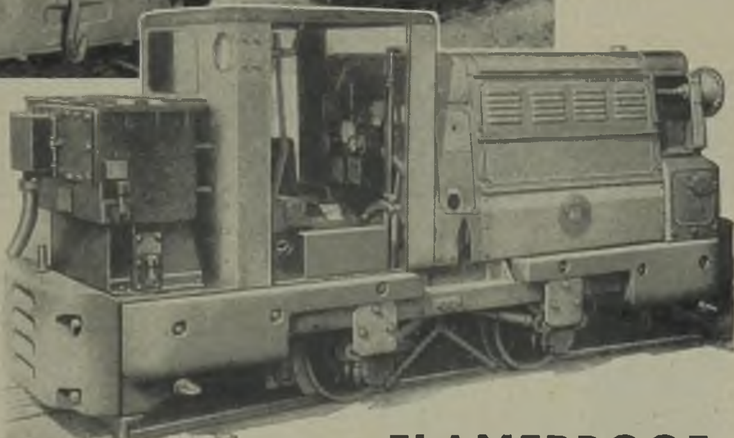

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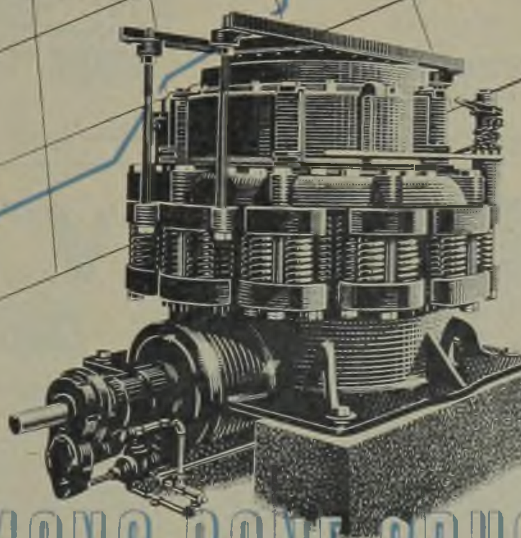


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CONTENTS

EDITORIAL

IT is interesting to note that Dr. Jacob Bakker, mining engineer of the Netherlands State Coal Mines, has joined the National Coal Board as Adviser to the Chief Mining Engineer.

THE Institution of Mining Engineers recently announced that the scheme of examinations for Associate Membership is to be inaugurated in 1947. For the first five years these examinations are to be on a voluntary basis, but after April 30, 1952, admission to Associate grade is to be restricted to applicants who have qualified by examination.

OLD Tunnellers will be interested to learn that it is proposed to hold a Reunion Dinner in London about March next. Members of the Tunnellers Old Comrades' Association who are interested are asked to communicate with the Honorary Secretary of the Association, c/o the Institution of Mining and Metallurgy.

AT a special meeting of the Transvaal Chamber of Mines held last month Mr. G. Carleton Jones, the president, reviewed the demands being made at present on the gold-mining industry by the Union Government, suggesting that if costs continued to rise at the present rate it was likely that the consequent closure of mines would precipitate a decline in employment. In this connexion note should be taken of the renewed claims of native workers for increased rates of pay If these are granted they could be met by deliberately raising the grade of ore milled, although such a step could be taken only at the risk of advancing the demise of some of the lower-grade producers. The alternative would seem to be a revision of taxation policy by the Union Government and this has already been suggested by representatives of the Rand Mineworkers' Union.

EARLIER this month a motion was approved in the Rhodesian Legislative Assembly temporarily accepting the principle of subsidizing the operations of low-grade gold mines. The Southern Rhodesian Minister of Mines and Public Works said the intention was to support the activities of mines with a chance of becoming economic producers. The maximum subsidy allowable would be 40s. an oz. and, while a 5% margin between revenue and working costs would be permitted, no profit on any such operation was envisaged. Earlier the Minister had suggested that any such subsidy should be available: (*a*) When a mine is unable to continue under present conditions, but has a reasonable chance of becoming an economic producer, and (*b*) when the closure of a mine would result in a serious economic loss to the community or a permanent loss of ore which would be recoverable if subsidized.

IN the course of his address at the first general meeting of the British Overseas Mining Association, held on November 11 in London, the Hon. R. M. Preston, who presided in the absence of the president, Lord Geddes, drew attention once again to the Association's direct succession to the Mining Taxation Committee, set up and financed by 12 of the principal London mining houses. The work of the Taxation Committee has been taken over by the Taxation and Tariffs Sub-Committee of the Association, which has, in addition, set up three other Sub-Committees. The first of these is concerned with the Association's finances, while the second—the Public Relations and Liaison Sub-Committee—preserves contacts with Government departments and other organizations connected with mining and metallurgy. Lastly there is an Information and Statistics Sub-Committee to circulate current information to members. In this connexion it is interesting to note that in conjunction with the British Non-Ferrous Metals Federation and the British Non-Ferrous Smelters' Association it is hoped to establish a British Bureau of Non-Ferrous Metals Statistics early in 1947.

THE ceremony of opening Selkirk Hall, 50 Holland Park, London, W. 11, took place on October 24. This is the first of the halls of residence for students of the Imperial College and is the gift of Mr. William Selkirk. In some introductory remarks the Rector (Mr. R. V. Southwell) paid tribute to the founder's generosity and referred also to the scholarships in mining which the same benefactor has endowed. Mr. Selkirk, after formally unlocking the door, made a short speech in reply, in the course of which he referred to his early training as a mining engineer as being of a more practical kind as there were few colleges in existence in those days. Of the benefits of such accommodation he rightly said : " I do not see that it can be other than a great advantage. It gives them excellent opportunities for further studying if they wish, opportunities for discussions with students who are studying other branches of engineering, and the advantage of learning how to live in harmony with their fellow students. . . . Students will, I trust, derive great benefit from the scholarships and from the use of this hall." He also expressed the hope that successful past students and others interested in mining might be persuaded by his example to come forward and assist in the establishment of similar residences—a hope which we can only echo. It is not without interest to add that of the available places in this first Imperial College Hall of Residence half are at present taken by students of the Royal School of Mines, although it must be emphasized that places are open to students of all three colleges.

The Tin Industry

It was suggested in our last issue that the International Tin Conference then being held in London might be able, in broad terms, to define the future of control in the industry. Actually decisions on these lines were taken. Briefly it can be said that the main tasks of the Conference were to survey the present position of the tin-producing industry and to review possible future supplies of the metal in the light of probable trends in consumption and production, taking into account the tremendous task of rehabilitation that faces those at work in the Far East. It was proposed accordingly that recommendations should be made to the interested Governments that during the expected period of tin shortage thought likely to cover the next two years the allocation of the metal should remain in the hands of the Combined Tin Committee in Washington and also that consideration should be given to the establishment of an International Tin Study Group.

Following the Conference the head of the United Kingdom delegation, Mr. G. Archer, of the Ministry of Supply, stated that the Study Group, if set up, would be on similar lines to that already established for rubber, which had now been at work for two years. The two groups would be planned to fit into the general pattern of the international trade organization already envisaged and now being considered. The duties of such groups are to find ways and means of dealing with possible situations that may arise and to make recommendations to the interested Governments. It is hoped, as our Metal Markets correspondent points out elsewhere in this issue, that the new Study Group will be able to start work at the end of the current year, when the current International Agreement is due to conclude.

From the evidence presented to the Conference it emerges that tin production for 1946 has been estimated at 94,000 tons and that consumption, largely by drawing on existing stockpiles, would reach 137,000 tons ; production for 1947 is expected to reach 142,000 tons. It is thought that by 1948 this figure will have reached some 190,000 tons, but that the 200,000 mark will not be attained until the following year. The general conclusion is reached, therefore, that, after making full allowance for uncertainties, there is unlikely to be an excess production of tin for the next two years and that any question of production control does not call for urgent attention.

Meanwhile in the Far East it would seem that the path to rehabilitation is not proving as smooth as was at one time expected, lack of supplies and political difficulties standing much in the way. At the end of September stocks of tin ore in the United Kingdom amounted to 8,052 long tons, a reduction of nearly 1,000 tons as compared with stocks at the beginning of the month, when they stood at 9,049 long tons. Official figures show that stocks of tin metal held by the Ministry of Supply on September 30 were 8,738 tons, compared with 9,267 tons at the beginning of the month, while stocks held by consumers at the end of September were calculated at 4,237 tons and reported to be 3,908 tons. There were no arrivals of tin metal during the month. In Malaya the present position regarding costs and supplies is viewed with some concern, particularly as these factors affect the lower-grade property, and it has been suggested that early consideration should be given by the authorities to a revision of the present mining taxation scheme. From Siam, fortunately, there is more favourable news. It was announced last month that the Siamese Government was now in a position to commence returning British and Australian mines to their owners. There is, however, no cause at present to revise the estimates of future production already given and consequently no immediate fear of output control. The industry is free to plan ahead and the projected Study Group, should it be formed, will have plenty of time to make up its mind as to the future.

The Mineral Industry of Uganda

Until the end of the 1914–1918 war little was known of the geology of Uganda, for it was not until 1919 that the Geological Survey was instituted. Since that time the broad outlines of the country's general geology have been determined, although a great deal still remains to be done. This point was stressed by Mr. C. B. Bisset, Deputy Director of the Geological Survey of Uganda, in the fifth of the Imperial Institute's series of lectures on the geology and mineral resources of various parts of the Colonial Empire held earlier this month. Mr. Bisset briefly reviewed the geography of the Protectorate and dealt with the provisional conclusions reached by the Survey regarding its geological history, before reviewing its mineral resources and surveying the future.

As regards Uganda's geographical aspects Mr. Bisset showed that the Protectorate with an area of about 90,000 square miles is approximately equal in size to Great Britain, but although it lies about the equator the climate is ameliorated by its general elevation of some 3,000 to 4,000 ft. above sea-level. Slightly higher country of 5,000 to 6,000 ft. is found in the south-west and rather lower country than the general level, down to 2,000 ft., occurs in the north-west. Mount Ruwenzori, with its permanent ice-cap, is the highest point at nearly 16,800 ft., while in extreme contrast are the papyrus swamps of the southern half of the country. Communications are on the whole good, although detailed traversing is hindered by most of the difficulties usually found in Central Africa. Little was known of the economic minerals occurring in the country before the Survey was founded and work has since been complicated by the fact that mineral rights over about one-fifth of Uganda are held by native landowners. In the kingdom of Buganda prospecting has heretofore been difficult as it was not until recently that the Native Government would come to terms on the matter. Now that this position has improved the fact that there is scant opportunity for the sale of mineral products locally and that the geographical situation is difficult still weigh heavily against exports. However, the production of tin began in 1927, when approximately 114 tons of concentrates was exported, while gold mining was started in 1931. The outputs of both tin and gold increased steadily to 1938, since when there has been a decline. In addition to these minerals columbite-tantalite, wolfram, bismuth, mica, beryl, bismutotantalite, phosphate, and salt have been produced, while occurrences of copper, petroleum, and many other minerals are known. At present water is one of Uganda's most important minerals. More than 600 bored wells have already been installed, while construction of small reservoirs is proceeding. A grant of £279,000 has been made from the Colonial Development Fund for further improvements. It is interesting to note that a third of the minerals produced has resulted from discoveries made by the Survey and that from the total production of over £2,000,000 of minerals until 1945 the Government had received in rents, fees, and royalties nearly the total cost of the Geological Survey.

The speaker, in concluding his lecture, took the view that the rapidly-changing needs of industry and the experience of two wars had clearly shown that many mineral deposits can unexpectedly and even urgently become of great importance. It was the view of the Survey, therefore, that all information regarding useful minerals should be gained as rapidly as possible to provide for future demands. It is important to note that the work done so far has played an important part in opening up the Protectorate and has had far-reaching beneficial effects on the native population. As has already been pointed out, however, there is much yet to be done, but it is gratifying to learn that future work is already planned on the right lines.

MONTHLY REVIEW

Introduction.—The results of the mid-term elections in the United States, which provided a temporary set-back for the New Dealers and vague talks over here of slumps to come, have proved something of a damper on business confidence. It is difficult, however, to envisage slump conditions in a world short of commodities of all kinds and the present uncertainties can hardly be more than temporary in their effect.

Transvaal.—The output of gold from the Rand mines for September was 961,425 oz., and from outside districts 22,749 oz., making a total of 984,174 oz. for the month. The number of natives employed in the gold mines at the end of September was 292,246, as compared with 295,788 at the end of the previous month.

In the three months ended September 30 last the joint ore shaft at Springs and West Springs was sunk 191 ft. to 4,436 ft., while in the same period No. 4 shaft at Daggafontein Mines was 66 ft. deeper at 167 ft.

The report of Blyvooruitzicht Gold Mining for the year ended June 30 last shows a profit of £527,309, of which £269,500 was required for the payment of a first dividend, equal to 10%. In the year the 199,600 tons of ore milled yielded 137,141 oz. of gold. At June 30 last the available ore reserves were estimated at 5,569,000 tons, averaging 14·8 dwt. in value over 45 in. During the September quarter this company acquired freehold of approximately 139 morgen on the farm Blyvooruitzicht No. 1.

The acquisition of additional mining ground by Van Dyk Consolidated Mines is announced in the report for the September quarter, which states that the negotiations in progress to acquire the Phœnix Mynpacht and claims from Union Corporation, Ltd., have now been concluded. The purchase price is £22,400, with which amount the Corporation has agreed to subscribe for 32,000 shares at 14s. per share out of the reserve capital of the company. Arrangements have also been made to purchase 215 claims situate on the farms Leeuwpoort No. 4 and Finaalspan No. 3 adjoining the western boundary of the company's property from African and European Investment Co., Ltd., for the sum of £6,092.

In the report of West Driefontein Gold Mining for the three months to September 30 last it is stated that the No. 2 Level Drive from the Blyvooruitzicht mine had reached within 30 ft. of the common boundary and that arrangements were being made to instal watertight doors to safeguard Blyvooruitzicht property.

Sinking at No. 2 shaft of Libanon Gold Mining was resumed at the end of May and by September 30 a total depth of 2,935 ft. had been reached.

In the three months ended September 30 last No. 3 shaft at Vogelstruisbult was advanced 443 ft. to 2,267 ft. and No. 4 shaft 531 ft. to a final depth of 2,054 ft.

Shareholders of West Vlakfontein Gold Mining are informed in the report for the September quarter that development operations have been resumed. The re-equipping of the West Haulage was completed in the period.

Consolidated Main Reef Mines and Estate reports a profit of £295,753 for the year to June 30 last, the accounts showing a total of £804,953 available, of which £218,330 was required for dividends totalling 17½%. In the year 2,518,000 tons of ore milled yielded 330,790 oz. of gold. The available ore reserves at June 30 last were estimated to be 5,180,000 tons averaging 3·6 dwt. in value over 56·7 in.

The accounts of Sub Nigel, Ltd., for the year ended June 30 last show a profit of £2,097,383 and an available total of £2,393,506. Of this amount £797,334 was required for dividends totalling 9s. per share. The report shows that 785,500 tons of ore was milled and 408,581 oz. of gold recovered. At June 30 last the ore reserves were estimated to be 2,718,000 tons, averaging 11 dwt. in value over 35·4 in.

The report of Venterspost Gold Mining for the year to June 30 last show a profit of £508,347 and a total of £934,840 for appropriation, £245,000 of this amount being required for dividends totalling 1s. per share. The ore milled in the year amounted to 1,242,000 tons, from which 256,712 oz. of gold was recovered. The ore reserves at June 30 last were estimated at 2,371,000 tons, averaging 5·3 dwt. in value over 70 in.

In the year to June 30 last Luipaards Vlei Estate and Gold Mining made a profit of £371,762, the accounts showing a total of £663,943 available and £165,636 distributed as dividends totalling 8d. a share. The mill dealt with 1,002,000 tons of ore and recovered 204,917 oz. of gold. The ore reserves at the end of the year were estimated at 2,750,000 tons, averaging 4·8 dwt. in value over 44·7 in.

Nourse Mines reports a profit of £148,906 for the year to June 30 last, the accounts showing an available total of £369,613, of which £107,754 was required for dividends totalling 13¾%. In the year 840,000 tons of ore was milled and 160,807 oz. of gold recovered. The available ore reserves at June 30 last were estimated to be 2,396,300 tons averaging 4·7 dwt. in value over 46 in.

The report of Van Ryn Gold Mines Estate for the year ended June 30 last shows a profit of £31,004 and a total of £102,713 available, of which, after allowances for taxation, an unappropriated balance of £99,668 was carried forward. The 690,000 tons of ore milled in the year yielded 78,550 oz. of gold. The ore reserves at June 30 last were estimated at 106,000 tons averaging 2·4 dwt. over 33 in.

According to the report for the year ended June 30 last development operations at No. 1 shaft of Libanon Gold Mining were resumed in December, 1945. At the end of the year the ore reserves fully developed were estimated at 505,000 tons averaging 4·4 dwt. in value over 75·2 in.

At an extraordinary meeting of Welgedacht Exploration to be held following the annual general meeting on November 15 shareholders were to be informed of the financial arrangements made to permit of re-opening the mine and commencing the erection of a treatment plant.

Proposals relating to an increase in the capital of the General Mining and Finance Corporation are to be submitted to shareholders at an extraordinary meeting to be held on December 5 in Johannesburg. It is proposed that 500,000 new £1 shares be created and that the directors be given power to issue these shares together with the 235,421 shares at present authorized but not issued.

Rooiberg Minerals Development reports an estimated profit of £4,913 for the September quarter, when the 6,979 short tons of ore and 1,516 tons of alluvial ground treated yielded 130 long tons of tin concentrates.

The report of Zaaiplaats Tin Mining for the year to July 31 last shows a profit of £25,834 and a total of £51,973 available, of which dividends totalling 25% required £22,312. In the year 41,420 short tons of ore was milled and 196½ long tons of tin concentrates produced.

The Victoria Falls and Transvaal Power Co. reports a profit of £582,050 for 1945.

Orange Free State.—During the past month the Free State Development and Investment Corporation reported that Bore-hole W.T. 3 on sub-division 4 of the farm Weltevreden 59 was stopped at a depth of 5,045 ft. The "A" Reef was intersected at 4,030 ft. and assayed 8·1 dwt. over 6·5 in. The "B" Reef was intersected at 4,299 ft. and assayed 3·2 dwt. over 12 in. The Leader Reef was intersected at 4,811 ft. and assayed 3·2 dwt. over 8 in. and the Basal Reef was cut at 4,873 ft. and assayed 8·2 dwt. over 5·9 in. Bore-hole H.T. 2 drilled on joint account with the Central Mining and Investment Corporation, Ltd., on the northern boundary of the farm Hilton 530, approximately 7 miles north-east of Odendaalsrust was stopped at a bore-hole depth of 1,176 ft. in measures considered to lie in the footwall of the Basal Reef. Bore-hole W.T. 5 on the remaining extent of farm Weltevreden 59 intersected Leader Reef at 2,799 ft. which assayed 1·2 dwt. over 12·7 in. The Basal Reef was intersected at 2,858 ft. and assayed 1 dwt. over 9 in. Later it was announced that the deflection in Bore-hole W.T. 3 intersected the Basal Reef at a depth of 4,872 ft. and assayed 14·8 dwt. over 6 in. Bore-hole W.T. 5 intersected the Basal Reef at 2,863 ft. and assayed 2·6 dwt. over 7·7 in.

Bechuanaland.—Tati Goldfields reports a profit of £3,356 for the year to March 31 last, the accounts showing £9,270 available and carried forward. In the year 56,100 tons of ore was milled and 10,347 oz. of gold recovered.

Southern Rhodesia.—The Gold Fields Rhodesian Development Co. announced recently that a company was registered on October 28, 1946, under the name of Motapa Gold Mining Co., Ltd., with a nominal capital of £850,000 in 5s. shares, to acquire and work the properties known as the B. and S. Mines and Fossicker Claims situated in the Bubi district.

Northern Rhodesia.—A preliminary statement issued by Roan Antelope Copper Mines and covering the year to June 30 last shows an operating surplus of £853,803, as compared with £965,518 for 1944–45, a decrease of £111,715. After charging administration expenses, interest, etc., and providing £300,000 for replacements and obsolescence, and £190,000 for taxation, the net profit is stated as £296,239.

Gold Coast.—Taquah and Abosso Mines reports a profit of £86,373 for the year to

March 31 last and a total of £156,553 available, of which £53,367 is required for a dividend equal to 25%. During the year 300,000 tons of ore was milled and 72,420 oz. of gold recovered. The ore reserves at March 31 last were estimated to be 1,924,430 tons, averaging 5·41 dwt. in value over 49 in.

Shareholders of Ashanti-Obuasi Reefs, Ltd., were informed last month that the lode had been struck in the South-East Abayie Lode shaft at 59 ft., where it assayed 12 dwt. in value over 18 in.

At an extraordinary meeting of North Ashanti Mining held on November 6 resolutions were approved reducing the value of existing 4s. shares to 1s. and increasing the capital to £500,000 by the creation of 8,200,000 new 1s. shares.

Kwahu Mining reports a profit of £14,115 for the year to June 30 last, the accounts showing £73,289 available. Dividends totalling 75% require £15,500 of this amount.

Nigeria.—The report of Gold and Base Metal Mines of Nigeria for 1945 shows a profit of £34,617 and a total of £75,951 available, of which £9,625 is required for a dividend equal to 5%. The output of tin concentrates for the year was 765 tons.

United Tin Areas of Nigeria reports a profit of £15,840 for the year to June 30, 1945, when 249 tons of tin concentrates was produced.

Kenya.—The accounts of Rosterman Gold Mines for 1945 show a profit of £32,250 and a total of £33,277 available, of which dividends equal to $4\frac{1}{6}$% require £14,311. During the year 46,970 tons of ore was milled and 18,982 oz. of gold recovered.

Tanganyika.—In Progress Report No. 29 shareholders of Kentan Gold Areas are informed that the plant ordered to expand milling capacity at Geita Gold Mining is now coming forward and that erection is proceeding. It is expected that the new plant will be ready by the end of June, 1947.

Australia.—Cabled advice from Melbourne gives the profit of North Broken Hill for the year ended June 30 last as £461,670 and the total available as £905,094. Dividends require £280,000 of this amount and £110,000 has been appropriated for new plant, leaving £515,094 to be carried forward.

Broken Hill South announces a profit of £321,400 for the year ended June 30 last.

With the notice of the final dividend shareholders of Lake View and Star are informed that the net profit from mining operations for the year ended June 30 last is £311,817.

New Zealand.—Clutha River Gold Dredging reports a profit of £12,727 for the year to March 31 last, the accounts showing £15,440 available, of which £6,600 is required for the dividend paid in May last. Dredging operations during the year resulted in the production of 5,940 oz. of gold.

Malaya.—In the report for 1945 shareholders of Tronoh Mines are informed that dredges Nos. 4 and 8 are on the eve of production, while the rehabilitation of No. 5 dredge is in progress.

The dredge on the Pelepah section of Sungei Besi Mines started full-scale operation on October 1, while No. 1 dredge of Southern Tronoh Tin Dredging started its trials on the same date.

India.—In the three months ended September 30 last the Indian Copper Corporation milled 93,584 tons of ore and produced 1,508 long tons of refined copper.

Burma.—At an extraordinary meeting of the Anglo-Burma Tin Company held on November 15 it was proposed that the directors should be authorized to create an issue of £80,000 4% Prior Lien Debenture Stock in order to finance the costs of rehabilitation.

Bolivia.—The accounts of the Aramayo Mines in Bolivia Company for 1945 show a profit of S.Fr. 5,744,120, making with the sum brought in an available total of S.Fr. 6,887,827, of which S.Fr. 4,032,000 have been set aside for distribution to shareholders.

Fabulosa Mines Consolidated reports a loss of Bs. 1,069,336 for 1945, which decreases the credit balance brought in to Bs. 2,183,357. During the year 874 tons of tin was produced, as compared with 706 tons for the previous year.

Colombia.—A special resolution is to be considered at the annual general meeting of Frontino Gold Mines to be held later this month. This calls for an increase in the capital of the company to £353,390, by the creation of 109,427 ordinary £1 shares, which are to be used when necessary to raise the funds for opening the new mines. The accounts of the company for 1945 show a profit of £9,457. In the year 97,320 tons of ore was milled and 51,712 oz. of gold and 47,061 oz. of silver recovered. The ore reserves at the end of the year were estimated to be 456,600 tons, averaging 12·26 dwt. in value.

Venezuela.—In a recent circular to shareholders of New Goldfields of Venezuela it is stated that in order to provide new working capital a new company is to be formed in Canada by Ventures, Ltd. Milling operations are to be suspended and an effort made by prospecting and development to increase the ore reserves.

Cornwall.—In the report of the British Malayan Tin Syndicate for the year to June 30 last it is stated that the company is to take over a plant in Cornwall designed to treat material from extensive tin-bearing dumps. The capital of the company has been increased to £50,000 by the creation of 500,000 new 1s. shares.

Consolidated Gold Fields of South Africa.—With the recent dividend notice shareholders of the Consolidated Gold Fields of South Africa, Ltd., are informed that the profits of New Consolidated Gold Fields, Ltd., for the year to June 30 last amounted to £1,392,094.

Selection Trust.—A circular to shareholders of Selection Trust, Ltd., issued earlier this month contains particulars of an issue of 462,557 shares of 10s. each at 35s. a share.

Tanganyika Concessions.—The accounts of Tanganyika Concessions, Ltd., for the year to July 31 last show a surplus of £341,153. A dividend equal to 8% has been declared on the ordinary shares.

NEW COMPANY REGISTERED

Coolgardie and Hampton Gold Mines.—*Capital :* £10,000 in 5s. shares. *Objects :* To acquire gold mines in Australia or elsewhere. *Directors :* C. J. Turle, H. D. Simmonds, C. A. J. Sanders, and E. O. Boardman.

DIVIDENDS DECLARED

* Interim. † Final.
(Less Tax unless otherwise stated)

***Anglo-Huronian.**—10 cents, payable Jan. 31.
***Barrow Hæmatite.**—5%.
†**Borax Consolidated.**—Pref. Ord. 3%.
***Boulder Perseverance.**—7½%, payable Dec. 16.
***Broken Hill Proprietary.**—9d. (Aust.), payable Nov. 27.
***Broken Hill South.**—1s. 3d. (Aust.), payable Dec. 18.
†**Consolidated Gold Fields of South Africa.**—2s. 6d.
†**Consolidated Rand Investment.**—9d., payable Dec. 30.
†**Delagoa Bay Development.**—12%.
†**Gold and Base Metal Mines of Nigeria.**—5%, payable Dec. 21.
†**Gold Coast Selection Trust.**—10%, free of tax, payable Dec. 17.
†**Gold Fields Rhodesian Development.**—1s., payable Dec. 11.
***H.E. Proprietary.**—6d., payable Nov. 28.
†**International Nickel.**—40 cents, payable Dec. 31.
†**Lake Shore Mines.**—18 cents.
†**Lake View and Star.**—27½%, payable Dec. 18.
***Lake View Investment.**—Pref. 2½%, Ord. 4%, payable Dec. 2.
†**Lena Goldfields.**—13⅓%.
†**Lydenburg Gold Farms.**—5¼d., payable Dec. 31.
†**Morning Star (G.M.A.) Mines.**—6d. (Aust.), payable Nov. 22.
†**Mountain Copper.**—10% and 2½% bonus, payable Nov. 8.
†**New Witwatersrand Gold.**—4½d., payable Dec. 31.
***Noranda Mines.**—$1·00.
***Patino Mines and Enterprises.**—1s., payable Nov. 6.
†**Read's Drift Land.**—5%, payable Nov. 25.
***Rio Tinto.**—Pref. 2s. 6d., payable Nov. 14.
†**Roan Antelope Copper Mines.**—6d., payable Jan. 6.
†**Rooderand Main Reef.**—9d., payable Dec. 31.
***St. John d'el Rey.**—Pref. 1s., Ord. 6d., payable Nov. 22.
†**Tanganyika Concessions.**—Pref. 10%, Ord. 8%, payable Nov. 29.
†**Taquah and Abosso Mines.**—1s., payable Dec. 4.
†**Tati Co.**—3%, payable Nov. 21.
†**Transvaal Mining and Finance.**—1s., payable Dec. 30.
***Union Corporation.**—2s., free of tax, payable Dec. 5.
***United Tin Areas of Nigeria.**—6%, free of tax, payable Nov. 27.
†**Victoria Gold Dredging.**—1s. 6d. (Aust.), payable Nov. 22.
†**Waihi Investments.**—2%, payable Dec. 4.
†**Wanderer Consolidated Gold Mines.**—6%, payable Nov. 26.
†**West Rand Development.**—6d., payable Dec. 31.
***Zambesia Exploring.**—3%, payable Dec. 13.

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	380	10	0
Zinc (g.o.b.)	50	0	0
Platinum (Refined)	18	0	0
Silver		4	7½
Gold		8·12	3
Wolfram (Buying f.o.b.)		3	2	6
,, (Selling, Delivered)		3	7	6

Colombian Survey

By N. W. Wilson, A.R.S.M., Assoc. Inst. M.M.

Notes that include a review of Colombia's mineral resources.

Geography and Topography

The Republic of Colombia is situated on the north-western coast of equatorial South America between latitudes 12° 24′ North and 4° 17′ South, and longitudes 66° 7′ West and 79° West. The length of the Pacific coastline is 468 miles ; that of the Caribbean coastline is 641 miles. Countries which have land frontiers in common with Colombia are : Panama, Venezuela, Brazil, Peru, and Ecuador. The area is about 450,000 square miles and the population about 8,700,000, or 19 per square mile. Estimates of these figures vary as surveys are incomplete and inadequate and census returns for the Amazon and Orinoco lowlands are largely guesswork.

A list of the departments and intendencias, with their capitals is given in Table 1 and illustrated in Fig. 1. More than half of Colombia is composed of the Amazon and Orinoco lowlands, collectively known as the Oriente.

To the north of the Pasto Knot, which is on the Ecuadorian frontier, the Andes split up into three ranges separated by the two great Colombian rivers—the Magdalena and

Fig. 1.—Colombian Departments and their Capitals.

Table 1

Department.	Population.	Capital.	Population of Capital.	Altitude of Capital, Feet.	No. of Department on Plan.	Area of Department, Sq. Miles.
Antioquía	1,011,224	Medellín	120,044	4,800	1	24,401 [1]
Atlantico	242,817	Barranquilla	139,974	Sea Level	2	1,082
Bolivar	642,770	Cartagena	92,494	„	3	23,938
Boyacá	950,264	Tunja	19,064	8,600	4	17,564
Caldas	624,201	Manizales	81,091	7,000	5	7,915
Cauca	317,782	Popayán	31,839	5,700	6	21,882
Cundinamarca	1,056,570	Bogotá	235,421	8,560	7	8,629
Huila	207,034	Neiva	29,988	1,560	8	8,687
Magdalena	302,031	Santa Marta	30,942	Sea Level	9	20,463 [2]
Nariño	411,763	Pasto	43,162	8,400	10	10,039
Santander Norte	328,872	Cúcuta	49,279	700	11	6,708 [2]
Santander Sur	594,799	Bucaramanga	44,083	3,300	12	19,161
Tolima	444,592	Ibagué	56,333	4,250	13	10,811
El Valle	531,570	Calí	122,847	3,000	14	4,179
Intendencias—						
Chocó	85,399	Quibdó	21,916	?	15	13,761 [3]
Meta	19,320	Villavicencio	7,706	?	16	85,328
San Andrés y Providencia	5,987	San Andrés	3,898	?	17	?
Arauca	?	?	?	—	18	?
Caquetá	?	?	?	—	19	187,258
Territory of La Goajira	99,184	?	?	—	20	5,019
Putumayo	?	?	?	—	21	?
Vaupes	?	?	?	—	22	?
Vichada	?	?	?	—	23	?

[1] Chief Mining and Industrial Department.
[2] Oil Producing State.
[3] Chief source of platinum.

the Cauca. From east to west these ranges are known as the Cordillera Oriental, the Cordillera Central, and the Cordillera Occidental. Entering from Ecuador with a trend east of north, the two Western ranges gradually bend round into a nearly north–south direction. On the coast, separated from the Cordillera Occidental by the valleys of the San Juan and Atrato rivers, is the chain of low hills known as the Cordillera Chocó. The Atrato, the longer of the two rivers, empties into the Caribbean ; the San Juan flows southwards and debouches into the Pacific to the north of Buenaventura.

The Cordillera Oriental maintains an average height of 7,000 ft., the highest peak, Cocui, being 16,700 ft. above sea-level. Slopes are steepest on the west flank facing the Magdalena Valley ; on the eastern side the fall to the Amazon and Orinoco lowlands is more gradual. Near Bogotá there is a pronounced flattening in the range and further to the north, close to Pamplona, it splits into two branches. One of these, known as the Sierra de Perijá, trends northwards along the Venezuelan frontier and connects with the group of coastal mountains called the Sierra Nevada de Santa Marta ; the other swings to the north-east and extends into Venezuela, to the south of Lake Maracaibo, as the Sierra de Mérida.

Between the Magdalena and Cauca valleys lies the Cordillera Central. These mountains culminate in the southern departments towards the Ecuadorian frontier in the peaks of Huila (17,700 ft.), Nevada del Tolima (18,400 ft.), Ruiz (18,300 ft.), and Santa Isabel (16,700 ft.). From 3° North the range broadens into the Antioquian tableland which has an elevation of from 6,000 to 8,000 ft. and is 300 miles long and 150 miles wide. Relief is very marked as there are numerous large valleys, including those of the Porce, Nechi, and Medellín rivers, that are several thousand feet deep.

The Cordillera Occidental divides the valley of the Cauca from that of the San Juan-Atrato River system. The range lacks the plateau-like character of the Cordillera Central ; its greatest elevations are close to the Cauca Valley and the eastward slopes are thus abrupt. Westwards to the San Juan-Atrato valley gradients are flatter and the westerly drainage is consequently more important than that to the east. The general elevation of the northern part of the range is from 5,000 to 8,000 ft., the highest point rising to about 12,000 ft. ; in the south

Fig. 2.—The Mountain Ranges of Colombia.

the highest peaks are Chiles (15,680 ft.) and Cumbal (15,710 ft.). There are several passes with elevations between 2,000 ft. and 5,000 ft. between the Cauca valley and the Pacific; that which the railway between Calí and Buenaventura crosses is known as the Cresto de Gallo and is 2,250 ft. high.

Subsidence along the Colombian Coast has rejuvenated the rivers and flooded the lower parts of their valleys. This phenomenon is responsible for the deep gorge, 250 miles long, cut by the Cauca between Calí and Caceres and for the swampiness and poor drainage of the middle and lower Magdalena valley. The great width of the middle part of this valley, which in places is as much as 50 miles, is probably attributable to trough faulting.

Climate and Vegetation

Climate in Colombia is dependent mainly upon altitude. Four temperature zones have been distinguished—namely :—

Tropical zone .	0 to 4,000 ft.
Subtropical zone	4,000 to 6,000 ft.
Temperate zone	6,000 to 10,000 ft.
Páramo .	10,000 to 14,000 ft.

Day temperatures in the Chocó average 90°; at night they fall to 75°. The mean annual temperature at sea-level is 82°, with about 100° for the mean maximum and 65° for the mean minimum. At Bogotá (8,700 ft.) the corresponding figures are 58°, 75°, and 40°. Between 10,000 and 14,000 ft., in the Páramo zone, it is cold and frosts and snow are frequent. The perpetual snow line lies at 16,000 ft., but some peaks of only 14,000 ft. are snow-covered most of the year.

The seasonal distribution of rainfall in Colombia is irregular. In the Cauca valley, between the months of February and June, there is usually two hours' rainfall in the afternoon. July to September are dry, but there are heavy rains in October and November. December to January are dry again. In Western Colombia rain falls almost daily throughout the year, although a " wet " season, in which the rain is heavy and continuous, and a " dry " season in which the rains abate slightly and fall mainly at night are distinguished. During the " wet " season the Condotó and San Juan rivers sometimes rise as much as 8 ft. in as many hours. These floods cause considerable inconvenience to dredging operations. Around Bogotá and Medellín there are two wet and dry seasons—

the typical equatorial arrangement ; the wet seasons being April–June and October–December. Rainfall in the southern Amazon lowlands is very heavy between May and December and at this time of the year large areas are usually under water. On the central Caribbean coast rainfall is light and considerable aridity prevails.

Correspondence between altitude, vegetation, and climate is close. In the Caribbean lowlands, near the coast, where the rainfall is light, there are grasslands and a scanty covering of scrub. The lower slopes of the Cordilleras and the lower Magdalena valley are clothed with dense tropical forest. At higher altitudes there are first temperate rain forests, then grasslands. In the southern part of the eastern lowlands the plains are thickly forested, but northwards the savanna type of vegetation appears, consisting of grasslands interspersed with dense forested thickets.

Health

Areas above 5,000 ft. are, upon the whole, healthy, although on account of the poor sanitation typhoid and similar diseases are

Fig. 3.—Vegetation Map of Colombia.

more prevalent than in England or the United States. In the lowlands, particularly on the Pacific Coast where the rainfall is high, malaria, blackwater, and hookworm are endemic. Yellow fever is no longer common in the coastal towns, but still lurks in the bush. At Asnazu in the Cauca valley at an altitude of 3,400 ft. malaria was initially a serious problem as the percentage of infections in employees was 100, with a monthly sickness rate of 50% to 60% and a monthly mortality of 3% to 4%. By wiring dwellings, clearing the surrounding bush, canalizing streams, and enforcing thorough treatment on all who fell sick of malaria the incidence of the disease was reduced to negligible proportions. In general it may be said that no large industry or enterprise on the coast or in the river country can be permanently successful unless sanitary measures similar to those practised at Asnazu are undertaken.

Politics

Colombia is an oligarchy—that is to say, power is concentrated in the hands of a few landowning families. During the last decade nationalistic feeling amongst the Spanish-speaking people of Colombia has grown markedly. The country at the beginning of the war was aiming to escape from the colonial "raw material" type of economy and to achieve the greatest possible measure of autarchy consistent with her tropical environment by the promotion of mining, agriculture, cattle-raising, and secondary industry. Foreign technologists and capital are welcome, but only if they can be used to further the interests of the State. In the words of a recent article in one of the Colombian Mining Bulletins: "We should prefer our mines to be exploited by our fellow countrymen; however, as this is impossible, let us accept the capital and exploitation of foreign companies, but in circumstances favourable to us."

Hitherto the base-metal resources of Colombia, although comparatively close to world markets, have been kept in cold storage by lack of transport facilities. Lately, however, the great increase in the revenue from gold, platinum, oil, and agriculture has provided capital with which to finance extensions of the railways and improvements in the roads. Each improvement in transport liberates large numbers of transport workers for employment in more productive occupations and tends to reduce the exorbitant freight rates.

Mining Law

According to Colombian law any person may discover, prospect for, and sample, without licence, mines on land owned by the Government, which comprises about one-third of the total area of the country. On privately-owned land prospecting may only be undertaken by permission of the owner. Precious metals, copper, and precious stones belong to the State wherever they are situated. Base metals and minerals—such as, oil, low-grade beryl, mica, tin, mercury, and iron—belong to the State only if they are situated upon waste lands, or lands that were declared waste before October, 1873. Otherwise they belong to the owner of the surface rights.

Occurrences of state-owned minerals are divisible into two classes :—

(1) "Minas Denunciables" (Mines that may be proclaimed). Deposits of precious metals. Alluvial precious-metal deposits on permanently cultivated land to which the

Table 2

Types of Colombian Mining Title

Type of Grant.	*Type of Mine.*	*Limiting Area.*	*Duration of Title.*	*Tax.*	*Remarks.*
Concession	Alluvial deposits of precious metals in bed or on banks of navigable rivers. Base metals and minerals.	8·25 sq. km.	25 years.	Matter for negotiation.	Precise location of concession, plan of workings, samples of minerals must be filed with Ministry of Public Works within 18 months of grant of Concession. Royalties prescribed by the Government or must be negotiated.
"Pertenencia" or claim.	Precious metals—Vein.	3 pertenencias each measuring 600 by 200 metres.	During payment of taxes.	$20 per pertenencia.	Claimants may denounce subsidiary areas, but only as separate claims and denouncements.
Ditto.	Precious metals—Alluvial.	Square of 3 km. or rectangle 2 km. by 5 km.	Ditto.	$30 per pertenencia.	Ditto.
Ditto	Precious metals or stones. Bedded deposits.	Square of 2 km.	Ditto.	Royalty of 5% on output.	Ditto.
Ditto	Precious stones.	Square of 1 km.	Ditto.	$50 per pertenencia.	Ditto.

owner acquired his title before October, 1873, may only be proclaimed by him or with his permission. For any damage occasioned by mining to the surface the miner must compensate the owner of the surface rights.

(2) "Minas Contratables" (Mines that may be worked on contract). Deposits of base metals and minerals. Precious metals in alluvial deposits in the beds of navigable rivers and in strips 300 metres wide on their banks also fall into this class. The working of emerald mines is a Government monopoly, though rights have sometimes been leased to private persons and companies.

Respecting precious metals, including copper, a charge of 50 pesos is made for issuing a mining title; a further charge of 10 pesos is made for each claim proclaimed. The sides of claims are considered to extend vertically downwards; no difficulties can thus arise over extralateral rights.

In order to proclaim a mine a base line defining one of the sides claimed is measured and beaconed. The side on which the claims are intended to extend is indicated by marks placed on that side of the beacons. A plan of the area is drawn on which conspicuous fixed objects—such as, houses, trees, or large rocks—are shown. To this must be attached a written description. If the name of the previous owner of the mine is known it must be cited. Within 90 days of the initial discovery plan and description should be lodged with the *alcalde* of the municipality in which the mine is situated so that they may be forwarded to the Departmental Government. After the documents have been forwarded the intended proclamation must be published locally for two consecutive days. If within 30 days of the second publication no contestants appear and there are no other reasons to the contrary, title is granted by the Departmental Government to the claimant and is sent to the *alcalde* so that he may proclaim the mine.

The title remains in force only as long as the claim-holder pays his taxes and provided that development is undertaken within three years of the grant. Lists of new locations and abandonments are published twice annually by the gazette of the Departmental Government. Payment in one instalment of 40 years' taxes per claim entitles the claim-holder to rights to a vein mine in perpetuity and absolves him from further mining taxation. Foreigners may only acquire mining rights by transfer from a Colombian.

For the working of *Minas Contratables* owned by the Government the usual system is to grant concessions to suitable applicants in return for a fixed royalty. This royalty amounts to $5\frac{3}{4}\%$ of the value of the bullion produced. At coal mines the royalty is 5% of the value of the coal railed. For alluvial mines on the banks of navigable rivers the rates fixed are :—

Gold Content.	*Percentage of Value of Bullion Payable.*
Mg./M³.	%
600	7
601– 800	8
801–1,000	9
1,001–1,200	10
1,201–1,600	14
1,601–2,000	18
Over 2,000	20

The scale may be altered at the Government's discretion, but in theory the royalty may not be less than 7% of the value of the bullion produced; in practice big companies seem to be able to obtain reductions in this rate. An additional $\frac{1}{4}\%$ of the value of the production is charged by the Government to cover the costs of State inspection and technical services.

Strict regulations cover the disposal of bullion and platinum produced in Colombia. In 1936 platinum might only be exported by permission of the Board Controlling Exchange and Export. Proceeds of overseas sales had to be returned to Colombia; 40% might then be used to purchase foreign exchange, 15% might be sold to the Bank of Colombia at a fixed rate of 113 pesos per 100 U.S. dollars, and the remaining 45% might be sold at 175·5 pesos per 100 U.S. dollars. The effect of these regulations was that 40% of the proceeds might be exported, the rest being for use only in Colombia. For gold the regulations are similar; 40% of the proceeds of sales may be exported, the rest must be sold to the Government at from 2–3 U.S. dollars below the world price.

Acquisition of mining rights from landowners who also own the mineral rights is a matter for negotiation. Provided a small cash payment is offered and there is evidence that the negotiator intends to work the mine and not to buy it as speculation there is often no difficulty in concluding an agreement. Land belonging to the poorer class of farmer, more particularly the Indian farmer, is frequently held communally and is undivided. Acquisition of rights to this sort of property is seldom easy to negotiate in any part of the world.

This summary of Colombian mining law has been deduced mainly from reports of litigation in the Colombian mining bulletins ; it is quite possible that some of the interpretations of legal argument may be incorrect. Expenses for locating claims, obtaining possession, and annual taxation are low. However, there are often long delays in obtaining title : further the acquisition of mining rights in perpetuity and the inadequate methods of locating claims lead to much litigation. For foreigners the partial embargo on the export of earnings is a source of dissatisfaction.

Labour

The Colombian population is about 20% pure white (concentrated mostly in the uplands around Bogotá and Medellín), 5% pure Indian, 5% pure negro, and the rest mestizo, zambo, and mulatto. Negroes and mulattoes live chiefly in the western lowland areas ; for example, of the total population of 85,000 in the Choco, 60% are negroes, with 20% mulattoes, 15% Indians, and 5% of whites. Mestizos live mainly in the same areas as the whites. Negroes living under the conditions which normally apply in the lowlands are incapable of sustained effort, but improve in more favourable circumstances. Trade in the hotter and more inaccessible parts of the country is almost wholly in the hands of Syrians. In 1933 the percentage of illiteracy was estimated to be 55.

Studies of the agricultural resources of the country seem to indicate a lack of sufficient labour in many districts. Thus in Caldas there is at certain seasons of the year a labour shortage, as the small farmer, who forms the greater part of the population, will work by the day for others only when his own plantation does not require attention.

Colombians make good packers, canoe men, and machete and axe men for cutting trails and building roads. Carpenters, blacksmiths, and similar skilled workmen are rather scarce, but are quite competent when obtainable. Medellín and other big towns are the chief markets for skilled labourers, but to attract these men away from their homes into unhealthy or hot regions it is necessary to offer them about 75 pesos monthly, with allowances for lodging and payment in full of their travelling expenses to and from their homes. Wages for miners average from 1 to 1½ pesos daily, but foreign companies usually pay supplementary bonuses based on performance. Mule drivers receive from 0·60 to 1·20 pesos daily.

According to Colombian law no work is to be required of the labourer on Sunday. Codes regulating hygiene in mines and factories are theoretically in force throughout Colombia ; in practice they affect chiefly the Colombian employees of foreign companies.

It is estimated that in 1942 80,000 men were actively engaged in mining and that 500,000 people depended upon the industry.

Communications and Transport

In 1938 some 2,090 miles of railway of various gauges were in operation. Of this total part is owned by the National Government ; part by the Departmental Governments, and part by private companies. Bogotá is now in direct communication, *via* Cartago, the Quindío Pass, and Calí, with the Pacific Coast at Buenaventura. However, this line is unsuitable for heavy traffic ; moreover, in its western portion it is subject to flooding by the Dagua River. To Medellín, goods may now be hauled directly from Puerto Berrio on the Lower Magdalena without transhipment. There is an aerial cable line 45 miles long for the transport of merchandise between Mariquita near the Magdalena and the city of Manizales, capital of the Department of Caldas. This provides an alternative route to the railway. Two other cableways—one from Gamarra on the Magdalena River to Cúcuta on the Venezuelan frontier, the other from Villa Maria to Manizales—have recently been opened. In spite of these improvements for the upland plateaus of the interior, the Magdalena is still the main transport thoroughfare. Unfortunately this river is a poor water route. The depth of water over the bar at the mouth is only 6 ft. and is too shallow to permit ocean-going vessels to pass. For this reason Puerto Colombia, located on the coast some seven miles west of the river's mouth, is the direct port of entry ; here ocean-going vessels load and unload. Puerto Colombia is connected with Barranquilla, the official starting point of up-river steamers, by 18 miles of railway. On the river itself delays are frequent in the dry season because of low water.

A direct journey from the sea to Bogotá in favourable circumstances takes about 10 days, or in the reverse direction about seven days. In unfavourable circumstances, during the dry season, the journey may take a month. The route followed is: First by rail (1 metre gauge) from Puerto Colombia to Barranquilla; secondly, by river steamer from Barranquilla to La Dorada, for the greater part of which journey, 600 miles long, travel is only possible by day; thirdly, by railway (0·914 metre gauge) from La Dorada to Bogotá *via* Beltrán, Ibagué, Espinal, Girardot, and Facatativa. Other methods of making the journey are to take the seaplane from Barranquilla to Girardot and proceed thence by rail, the time required being two days, or to fly the whole distance from Barranquilla to Bogotá in nine hours.

With respect to freight about 50 river steamers on the Lower Magdalena handle daily in favourable conditions 300 tons upstream and 400 tons downstream. Charges are exceedingly high, the freight from the coast to Bogotá being about £5 per ton.

The second great waterway in Colombia is the Cauca. It is divided into two navigable sections—the first from Calí to Cartago, a distance of 187 miles, and the second from the mining town of Caceres to the Magdalena, a distance of 170 miles. From the mouth of its tributary the Nechi, to the Magdalena, a distance of 74 miles, the Cauca is navigable throughout the year for steamers of 120 tons burthen and 3 ft. draught. This service is important, because it gives access to the rich placer-mining region of the Nechi and San Jorge rivers.

Access to the Chocó is provided by the Atrato River. The size of the boats used on this waterway is limited by the shallowness of the water over the bar at the mouth; but for this obstacle, as the river is very deep, vessels of comparatively large size could be used even to points beyond Quibdó. In the department of Nariño it is possible for boats of 120 tons burthen to carry freight up the river Patía and its tributary the Telembí from Tumaco as far as Barbacoas.

The Colombian road system is poor. In 1921 there was only one wagon road in the, admittedly poverty-stricken, Department of Bolívar. However, two great trunk roads have recently been completed. They connect with one another and link up with the railways and navigable rivers. The Eastern Trunk Highway, 470 miles long, runs along the Cordillera Oriental from Girardot in the valley of the Magdalena to the Simon Bolívar International Bridge on the Venezuelan Frontier *via* Fusagasuga, Bogotá, Tunja, Capitanejo, and Cúcuta. For the Western Trunk Highway the route traverses the Cordillera Occidental and the Cordillera Central from Ipiales on the Ecuadorian frontier to Puerto Valdivia on the River Cauca *via* Espina, Tuquerres, Pasto, Popayán Calato, Calí, Cartago, Pereira, Manizales, Sonsón, Medellín, and Yarumal.

Besides these national highways there were, in 1920, about 4,000 miles of wagon roads and trails maintained by the State. Construction of a good wagon road, in the upland areas, because of the steep gradients and the heavy rainfall, costs as much as the building of a narrow-gauge railway; furthermore the maintenance cost of the road is greater than that of the railway.

Freight rates between Segovia and the sea *via* Zaragosa were quoted in 1930 as £8 per ton for packages of convenient size for mule transport and £16 per ton for inconvenient packages such as rails. Machinery destined for mines in remote situations should as far as possible be sectionalized in sizes that are not too big to be packed as loads for one or two mules. For gold mines a stamp mill with counter-current decantation is usually considered the only type of installation suitable in these circumstances. However, at the Timmins Ochali gold mine, 34 miles from Yarumal, in Antioquía, it was decided to build a tractor road over which a modern type of mill that could only be sectionalized in part might be transported. The road cost about £600 a mile to build. When completed tractor transport cost about £8 per ton as against £2 per ton for transport of sectionalized machinery by mules. As tractors were operated during the construction period continuously throughout the wet season road maintenance costs were high. At present orders are placed well in advance so that the transport of heavy loads may be confined to the dry season. Ordinary freight amounting to 110 tons monthly is moved by the owners of beasts of burden near the mine under contract.

History

In general the chief mining districts of Colombia are still those that were discovered and worked by the Spaniards in the departments of Antioquía, Cauca, Santander, and Tolima. European production of gold began in 1534, shortly after the Spanish Conquest. At first only alluvial deposits were worked, but in 1581 vein mining was started. A decree of the King of Spain in the 18th

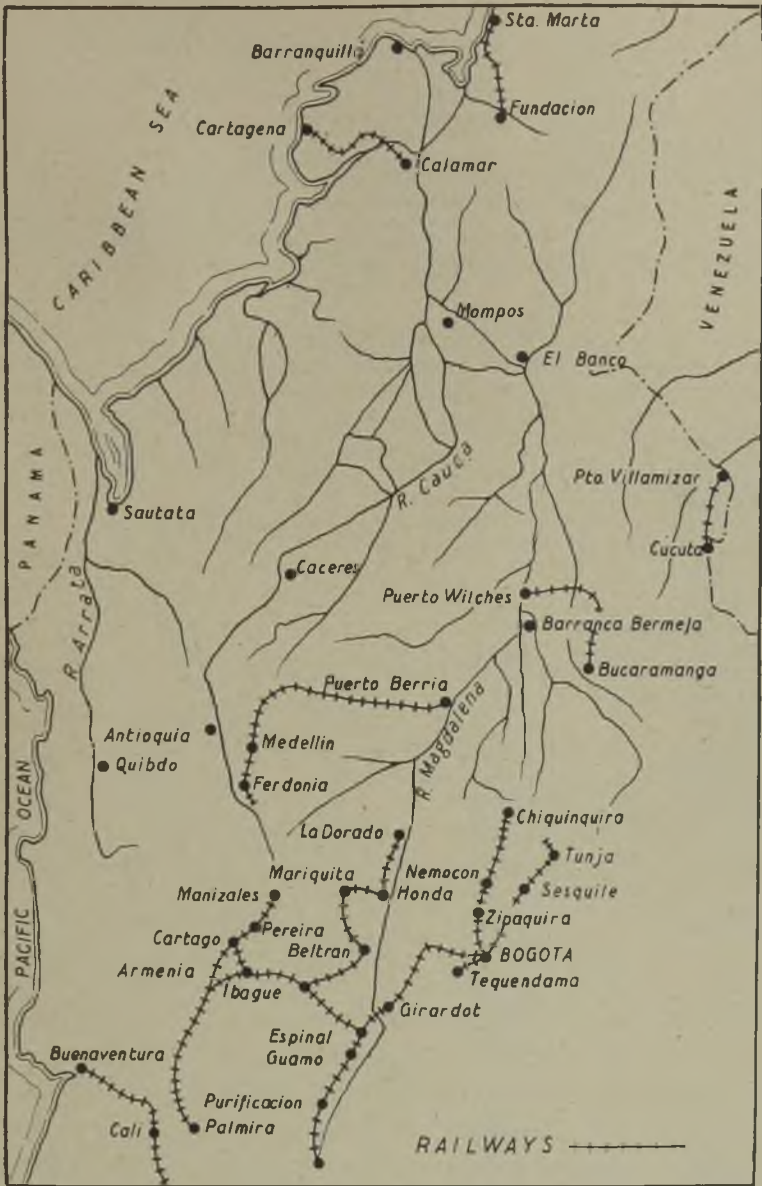


Fig. 4.—Communications in Colombia.

Century relieving Indians from the compulsion to work in the mines (a measure which affected the industry disastrously in upland districts such as those surrounding Pamplona and Mariquita) did not benefit the negroes. They continued to labour in the mines as slaves until the liberation in 1851. This accounts for the thorough prospecting that has been done, even in remote and unhealthy districts. It also explains the present scarcity of mines carrying easily-accessible free gold that have not been worked in the past.

The war of Independence between 1810 and 1819 and the revolutionary wars between 1885 and 1902 do not seem to have affected mining much, although a few foreign mines were closed during the second period, but the secession of Panama is still a bitter memory. It is largely responsible for the fear, ever-present with the Colombian, that powerful foreign governments may intervene in support of companies belonging to their countrymen against his interests. Clauses in the agreements with the oil companies expressly exclude intervention of this kind.

The revaluation of gold in 1932 has affected gold production markedly. Of the 4,000 proclamations of mines made since 1904, much the greater number was made in 1935 and 1936.

A chronology of some of the more important recent events in the Colombian mining and oil industries is given below :—

1852—Frontino and Bolivia Mining Co. bought several gold mines including the Frontino near Remedios in Antioquía.

1908—Drilling for oil began near Turbo. The holes were later abandoned.

1910—About this date Pato Consolidated Gold Dredging, Ltd., began operations.

1916—About this date South American Gold and Platinum Co. began large-scale dredging operations in the platinum-bearing regions of the Choco.

Table 3

Mineral and Metal Production

Year.	*Oil Barrels, 42 Gals.*	*Oz. Gold.*	*Oz. Silver.*	*Oz. Platinum.*	*Cts. Emeralds.*	*Remarks.*
1534–1600		10,600,000				
1601–1700		34,600,000				
1701–1800		41,000,000				
1801–1886		41,600,000				
1886–1900		8,216,000				
1901		136,000	2,520,000			
1902		122,000	?			
1903		132,000	?			
1904		95,800	?			
1905		125,000	1,000,000			
1906		106,000	980,000	6,813		
1907		157,471	?	?		
1908		145,649	?	?		
1909		150,000	?	?		
1910		279,342	?	10,000		
1911		340,000	?	12,000		
1912		344,000	?	12,000		
1913		348,000	?	15,200		
1914		?	351,311	17,500		
1915		?	?	13,601		Exports to U.S.
1916		?	?	25,588		
1917		?	?	21,278		
1918		?	?	33,543		
1919		300,000	?	26,046		
1920		?	?	20,000		
1921	65,185	?	?	?		
1922	318,812	?	?	45,448		
1923	421,403	300,000	?	48,348		
1924	442,453	?	?	51,530		
1925	1,000,930	?	?	62,000	250,000($)	
1926	6,441,249	?	?	?	?	
1927	14,999,681	?	?	?	?	
1928	19,892,778	?	?	53,330	22,712	
1929	20,381,184	?	?	45,576	?	
1930	20,343,428	?	?	42,381	?	
1931	18,234,679	184,274	77,709	35,793	?	
1932	16,415,214	248,249	194,761	40,500	?	
1933	13,156,126	298,242	108,005	45,971	?	62% of gold estimated to have been produced in Antioquía.
1934	17,337,900	344,310	127,461	54,768	20,608 ?	52% of gold estimated to have been produced from Antioquía.
1935	17,597,655	328,991	132,406	38,628	60,000	
1936	18,756,119	388,739	152,000	38,333	?	Natives estimated to have produced 45% of total platinum output.
1937	17,731,798	422,222	168,000	29,315	?	
1938	21,451,000	520,715	192,879	34,549	?	
1939	22,001,000	551,417	242,627	39,070	?	
1940	25,932,000	631,900	260,313	?	?	
1941	24,313,000	656,019	271,115	48,200	?	48% of gold from lode mines.
1942	?	?	?	?	?	40% of gold from lode mines

1916—Tropical Oil Company began to drill for oil in the De Mares Concession ; the holes later struck oil.

1916—A scientific commission under Dr. Robert Scheibe was appointed to study the geology and mining resources of Colombia.

1921—First exports of oil.

1923—Lease of emerald mines to foreign company. Output of emeralds interrupted as a result of the litigation which ensued.

1923—Favourable new oil laws passed.

1924—South American Gold and Platinum Company completed the second of their two hydro-electric plants in the Choco.

1925—As a result of legal difficulties South American Gold and Platinum Company shut down one of their dredges temporarily.

1926—Oil pipe-line from Barranca Bermeja to Mamonal completed.

1928—New and unfavourable oil laws passed.

1928—Agreement by which French company marketed entire Colombian output of emeralds terminated.

1929—Drilling in oilfields ceased partly because of the onset of the depression, partly as a protest against the oil laws.

1930—Armed mob took possession of the emerald mines at Muzo: later in the year a lease was granted to an American company.

1931—Issue of a decree decreasing tax on platinum from 10% to 5% *ad valorem*.

1933—The scientific commission under Dr. Robert Scheibe completed its report.

1933—Oil laws rescinded in favour of oil companies.

1935—Decision to erect a State metallurgical plant at Medellín for testing purposes.

1935—Appointment of State metallurgical commission under Wallace G. Fetzer to investigate problems.

1935—Timmins Ochali Mining Company began milling at Yarumal, Antioquía.

1936—Dredging in Department of Nariño begun by South American Gold and Platinum Company.

1939—Proposal for a new pipeline from the Barco Oil Concession.

1942—Erection of steel mill at Medellín consisting of two electric furnaces to melt scrap, two gas furnaces to heat ingots, and one 100-ton rolling mill. Reconditioning of blast-furnace at Pacho, Cundinamarca.

Table 4

Distribution of Gold Production to 1886 by Departments

Department or Intendencia.	*Gold Production, Millions £ Sterling.*	*No. of Mines known in 1915.*	*Remarks.*
Antioquía	50·0	12,181	Though these figures do not check with the total production of gold to 1886 given in another table, they are of use to indicate the comparative importance of the various departments respecting gold production.
Bolívar	14·0	?	
Boyacá	0·04	—	
Cauca	49·8	641	
Cundimarca	0·36	—	
Magdalena	0·20	—	
Santander	3·0	—	
Tolima	10·8	502	
Chocó	14·0	?	To 1800.
Caldas	?	2,610	
Nariño	?	2,452	

Table 5

Summary of Output from Vein and Alluvial Gold Mines in Colombia—1941

Type of Mill or Alluvial Appliance.	*Number of Mills.*	*Number of Stamps.*	*Tons per Day.*	*Grade (grm.) Recovered.*	*Kg. Gold per Day.*	*Kg. Gold per Month.*	*Oz. Gold per Month.*	
Antioquian mills	460	2,300	1,610					
Californian mills	68	480	1,300					
Ball-mills	12		500					
Drag mills	400		50					
			3,460	7·5	25·95	778	25,000	49%
			Yds.³ per Month.					
Dredges	17		3,100,000					
Draglines	2		60,000					
Hydraulic elevators	110 }		880,000					
Monitors	400 }							
Washers	—		20,000					
			4,060,000	0·2		812	26,100	51%
Total Weight of Gold Monthly						1,590	51,100	

Note.—Figures are approximate only.

Production

Details of Colombian mineral production, for 60% of which foreign companies are at present responsible, are given in Tables 3, 4, and 5. Records of individual mines are not always easy to trace on account of the frequent changes of departmental boundaries. Figures for gold production are unreliable as there are no licensed gold buyers in Colombia and smuggling is rife. Respecting platinum, the figures are more trustworthy. Most of the metal won by the native small-workers, and this amounts at present to about 45% of the total, is sold to agents of the Syrian merchants in Cartagena who maintain stores at Quibdó, Istmina, Baudo, Tado, and other places in the Chocó. Prices paid are about 30% of the New York valuation of platinum after deduction of 10% to allow for the (often very valuable) impurities in the crude metal. Almost all the Colombian precious-metal production is exported and the revenue from sales amounts to about a third of the total receipts of foreign exchange. Of the petroleum production roughly 10% is used in the country.

The figures given in Tables 3, 4, and 5 are all approximate. In general Colombian statistics indicate only the order of production, not the exact figure.

(To be concluded)

Cooling for the Ultra-Deep Mine

By Maxwell McGuinness

A description of a proposed "high-column" refrigeration scheme designed to control air temperatures at working faces.

Introduction

As experience has been gained with the air-conditioning plants installed at deep mines in various parts of the world it has been gradually realized that at depths of 8,000 ft. and over surface refrigeration can become uneconomic, particularly when the geothermal gradient is unfavourable. If, for example, to gain workable temperatures below the depth named it is necessary to cool the air entering the mine below 32° F. the air-cooling coils of the refrigerator installed at the surface would freeze solid. This places a lower limit on the cooling capacity of the plant and a maximum depth at which it can work efficiently.

It has been calculated for the Rand mines, for example, that the 8,000-ft. mark is the lowest vertical depth to which a surface refrigerator can work economically, whereas, in the case of the prospective mines of the Orange Free State, where the rock-temperature gradient is much higher than on the Rand, the limitation imposed by the 32° F. minimum may make a surface refrigerator uneconomical at about 5,000 ft. vertical depth. A similar situation arises with many mines in the tropics, where a surface refrigerator may become useless at about 4,000 ft.

To meet this prospective impasse a new system of mine cooling has been designed. This takes the form of a "high-column refrigerator," a description of which, compiled by a well-known South African engineer, is given in what follows.

The High-Column Refrigerator

The medium of cooling envisaged in a plant to the projected design is carbon dioxide. On the surface the plant consists of a compressor, which takes in superheated CO_2 vapour at about 60° F. and a pressure between 300 lb. and 400 lb. per sq. in. (depending on the depth of the mine), and compresses it to about 1,040 lb. per sq. in., the last-named figure being standard practice in the preparation of CO_2 as a refrigerant. The compressor discharges the CO_2 vapour to a cooler in which it is cooled by water so that it liquefies at about 86° F., after which the liquid may be still further cooled to an extent depending on the condition of the water available. The cooling condenses the CO_2 into a liquid while removing the sensible heat added in the compressor and a larger quantity of heat equivalent to the latent and sensible heat of the vapour entering the compressor.

The liquid CO_2, at 1,040 lb. pressure and, say, 75° F., is then led to a vertical pipe to descend into the mine. The down-going pipe is preferably located in the upcast shaft, as therein it is not liable to damage by a winding accident and if a leakage should occur it is of less consequence than if it occurred in the downcast shaft. The descending CO_2, whether in the condition of a liquid or a very dense gas, is nearly as heavy as water and so acquires a high pressure due to the height of the column *plus* its initial pressure. At suitable intervals in the descending pipe (determined by the economics of the cost of very thick pipes)—say, 4,000 ft. apart—the CO_2, at, say, 2,600 lb. per sq. in., is led into a decompression engine in which its pressure is reduced to about 1,040 lb. while gravity energy is taken out and converted into useful work—such as driving an electric generator connected to the electric mains of the mine.

After passing through at least one intermediate decompression engine en route, the CO_2 arriving at the bottom of its vertical descent is passed into another decompression engine which operates as previously described. It is to be noted that any or most of the heat of auto-compression which CO_2 may acquire in its descent is removed when it is expanded in the decompression engines.

The CO_2 discharged from the lowest engine is in much the same condition as when it left the surface—that is to say, it is in the condition of a refrigerant prepared for subsequent expansion to a much lower temperature, as if it were operating as one stage of an ordinary mechanical refrigerating cycle.

The refrigerant thus prepared in the lowest decompression engine is led in small branch pipes at about 1,100 lb. pressure to a number of evaporators, each located close to a working place (stope faces) in the mine. An evaporator contains no working parts and consists of a number of pipes into which CO_2 is expanded through a standard type of expansion valve to a lower temperature (say 60° F.) and a reduced pressure (784 lb. for 60° F.). The portion of the ventilating air allocated to the particular working place also passes through the evaporator in direct heat-exchanging relationship with the CO_2 passing through the pipes in the evaporator, the ventilating air being thus cooled to such a temperature that conditions at the stoping faces served are suitable for the performance of manual labour at reasonable efficiency and without distress or ill effects.

The proposed temperatures are given in the Table 1 and it will be seen that they also provide a favourable temperature gradient in the evaporator, which minimizes the pipe surface required for the heat exchange specified. The CO_2 on expanding into the evaporator converts into a colder liquid and a certain amount of vapour. In passing through the evaporator all the liquid CO_2 is evaporated at a constant temperature and pressure by the heat extracted from the ventilating air. The cooled ventilating air leaves the evaporator for a working place, its temperature being arranged so that it will not be heated to more than 80° F. wet-bulb by the heat it picks up in the working place. Such a temperature would doubtless be accepted by all concerned as a satisfactory working condition in a deep mine.

The CO_2 vapour leaving the evaporator at 60° F. and 784 lb. is piped to the bottom of the downcast shaft, from which point it ascends to the surface through two or more 6-in. pipes. The CO_2 vapour traversing the ascending pipes tends to cool by auto-expansion while lifting itself against gravity and also tends to cool to the lower temperature associated with its lower pressure and therefore it can exercise a very considerable cooling effect on the warmer downcast air in the shaft. The benefit of this effect is obtained by providing sufficient heat-exchanging surface in the ascending pipes to cause heat to pass from the downcast air to the CO_2 to maintain the latter at a roughly constant temperature of 60° F.

The CO_2 arrives back at the surface at a reduced pressure and is led to the suction of the compressor for the cycle to be repeated. The refrigerant CO_2 is non-poisonous, but as a safety measure the following precautions might be adopted in any plant installed: (1) The pipes in the downcast shaft should be provided at suitable intervals with standard self-closing safety valves which automatically limit leakage to the contents of a short length of pipe; (2) the pipes underground should be carried along the roof of an airway or in a trench in the floor, a few safety valves being also provided; (3) the descending pipe in the upcast shaft will need fewer safety valves or none at all.

Design Factors

The following assumptions can be made in estimating requirements :—

(1) The mine output may be about 100,000 tons per month, so that probably two main winding shafts will be required. To minimize the risk of rockbursts at the great depths under review it is considered that the stoping faces will need to be advanced rapidly—say at nearly 30 ft. per

Table 1

Data for a High-Column Refrigerator

Vertical depth of mine in feet, average	8,000	10,000	12,000
Heat picked in shafts by downcast air (B.T.U. per lb.)	2·0	3·0	5·7
Heat picked by downcast air in airways (do.)	5·2	7·8	9·0
Heat of autocompression of air (do.)	10·32	12·9	15·48
Heat picked up from two stoping faces each 400 ft. long	4·0	5·0	6·5
Refrigeration supplied in shafts (B.T.U. per lb. air)	2·63	6·5	10·0
Refrigeration supplied by evaporators (B.T.U. per lb. air)	5·2	10·0	17·0
Weight of CO_2 to be circulated per minute, lb.	1,620	3,400	5,000
Temperature of CO_2 in evaporator (°F.)	60	60	60
Pressure of CO_2 vapour at compressor suction, lb. abs.	400	350	300
Installed capacity of refrigerator, B.T.U.s per min.	144,000	320,000	480,000
Refrigeration supplied by evaporators, per lb. CO_2	59	59	59
Refrigeration by the rising CO_2, per lb. CO_2	30	35	39
Temperature of air leaving surface in summer, wet-bulb	58	58	58
Temperature of air at bottom of downcast shaft, wet-bulb	76	77	80·5
Temperature of air entering evaporators (average)	81	85	89·5
Temp. of air leaving evaporators and entering stopes (average), wet-bulb	75·7	74	72
Temperature of air leaving stopes on way to upcast shaft, wet-bulb	80	80	80
Number of decompression engines	2	2	3
Horse power input to surface compressors	800	2,000	3,500
Horse power recovered by decompression engines	300	750	1,300
Net power consumption (yearly average)	500	1,250	2,200
Suggested diameter of descending pipe for CO_2, in.	4¼	6	7½
Thickness of the same, top to bottom, in.	¼ to ½	$\frac{5}{16}$ to $\frac{13}{16}$	⅜ to ⅞
Weight of the above pipe, without joints, tons	75	200	336
Number of ascending pipes for CO_2, 6-in. diam., ½ in. thick	2	4	6
Weight of the set of ascending pipes, tons	136	340	612

Note.—All temperatures are degrees Fahrenheit, wet-bulb. If the volume of ventilating air exceeds 300,000 cu. ft. per min. by say "x"%, then the figures for h.p. installed capacity and weight of CO_2 can be increased by x % without serious error.

month. Therefore it is assumed that 30 stoping faces, each 400 ft. long, are operated either in pairs or as portions of long walls. An evaporator constructed of plain pipes and a simple expansion valve might be provided per two stoping faces, a total of 15 sets.

(2) The surface is about 5,600 ft. above sea-level, as on the Witwatersrand.

(3) The temperature of virgin rock increases 50° F. per 1,000 ft. of depth.

(4) The main and sub-shafts are vertical and of ample area.

(5) The volume of ventilating air supplied is 300,000 cu. ft. of free surface air per minute (about 18,500 lb.).

(6) The average maximum temperature to be secured at the stoping faces is 80° F. wet-bulb, a figure which most mining men would regard as satisfactory for the performance of manual labour and the preservation of health

(7) The calculations arrived at in the accompanying table are for the hottest summer months on the Rand, so that the annual average amount of refrigeration needed will be less by some 25%.

(8) The main fan is of the suction type operating on the upcast air, to avoid adding the heat of the fan horse-power to the downcast air. A pressure fan acting on the downcast air increases the refrigeration required by about 30% at 8,000 ft.

(9) The winders for the subvertical shaft are compressed-air driven, so that no electrical heat is liberated underground; alternatively sufficient electric power is produced underground by generators driven by air motors, to produce enough coldness (negative B.Th.U.s) to neutralize the heat produced by the electric winders, the generators, and the personnel at the substation.

(10) Steps will be taken to minimize evaporation of moisture in shafts, airways, and stopes in order to give as much difference as possible between the dry-bulb and wet-bulb readings. The wet-bulb reading is the real criterion of the condition of the air, but a high dry-bulb temperature serves the useful purpose of reducing the temperature gradient between the walls of airways and the ventilating air with a consequent reduction in the heat thus picked up. It is possible to predict wet-bulb temperatures fairly reliably, as in the table of calculations, but it is not possible to predict dry-bulb temperatures with any pretence to accuracy. The latter fact is relatively unimportant in refrigeration calculations.

General Considerations

It will be seen from the description that 80° F. wet-bulb was selected as the most suitable temperature for the air in the top of the stopes; this gives an average temperature in the stopes varying from 77·8° F. to 76° F. wet-bulb. The temperature of 80° F. was selected after taking into consideration the fact that at this temperature the workers should be able to work with good efficiency and without distress.

It is considered that considerable improvements in dealing with the problem of dust in the air should be effected when using the high-column refrigerator. One considerable advantage to be gained, it is thought, will be that workers in a hot humid atmosphere in mine stopes, generally distressed to a point at which their systems are much less resistive to the effects of inhaling dust, will be able to work without distress when the air in the stopes is kept at an average of under 80° F. wet-bulb, while their systems should be much more resistive to the effects of inhaled dust.

Wet-mining methods may continue to be used and the air sprayed with copious amounts of water to wash out as much of the dust as possible, which of course would result in the air becoming nearly saturated. However, as the air would be kept at a temperature at which the bodies of the workers, although wet by sweat or water or both, would be cooled by radiation etc., they can work at full efficiency without distress. When the first high-column refrigerator is installed the refrigeration experts in charge will start with the advantage of being able to use any desired temperature in the stopes.

It is also considered that while the air is kept at a desired temperature its volume may be varied as desired and the variations in the velocity of the air will cause the air to be exposed to repeated washing. This should result in a considerable reduction in the dust content of the air. It is thought likely that experiments along these lines may give good results and that the refrigeration experts starting with the above advantage will be in a position to evolve other and better methods of dealing with the dust problem.

By arranging the evaporators at or near the bottom of the stopes, as already described, the best positional efficiency is obtained, but if desired a single evaporator may be used near the bottom of the downcast shaft or several evaporators arranged, each to cool a number of stopes.

The Czechoslovakian Non-Ferrous Metals Industry

By Jaroslav Malkovský, D.Sc.

A review of the present position.

Introduction

Although famous for the mining of silver, gold, and tin in the past Czechoslovakia to-day is a country whose production of non-ferrous metals is rather limited. Silver has been mined in Czechoslovakia since the middle of the 10th Century, the mines around Jihlava, Tábor, and Kutná Hora becoming famous in the 13th Century. At that time Kutná Hora was the richest silver mine in the world and its *groš* was the most valued silver piece in Central Europe. The Hussit wars in the 15th Century mark the downfall of Kutná Hora as well as of the others. At the beginning of the 16th Century Kutná Hora attempted a come-back, but it never attained its old glory. This now shifted to another Czech mining district, to Jáchymov in north-western Bohemia, where the silver mines boomed at that time. It was here that the heavy and rich Czech *tolars*—a name that still lives in the American dollar—were coined. Here lived the learned physician Agricola and here he wrote his famous works on mining and metallurgy.

This glorious chapter of Czech mining history closed with the Thirty Years wars, from which the mines only recovered in the 19th Century, when Příbram successfully developed its silver-lead deposits and started extensive silver and, later, considerable lead production.

In the 13th Century much gold was

produced in Bohemia, at Kašperské Hory and Jílové, and in Slovakia at Báňská Štiavnica and Kremnica. Gold was also washed from the then rich sands of Otava and other Czech rivers.

Bohemia, however, was known not only for its mining for precious metals, for it was in 1240 that a large group of miners came from Cornwall to start work in Krušné Hory, the mountains in the north-west of Bohemia. Here, on the sites of very old and primitive mines, tin production was started. This reached its peak in the 16th Century when the yearly output was of the order of 35,000 *cents.*—*i.e.*, 1,750 tons of tin. In the 17th Century these famous mines shared the fate of the others and not until the 1914–1918 war was a serious attempt made to renew their operation.

To-day there is nothing spectacular, alas, about metal mining and production in Czechoslovakia. Some gold is still being mined in Bohemia and Slovakia, silver became a by-product of lead smelting, and most mining activities have been shifted to the coal and iron mines. However, some metal mines are still being worked and some development of prospective ore-bodies is to be expected.

The following notes give a short review of the present metal production of Czechoslovakia.

Lead

Lead is being produced at Příbram in Bohemia and at Báňská Štiavnica in Slovakia.

Příbram.—Príbram works its own ore, which contains some 1·5% to 2% lead, 200 to 300 grams. per ton of silver, and a number of impurities. The ore is taken from a depth of and slightly over 1,500 m., crushed, and floated. The products of the ore-dressing plant are the lead and zinc concentrates. The lead concentrate carries 35% to 40% lead, 6% to 8% zinc, 4% to 6% antimony, 0·6% copper, and 0·2% tin, as well as some As and traces of Bi, and 4,000 to 5,000 grams. per ton of silver, 0·5 grams. per ton of gold and 4% CaO, 8% Al_2O_3, and 28% sulphur. The zinc concentrate contains 60% to 70% zinc and 200 to 300 grams. per ton of silver. The smelter uses the lead concentrate and either disposes of the zinc ore to the domestic smelters or exports it.

The lead concentrate, after a roasting in a Humboldt roasting furnace, where the sulphur content is reduced from 28% to 8 or 10%, goes to the Greenawalt pot for agglomeration and a further reduction of the sulphur to 3 or 4%, and from here to the lead blast-furnaces.

The smelter has three blast-furnaces 2,000 mm. in diameter, with 12 tuyeres and an Arents syphon-tap. The capacity of each is 15 to 20 tons of lead in 24 hours. Only one or two furnaces are in operation.

The lead from the blast-furnace, containing approximately 6 to 7% antimony, 1% arsenic, 0·4% tin, and 0·8% of silver goes, after the removal of the rest of the copper, to the Harris refining plant, where the antimony, tin, and arsenic are removed. Then the lead is desilverized with zinc, goes back to the Harris plant for the removal of the zinc, and thence to the casting equipment.

The first silver-lead bullion, which contains most of the gold, is concentrated in two stages in English-type furnaces to 50% and 99% silver, cast in anodes containing 0·3% to 0·4% gold and sent for electrolysis to Kremnica.

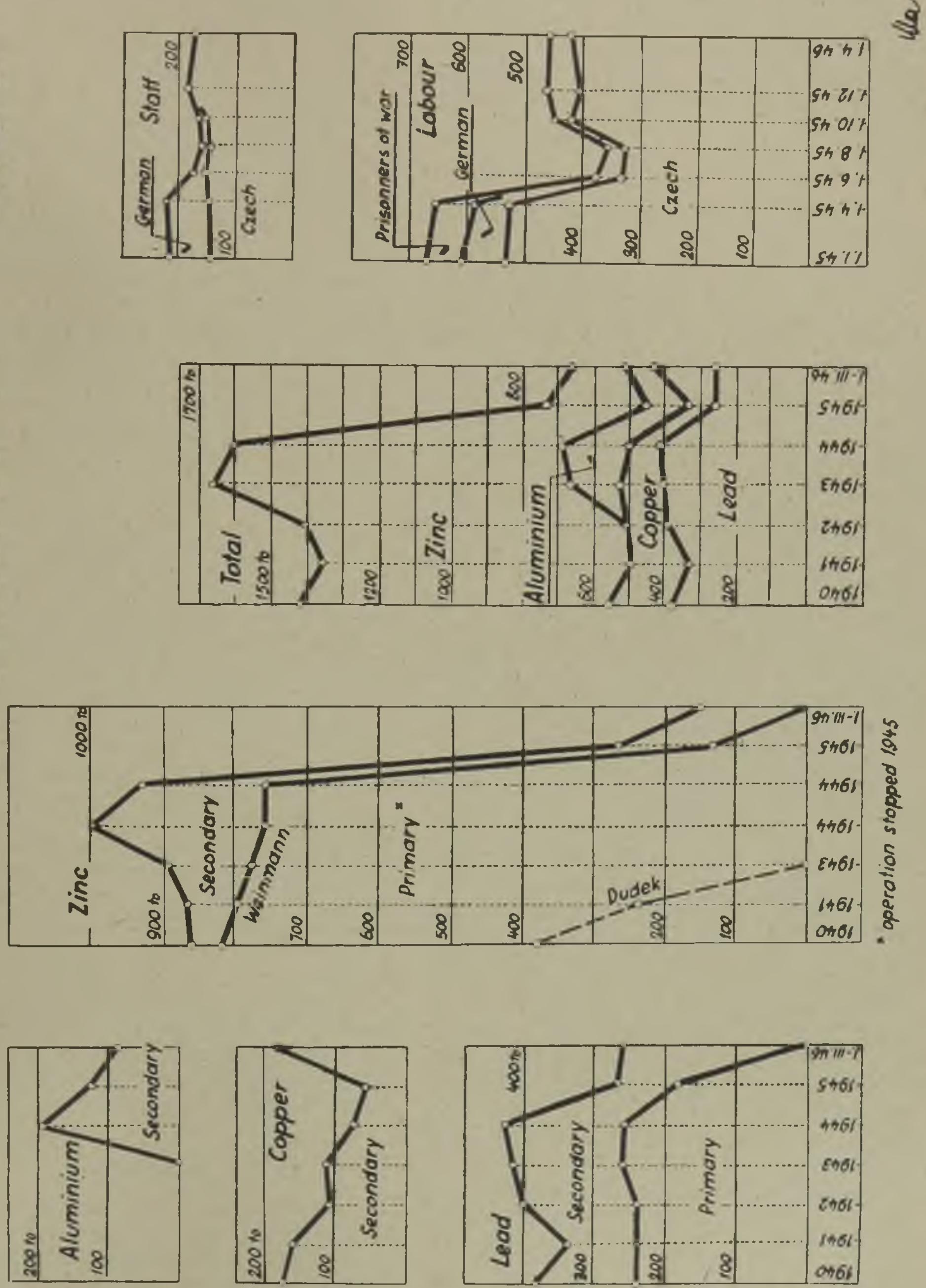
The second and third lead bullion is enriched at 800 to 850°C. in a special crucible. The crust, taken from the surface of the cooled metal in the crucible, contains about 45% silver and 25% zinc. The crusts are retorted in a 250-kg. furnace, where the greater part of the zinc is distilled off and returned for the future desilverization. The product of the retorting is then double-refined in an English furnace to 99·9% purity and either granulated or cast in blocks of 33 kg.

The capacity of the smelter at Příbram is 15,000 tons of raw lead yearly. The Harris plant is built for a yearly production of 8,000 to 10,000 tons of soft lead. The actual production of the smelter in the war years was substantially less and to-day does not amount to more than 2,500 tons of soft lead in a year. The reason for the limited output of the smelter lies in the fact that the Příbram mines cannot greatly increase deliveries without running the danger of quickly exhausting their ore reserves. The known reserves will, at the present rate of mining, last some ten years, but it is expected that further development will extend the life of the mines to about 25 years.

Báňská Štiavnica.—As the production of the Slovakian lead smelter in Báňská Štiavnica does not amount to more than 1,000 tons yearly, whereas consumption in

Average monthly production of non-ferrous metals and alloys in Czechoslovakia 1940-46.

/Slovakia not included/



Czechoslovakia runs to some 15,000 tons steps are being taken to renew ore production at Kutná Hora and, in the meantime, to import concentrated lead ores in order to relieve a threatening serious shortage.

Příbram produces about 25,000 kg. silver and 5 kg. gold, the production at Bánská Stiavnica being 10,000 kg. silver and 80 to 120 kg. gold.

Zinc

The two zinc smelters, in Retenice and Chudeřice, in the north of Bohemia, are at present at a standstill. The small zinc ore deposits of Slovakia were never worked, the country importing all the ore required. Originally roasted ores were imported, but later zinc concentrates were roasted at Ustí, where a considerable tonnage—up to 40,000 tons yearly—of ore was treated to provide sulphuric acid for the chemical industries of north Bohemia.

Before the recent war both these smelters supplied all of the zinc consumed in Czechoslovakia, one producing 4,000 to 5,000 tons and the other 8,000 to 10,000 tons of spelter yearly. In the early stages of the war the smaller of the two was closed down and production concentrated, under a working agreement, at the larger and better-equipped smelter at Chudeřice, which, heavily subsidized by the Germans, produced on the average some 10,000 tons of zinc annually.

At the end of the war, when the Czechs took over the two smelters with the Sudetenland, ore reserves had dwindled to a few hundred tons. An attempt was made to continue their operation and to use concentrates from Příbram, but, owing to the limited supply and the resulting uneconomical operation, the smelters have been closed until satisfactory reserves can be imported.

In the meantime a zinc ore deposit on the slopes of the Praděd mountain, in north-eastern Moravia, is being investigated. The ore found in this district contains sphalerite and galena to the extent of 12% metal, 6% of which is zinc and the rest lead, with little antimony.

Czechoslovakia has no zinc refining plant and has to import all of her requirements of refined metal.

Copper

Very little copper can be successfully mined in Czechoslovakia and that in Slovakia only. There chalcopyrite occurs in the siderite veins at Kotrbachy, Slovinky, Gelnice, Spania Dolina, and Staré Hory. Some copper is also found in quartz veins in the district around Cucma and some in the pyrite deposits of Smolník. The copper content of these ores is low—$\frac{1}{2}$ to 2%—and the two smelters at Krompachy and Bánská Bystrica were operating before the war rather uneconomically. Krompachy produced about 1,800 tons and Bánská Bystrica about 800 tons of electrolytic copper yearly.

The last phases of the war in eastern Slovakia put an end to the operation of the Krompachy copper smelter, which, including its largest Czechoslovakian electrolytic plant, was completely destroyed. Following the loss of this plant, which produced 500 tons of electrolytic copper monthly, only the electrolytic plant at Bánská Bystrica remained in operation. The output of this plant, some 80 tons of cathodes monthly, is too small even for the secondary copper production in Czechoslovakia.

Tin and Tungsten

Practically all the Czechoslovakian tin deposits are concentrated in the north-western border mountains of Bohemia, at Krusné Hory. The mines there, known from the 13th Century, and worked probably very much earlier than that, are at Krásno, Rotava, Přebuz, Krupka, and Cinvald. During the war the Germans used every effort to increase the output of these rather neglected mines and at the end of hostilities the mills and flotation plants in the district were dressing 17,000 tons of ore monthly and producing about 260 tons of concentrates containing roughly 35 tons of tin, 40 tons of WO_3, 6 tons of arsenic, and some copper and molybdenum.

At the present the tin and tungsten ores are being smelted abroad, as Czechoslovakia has no plant which could take care of such work. The advisability of erecting such a plant is being investigated by the Příbram works.

Aluminium

Several proposals to start the production of aluminium in Czechoslovakia were put forward before the recent war, but all were abandoned. There are no known large deposits of bauxite in the country, although large quantities are being mined in Hungary, just across the Danube, and could be easily imported. However, the water power in the country is not yet abundant enough to furnish the necessary cheap energy supply and the coal situation, although not as serious as in other parts of Europe, still will not permit of any considerable increase in consumption for some time.

Nickel

Considerable surface deposits of workable nickel ore have been located in the south Bohemia region around České Budějovice. This ore resembles the Canadian, but its nickel content is low—about 2%. Should the study of the technical aspects of the development of this deposit now in progress prove it an economic possibility Czechoslovakia might be able to produce about 2,000 tons of nickel, either as such or as ferro-nickel.

Antimony

Czechoslovakia is one of the largest producers of antimony in the world. The ores (antimonite and berthierite) found in the gold-bearing veins at Zlatá Ida and the antimonites from Čučma and Betliary in Slovakia are dressed and smelted at Vajskova. The smelter produces more metal than can be used in the country and antimony is the only metal that is at the present time being exported.

General

What has been so far said about metal production shows clearly that Czechoslovakia depends to a great extent on the import of the basic metals and much care is therefore taken not to waste metals and to re-melt and re-use scrap.

Secondary lead is being produced by the Příbram smelter, as well as by several smaller works at Uhříněves, Dolní Mlýn, and Velvary, in Bohemia, and at Rýmařov, in Moravia. The approximate yearly production of the secondary lead, soft and hard, is 2,000 tons.

Secondary zinc is being recovered by several smaller works—three in Bohemia and one in Moravia—to the amount of 1,000 to 1,500 tons yearly.

The copper and copper-alloy scrap and other residues are re-worked by a non-ferrous smelter at Moravská Ostrava, in Moravia. This works, with two small copper blast-furnaces and two reverberatory furnaces, produces 1,000 to 1,500 tons of either fire-refined copper or anodes yearly, which it sends to Báňská Bystrica for electrolysis. The same smelter deals with nickel scrap and some nickel ores, from which nickel sulphate is produced for the Czechoslovakian food industries. A considerable tonnage of rolling-mill scrap is fire-refined by one of the copperworks in two reverberatory furnaces of 15 and 25 tons capacity at Povrly, in North Bohemia.

One of the steelworks at Moravská Ostrava produces about 2,000 tons of cement copper yearly from either Slovakian or imported burned pyrite. The finely-crushed burnt ore is subjected to a chloridizing roast in a seven-hearth Humboldt roasting furnace. The escaping gases are condensed in a Gossage tower and the "tower liquor" is used as a solvent in the leaching of the chloridized ore, which takes place in wooden leaching tanks with perforated false bottoms and a quartz-gravel filter, covered with a layer of pea-sized coke. The copper liquor is collected in large storage tanks, where it clarifies, and from here is pumped to three revolving precipitation barrels. These are made of steel, lined with sheet lead and wood, and each takes care of 15 cu. metres of liquor. The precipitation lasts two hours at the most, after which the contents of the barrels are run off to settling tanks, the mother liquor being decanted and the copper removed for washing and drying. The residue of the leaching vats is mixed with coke, blast-furnace flue dust, and with the fine ores, agglomerated on a Dwight-Lloyd straight-line roasting machine and on two Greenawalt pots and used as an iron ore for the blast-furnaces.

Like everywhere else in countries engaged in the recent war there are large quantities of aluminium scrap in Czechoslovakia. The recently-erected aluminium re-melting plant at Hostivař takes care of its utilization. The work is modern, with crushers, dryers, and cleaners for the shavings, two large stationary melting furnaces, and one rotary furnace, the erection of which is being completed. The yearly capacity of the works, when in full production, will be 3,500 to 4,000 tons of re-melted aluminium and light alloys. Although this capacity is not large enough for the present peak demand and the volume of scrap offered it will easily take care of the demand in the more normal conditions expected later.

Extensively-industrialized Czechoslovakia needs far more base metals than she can or ever will produce. Against an average consumption of 14,000 to 18,000 tons of lead, 14,000 to 16,000 tons of zinc, 18,000 to 26,000 tons of copper, and about 6,000 to 10,000 tons of aluminium there is available to-day a production of about 3,000 tons of primary and 2,000 tons of secondary lead, a small production of primary copper and of about 1,500 tons of secondary copper, an insignificant tonnage of re-melted zinc, which, anyway, can be used almost only for the chemical industries, and 2,000 to 3,000 tons of re-melted aluminium, chiefly for foundry purposes. Czechoslovakia must import all her consumption of tin, nickel, chromium, tungsten, and molybdenum.

One of the most pressing problems of the industrial recovery of the country is the replenishing of the stocks, which were so effectively exhausted by the Germans during the war. The few thousand tons of material the Germans left in the country after the occupation is but very poor compensation for what they took away. Rationing is in full force and, unless a considerable tonnage can be imported, a serious shortage of raw material is feared towards the end of the current year. This, unless it can be remedied, will cause retardation of the very promising consolidation process taking place in the country.

Ore-Dressing Notes

(19) *Dust.*

The Mill Atmosphere

There are several good reasons why dust in a concentrator should be kept to a minimum. First, there is the health hazard. Even if the ore undergoing treatment is not silicotic it is but sensible to keep the air breathed by everybody as clean as possible. Next, it must be remembered that we pay for our dust in added maintenance costs. Once dust has mixed with lubricant and worked its way into a bearing the true function of that lubricant is gravely impaired. Instead of providing an easily-sheared zone separating two surfaces and protecting them from damage it now becomes an abrasive paste of higher viscosity, wasting power in its shearing and having its designed composition adulterated by a random addition of the substances of which the dust is composed. Third, there is the loss of light due to dust films on windows and electric lamps—a loss which contributes to bad maintenance and to accidents, beside lowering the supervising efficiency of the mill personnel.

The effect of dust on flotation has not yet been closely studied, to the present writer's knowledge. It is well known, however, that flotation pulps are sensitive to comparatively small traces of impurity and one can imagine a definite effect being produced in some cases. In one experiment a Denver cell was made to draw its air from a smelter stack, but the sulphur fume may have been more responsible than the dust drawn into the cell for the change in flotative value. Another phenomenon which plant operators may have involuntarily witnessed is the bad effect on the circuit caused when an unusual quantity of very fine material finds its way into the circuit, from such operations as cleaning up spillage from a dusty floor, or washing down a dusty stope and sending the product to mill without warning.

Dust does not occur only as a visible cloud, hanging round such places as bins, screens, dry crushers, and transfer points for dry ore. Appreciable quantities are to be found where pulp launders deliver a stream in such a manner as to entrain air—for example round the closed circuit of the ball-mill, near automatic pulp samplers, above aerating tanks such as agitators and flotation cells. There is a good case for making a dust survey in the mill and for considering carefully whether it would pay to take it out of the atmosphere and to keep it out. It is not enough to instal devices which collect dust and discharge it to a place where it can become a nuisance to others. Nor is there much point in expelling it from the mill and then letting it find its own way back in. The technique sometimes used in air conditioning, which keeps the building sealed and slightly pressurized and only admits washed and cleaned air, is not suited to mill conditions where the dust is generated inside the building. What is wanted is a system which deals with the worst generators of dust locally and which replaces the general dusty atmosphere with a clean one, while giving suitable purifying treatment to the issuing fouled air.

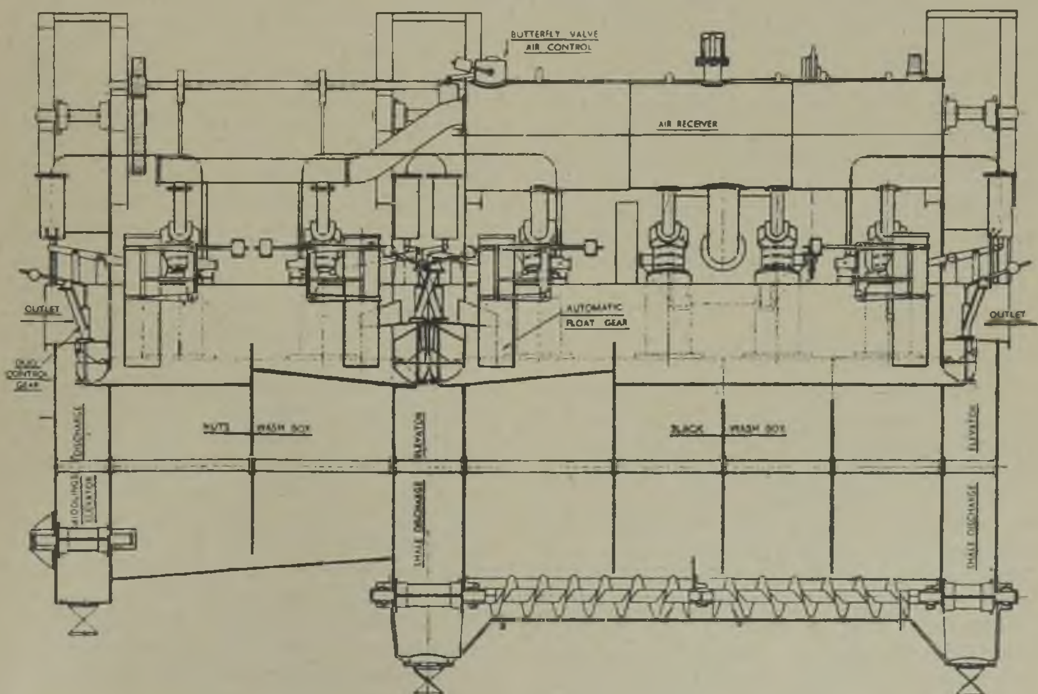
(20) *Coal.*

The Baum Jig

With the growth of mechanization in the mine, coupled with the need for increased output as the richer mineral deposits are depleted and the poorer are worked, the selectivity possible when using hand methods at the working coal face is giving way to techniques in which waste rock can be so cheaply gathered and transported that it becomes good policy in many cases to get the lot out to surface and deal with undesired rubbish there. So far as British coal is concerned policy as regards treatment is at present in a very confused state. Everything the miners send out can be sold and with the State in the throes of taking over control of a herd of highly individual enterprises the consumer has to do the best he can. The arguments in favour of beneficiation of coal become increasingly powerful with each inroad of mechanized "getting" and with the change from the old tradition of hand craftmanship to the ideas of the new generation, which has not the same outlook toward the job in hand.

This does not, of course, alter the fact that the coal consumer needs B.Th.U.s or chemicals, not shale or slate. Since the best place to produce a tailing and reduce the shipped product to grade is at the nearest convenient point to the mineral deposit, and not on the customer's clinker heap, the practice of coal-cleaning in this country may confidently be expected to increase despite the change in ownership.

The three main divisions of coal cleaning are all wet processes, the dry tabling of coal being still in the advanced development stage. The three general methods are jigging, Rheolaveur, and sink-float. The dominant jig in the coal industry is the Baum, which during the past ten years has developed to meet the challenge of the competing systems. The Comrie washery in Scotland, perhaps the most modern in the world, uses the Baum jig. Abroad, as here, this type of jig has won important success. Part of this is due to performance and part to the fact that automatic control has rendered possible a maximum production of grade product with a minimum of operator's supervision. One



Cross-Section through the Norton Double Coal Washer.

modern form has several features of interest to those whose work is connected with the hard-rock minerals. With coal one trouble until recent times has been the impracticability of providing a surge reservoir between the mine and the washery. So long as a dominant factor was the avoidance of breakage in transit the use of skips and storage bins was ruled out. With to-day's consumer demand large coal is not important and washed " smalls " find a ready market. This has made possible the use of modified skips and the binning of the coal to equalize feed into the washery. Meantime, however, the Baum jig, which had to compete with systems not upset by irregular feed, acquired a float control, which rides in the jig bed and rises as the refuse on this bed builds up. By varying the rate of withdrawal of shale it maintains a working bed within close maximum and minimum thicknesses. This, coupled with an automatic stop-start control which causes the jigging pulsations in the washer to cease whenever the supply of raw coal shuts off and puts it into action again as soon as new feed arrives, renders the jig independent of surging and allows it to operate under steady set conditions. The illustration does not show the fact, but the tank and its contents have been streamlined to minimize eddy resistance and thus save operating power.

In practice the use of the jig enables operation to be set for a definite specific gravity for each jig in the flow-sheet. This allows a difference between the coarser and finer fractions to be made, the separation usually being at about $1\frac{1}{2}$ in. A jig is made in which something of this effect can be obtained in a single machine with a double washbox.

(21) *Test-Work.*

Quebec Pilot Plant

Active development of the Val d'Or belt of mineralization has influenced the siting of an ore sampling and treatment plant on the Provincial School of Mines land 5 miles west of Val d'Or. This training school was closed in 1942 and is about to be re-opened. The sampling plant, as described in a recent trade publication, has been designed with special consideration for patchy ore. All ore is crushed to $-\frac{1}{16}$ in. before a cut is taken and to avoid trapped " metallics " no screens or elevators are used. From the truck scale ore goes to one of two 20-ton bins, which feed to a 9-in. by 16-in. jaw-crusher and thence to a cone-crusher releasing a $-\frac{1}{16}$-in. product. From this a vibrating feeder delivers to a mechanical sampler which makes a 10% cut. This is reduced in a special cone crusher to $-\frac{1}{32}$ in. and mechanically cut to 20% of its 10%. This is further reduced, to $-$ 100 mesh, and again cut to 10% before pulverizing and riffling down to assay size. In addition to this sampling plant there is a small cyanide section capable of treating the sample rejects and the gold ore mined by trainees at the Government School. During the war a small flotation *plus* gravity scheelite plant was also operated.

(22) *Flotation.*

Separation of Potassium and Sodium Chlorides

The drying up of Lake Bonneville, in northern Utah, has left a briny area of mud flats from which potassium chloride is differentially floated from NaCl as the result of pilot operations begun with a 75-ton mill in 1937 and to-day grown to a throughput of 450 tons. The flats cover some 75 square miles of featureless flat desert, the salt deposit varying down to 3 ft. in thickness, overlying a fissured clay bottoming on an impervious clay. Special tractors dig ditches 3 ft. wide and 14 ft. deep through which the brine gravitates to one of three pumping stations which lift it 10 ft. to the evaporating ponds where sun heat evaporates the entering flow from its original 1·2% KCl, 1·6% $MgCl_2$, and 19% NaCl to saturation point ($7\frac{1}{2}$% KCl, 9% $MgCl_2$, and 16% NaCl). Evaporation is continued in a second series of ponds until the $MgCl_2$ content is 20% and the potassium and sodium chlorides are crystallizing out in a 1/3 ratio. At this point carnallite begins to form and the residual liquor is removed to waste storage, leaving a precipitate of mixed salts 4 in. to 6 in. deep. These are loaded mechanically into trucks and stockpiled at the mill. The weather is an important factor in all this, rain, cool overcast skies, and adverse winds badly upsetting the evaporating routine in the 4,000 acres of evaporating ponds. According to a trade publication[1] from which this description is taken the optimum travel of each molecule of KCl during evaporation is 45 miles and in the 100-day season 4,000,000 tons of brine yield 1,000,000 tons of salts, the sun doing a job which would otherwise need 300,000 tons of coal.

[1] Denver Equipment Co. Deco Bull. No. M 4–B39.

From the stockpile the mixed salts go *via* a small hammer-mill to two grinding stages releasing — 30-mesh material to the flotation section at 40% solids and a natural alkalinity of *p*H 8. The collector agent is Armour Amine No. 1880, which has some frothing characteristics. Overgrinding beyond 150 mesh is bad for the process, the amine selectively coagulating the KCl into a fast-floating concentrate provided the grind is coarser than this, the coagulation being accompanied by a considerable occlusion of air. Only three minutes in the cells are needed to give an 85 < 90% KCl product. This is raised to 95% by a quick water-wash, without undue loss of KCl, as the entrained NaCl returns to solution and is then filtered to a 6 < 8% moisture concentrate which is fire-dried to ½% moisture before shipment. Any KCl escaping this operation is eventually retrieved from the tailings pond.

Letters to the Editor

Canadian Magnesium Production

SIR,—I was greatly interested in the digest of the *Compressed Air Magazine* article that appeared in the July issue. This dealt with certain electrometallurgical developments in Eastern Canada, especially with magnesium production in the Province of Ontario. In view of the many published statements on this subject I would like to draw your attention to certain well-established facts concerning the origin of this Canadian development.

The history of magnesium production in Canada dates from the years before the war, when, as a result of certain experimental work undertaken at the National Research Council in Ottawa, Dr. L. Pidgeon published a report stating that as far as could be seen it was impossible to produce magnesium in metal apparatus. In May, 1940, a copy of this report was handed for criticism to me, as Consultant to the British Government authorities in Canada, and, owing to the urgent demand for this metal for war and other purposes, the then Director-General of the British Supply Board in Ottawa and New York, in consultation with the British Treasury representative, both of whom were vitally interested in trying to establish production of magnesium and its alloys in Canada, agreed to my suggestion that the National Research Council should be given full information relating to a certain long-established English process involving distillation from metal apparatus and using calcium carbide as the reducing agent for magnesiferous raw materials.

Details of the plant used in England, as well as full information concerning the operating conditions, which are as defined in the summarized description of the Canadian process, were accordingly communicated verbally but officially to those at the National Research Council who had been engaged on the pre-war experimental work referred to above. In addition, certain modifications and improvements in the design and construction of the English plant were suggested —such as, the use of heat-resisting alloy retorts, the materials for which were much more readily procurable in the United States and Canada than in England. The digest you have published accordingly now makes it clear that in establishing production of this metal in Canada the general principles and methods of the original English process have been followed and that the improvements suggested as above were also incorporated when designing the necessary plant and equipment. There would nevertheless appear to be certain departures from the original English practice, as for example, the following :—

(*a*) The use of ferro-silicon in place of calcium carbide as the active reducing agent.

(*b*) The use of horizontal retorts instead of vertical retorts.

(*c*) The application of electrical methods of heating.

In regard to these observed differences between Canadian and English practice it should be remarked that the possible benefits of ferro-silicon as a reducing agent were mentioned to the National Research Council at the time of giving them details of the English process, the English company having experimented in that direction, as well as with electrical heating, in pre-war days. Furthermore, its employment for this purpose has been described in the patent literature—notably, in American patent reports and specifications since about 1916. As to the use of horizontal retorts, many such designs for both batch-type and continuous operation have been evolved and patented in the past, while as regards the use of electric heating this is ultimately a question of local convenience and of supply.

In the light of the information now available it seems fairly evident that any patents covering the process described in your digest should refer primarily to certain forms of apparatus adopted. This then becomes a question of considerable importance, in view of later English developments—such as, that described in British Patent No. 562,108 and its American and Canadian counterparts, when issued—by which the distillation process for the production of magnesium metal may be developed on a fully-continuous basis, with many consequent benefits as regards both output and production costs. It is accordingly my hope that the publication of these additional facts will prove of interest to your readers in completing the historical and technical details already made known to them.

W. F. Chubb.

London, S.W. 19.
October 19, 1946.

"Mining Efficiency"

Sir,—I have read with interest the letters of Messrs. C. H. Trezise and R. B. Allwright under the above heading.

As one who has worked on alluvial mines in Nigeria since 1913 I may say that Mr. Trezise is quite right in saying that wheels have been removed from wheelbarrows to facilitate the carrying of the bodies as headpans. This was particularly noticeable among crude types of pagan labour and recently among the Government Selected Labour. I cannot recall seeing it among the more sophisticated Hausas, although I have seen on a return journey the barrow reversed and carried on the head.

As regards the relative efficiency of the headpan and wheelbarrow; this entirely depends on whether the ground is wet or firm between the loading and unloading, the nature of gradients and obstacles encountered, and the length of carry. If this is, say, 100 yards over rough ground the headpan is undoubtedly the more economical, especially as women and children are used on this type of work who could not push a wheelbarrow. However, as this type of work is now usually done by contract, the labourer often has the choice and generally speaking his choice is the headpan.

A. Fairfax Scott.

London.
October 27, 1946.

Engineering Log

Steel wire rope which goes to sea has not only the ordinary vicissitudes of its job to withstand but also corrosion by salt water. In one manufacturing process the wire is first tempered, or "patented," in oxygen-free tubular furnaces. The issuing wire is passed through a molten cleaning agent while cathodically charged, to break down scale. After washing off any residual matter in successive water rinses, the wire, still running continuously, receives an electrolytically deposited coating of zinc. This zinc comes from an acid sulphate electrolyte prepared direct from roasted sphalerite, and purified to ensure that the zinc coating shall be practically 100% pure. Special stirring and handling methods in the cells ensure uniformity of deposition, the speed of passage of the wire determining the plating thickness. The plated wire is reeled as it emerges from the bath. It can then be drawn down to any desired wire size before being spun into rope.

* * *

For lack of imported coal Eire is turning to large-scale use of peat or, as the Irish call it, turf. A pound of turf with a moisture content of 30% gives 6,300 B.Th.U., a little poorer than properly-seasoned logs. Completely dehydrated turf would give 9,000 B.Th.U.s, but the last 20% of moisture would be hard to remove economically. A ten-year plan estimated to cost £3,870,000 aims to develop mechanized bog development and make Eire 75% self-sufficient for fuel. This will give permanent employment to 3,400 and seasonal work to a similar number for an eventual output of 1,000,000 tons/annum. The war brought prosperity to cottagers who got about 22s. per ton for stacked turves. Machinery makes a cheaper job, but the price to a customer in Dublin—£2 per ton—involves a state-borne transport loss. Two turf-burning power stations are planned, one to take 120,000 tons annually from the Clonsalt bog and produce 90,000,000 units and the other to produce 120,000,000 units from 160,000 tons in Ferbane. Reserves suffice for 200 years and bogs replenish themselves at about one half-inch annually.

* * *

At a late stage in the war a large barge was convoyed under tow across the Atlantic, at 3 knots. It took 51 days to reach Antwerp and was the centre of a night's fighting with U-boats in the Scheldt estuary. Although unable to propel itself it held in its steel hull a turbine generator set good for 30,000 kW., from steam raised in two oil-fired boilers using 500,000 gallons of fuel oil per week. Despite the 2,600 V-bombs which fell on Antwerp the power barge escaped serious damage and, hooked up *via* the 20-ft. high transmission tower on its deck to the Belgian power distribution system, it kept the city supplied with electricity for several critical months.

* * *

"Hardness" in water is easy enough to recognize, but less simple to define. A simple, albeit unscientific, description is its power of destroying soap froths, as measured by standard titration methods which observe the continuity of a lather. Hardness takes two forms—temporary and permanent. The former is caused by the carbonates of magnesium and calcium, rendered soluble by excess carbon dioxide, and therefore precipitating out when this CO_2 is driven off by heating—

$$CaH_2(CO_3)_2 \rightarrow CaCO_3 + CO_2 + H_2O.$$

If such water is treated with lime in a softening plant the temporary hardness can be removed, according to the equation :—

$$CaH_2(CO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$$

This precipitate is coagulated with aluminium sulphate and trapped in a sedimentation bed

$$Al_2(SO_4)_3 + 3Ca(OH)_2 = Al_2(OH)_6 + 3CaSO_4.$$

The Clark process, now a century old, bases all lime-softening methods. The usual method to-day, as described by E. G. Kimsey[1] first mixes lime with from 10% to 20% of the hard water undergoing treatment, while the balance goes direct to mixing tanks where it meets this limed water and a dosage of aluminium sulphate and is agitated for ten minutes. The reacted water next goes to a flocculating tank where grain size increases during slow stirring. After 18 minutes here it goes to sedimentation in manually-operated thickener tanks and on through filters to its delivery into service. Only ¼% of the entering water is lost with the discarded sludge.

Magnesium is removed by the use of excess lime :—

$$MgCO_3 + Ca(OH)_2 = Mg(OH)_2 + CaCO_3.$$

The excess lime required for this reaction is re-dissolved after sedimentation of the magnesia by bubbling in CO_2, the resulting water being soft and of high bacteriological purity.

In a more modern method (the Accelator Process) the sludge is accumulated in a special mixing tank, where it acts as a filter, excess being run off intermittently. Lime is used quick or slaked and is fed as a cream under close proportioning control, as in the aluminium sulphate.

Where zero hardness is called for base exchange softening is employed, the industrial process being a larger-scale application of the familiar household method, in which:—

$$CaCO_3 + \text{Na Zeolite} \rightarrow \text{Ca Zeolite} + Na_2CO_3$$

the zeolite being periodically regenerated with brine :—

$$2NaCl + \text{Ca Zeolite} \rightarrow \text{Na Zeolite} + CaCl_2$$

With base-exchange methods the plant is simple and compact and there is no problem of sludge disposal, the NaCl effluent going to ordinary drainage.

* * *

Among the war-time activities which were associated with the Imperial College of Science and Technology was Fido. Visitors to the Centenary Exhibitions were able to see the flame-throwers developed by research workers at the City and Guilds College. The technical problem was to clear 1,500 yds. of runway of fog, plus 250 yds. of approach, for a height of 100 ft. and to give an unobstructed landing lane of at least 50 yds. in width. Data was accumulated by using a large wind tunnel and wind channel, installed at Earl's Court, so the heat distribution required could be calculated. Then, starting from pre-war experimental work with mixtures of petrol and alcohol, the basic problem of vaporizing a combustible gas for burning in a long line of nozzles was tackled. Heat distortion was overcome by the use of zig-zags and on February 10, 1943, the first installation was ready for action, though it was not needed for another five months. By early 1944 six airfields were equipped and seven more in hand. Altogether some 2,500 fog landings were made before the close of hostilities by the aid of Fido.

* * *

Until recent years it was far easier to know what one meant by the "metallic" state than to define it. To-day it is known that the form of electronic bonding typified

[1] *Journ.* Jun. Inst. Eng., July, 1946.

in a metal consists of an arrangement of positive ions which share a cloud of electrons capable of passing, as an "electron-gas" freely through a metallic structure. This confers on a metal its power of conducting electricity. When a pure metal is examined by specialized X-ray methods the atoms are found to be symmetrically disposed. If a perfect crystal is formed it has practically no structural strength and can be moulded like clay. With a little "cold-working" it soon acquires strength and resisting power. At first the atoms are arranged in rows and slip over one another on the application of a light shearing force. As the original crystal becomes a mass of unoriented smaller crystals this easily-sheared arrangement falls into disorder and resistance to shear is no longer just a matter of sliding one plane of atoms leap-frogwise over another, but of overcoming complex matted and tangled shear-planes with our vectorially applied force. If a metal is given such a structure that any slip is held to a very short run—by not having large crystals or an open-grain structure—then the metal is strong. This can be done not only by cold-working the metal but by the formation of suitable alloys. In this case foreign atoms of a different size are introduced and they upset the rhythmic and regular disposal of the atoms so that it is no longer possible for slipping to take place easily, the structure being, so to speak, locked or spragged. There is a limit beyond which strengthening of this kind must not be pushed, or the metal will lose the ability to yield elastically and become so brittle as to be unable to withstand tensile stress without cracking and then breaking. In a recent article Sir Lawrence Bragg (*Penguin Science News*) remarks that "a smile is ordinarily quite a pleasant movement, but we all know how painful it can be when the strain is concentrated at one point owing to the rigidity associated with a cracked lip," in illustration of the difference between elastic yield and the embrittled state.

* * *

Lignin is the hard fibre which makes over 20% of the weight of wood and which before the war was largely wasted. Some three million tons are produced annually and a good part of this now finds its way into the plastics industry, either as a diluent of synthetic rubber, or as the basis of the glues used in laminated wood sheeting.

* * *

"Turpentine farming" or the "Naval Stores" industry, is extensively practised in some of the southern States of America, where the tapping of gum from the long-leafed or slash pine is to-day a $30-million-a-year business and a hundred million trees are being worked. This achievement is in large measure due to the establishment of a Governmental research station in Florida in 1932, when the industry was still a depressed one, despite 300 years of practice. The flow season is March to November. The tree receives a shallow streaking cut 2 ft. long, with a U-shaped "hack" tool and acid is then applied to the wound to increase flow of sap, which is led into a cup. For 36 hours flow is continuous, after which it starts at 8 a.m. and stops at 5 p.m., doubtless conforming to customary business usage. The resin is hauled to the nearest distilling plant and distilled to yield turpentine and leave behind molten resin which is strained and cleaned and then solidified in barrels, drums, tank cars, etc., and sold to makers of soap, varnish, paper, printers' ink, sealing wax, lino, etc.

News Letters

VANCOUVER

October 5.

Labour.—A sharp division of opinion exists between the Provincial Departments of Labour and Mines in the interpretation of the Hours of Work Act. The Mines Department contends the hard-rock mining industry of British Columbia is exempt from application of the Act, which limits the hours of work to 44 per week, and recently appointed a committee to investigate the matter. The members of this committee were Dr. J. F. Walker, Deputy Minister of Mines; Dr. Hartley Sargent, Chief Mining Engineer; and Mr. James Dickson, Chief Inspector of Mines. Their report unanimously recommended against the enforcement of any 44-hour week upon the mining industry at the present time, stating in part:

We find that the working week of six shifts of eight hours is at present the only practical one in the mining industry and we recommend that Section 28 of the Metalliferous Mines Regulation

Con Mine Buildings.

Act be amended as provided for in sub-section 3 of said section to make it lawful for any person to be employed for 48 hours in any week in or about any mine, quarry, or metallurgical works.

The report of the committee has been submitted to a bitter attack by officials of the International Union of Mine, Mill, and Smelter Workers, who demand the resignations of the members of the committee. In complete opposition to the attitude of the Mines Department, the Hon. Geo. S. Pearson, Minister of Labour, holds that mining is not exempt from the provisions of the Act and has stated a test case will be made by notifying the Consolidated Mining and Smelting Company of Canada, Ltd., that the 44-hour week applies to all operations of that company in British Columbia.

Atlin.—The production of Polaris-Taku Mining Co., Ltd., has been increased during the past month from 140 to 180 tons per day as a result of the acquisition of additional underground labour. Two separate examinations of the property within recent months by prominent eastern geologists have resulted in reports of a most encouraging nature. One stated that with a minimum of development it could reasonably be expected that the ore reserves could be trebled from the present figure of 330,000 tons, averaging 0·343 oz. of gold per ton, and the other suggested the property could easily warrant a milling operation of 1,000 tons per day within a short time. A new crusher and flotation unit are being installed to increase milling capacity to 500 tons daily and, it is hoped, to increase recovery by $1·00 per ton of ore treated.

The company has under consideration the erection of a roasting plant to permit cyanidation of the concentrate, thus obviating the necessity for shipment to the Tacoma smelter. A new vein of considerable importance has been opened on the "B" level, 300 ft. above the Polaris or main level. In the first 75 ft. of driving, width averages 3·0 ft. and grade 0·53 oz. of gold per ton; both faces continued in ore at last report.

Portland Canal.—Silbak Premier Mines, Ltd., has announced that no semi-annual dividend will be forthcoming during the second half of 1946, marking the first time since the incorporation of the company for such an omission.

The surface exploration programme of Big Four Silver Mines, Ltd., has been materially assisted by the recession of the Silverado glacier, which has resulted in exposing indications of the extension of the Nos. 1, 2, and 4 veins for lengths of from 600 to 800 ft. beyond previous expectations. Subsequent stripping, open-cutting, and sampling have justified an extensive programme of underground exploration. The Zero tunnel on the Silverado group is being advanced to reach an ore-body indicated at the toe of the glacier and other lateral work is shortly to be undertaken to investigate the other suggested ore-bodies. The Porter Idaho ropeway has been dismantled and re-erected to connect the portal of the Silverado main adit with the head of the lorry road from the town of Stewart—a distance of some 4,000 ft. Extension to tidewater is subsequently to be made to a projected mill site.

The Mining Corporation of Canada, Ltd.,

has made a payment of $300,000 on the Toric group of silver-lead claims at Alice Arm, previously held by Torbrit Mining Co., Ltd.—a subsidiary of Britannia Mining and Smelting Co., Ltd. It is proposed to prepare the property for production within one year on a scale of 300 tons daily.

Alberni.—Mr. D. S. Tait, president of Privateer Mine, Ltd., has appraised shareholders of the value of the Pandora property, recently acquired by the company. A strong shear zone within a large dyke has been traced by tunnelling and open-cutting for a length of 1,600 ft. over a vertical range of 900 ft., without delimitation. Three tunnels have been driven and extensive ore-bodies developed, as a result of which the engineering staff has estimated a presently-developed reserve of 55,100 tons of ore averaging 0·40 oz. of gold per ton across an average width of 5·0 ft. Development is being continued with a view to undertaking production at an early date.

Victoria.—Twin " J " Mines, Ltd., reports an intersection of 9·5 ft. true width in the South ore-body averaging $26·00 per ton in contained metals at current prices. Values across 60 in. show gold 0·12 oz., silver 1·9 oz., copper 1·6%, and zinc 8·4%. The best section yielded assays of 0·3 oz. of gold, 3·0 oz. of silver, 4·2% copper, and 2·9% zinc over a width of 18 in. The company has recently obtained fresh backing and is now fully financed for the programme of work in hand.

Nanaimo.—Lasco Gold Mines, Ltd., reports the intersection of a high-grade gold-copper ore-body in a drive now advanced 180 ft. in the St. Joseph claim of its Lasqueti Island property. The ore is of such quality as to warrant stockpiling for treatment at a later date. The drive is to be advanced to an additional length of 1,780 ft. to explore the full length as indicated by surface exposures. A shaft will be sunk to a depth of 250 ft. to provide two levels for exploration at depth.

Lillooet.—During the fiscal year ending May 31, 1946, Congress Gold Mines, Ltd., increased its capital from 2,000,000 shares of $1·00 par value each to 4,000,000 shares of the same value. Of this 1,250,000 shares were sold to net the treasury $80,500. The remaining treasury shares were later sold on option to Sheep Creek Gold Mines, Ltd., at 11 cents per share and, as this is written, the second block of 250,000 shares has been taken up. If and when the Sheep Creek company completes payment under the option, the capital of the Congress company will be increased to 5,000,000 shares and Sheep Creek will be granted a further option to purchase the additional 1,000,000 shares at prices ranging from 15 to 50 cents each. Shaft sinking has been temporarily halted at the 275-ft. level to permit of lateral exploration at that horizon.

Cariboo.—North American Goldfields has stopped work on the Ashby-Speers leases on Spanish Creek and moved all equipment, including the dragline dredge, washing plant, and portable camp to the French Flat Leases within 25 miles of the town of Quesnel, where the company holds 2·2 sq. miles of ground, estimated to contain reserves averaging 38 cents per cu. yd. and sufficient to maintain capacity operation for two years. No loss was experienced on the Ashby-Speers project, although reserves were found to be considerably short of the original estimate. Every preparation will be made this autumn to expedite an early start on dredging at French Flat in 1947.

The shaft being currently sunk by Cariboo Canusa Gold Mines, Ltd., has reached a depth of 84 ft. and with progress at a daily average of 5 ft. it is expected to reach the objective of 320 ft. by the end of November. A programme of 5,000 ft. of lateral development has been recommended by Dr. Victor Dolmage, consulting geologist.

Osoyoos.—Hedley Monarch Gold Mines, Ltd., has obtained firm commitments for the sale of 400,000 treasury shares to net $80,000, which with the $20,000 now on hand is considered sufficient to finance the present ambitious development programme to a point where production will either be warranted or discouraged. The Monarch company is capitalized at 3,000,000 shares of a par value of 50 cents each, of which 1,000,000 shares have been issued for properties; to date 1,000,000 shares, including the present transaction, have been sold for cash, leaving 1,000,000 shares in the treasury for future requirements. Mr. T. C. Botterill, the managing director, states: " There is a strong indication of sufficient ore in sight to justify a milling operation, but development will be systematically advanced to prevent any error through too much optimism."

Nelson.—For the first time in the past nine years Sheep Creek Gold Mines, Ltd., is to pass its regular quarterly dividend in October. The wholly-owned subsidiary, Zincton Mines, Ltd., has developed a silver-lead-zinc ore-body at an elevation of 1,300 ft. above the concentrator at its Lucky Jim property in the Slocan mining division. A road has been constructed to connect the portal of the new development adit with the camp and connexion with the mill is being made by installation of a tram-line. At the same time a new lead-recovery circuit is being added to concentrating equipment to effect differential flotation. The company has shipped zinc concentrate for a number of years.

Slocan.—The presence of cassiterite in the zinc ores of the Bosun mine has been noted with increasing content as depth is gained. Samples from the 7 level are reported as averaging 0·23% tin, according to an announcement by Mr. R. Crowe-Swords, president of Santiago Mines, Ltd. Cassiterite has also been found in the ores of the adjoining Hartney mine, also under development by Santiago.

Yukon Territory.—The August production of the Yukon Consolidated Gold Corporation, Ltd., was valued at $304,000. The various placer operations were visited late in August by Mr. G. Goldthorp Hay, president, who has since returned to England.

Alaska.—The shortage of labour supply has placed the mining industry in a perilous position in the Territory. The Alaska-Juneau mine, leading lode-gold producer, has been closed since 1942, when the cost of production combined with increased costs due to labour shortage made it impossible to continue the world's biggest low-grade gold-mining operation. Territorial officials state there is no hope of renewed production at present labour costs.

The United States Smelting, Refining, and Mining Company, conducting dredging operations along the Yukon River and its tributaries in the vicinity of Fairbanks, is currently operating four of its ten dredges. The supply of labour, however, is so small that no development work can be done in advance of mining. Other large-scale placer operations are either suspended or working on a greatly-reduced basis.

Santiago-Alaska Mines, Inc., a subsidiary of the Canadian incorporated Santiago Mines, Ltd., is re-opening the Dolomi mine on Prince of Wales island at an initial capacity of 50 tons daily. It is hoped to increase capacity to 200 tons daily in the near future. Preparations are being made for the re-opening of the Hirst-Chichagof mine, 60 miles north of Sitka, and there is a likelihood of new production from the promising Hawk Inlet mine of Alaska Empire Gold Mining Company.

The Alaskan mining industry suffered drastic reduction by the war-time restrictions placed on gold production, but had hoped to recover its place in the Territorial economy after peace was declared. The restrictions have been removed, but there is no labour supply, owing to the fact that the construction of defence projects is even more active to-day than at any time during the war.

British Guiana.—During the fiscal year ended March 31, 1946, Cuyuni Goldfields, Ltd., produced gold valued at $416,580. After all operating cost and provision of $51,011 for interest, depletion, depreciation, and income tax, net profit for the year was $208. The company borrowed a further $178,880, bringing its commitments to $268,991. From April 1 to July 31, 1946, production was 2,955 oz. of gold, from 4,555 tons of ore, averaging 0·759 oz. of gold per ton.

TORONTO

September 21.

Gold Production.—During July the gold mines of Ontario treated 625,359 tons of ore and recovered 152,215 oz. of gold and 20,790 oz. of silver, valued at $5,374,170. The month's output figures for the various producing districts were as follows : Porcupine, 355,313 tons milled, 81,145 oz. of gold, 10,353 oz. of silver, value $2,862,917 ; Kirkland Lake-Larder Lake, 152,868 tons milled, 43,645 oz. of gold, 7,791 oz. of silver, value $1,549,234 ; Matachewan-Sudbury, 37,576 tons milled, 4,027 oz. of gold, 1,053 oz. of silver, value $141,916 ; North-Western Ontario, 79,602 tons milled, 23,398 oz. of gold, 1,593 oz. of silver, value $820,103.

The July bulletin of the Ontario Department of Mines reports that the return of the Canadian dollar to parity with the American in early July resulted in a drop in the production value of gold bullion by Ontario gold mines ; the average grade of ore during July was $8·59, the lowest recorded since December, 1933. The Statistics Branch of the Department reports that production of bullion by the Pamour mill on the account of Hoyle Gold Mines for the months of March, April, May, June, and July are aggregated in the Porcupine total for the last-named month. The price paid for gold at the Royal Canadian Mint was $38·50 up to and including July 5 and $35·00 after that date.

Gold production for the whole of Canada for June totalled 234,383 oz., while that for July was 239,554 oz., valued at $8,384,390; the July, 1945, output was 210,209 oz. The production in July last included 203,228 fine oz. from auriferous quartz mines and 36,326 oz. from base-metal mines. The output from auriferous quartz mines and placers rose 15·6% over July, 1945, and production from base-metal mines rose 5·7%. Employees in producing auriferous quartz mines, including both salaried employees and wage-earners, numbered 17,702 in July, 1946; the corresponding total for active non-producing mines was 298. Employees in non-ferrous metal mines, smelters, and refineries totalled 26,569 during the month under review.

Porcupine.—McIntyre Porcupine Mines reports net earnings of $466,817 for the June quarter, which compares with $580,063 for the corresponding period of 1945.

In the three months to June 30 last Coniaurum Mines treated 29,110 tons of ore and an operating profit of $66,907.

The production of Paymaster Consolidated Mines for July is given as $98,044 from 13,536 tons of ore milled. In the year to June 30 last the company made a profit of $117,133. In the period 135,407 tons of ore was treated for an output valued at $1,156,146. The ore reserves at June 30 were estimated to be 583,674 tons averaging $7·80 per ton in value.

Kirkland Lake.—In the year to April 30 last Upper Canada Gold Mines treated 87,591 tons of ore for an output valued at $1,067,716. The net profit is reported as $172,864. The company has acquired two additional properties—the Brock and Eastward.

Lake Shore Mines reports a profit of $1,652,791 for the year ended June 30 last, when 331,048 tons of ore was milled for an output valued at $4,983,114.

The shaft at Amalgamated Larder Mines has passed the 700-ft. horizon on its way to its objective at 1,000 ft. Cross-cutting to the ore zone is expected to be under way about the end of the current year.

Sudbury.—Falconbridge Nickel Mines reports an estimated net profit of $295,604 for the three months to June 30 last and of $185,139 for the first half of the current year. The company states that the refinery in Norway is now operating at a rate sufficient to cope with the current mine output.

North-Western Ontario.—In the three months to June 30 last Cochenour Willans Gold Mines treated 14,107 tons of ore for an output valued at $239,564. The total recovery for the six months to that date was $473,722.

In the Little Long Lac area Magnet Consolidated is endeavouring to raise the tonnage treated to 150 daily, although operations are hampered by labour shortage. Good developments are reported from the 8th level. During July the mill dealt with 2,485 tons of ore for an output worth approximately $30,000.

The output of Leitch Gold Mines for the June quarter is reported as $244,082, net earnings for the period being given as $65,014.

In the three months to June 30 last Hard Rock Gold Mines treated 27,948 tons of ore and recovered gold worth $239,649.

Starratt Olsen Mines, whose property lies to the south-west of Madsen Red Lake, reports that its shaft has passed the 600-ft. mark on its way down to 825 ft. It is proposed to open up four levels and to carry out a programme of diamond drilling.

Crowshore Patricia Gold Mines, which has let a contract for a new shaft, reports that sinking started on August 17.

Manitoba.—In a report covering the second quarter of the current year the president of Sherritt Gordon Mines states that new gold discoveries have been made in an area 25 miles east of the Lynn Lake nickel-copper claims. In the period 148,180 tons of ore was milled at Sherridon and 5,478,186 lb. of copper, 5,119 tons of zinc concentrate, 1,568 oz. of gold, and 53,318 oz. of silver recovered. The accounts for the quarter show a profit of $154,409.

The Hudson Bay Mining and Smelting Company reports net earnings of $3,898,606 for the first half of 1946, during which 915,424 tons of ore was treated.

Quebec.—The Department of Mines reports that the gold output of Quebec Province for the first six months of the current year was valued at $12,591,502, as compared with $13,735,453 for the corresponding period a year ago. The silver output for the half year was 887,267 oz., against 1,122,095 oz.

It was recently reported that the Quemont Mining Corporation expected to commence shaft sinking early in November.

Sigma Mines reports an output of $141,891 for July, from 24,900 tons of ore milled.

An operating profit of $66 is returned by Sladen Malartic Mines for the June quarter, during which 46,988 tons of ore milled yielded an output valued at $176,116. The report for the period states that drives east and west of the north cross-cut in the north zone on the 500-ft. level have each been advanced 333 ft. The east drive has disclosed three ore sections; the first averages 0·543 oz. per ton over 7·6 ft. for a length of 50 ft.; the second section averages 0·555 oz. per ton over 3·02 ft. for a length of 142 ft.; the third averages 0·794 oz. per ton over a width of 1·5 ft. for 50 ft.

In the three months to June 30 Stadacona Mines (1944) treated 32,310 tons of ore for a production valued at $233,565. The operating profit for the period is given as $49,979.

MELBOURNE

October 21.

Gold Production.—Of three gold-producing states two have shown an important improvement in output during the current year. Western Australia reported production of 388,478 fine oz. for the eight months to the end of August, as compared with 320,643 fine oz. for the same period of 1945. The position will be further strengthened by a resumption of operations at Big Bell Mines, which has a milling capacity of 45,000 tons of 2·8 dwt. ore per month. Preparatory work is nearing completion, having been greatly delayed by non-return of a large power unit and four motors of 220 h.p., impressed by the Government for war-time purposes. Triton Gold Mines is also expected to resume production early in the coming year. Finance for reconditioning the workings is being provided by loans aggregating £96,000 (Aust.) and active exploratory work is being carried out with satisfactory results. Kalgoorlie mines are increasing output, as rapidly as a slowly improving labour position and a continued shortage of stores and essential items of plant will permit. There is considerable activity amongst smaller producers, particularly on the Yilgarn field, and companies which have worked out their properties prior to the war are now looking for options with merit to warrant investigation. The strongly-financed Western Mining Corporation is examining a number of areas under option, not only old lines of lode, worked in earlier years, but has secured substantial interests in the new field south-east of Coolgardie.

Gold production in Victoria for the seven months to the end of July last produced 44,557 fine oz. of gold as compared with 31,371 oz. in the corresponding period of the previous year, the output for the month of July being 7,660 oz. Although the supply of labour is improving it is not plentiful; many store items are still in short supply and the position of wood fuel is causing much anxiety, the prevailing shortage of coal for manufacturing industries having brought about a demand for firewood and a serious inroad into supplies usually available exclusively for the mines. Mines in Bendigo and smaller fields are being unwatered and prepared for renewed exploration and production. Gold Mines of Australia is active in the search for new properties and has been engaged in the examination of the Stawell goldfield, in the west of Victoria, for more than a year; the geological investigation has been completed and drilling is to be commenced with two plants. The Stawell field was an important producer up to 1921 and mining was carried to a maximum depth of 2,425 ft. in lodes with widths up to 30 ft., the ore being more highly pyritic than is usually the case in this State. Test work by drilling will be directed first to exploring a reef known as the Carolina and to prospect for a possible extension of the Magdala orebody, beyond the Scotchman's fault zone. A proposed major operation is the re-opening of the mines of Ballarat East, which have been idle for about 30 years, but which possess very encouraging possibilities and may restore Ballarat to the position of an important mining field.

New South Wales reported a decreased output of gold for the first seven months of the year compared with the same period of 1945. Production was 15,242 fine oz.—a decrease of 11,087 fine oz. The principal producer is New Occidental Gold Mines, at Cobar, which has been actively developing the property and preparing two new levels for stoping, the necessity for pushing copper production on other leases having caused development of the gold section of the property to fall into arrears through withdrawal of labour; during the renewed period of development gold production has been greatly curtailed. Normal production is now being approached. The dredge of Wellington

Alluvials, Ltd., on the Macquarie River is once more in operation, after being idle since 1942. owing to conditions imposed by the war, and the Cowarra mine, of the Broken Hill Proprietary Co., Ltd., is being examined and tested with a view to determining its output possibilities. The State is being explored for likely prospects, but apart from the operations referred to there is, as yet, no great prospect of improved production.

Mount Morgan.—Mount Morgan, Ltd., Queensland, mined a considerably greater tonnage of ore during the year ended June 30, 1946, than in the previous year, but the grade was lower. Operations have been greatly assisted by two new $2\frac{1}{2}$-cu. yd. capacity electric shovels, which were put into use in September, 1945, and March, 1946 ; tonnage has been increased and costs reduced. A comparison of results of the 1946 period with those of 1945 is shown in Table 1.

Table 1.

Year ended June 30.	*1945.*	*1946.*
Ore mined : tons	1,320,310	1,772,359
Ore milled : tons	549,350	614,700
Concentrates produced : tons	31,511	29,733
Containing gold : oz.	43,400	48,256
copper : tons	3,149	2,935
Profit :—		
From mining : £A	45,525	23,398
From other sources : £A	6,321	13,276
Total profit : £A	51,846	35,674

The mine is worked by open-cut, which is approaching a depth of 650 ft. from surface. The difference in tonnage between ore mined and ore milled represents unpayable overburden, which is removed direct to the dump, as much as will carry costs being sent to the mill. The total dumped during the year was 1,125,792 tons. Average weekly production has been increased to 34,084 tons, as compared with 24,911 tons in the previous year.

Table 2.

	1945.	*1946.*
Sulphide ore : tons	5,780,363	5,542,294
Average value :—		
Gold : dwt. per ton	4·23	4·23
Copper : %	1·87	1·90
Indicated additional material : tons	3,412,750	3,004,252
Average value :—		
Gold : dwt. per ton	1·74	1·65
Copper : %	0·45	0·48

Mining costs were reduced from 4s. 9·01d. per ton in 1945 to 3s. 11·93d. in 1946, mainly as a result of the work of the new shovels. On the other hand smelting costs increased by $11\frac{3}{4}$%. The ore reserves for the two years are in Table 2.

Victorian Coal Resources.—Victoria has suffered serious inconvenience and loss through shortage of black coal resulting from the continuous industrial trouble on the coalfields of New South Wales. The position has been such that gas supplies have had to be rationed, train services curtailed, and manufacturing industries depending upon black coal have been curtailed or compelled to cease operations for varying periods. This situation has directed attention to the direct utilization in steam plants of brown coal. The most suitable occurrence for this purpose is that at Bacchus Marsh, 34 miles west of Melbourne. The seam, which is 60 ft. to 90 ft. thick, lies under shallow overburden in the vicinity of Bacchus Marsh, where it can be mined by open-cut at low cost. The moisture content is 30 to 40%, which is much below that of the brown coal of Gippsland, which contains as high as 65% moisture. Users are taking the coal direct from the mines, two being in production, and the only drying is that which takes place between mine and the purchaser's works. Low cost and continuity of supply compensate for the disability of high moisture and the demand is greater than can be supplied by the mines which have been opened up.

The general position on the coalfields of New South Wales and the limited possibilities of the black coalfields of Victoria point to a continued demand for brown coal of this class. A large manufacturing company—Australian Paper Manufacturers—has just secured an interest in one of the brown-coal mining companies and it is hoped to obtain its requirements of 3,000 tons of coal per week from this source. In recent months this company has been forced to burn green firewood, sawdust, and fuel oil at its mills, with very adverse effects upon output and costs.

Briseis Consolidated.—This mine is situated at Derby, in the north-east of Tasmania, and for a number of years was the largest tin producer in the Commonwealth, the output of concentrate being about 60 tons per month. The deposit is a basalt-covered deep lead from which the basalt has been partly eroded by the Ringarooma River. The stanniferous wash and the overlying drift, which carries low values, have a total depth of 230 ft., of which about 200 ft. is sent through the sluice-boxes. Basalt overburden has a thickness of 130 ft. The bottom of the cut is over 200 ft. below the level of the river, which has been diverted three times in the course of mining operations and has been carried on a new bed of tailings.

Both overburden and drift were worked by hydraulic sluicing, with water under a head of about 360 ft. at the nozzles. Basalt overburden was undermined by the nozzles and broken up in the fall, large masses being further reduced by blistering. This material was then sluiced through passes into an overburden tunnel and carried by a steel-lined flume to the dump. Drift was raised by two 16-in. electric-driven pumps in series to the sluice-boxes. In the years of the war workings down lead entered ground of decreasing value ; at the same time the labour force steadily decreased and with the demand for tin for war purposes it became increasingly difficult to keep overburden removal at a satisfactory distance from the wash face. The position became such that falls of overburden interfered with sluicing to an increasing extent and the resulting dead work combined with low-grade ground rendered work unprofitable. Heavy rains in July caused major falls of overburden and drift ; the overburden shelf was destroyed and all falling material went to the bottom of the cut, submerging the drainage pump and some hydraulic elevators.

This happening has forced the abandonment of any further work in the bottom, but salvaging of much of the plant has been successful. The company will now sluice some shallow ground which will give a life of about six months and produce about 100 tons of tin oxide. The mine has had a long life and was outstanding among the hydraulic sluicing mines of the world—not only from the size, depth, and character of the operations, but from the engineering work involved in the river diversions. It is hoped, at a later date, to transfer the activities of the company to Malaya.

South Kalgurli Ore Treatment.—Early in the war it became apparent that ore from this mine could be treated more economically at the mill of Kalgurli Ore Treatment Co. than at the company's own mill. The Ore Treatment Co. was then treating the output from Boulder Perseverance, Kalgoorlie Enterprise Mines, and North Kalgurli (1912), Ltd., mines. About 1940 the North Kalgurli company completed the erection of a new mill on its Croesus Proprietary lease, but operations were soon suspended, owing to war-time conditions. The agreement between South Kalgurli Consolidated and the Kalgurli Ore Treatment Co. has expired and a new company has been formed—called Croesus Proprietary, Ltd. — which will take over the mill of North Kalgurli, situated on the Croesus lease. The constitution of the treatment company will be South Kalgurli and North Kalgurli ; the mill is now in operation treating 5,500 tons of ore from the former company per month and 1,500 tons per month from the latter company. The mill capacity is 7,000 tons of ore per month, but capacity is to be doubled ; certain items of plant are to be removed from the South Kalgurli mill, including a ball-mill, classifier, and a roasting furnace ; a new flotation machine is to be added. Delay will ensue in obtaining all the required machinery and the work of increasing capacity will not be completed until 1947.

Northern Territory.—There are indications that mining in the Territory will become increasingly important. Men are returning to that region, small mines are being re-opened, and one of the three Government treatment plants has recommenced work. Options have been let to companies with sufficient capital to test and equip leases and suitable options are being sought, mainly on the Tennant Creek field.

The Mount Todd gold mine has been taken over and is to be operated by a company. Equipment of the property was completed just prior to the war, but before production commenced the country in the vicinity was evacuated and much of the plant taken over by the military authorities. The mine contains a lode 1,400 ft. long and $2\frac{1}{2}$ ft. in average width ; reserves of proved and probable ore, to a depth of 250 ft., are estimated at 80,000 tons, with an average assay value of 13·5 dwt. gold per ton.

The recently-opened mine at Tennant Creek, the Whippet, is raising very rich ore. The first lot of 80 tons treated at the Government mill returned 273 oz. of gold ; this is said to be lower-grade material than normal. About 1,000 tons have yet to be treated, some of which is stated to assay up to 50 oz. gold per ton and average value is expected to be about 4 oz. per ton. The shoot being worked is reported as being 40 ft. wide.

Personal

D. G. Armstrong has left for India.

W. K. Brown is returning from India.

A. R. Clark, formerly with Noranda Mines, Ltd., is now teaching geophysical prospecting in the University of British Columbia.

N. Baldwin Davies was here from South Africa.

A. S. Dains has been appointed a director of Boulder Perseverance, Ltd.

K. H. Davison is now in Colombia.

I. S. Ferguson, now released from the Forces, has joined the Colonial mines service and expects shortly to leave for Nigeria.

W. H. Hannay has retired as senior research engineer of the Consolidated Mining and Smelting Co. of Canada.

J. W. Harding is now in Nicaragua.

C. M. Harris has retired from the staff of Great Boulder Proprietary.

L. E. Langley has left for Brazil.

W. J. MacKenzie is now in Canada.

R. H. Mitchell is returning from Southern Rhodesia.

T. R. Naylor is home from the Gold Coast.

A. P. Newall is visiting Australia.

D. J. Rogers is visiting South Africa.

J. E. Salter has joined the Department of Mines of Victoria as an Inspector.

F. G. Sharp is leaving for India to rejoin the Mysore Gold Mining Co.

H. W. Smith is leaving for Rio Tinto.

G. G. Suffel has joined the staff of the geology department of the University of Western Ontario.

G. P. Wigle is leaving Canada for Brazil.

W. Rees Williams is now in Iraq.

Harold Edward Cohen, who died recently in Australia, aged 65, received his training at Melbourne University. In the 1914–1918 War he served with the Australian Forces, being awarded the D.S.O. in 1917 and becoming C.M.G. in 1918. He retired with the rank of Colonel and, resuming his law practice, was made C.B.E. in 1934. From March, 1935, Colonel Cohen had been Member of the Legislative Assembly for Caulfield, Victoria, holding the posts of Solicitor General in Australia, 1932, and Minister of Public Instruction between 1932 and 1935. He was a director of the Electrolytic Zinc Co. of Australasia, Zinc Investments, Ltd., and other companies.

Samuel McEwen, who died on October 16. graduated from the Royal School of Mines in 1896, Mr. McEwen's first appointment was as metallurgist to the Gold Extraction and Bromine Recovery Co., Ltd., in London. He later went to Kalgoorlie and Colorado, spending some time in the last-named area for various interests and also visiting British Columbia. In 1907 Mr. McEwen was appointed combustion engineer to the Underfeed Stoker Co., Ltd., of which he subsequently became a director, as well as of International Combustion, Ltd. He was also a director of the Carbo Union (Holland) and in 1932 became managing director of the Coal Oil Extraction Company, Ltd. Here, in collaboration with Dr. Runge, he developed and patented his process for the low-temperature carbonization of fuel known as the McEwen-Runge process. In July, 1935, Mr. McEwen joined Mitchell Engineering, Ltd., as a director, and was responsible for all matters relating to steam-raising plant. He was a Founder Member of the Institute of Fuel and a Fellow of the Institute, serving it later as Vice-President and as its representative on many committees, while for many years he was an Associate of the Institution of Mining and Metallurgy. He was also Vice-President of the Combustion Appliance Makers' Association, a Member of Council of the British Coal Utilization Research Association, and a member of the Royal Institution of Great Britain.

Walter Broadbridge, who died on October 23 as the result of a motor accident, aged 76, received his training as a pupil engineer in South Africa and had early experience of Rand mining before leaving the Transvaal for service in Sumatra, Malaya, and the Sudan. In 1902 he was with Messrs. Bewick, Moreing, and Co. in Western Australia for a time as assistant manager of the Sons of Gwalia. In subsequent years he was associated in a consulting capacity in turn with the South African Land and Exploration, Mr. H. B. Marshall, and Messrs. Hamilton, Ehrlich and Co. in Johannesburg. There followed a short partnership with Mr. H. G. Payne before, in 1908, Mr. Broadbridge went to West Africa where he was appointed technical adviser to Prestea Block A and Abbontiakoon Block 1, becoming general manager of the former company and of Prestea Mines and Anfargah Gold Mines. Later he was appointed superintending engineer in West Africa for Consolidated Gold Fields of South Africa. In 1911 he joined Minerals Separation, Ltd., but during the 1914–1918 war was in the Forces, attaining the rank of Captain in the Royal Field Artillery and, after being invalided from the Army, acting for a time as Director of Aluminium Supplies, Graphite, and Carbide for the Ministry of Munitions. Following the period of hostilities Captain Broadbridge rejoined Minerals Separation, of which he became a director and he was closely connected with developments in the Northern Rhodesian copper belt, particularly through his association with Rhodesian Congo Border Concession, Ltd. In 1930 he joined in practice with Mr. Preston K. Horner and, with British American Mines as an operating company, became connected with developments in gold-mining in Western Australia and tin in Siam. In 1931 he also joined the Board of Boulder Perseverance, Ltd. Captain Broadbridge was a Member of the Institution of Mining and Metallurgy and served on the Council from 1920–1925.

Trade Paragraphs

Mond Nickel Co., Ltd., of Grosvenor House, Park Lane, London, W. 1, in the *Nickel Bulletin* for July-August reproduce abstracts on universal metallographic polishing procedure, properties of wrought and cast nickel, a new copper-base alloy containing phosphorus, lead, and nickel, development of the internal combustion turbine, and properties of nickel-chromium stainless steel weights.

Ransomes and Rapier, Ltd., of Ipswich, have issued a folder giving in pictorial form a synopsis of their principal manufactures—such as, excavators, mobile cranes, concrete mixers, and other contractors' plant, railway plant, general engineering items such as transporters and swing-bridges, water control gates for dams, power plants, etc. Another leaflet issued at the same time gives particulars of apprenticeship training in general engineering offered in various departments of the company's Waterside Works.

E. J. Longyear Co., of Minneapolis, Minnesota (London representatives: Austin Hoy and Co., Ltd., 39, St. James Place, S.W. 1), have compiled a bibliography of diamond drilling with the assistance of the Engineering Societies Library of New York. This is a very comprehensive publication and covers the following main aspects of the subject. General: drilling machines and equipment, standards and specifications, diamonds and other cutting media. Field of application or purpose of drilling: (*a*) Prospecting for minerals, (*b*) prospecting for oil, (*c*) blast-hole drilling, (*d*) foundation site testing, (*e*) others—for example, bore-holes for power cables in mines—surveying and deviation of drill holes, sampling, estimating, and interpretation of drilling results, geophysical studies of formations in drill holes, costs, and records.

Hadfields, Ltd., of Sheffield, have issued some notes on a recent visit to their East Hecla Works by 50 leading foundry experts who were attending the British Steel Founders' Technical Convention then being held in Sheffield and where they were able to study some of the important advances made in the technique of steel founding during the war years. Particular interest centred in the special high-tensile steel castings produced for the "Tempest" and "Typhoon" and for other famous fighting aircraft and in the special methods of manufacture which were developed to ensure the soundness and consistent accuracy of these vital castings. The latest developments in non-destructive methods of testing by X-rays, radium, and supersonic technique were demonstrated and also the production of castings in manganese, austenitic, heat-resisting, stainless, and armour-quality steels. Every method of melting from the Bessemer converter to the latest high-frequency and arc-electric processes can be seen in these foundries. Scientific sand treatment and recovery and core making methods were also subjects of keen inquiry and discussion.

Imperial Chemical Industries, Ltd., of Nobel House, Buckingham Gate, London, S.W. 1, recently made available for exhibition a series of original artists' portraits and other paintings and drawings which have been commissioned by the company for use in their advertising. The exhibition, which was sponsored by the Central Institute of Art and Design, was held by the courtesy of the New English Art Club at the Suffolk Galleries, London. In the course of a foreword to a catalogue of the exhibition Sir Charles Tennyson writes: "The application of art to advertisement by this company ranks high among the many notable developments in the relation of the arts to the public that have taken place during recent years. Indeed, the policy followed by I.C.I. of thus employing distinguished artists is of great significance. It indicates that advertisement, so prosecuted, can form a most remunerative source of employment for the artist; and afford the public a fresh and extensive contact with the arts. The movement owes its origin to the fight which British science on the outbreak of war had to make against the tremendous world prestige enjoyed by Germany, as the result of years of energetic propaganda in a field where Great Britain had done virtually nothing. British goodwill was further jeopardized when the falling off of her international trade progressively weakened the contacts between Britain and the overseas world. The fewer goods that were exported, the more necessary it became for ideas to be projected in their place."

Fraser and Chalmers Engineering Works, of Erith, Kent, have prepared a booklet on the treat-

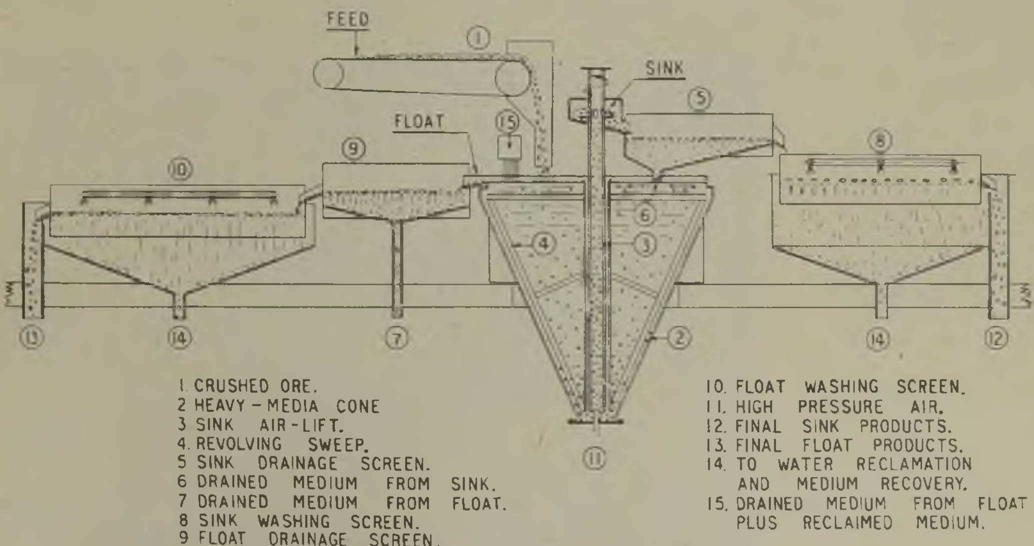
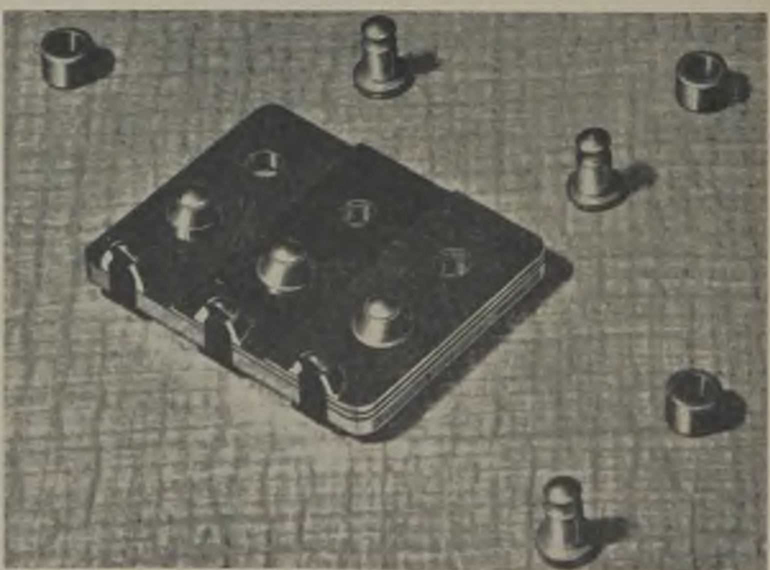


Fig. 1.

ment of ores by heavy-media separation (sink and float). In the course of an introduction this states: This publication describes heavy-media separation processes which are covered by patents controlled by American Zinc, Lead, and Smelting Co. The American Cyanamid Co. is the sole technical and sales representative throughout the world for these processes and, in association with Cyanamid Products, Ltd., negotiates licences for the use of these processes on behalf of American Zinc, Lead, and Smelting. Fraser and Chalmers Engineering Works, in collaboration with Cyanamid Products, Ltd., have installed at Erith a continuous heavy-media separation test unit in order to further their policy of providing service to the mining industry. The sink-float test as employed by the laboratory technician for the separation of minerals of different specific gravities consists in the selection of a liquid of high specific gravity in which minerals of greater specific gravity will sink and on which those of lesser gravity will float. The heavy liquids employed may be inorganic salt solutions, as of zinc chloride, or organic liquids such as halogenated hydrocarbons. Heavy-media separation processes constitute improvements of sink and float practice, equipment, and medium recovery, to the point where separation of heavy minerals is made through the use of ferrous and non-ferrous media of high specific gravity such as ferro-silicon, magnetite, and galena. Although a relatively recent development, much progress has been made in applying heavy-media separation processes to a wide variety of ores. Concrete evidence of the value of these processes is attested by the large tonnage of ore being treated by these processes. Most of this tonnage was formerly treated by older and less efficient beneficiation methods, but a substantial portion consists of tailings from older concentration methods now being profitably re-treated. Fraser and Chalmers Engineering Works have entered into an arrangement with Cyanamid Products, Ltd., for the manufacture of these plants and samples of ore can be tested by arrangement. The illustration gives a diagrammatic flow-sheet of the separation plant (Fig. 1). The catalogue sets out in detail the advantages of the processes, the reasons for installing the plant, the sequence of operations, and other relevant flow-sheets and information.

Simmonds Aerocessories, Ltd., of Great West Road, Brentford, has issued an illustrated leaflet describing their Hi-Shear Stop Pin, which consists of two parts—the pin and the collar. The illustration shows samples of these and also of a completed job. The pin is made from alloy steel of 55 tons per square inch minimum tensile strength. For protective purposes it is cadmium plated. As such hard material cannot be squeezed or hammered down to form a head, a malleable collar is placed over the pin and swaged into the groove by normal riveting methods. The collar is made from an anodized aluminium alloy, the use of which eliminates the need for heat treatment. The design permits the use of standard light-weight high-speed riveting equipment on even larger sizes than practical with soft rivets. An outstanding feature of the pins is the ease and convenience with which they can be handled and the regularity with which uniform well-formed heads can be made. The rivet set is a simple unit which by means of a conical bore in the end swages the collar into the grooved pin end. A port is provided through which rings of excess collar material are automatically ejected. The rivet set can be used as part of the dolly or fitted to the riveting gun. To determine the correct pin length it is a simple matter to insert a pin, slip a collar over it, and then note the relative position of the top of the collar to the edge of the pin. Suitable tools for the removal of the Hi-Shear Stop Pins have been developed. One tool, similar to a hollow milling cutter, removes sufficient material from the collar to enable the pin to be driven out by a sharp hammer tap. Another method consists of using a hollow punch to split the collar, thus releasing the pin. A tool that is universally available is a small chisel made from a pin punch. This can be used on the collar, partially splitting it in two places. The collar can then be prised away from the pin. The conventional

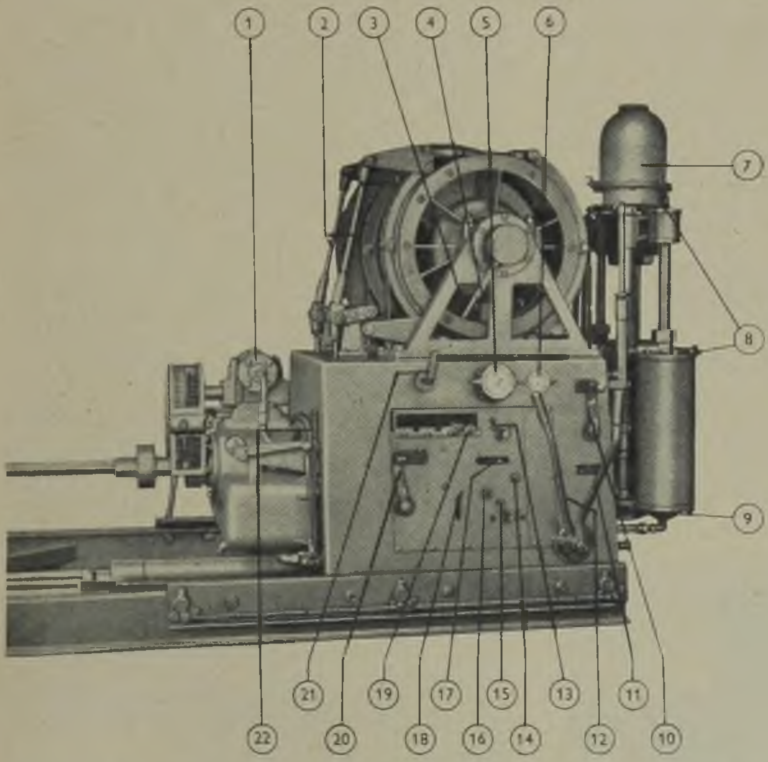


Simmonds Hi-Shear Stop Pin.

method of removing a rivet by drilling through the head may also be used on either end of a Stop Pin.

Craelius Co., Ltd., of 12, Clarges Street, London, W. 1, have recently produced a useful loose-leaf catalogue as a complete guide to all their products and activities under the following main headings: Diamond core drills, flush pumps, equipment (drill rods and couplings, core tube sets, casing tubes, pipe driving tools, water swivels, core splitters, fishing tools, etc.), contract core drilling, contract water drilling, bore-hole pumps, and geophysical surveying. A number of individual leaflets have also been issued giving illustrations and essential details of their range of core drills. Selected from these is that relating to the XO-2 which is the largest drill made. This drill, which is illustrated, has a rated capacity of 6,500 ft. although it is understood that greater depths can be attained. Other salient specifications are: Drill rod diameter $2\frac{3}{8}$ in and 2 in.; maximum hole diameter $5\frac{3}{4}$ in.; minimum hole diameter $2\frac{3}{16}$ in.; maximum core diameter $4\frac{23}{32}$ in., minimum core diameter $1\frac{11}{32}$ in.; drive shaft speed 1,420 r.p.m. (electric drive); bit speed maximum 490 r.p.m.; bit speed minimum 93 r.p.m.

The maker's general description reads: The XO-2 is direct driven through a telescopic shaft allowing a retraction of the drill for the purpose of hoisting or lowering the rods, the drill being firmly clamped to the foundation frame in any desired position by means of six eccentrics and lever (26). Power is transmitted through a multiple-plate clutch (22) and a six-speed gear-box (19–20) to the spindle and the hoist, separately or simultaneously, by means of gearing. The feed and return of the spindle, the adjustment of the hydraulic chuck (7), and the traverse of the drill are effected by means of oil pressure produced by a spiral gear pump (1) V-belt driven off the main shaft. Oil is fed to the hydraulic cylinders through a four-way cock (17) and a three-way cock (15) and the pressure is adjusted by a safety valve (14). An instantaneous valve (18) is used for rapid return of the spindle and traverse of the drill, the spindle feed being accurately controlled by a special feed valve (16). The pressure gauge (5) is connected to the hydraulic cylinders and has a fixed scale for the oil pressure and a movable scale for the bit pressure. The hydraulic chuck is adjusted by means of a three-way cock (13) without affecting the pressure recorded on the gauge (5). Any air trapped in the hydraulic system is released through the cocks (8). The oil tank is filled at (25).

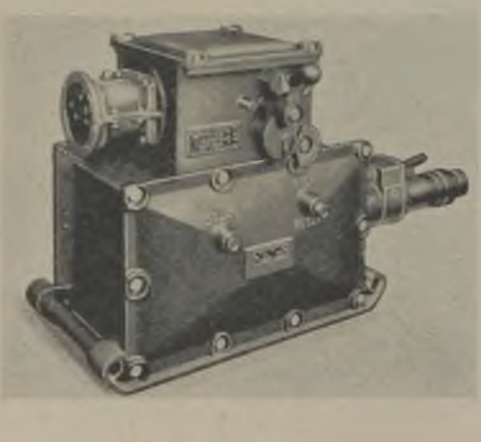


Craelius XO-2 Diamond Core Drill.

1. Oil pump
2. Brake adjusting rods
3. Cooling water outlet
4. Cooling water inlet
5. Pressure gauge
6. Speed indicator
7. Hydraulic chuck cover
8. Air release cocks
9. Screw chuck
10. Spindle clutch handle
11. Hoist drive lever
12. Hoist brake lever
13. Handle controlling hydraulic chuck
14. Safety valve handwheel
15. Handle controlling hydraulic cylinders
16. Spindle feed regulating valve
17. Reversing lever for spindle feed and drill retraction
18. Instantaneous valve
19. Secondary gear lever
20. Primary gear lever
21. Hoist clutch lever
22. Main clutch lever

The spindle is equipped with a hydraulic chuck (7) and a screw chuck (9), both of which are set with hard metal. It is separately coupled through a dog clutch (10). The speed is indicated on a tachometer (6). The hoist is driven through planetary gearing and a dog clutch (21) and is operated by means of drive lever (11) and brake lever (12). The drive drum and the brake drum are both equipped with a pair of compensated brake shoes, which can be adjusted by means of the rods (2). The brake drum is water-cooled through the water inlet and outlet connexions (3–4). A capstan head is fitted on the hoist shaft. All controls are grouped within easy reach and in front of the drill-runner.

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, issue some notes of particular interest to colliery engineers on a new mining contactor unit. In the course of these the makers state: The necessity for a light, mobile, flameproof gate-end switch unit for use in conjunction with the highly mechanized system of room and pillar coal mining in this country has given rise to a number of factors concerning detailed design not generally experienced hitherto in connexion with gate-end switches for longwall working. The essential problem of reducing the size and weight of the switch, whilst retaining the necessary safety features, has been dealt with by the production of their Type MCU80 Z mining contactor unit—generally termed a "room switch"—for the protection of locally controlled coal cutters and also for the control of conveyors and loaders. The weight of the unit, approximately 3 cwt. excluding cable fittings, is in accordance with the specification drawn up by the Mechanization Advisory Committee of the Ministry of Fuel and Power. The comparatively low weight and overall size (approximately 22 in. high, 25 in. long, 18 in. deep) together with the facilities provided for the ready connexion and disconnexion of cables fully meets the Ministry's requirements in regard to the degree of mobility necessary to keep pace with the rapid advance of the workings. Back-to-back construction of the panel carrying the electrical details, which include an 80-amp. contactor, has given a very compact construction, while the provision of front and back covers for the enclosure has preserved complete accessibility. A triple-pole reversing isolator is fitted and this is contained in a separate flameproof compartment. Protective features comprise over-current protection with mechanical time lags, under-voltage protection, earth continuity protection, including low-voltage relay, and a condenser for rendering the control circuit intrinsically safe. The condenser arrangement is such that the circuit is rendered inoperative if an internal open-circuit should develop in the condenser or its associated wiring. Start-and-stop reset pushbuttons are fitted in the front cover for local operation and a link is provided for use when starting from a remote point only is required. Flit plugs, plugs and sockets, etc., can be fitted to meet specific requirements and, when required, a sequence feed for a face conveyor.



International Combustion, Ltd. (Grinding, Screening, and Filtering Division), 19, Woburn Place, London, W.C. 1, report the following among orders recently received :—

Home—One Hardinge mill 7 ft. by 48 in. to grind ilmenite (feed 30 mesh and under ; product, 99·8% *minus* 180 mesh ; capacity 2 tons per hour) ; three Hardinge constant-weight feeders ; one Type "B" for handling 3 to 4 tons per hour of crushed burnt lime ½ in. and under, having an approximate weight of 42 lb. per cu. ft. ; one Type "B" for feeding ahead of Hardinge conical mill, one Type "A" for feeding ilmenite to 7 ft. by 48 in. Hardinge conical ball-mill ; two Raymond laboratory mills ; one 7 ft. diameter Raymond double-whizzer separator ; one No. 3 Raymond Impax pulverizer ; one No. 50 Raymond Impax pulverizer to grind coal (moisture, 5% maximum ; feed 1 in. down ; product 75% *minus* 200 mesh B.S.S. ; capacity 1,600 to 1,800 lb. per hour) ; one 30-in. Rayco mechanical separator for separating calcium carbonate (feed 300 lb. per hour ; fineness 98% *minus* 200-mesh B.S.S., moisture under 1%) ; twelve L.M. 10 Lopulco mills for grinding coal ; four Hum-mer screens ; one 4 ft. by 5 ft. single-surface Type 39 to screen foundry sand (feed 12-tons per hour ; separation at ¼ in.) ; three 3 ft. by 4 ft. single-surface Type 38 ; one 2-in. Vacseal pump to deliver 132 gallons per minute of tin sand, all *minus* 40-mesh, against a total head of 41 ft. (dilution : 4 to 1 water to solids) ; two 2-in. Vacseal rubber-lined acid-type pumps to deliver 80 gallons per minute of ferrosulphate, having a specific gravity of 1·2 at normal temperature, against a total head of 18 ft. ; one 2-in. Vacseal pump to deliver 132 gallons per minute of tin sands, against a total head of 41 ft. (dilution 4 to 1 water to solids ; solids *minus* 40-mesh) ; one 3-in Vacseal pump for handling slurry containing sand and other gritty solids from gravel washing plant (total head 60 ft.) ; seven 2-in. Vacseal pumps ; one 2-in. Vacseal pump to pump coal slurry at the rate of 50 gallons per minute against a total head of 50 ft. ; twelve V.15 Syntron electric vibrators with controllers and two V.55 ; one F.1 Syntron feeder ; one V.P.15 Syntron electric packer ; 13 Ro-Tap testing sieve shakers ; four Visco-Beth dust collectors to work in conjunction with four L.M. 12 mills for Morocco phosphate.

Abroad—One 5 ft. by 36 in. cyl. Hardinge conical ball-mill for gold treatment plant (20–30 tons per 24 hours in closed circuit with rake classifier ; feed ½ in ; fineness of product 95% *minus* 100 mesh B.S.S.) ; one Type "B" Hardinge constant-weight feeder for 20–30 tons per day, gold treatment plant to feed ore from 20-in cone-crusher (maximum quantity to pass to feeder of *minus* ½ in. material will be 60 tons during the day shift); four Raymond laboratory mills; one "0000" Raymond pulverizer; one 30-in. Rayco mechanical separator; one No. 3 Raymond Impax pulverizer; two 3 ft. by 10 ft. three-surface, Type 38 Hum-mer electric screens for screening sugar (feed 160 tons per day of 22 hours per screen; separations, 8 or 10, 14, 20 mesh); two 4 ft. by 8 ft. single-surface Type 38 Hum-mer electric screens for screening ammonium sulphate salt crystals (feed 82 tons per hour; separation 4 mm.); one 3-sq. ft. Rovac rotary filter; one 12-ft. Hardinge thickener mechanism and superstructure for 20–30 tons per day gold treatment plant (feed 30 tons of solids and 180 tons of liquid per 24 hours; overflow to pregnant solution; filter-bottom tanks; underflow to agitators); four 12-ft. Hardinge counter-current thickener mechanisms for 20–30 tons per day gold treatment plant; two 2-in. Vacseal pumps for 20–30 tons per hour gold treatment plant to pump between strakes and rake classifier (one pump to deliver 120 tons of solids *plus* 202 tons of liquid per 24 hours against a total head of 38 ft.; specific gravity of solids 2·6; one pump as stand-by); one 3-in. Vacseal pump for 20–30 tons per day gold treatment plant to pump between stock pulp tank and agitator (to deliver 250 gallons per minute of pulp against a total head of 44 ft.); one 2-in. Vacseal pump to deliver 40 gallons per minute of milk of lime at 10° Beaume against a total head of 35 ft.; three 2-in. Vacseal pumps, each to deliver 100 gallons per minute of pulp containing 1½ tons per hour of graphite and rock against a total head of 82 ft. (specific gravity 2·75); one F.M. 1–25 Syntron electric feeder machine with controllers for feeding permanganate of potash crystals, and two Ro-Tap testing sieve shakers with motor and time switch.

Metal Markets

Copper.—While there has been no change in the official United Kingdom copper quotation the past month has been characterized by a firmer tone on the international market. The United States export price—the figure generally accepted as being the nearest indication of a world value for copper—has risen steadily and now stands at fully 17½ cents per lb. f.a.s. New York, which, on a sterling basis, is equivalent to around £97 5s. a ton. In the circumstances a good deal of talk is heard regarding the possibility of an advance in the British price, but, while many quarters hold the view that the consumer is going to have to pay something in the neighbourhood of £100 a ton before long, information on official intentions is lacking. The unsatisfactory situation which had developed in Northern Rhodesia and which was threatening a hold-up in supplies, has now been liquidated. Sir Charles Doughty, the official arbitrator, has awarded the artisans an extra 2s. per shift as from August 22, which, together with the 3s. already announced by the mining companies, brings a total increase of 5s. to basic wages. With the matter of the rock-breaking contractors' wages also settled it is hoped that maximum copper production will be attained as quickly as possible, since supplies from the Colony are of major importance to consumers in Britain. Total consumption of copper in the United Kingdom during September amounted to 42,510 tons (an increase of some 5,000 tons over the previous month) and was made up of 29,255 tons of virgin metal and 13,255 tons of scrap.

U.K. official maximum price electrolytic, October 31, £84 a ton, delivered.

Tin.—No far-reaching decisions were arrived at by the International Tin Conference which opened in London on October 8 and was concluded on October 11, the chief recommendation of the meeting being that an International Tin Study Group should be formed to view the tin situation as a whole. It is hoped that the Group will be operating by the end of the year, when the current Tin Agreement is concluded. In the meantime there is to be no new system of control and available world supplies will continue to be apportioned by the Combined Tin Committee in Washington. During its deliberations the Conference estimated that world output would not reach 200,000 tons annually until some time in 1949, so that it is apparent that there is unlikely to be any balancing of supply and demand for another two years at least. Presumably after this period some measure of production control will once again have to be brought into play. At the moment rehabilitation of the Far East mining industry is not proceeding as favourably as was at first estimated, although a good deal of stimulant is being provided by the high price of tin now ruling. Meanwhile United Kingdom stocks of tin metal continue to decline; at the end of September the figure was 12,975 tons, as compared with 13,311 tons the month before, and was made up of 8,738 tons held by the Government and 4,237 tons by consumers. Ore stocks likewise declined from 9,049 tons (tin content) at the end of August to 8,052 tons.

U.K. official maximum price, October 31, £380 10s. a ton, delivered.

Lead.—The situation in lead has shown little change during the past month, with consuming industries still unable to obtain more than a percentage of their total requirements. United Kingdom reserves of raw metal are down at a low level and it remains apparent that there will have to be some improvement in imports if the position is to be prevented from deteriorating further. September imports amounted to a mere 8,702 tons, as compared with 18,228 tons the month before; consumption at the present time is running at about 17,000 tons a month. It is encouraging to note that a rail strike in Australia, which was holding up the movement of concentrates to the Port Pirie smelters, has now been concluded. A difficult situation was at once time feared.

The official U.K. quotation for soft foreign lead remains £55 a ton, delivered.

Zinc.—The situation in zinc throughout the world at the moment is undoubtedly being dominated by a shortage of smelting capacity rather than a shortage of concentrate supplies and while in Britain consumers remain able to cover themselves fairly easily it is time steps were taken to prevent any further attrition of the country's stocks. On the continent lack of fuel and labour difficulties are hampering operations, but an improved output from that quarter is looked for in the future. With effect from October 14 the Office of Price Administration in America advanced the "ceiling" quotation 1 cent to 9·25 cents per lb. East St. Louis. This is equivalent to £51 8s. 4d. a ton.

Mean U.K. price of g.o.b. foreign zinc, October 31, £50 a ton, delivered.

Iron and Steel.—The situation in the iron and steel industry of this country showed little change during the past month; production was fully maintained, but it is still insufficient to cater for the requirements of industrial consumers. Home needs are such that a good deal of "pruning" of export business has become necessary; this is unfortunate, since there is certainly no lack of enquiry. The major obstacle in the way of increased output is, of course, the shortage of fuel and unless there is some improvement in this direction production of iron and steel is likely to suffer. Pig-iron output during September, the latest figures available, was at the annual rate of 7,660,000 tons, as compared with 7,224,000 tons a year ago, while steel output was at a rate of 12,402,000 tons a year, against 12,514,000 tons in September, 1945.

Iron Ore.—With this country's output insufficient to cater for the present needs of the iron and steel industry it remains necessary to import substantial tonnages of good-grade foreign ore. Efforts are being made to increase shipments from abroad, but it has not yet been possible to obtain enough to meet the needs of the furnaces in Britain.

Antimony.—The past month has witnessed no fresh developments in this market; demand remains strong and continues to run well ahead of supplies currently available from smelters. Difficulties in obtaining adequate tonnages of ore continue to hamper efforts to increase production. Prices, however, are unchanged, with £125 per ton still the official quotation for 99% English regulus, delivered.

Arsenic.—The white arsenic market continues to be characterized by a decided shortage of supplies, but current quotations are unaltered at £38 6s. 3d. per ton, ex store, for 10-ton lots. For less than 1 ton £41 6s. 3d. per ton is quoted.

Bismuth.—As from October 21 the export of bismuth compounds from this country was removed from export licensing control. Dealers continue to quote 9s. per lb. for commercial quantities.

Cadmium.—Whilst supplies of cadmium remain very limited, leading sellers in Britain maintain their price at 7s. 6d. per lb. for minimum 1-cwt. lots. In other countries, however, somewhat higher figures are being paid, with business reported done at 10s. and 11s. 3d. per lb.

Cobalt Metal.—There has been no change, with 9s. to 9s. 1d. per lb. still the current quotation.

Cobalt Oxides.—Prices have shown no alteration since the reduction to 6s. per lb. for black oxide and 6s. 6d. for grey made during September.

Chromium.—A steady demand for chromium metal is reported, although a certain amount of delivery delay has once again become apparent. The current quotation shows no change at 4s. 5d. to 4s. 8d. per lb. for 98% to 99% metal.

Tantalum.—Dealers in Britain continue to ask around £18 to £19 per lb.

Platinum.—An improvement in supplies, the weakness of the New York stock market, and profit-taking sales by speculators, mainly American, resulted in a reduction in the platinum quotation, first from £23 5s. an oz. to £21 10s. and subsequently to £18. Current business is being done at around £18 to £18 15s. a troy oz., according to quantity.

Palladium.—A good deal of interest continues to be shown in palladium as a result of the high prices at which platinum has been offering during the past few months. The quotation has, however, been steadily maintained at £5 15s. to £6 an oz.

Osmium.—With available supplies negligible the current price is purely nominal at £20 to £25 per oz.

Iridium.—In iridium also the market is largely a nominal one at the moment, with dealers quoting around £30 to £35 an oz.

Tellurium.—The current price is unaltered at 7s. per lb.

Selenium.—There has been no change, with about 8s. per lb. still quoted by sellers.

Tungsten Ore.—There continues to be only a moderate interest shown at the present time, but leading sellers maintain their price at around 62s. 6d. to 67s. 6d. per unit of WO_3 c.i.f. for the usual 65% material.

Manganese Ore.—Supplies remain adequate to cover the current requirements of consumers in Britain, but on the Continent transport difficulties at the producing end are causing users a certain amount of difficulty. United Kingdom selling prices 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.—For 99% virgin metal £72 15s. per ton, delivered, continues to be quoted. Considerable quantities of secondary metal are being absorbed in the manufacture of temporary houses, while plans for the construction of two-storey permanent buildings in this country will ensure a steady outlet for the large tonnages of secondary material held.

Copper Sulphate.—For 98% to 100% material £33 10s. per ton, f.o.b., less 2%, remains the current quotation.

Nickel.—A good deal of interest is being shown in the proposed substitution of silver coinage in this country by cupro-nickel issues. At a rough estimate it would appear that the new coinage will require something in the neighbourhood of 4,000 tons of nickel. The current quotation in this country at the moment stands at £190 to £195 a ton.

Chrome Ore.—There has been no change in this market during the month, with users in Britain able to cover their requirements of Rhodesian and Baluchistan metallurgical grades adequately at the official figure of £10 a ton.

Quicksilver.—Whilst price control is no longer in force in this country leading dealers continue to quote £30 to £31 5s. per flask, ex store, according to quantity. While the world quotation is a good deal lower than that ruling in Britain at the moment there appears to be little likelihood of any reduction in the price here until such time as the Government ceases to control imports.

Molybdenum Ore.—Rather firmer conditions prevailed during the month, with the price 45s. to 47s. 6d. per unit of MoS_2, f.a.s.

Graphite.—The current quotation is largely a nominal one.

Silver.—There have been no fresh developments during the month, with fine spot silver on the London market quoted at 55½d. per troy oz. In the United States the domestic quotation has remained 90½ cents per oz.

Statistics

TRANSVAAL GOLD OUTPUTS

	September*		October*	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Alpine (Barberton)	4,833	1,099	—	—
Blyvooruitzicht	31,000	26,582	27,000	23,204
Brakpan	105,000	£176,644	109,000	£185,639
City Deep	80,000	20,404	82,000	20,907
Cons. Main Reef	210,000	28,589	215,000	29,373
Cons.Murchison (T.V.L.)	8,000	£21,651	8,500	£22,768
Crown Mines	255,000	55,422	275,000	57,805
Daggafontein	159,000	£378,772	161,000	£376,674
Dominion Reefs	23,400	3,378	25,220	3,645
D'rb'n Roodeport Deep	172,000	31,993	180,000	33,681
East Champ D'Or	23,000	£44,810	29,000	£48,038
East Daggafontein	92,500	£199,788	89,500	£195,535
East Geduld	150,000	42,026	162,000	45,198
East Rand P.M.	200,000	40,760	210,000	42,157
Geduld	103,000	21,703	111,000	23,387
Geldenhuis Deep	55,500	7,007	56,000	7,395
Glynn's Lydenburg ...	10,000	2,706	10,300	2,795
Government G.M. Areas	209,000	£327,227	236,000	£353,903
Grootvlei Proprietary ..	158,000	40,523	166,000	42,568
Langlaagte (In Liq.) ..	24,000	£47,703	16,000	£47,347
Luipaards Vlei	84,000	17,230	88,000	18,277
Marievale Consolidated.	53,500	16,052	55,000	16,465
Modderfontein B	60,000	8,847	62,000	9,159
Modderfontein Deep ..	30,200	4,902	32,000	5,205
Modderfontein East ..	118,000	17,701	101,000	19,339
New Kleinfontein	99,000	15,161	130,000	15,313
New Modderfontein....	82,000	11,353	88,000	11,549
New State Areas	106,000	£169,702	118,000	£177,121
Nigel Gold	42,000	10,396	43,000	10,361
Nourse	70,000	13,299	73,000	13,880
Rand Leases..........	169,000	£278,406	191,000	£306,336
Randfontein	340,000	£367,721	350,000	£383,149
Rietfontein Consolid't'd	26,000	5,343	28,000	5,742
Robinson Deep	94,000	18,612	106,000	20,299
Rose Deep	72,000	11,025	74,500	11,146
Simmer and Jack	135,000	24,541	140,000	25,378
S. African Land and Ex.	87,500	£137,513	87,500	£144,522
Springs	117,500	£171,653	121,000	£185,868
Sub Nigel	64,500	32,379	69,000	34,593
Transvaal G.M. Estates	24,200	5,121	22,400	4,925
Van Dyk Consolidated .	98,000	19,342	103,000	20,313
Van Ryn	58,000	£56,392	59,000	£59,729
Venterspost Gold......	107,000	22,516	112,000	23,552
Village Main Reef ...	25,200	£34,512	25,900	£34,555
Vlakfontein	22,500	9,450	24,000	10,056
Vogelstruisbult	72,500	17,766	76,500	18,752
West Rand Consolidated	219,000	£340,075	222,000	£347,773
West Springs	60,000	£102,840	60,000	£101,460
Western Reefs	79,000	£166,505	79,000	£166,780
Witw'tersr'nd (Knights)	79,000	£89,977	83,000	£94,255
Witwatersrand Nigel ..	9,100	£22,581	9,100	£22,209

* 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	1,014,081
September	1,054,980	1,024,341	1,002,716	984,174
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.
October, 1945	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
August	990,357	23,724	1,014,081
September	961,425	22,749	984,174

NATIVES EMPLOYED IN THE TRANSVAAL MINES

	Gold Mines	Coal Mines	Total
October 31, 1945	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
August 31	295,788	27,738	323,526
September 30	292,246	27,955	320,201

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.	£
Oct., 1945 .	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	4,814,600	35 0	24 11	10 1	2,436,942
July	5,016,700	34 9	24 10	9 11	2,497,347
Aug.	—	—	—	—	2,225,715
Sept.	—	—	—	—	1,843,218

MISCELLANEOUS METAL OUTPUTS

	4-Week Period		
	To Oct. 12		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South ...	23,370	3,674	4,909
Electrolytic Zinc	—	—	—
New Broken Hill ...	5,116	461	1,124
North Broken Hill ...	32,933*	6,178	6,860
Zinc Corp.	37,044	6,143	6,532
Rhodesia.Broken Hill	—	—	—

* To Sept. 28 † Metal.

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	46,939	8,462
August	47,666	7,846	47,027	8,190
September	47,995	8,100	—	—
October	47,550	8,471	—	—
November	45,567	7,687	—	—
December	45,620	7,707	—	—

RHODESIAN GOLD OUTPUTS

	September		October	
	Tons	Oz.	Tons	Oz.
Bushtick	12,600	1,849	13,300	1,878
Cam and Motor	23,000	£42,940	22,800	£42,897
Globe and Phœnix	6,000	3,050	—	—
Rezende	19,600	£17,643	20,000	£19,787
Sherwood Starr	—	£3,303	—	£1,324
Thistle-Etna	6,100	850	6,400	848
Vubachikwe	2,900	£5,354	—	—
Wanderer Consolidated	34,500	2,978	—	

WEST AFRICAN GOLD OUTPUTS

	September		October	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	21,591	1,455	—	—
Ariston Gold Mines	22,000	£63,965	—	—
Ashanti Goldfields	16,500	17,350	16,500	17,350
Bibiani	22,500	6,443	22,500	6,421
Bremang	—	1,241	—	—
Gold Coast Main Reef	9,323	4,127	9,383	4,125
Konongo	10,330	4,210	9,120	4,209
Marlu	17,511	1,693	25,040	2,876
Taquah and Abosso	25,000	5,630	25,000	5,820

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	87,563
September	39,475	33,578	55,123
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 September 17		To October 15	
	Tons	Oz.	Tons	Oz.
Boulder Perseverance	9,551	2,675	9,673	2,790
Central Norseman	8,874	3,282*b*	8,650	3,955*e*
Comet Mine	—	—	—	—
G.M. of Kalgoorlie	11,947	2,422*b*	12,186	2,359*e*
Golden Horse Shoe	—	811*c*	—	932*d*
Gt. Boulder Prop.	31,411	7,185	32,798	7,485
Kalgoorlie Enterprise	3,849	1,709	4,613	1,448
Lake View & Star	46,126	10,942	46,063	11,480
Morning Star (G.M.A.)	1,374	632	1,302	502
North Kalgurli	11,309	3,175	11,740	3,495
Paringa	8,320	1,871	8,020	1,804
Phœnix Mine	—	—	—	—
Sons of Gwalia	—	—	—	—
South Kalgurli	7,336	1,160	—	—
Tindals Gold	—	—	—	—
Waronga (Emu)	—	—	—	—
Wiluna	12,040	2,310	—	—
Yellowdine	—	—	—	—

b 4 weeks to Oct. 1. *c* Sept. *d* Oct. *e* 4 weeks to Oct. 29.

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	234,383	9,023,745
July	210,209	8,093,046	239,554	8,384,390
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 $
September 1945	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
July	625,359	152,215	20,790	5,374,170
August	600,896	149,925	20,830	5,267,175

CANADA'S LEADING MINERAL PRODUCTS

		June,* 1946	July,* 1946
Asbestos	Ton	47,353	45,733
Cement	Brl.	1,459,603	1,352,373
Clay products	$	1,021,516	1,221,741
Coal	Ton	1,258,752	1,152,994
Copper	Lb.	30,885,633	31,008,539
Lead	Lb.	30,927,636	31,659,550
Nickel	Lb.	15,188,844	16,240,647
Silver	Fine oz.	1,174,600	1,266,925
Zinc	Lb.	39,261,780	39,550,943

* Subject to revision.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA

	Sept.		October	
	Tons	Oz.	Tons	Oz.
Champion Reef	9,420	4,172	9,830	5,208
Mysore	16,704	4,340	16,128	4,119
Nundydroog	13,507	3,658	13,750	3,561
Ooregum	8,120	2,042	8,617	2,091

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	September		October	
	Tons	Value £	Tons	Value £
Blackwater (N.Z.)	2,013*d*	552*	—	—
British Guiana Cons.	—	647*	—	486*
Emperor Mines (Fiji)	28,029	8,576**b*	—	—
Frontino Gold (Colombia)	8,050	36,519	—	—
Geita Gold (Tanganyika)	7,553	1,349*	7,685	1,704*
Martha Gold (N.Z.)	9,691*b*	2,393* / 17,729†	10,701*c*	2,393* / 16,571†
New Goldfields of Venezuela	3,988	3,498	—	—
Rosterman (Kenya)	4,100	1,052*	—	—
St. John d'el Rey (Brazil)	—	92,300	—	—
Tati Goldfields (Bech'land)	4,400	250*p*	—	—
Victoria Gold (Vic.)	—	1,068**c*	—	750**b*
Yukon Consolidated	—	$238,000	—	—

* Oz. Gold. † Oz. Silver.
b Period to Oct. 29. *d* Period to Sept. 3. *p* Profit. *c* To Oct. 12.

OUTPUTS OF TIN MINING COMPANIES

In Long Tons of Concentrate

	Aug.	Sept.	Oct.
Amalgamated Tin Mines	540	485	520
Ampat Tin	—	19½	29
Bisichi	31½	36	48½
Ex-Lands	45	—	—
Fabulosa	—	—	—
Geevor	32	38	—
Gold and Base Metals of Nigeria	—	—	—
Jantar Nigeria	35	35	31
Jos Tin	—	—	—
Kaduna Prospectors	6½	5½	5
Kaduna Syndicate	42	43	45
Kagera	—	—	—
Kamunting	62	76	70
Keffi Tin	53	53	57
Kuchai Tin	—	22	10½
Naraguta Tin Mines	41	43¾	—
Naraguta Karama	23¾	27	—
Naraguta Extended	11	13¼	—
Nigerian Consolidated	—	—	—
Pahang Consolidated	—	—	—
Rahman Hydraulic	—	—	—
Rawang Concessions	32½	50¾	71
Rawang Tin	24½	17	29
Ribon Valley	—	—	—
Rukuba Tin Mines	1¾	2¾	—
South Bukeru	9½	6½	—
Southern Kinta	—	—	39½
Southern Malayan	—	8½	33
Sungei Kinta	—	21½	40
Tin Fields of Nigeria	4	5	—
United Tin Areas	—	—	—

QUOTATIONS OF OIL COMPANIES' SHARES

Denomination of Shares £1 unless otherwise noted

	Sept. 10, 1946 £ s. d.	Oct. 8, 1946 £ s. d.	Nov. 8, 1946 £ s. d.
Anglo-Ecuadorian	1 17 9	1 16 3	1 16 6
Anglo-Egyptian B.	3 18 9	3 13 9	3 10 0
Anglo-Iranian Ord.	4 15 6	4 17 6	4 15 0
,, ,, 1st Pref.	1 16 9	1 17 6	2 0 3
,, ,, 2nd Pref.	1 18 9	1 18 9	2 1 3
Apex Trinidad (5s.)	1 12 0	1 10 9	1 12 0
Attock, India	2 11 3	2 6 3	2 0 0
British Borneo Pet. (6s.)	1 11 9	1 10 3	1 10 0
British Controlled ($5)	4 6	4 3	4 3
,, ,, Pref. (,,)	13 6	13 9	13 6
Burmah Oil	3 11 0	3 6 9	3 6 3
,, ,, Pref.	2 1 9	2 1 0	2 2 3
Canadian Eagle Ord.	1 11 9	1 10 0	1 12 6
,, ,, 7% Pref. ($3)	13 3	13 3	12 9
,, ,, 8% Pref.	1 12 6	1 11 0	1 15 0
Kern (3s. 4d.)	5 6	5 0	6 9
Lobitos, Peru	3 5 9	3 5 0	3 5 3
London and Thames Haven	17 3	17 3	16 9
Mexican Eagle Ord. (4 pesos)	13 3	14 9	15 6
,, ,, 8% Pref. (4 pesos)	13 6	15 3	15 6
,, ,, 7% Pref. (,,)	8 9	8 9	8 6
Phœnix Roumania	5 9	5 0	4 6
Premier (Trinidad) (2s.)	4 3	3 3	3 6
Royal Dutch (100 fl.)	33 0 0	30 15 0	30 5 0
Shell Transport Ord. (Units)	4 10 9	4 8 9	4 10 0
,, ,, 5% Pref.	1 8 6	1 8 3	1 11 3
,, ,, 7% Pref.	1 18 3	1 17 9	2 1 6
Steaua Romana	5 9	5 0	5 9
Trinidad Central (10s.)	1 3 0	1 1 0	1 2 6
Trinidad Cons. (4s.)	7 0	6 3	6 3
Trinidad Leaseholds	5 17 6	5 10 0	5 18 0
Trinidad Pet. Dev.	5 2 6	5 5 6	5 10 0
Ultramar (10s.)	3 8 9	3 7 6	3 10 0
United British of Trinidad (6s. 8d.)	1 9 6	1 8 9	1 8 3
V.O.C. Holding (13s. 4d.)	3 15 6	3 13 9	3 15 0
,, 7% Pref. (13s. 4d.)	3 15 6	3 13 9	3 15 0

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	40	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	7
Copper Sulphate	per ton	33	10	0
Creosote Oil (f.o.r. in Bulk)	per gal.			8
Cresylic Acid, 98%	,,		4	2
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iron Sulphate	per ton	3	17	6
Lead, Acetate, white	,,	72	10	0
,, Nitrate	,,	72	10	0
,, Oxide, Litharge	,,	70	0	0
,, White	,,	84	0	0
Lime, Acetate, brown	,,	19	0	0
,, ,, grey, 80/82%	,,	23	10	0
Magnesite, Calcined ex W'h'se	,,	Nominal		
,, Raw	,,	9	7	6
Magnesium Chloride, ex W'h'se	,,	27	10	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	,,	102	10	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	1
Pine Oil	per cwt.	4	7	0
Potassium Bichromate	per lb.			7⅞
,, Carbonate (hydrated)	per ton	51	10	0
,, Chlorate	per lb.	Nominal		
,, Chloride, 96%	per ton	16	10	0
,, Amyl Xanthate	per lb.		1	3½
,, Ethyl Xanthate	,,			8
,, Hydrate (Caustic) solid	per ton	65	10	0
,, Nitrate	per cwt.	3	16	0
,, Permanganate	,,	7	19	3
,, Sulphate, 90%	per ton	Nominal		
Sodium Acetate	,,	41	0	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	11	0	0
,, Bichromate	per lb.			6½
,, Carbonate (crystals)	per ton	Nominal		
,, ,, (Soda Ash) 58°	,,	8	0	0
,, Chlorate	,,	46	0	0
,, Cyanide 100% NaCN basis	per lb.			8½
,, Hydrate, 76/77%	per ton	16	4	0
,, Hyposulphite, comml.	,,	16	0	0
,, Nitrate	,,	17	5	0
,, Phosphate (Dibaric)	,,	29	10	0
,, Prussiate	per lb.			9½
,, Silicate	per ton	8	10	0
,, Sulphate (Glauber's Salt)	,,	5	5	0
,, ,, (Salt-Cake)	,,	4	11	0
,, Sulphide, flakes, 60/62%	,,	20	2	6
,, Sulphite, comml.	,,	13	0	0
Sulphur, American, Rock (Truckload)	,,	12	10	0
,, Ground	,,	16	10	0
Sulphuric Acid, 168° Tw.	,,	6	12	6
,, ,, free from Arsenic, 140° Tw.	,,	4	11	0
Superphosphate of Lime	,,	5	8	6
Tartaric Acid	per cwt.	15	8	0
Tin Crystals	per lb.	Nominal		
Titanium white, 70%	per ton	37	10	0
Zinc Chloride	,,	22	0	0
,, Dust, 95/97%	,,	56	0	0
,, Oxide (White-Seal)	,,	54	5	0
,, Sulphate	,,	2	0	0

Share Quotations

Shares are £1 par value except where otherwise stated.

GOLD AND SILVER:

SOUTH AFRICA:	Oct. 8, 1946 £	s.	d.	Nov. 8, 1946 £	s.	d.
Blyvooruitzicht (10s.)	8	17	6	8	15	0
Brakpan (5s.)		15	6		13	9
City Deep	2	6	3	2	2	6
Consolidated Main Reef	1	15	0	1	13	9
Crown Mines (10s.)	5	5	0	5	0	0
Daggafontein (5s.)	3	1	3	3	0	0
Dominion Reefs (5s.)		5	0		5	0
Durban Roodepoort Deep (10s.)	3	10	0	3	6	3
East Daggafontein (10s.)	2	3	9	2	4	3
East Geduld	9	10	0	8	18	9
East Rand Consolidated (5s.)		13	0		12	0
East Rand Proprietary (10s.)	1	18	9	1	17	6
Geduld	6	15	0	6	3	9
Geldenhuis Deep (15s.)	1	10	0	1	10	0
Government Gold Mining Areas (5s.)	1	3	9	1	3	0
Grootvlei	6	7	6	6	10	9
Klerksdorp (5s.)		5	3		5	0
Lace Proprietary (5s.)	1	3	9	1	2	0
Libanon (10s.)	1	5	3	1	7	0
Luipaards Vlei (2s.)		19	6		19	0
Marievale (10s.)	1	7	9	1	7	6
Modderfontein B (5s.)		8	6		8	3
Modderfontein East	2	15	0	2	15	0
New Kleinfontein	1	5	0	1	5	0
New Modderfontein (10s.)		8	3		8	3
New State Areas	1	9	0	1	6	3
Nigel Gold (10s.)	1	5	0	1	3	9
Nourse	1	6	3	1	5	0
Rand Leases (10s.)	2	12	6	2	10	0
Randfontein	1	3	9	1	2	6
Rietfontein Consolidated (5s.)		14	3		14	3
Robinson Deep B (7s. 6d.)		14	3		13	6
Rose Deep	1	5	0	1	2	6
Simmer and Jack (2s. 6d.)		9	6		9	6
South African Land (3s. 6d.)	2	1	3	1	18	9
Springs (5s.)		12	3		12	6
Sub Nigel (10s.)	4	5	0	4	6	3
Van Dyk (10s.)		12	6		12	9
Van Ryn (10s.)		17	6		17	9
Venterspost (10s.)	2	1	3	2	2	0
Vlakfontein (10s.)	1	3	9	1	5	0
Vogelstruisbult (10s.)	1	2	6	1	2	6
West Driefontein (10s.)	4	5	0	4	7	6
West Rand Consolidated (10s.)	1	12	6	1	11	3
West Springs	1	0	9	1	0	9
West Witwatersrand Areas (2s. 6d.)	7	0	0	6	11	3
Western Holdings (5s.)	4	11	3	3	17	6
Western Reefs (5s.)	1	18	9	1	18	9
Witwatersrand Gold (Knights)	1	7	6	1	7	6
Witwatersrand Nigel (5s.)		7	0		6	3

RHODESIA:	£	s.	d.	£	s.	d.
Bushtick (10s.)		4	0		4	0
Cam and Motor (12s. 6d.)	1	6	3	1	10	0
Globe and Phœnix (5s.)	1	1	9	1	3	0
Rezende (1s.)		5	3		5	0
Sherwood Starr (5s.)		3	6		3	3
Wanderer		8	9		8	6

GOLD COAST:	£	s.	d.	£	s.	d.
Amalgamated Banket (5s.)		7	3		6	9
Ariston Gold (2s. 6d.)		12	3		12	0
Ashanti-Adowsena (2s.)		2	3		2	6
Ashanti Goldfields (4s.)	2	18	3	2	18	6
Bibiani (4s.)	1	8	6	1	9	0
Bremang Gold Dredging (5s.)		5	3		4	6
Gold Coast Banket Areas (2s.)		3	3		3	6
Gold Coast Main Reef (5s.)		11	6		11	6
Gold Coast Selection (5s.)	1	9	9	1	11	6
Konongo (2s.)		6	6		6	9
Kwahu (2s.)	1	12	6	1	11	3
London & African Mining Trust (5s.)		9	0		9	0
Marlu (5s.)		7	3		7	3
Nanwa		3	9		4	0
Offin River Gold (5s.)		4	9		4	6
South Banket Areas (2s.)		2	9		2	3
Taquah and Abosso (4s.)	1	6	3	1	6	6

AUSTRALASIA:	£	s.	d.	£	s.	d.
Blackwater Mines, N.Z.		8	9		8	9
Boulder Perseverance (4s.), W.A.		8	6		9	0
Gold Fields Aust. Dev. (5s.), W.A.		4	3		4	3
Gold Mines of Kalgoorlie (10s.)		9	0		9	0
Golden Horse Shoe (3s.), W.A.		2	3		2	3
Great Boulder Propriet'y (2s.), W.A.		8	3		8	3
Lake View and Star (4s.), W.A.	1	4	0	1	5	6
Martha Gold (5s.), N.Z.		4	3		4	3
Mount Morgan (2s. 8d.), Q.		6	6		6	6
North Kalgurli (1912) (2s.), W.A.	1	0	9	1	1	6
Paringa (1s.), W.A.		3	9		3	6
Sons of Gwalia (10s.), W.A.	1	6	0	1	6	0
South Kalgurli (5s.), W.A.		19	0		19	0
Wiluna Gold, W.A.		13	9		13	0

INDIA:	Oct. 8, 1946. £	s.	d.	Nov. 8, 1946. £	s.	d.
Champion Reef (10s.)	1	1	3		18	9
Mysore (10s.)		10	3		9	6
Nundydroog (10s.)		15	6		15	0
Ooregum (10s.)		8	9		8	3

MISCELLANEOUS:	£	s.	d.	£	s.	d.
Fresnillo	1	12	6	1	15	0
Frontino, Colombia	1	8	9	1	7	6
Kentan Gold Areas (10s.), E. Africa		7	0		6	9
New Goldfields of Venezuela (5s.)		1	3		1	3
Rosterman (5s.), Kenya		7	3		6	9
St. John d'el Rey, Brazil	2	0	0	1	12	6
Yukon Consolidated ($1)		7	6		7	6

COPPER:

	£	s.	d.	£	s.	d.
Esperanza Copper and Sulphur		2	3		3	6
Indian (2s.)		7	9		7	9
Messina (5s.), Transvaal		17	9		18	6
Mount Lyell, Tasmania		15	6		17	0
Nchanga Consolidated, N. Rhodesia	2	18	9	3	7	6
Rhodesia-Katanga		4	6		5	0
Rhokana Corporation, N. Rhodesia	8	5	0	8	12	6
Rio Tinto (£5), Spain	13	10	0	15	0	0
Roan Antelope (5s.), N. Rhodesia		13	0		13	0
Tanganyika Concessions		16	0		16	0
Tharsis (£2), Spain	1	18	9	1	18	9

LEAD-ZINC:

	£	s.	d.	£	s.	d.
Broken Hill South (5s.), N.S.W.	1	6	6	1	6	3
Burma Corporation (9 rupees)		10	6		10	6
Electrolytic Zinc, Tasmania	2	8	9	2	8	9
Lake George (10s.), N.S.W.		8	3		9	3
Mount Isa, Queensland	1	6	3	1	6	9
New Broken Hill (5s.), N.S.W.	1	7	3	1	9	3
North Broken Hill (5s.), N.S.W.	2	6	3	2	8	9
Rhodesia Broken Hill (5s.)		10	0		11	6
San Francisco (10s.), Mexico		19	0		19	3
Sulphide Corporation (15s.), N.S.W.		9	3		8	6
Zinc Corporation (10s.), N.S.W.	3	15	0	3	16	9

TIN:

	£	s.	d.	£	s.	d.
Amalgamated Tin (5s.), Nigeria		13	3		13	0
Beralt (5s.), Portugal		7	6		8	3
Bisichi (10s.), Nigeria		9	9		9	3
Ex-Lands (2s.), Nigeria		6	3		5	9
Geevor (5s.), Cornwall		5	6		6	0
Gold & Base Metals (2s. 6d.), Nigeria		3	9		3	9
Jantar Nigeria (3s.)		8	3		8	0
Jos Tin Area (Nigeria) (5s.)		10	0		10	6
Kaduna Syndicate (2s.), Nigeria		9	6		9	3
Mawchi Mines (4s.), Burma	1	6	9	1	6	9
Naraguta (10s.), Nigeria		7	9		7	9
Nigerian Consol. (2s.)		4	0		4	0
South Crofty (5s.), Cornwall		4	3		4	3
United Tin Areas (2s. 6d.), Nigeria		4	0		4	0

DIAMONDS:

	£	s.	d.	£	s.	d.
Anglo American Investment	3	2	0	2	17	3
Consol. African Selection Trust (5s.)	1	12	9	1	13	0
Consolidated of S.W.A. (10s.)	2	12	6	2	11	3
De Beers Deferred (£2 10s.)	22	0	0	20	10	0
West African Diamond (5s.)		2	3		2	3

FINANCE, Etc.:

	£	s.	d.	£	s.	d.
African & European	8	7	6	7	17	6
Anglo American Corporation (10s.)	5	12	6	5	7	6
Anglo-French Exploration	1	8	9	1	10	9
British South Africa (15s.)	1	11	9	1	15	3
British Tin Investment (10s.)		14	9		13	9
Broken Hill Proprietary	1	13	9	1	15	0
Camp Bird (10s.)		11	0		10	9
Central Mining (£8)	21	0	0	21	10	0
Central Provinces Manganese (10s.)	2	16	0	2	15	6
Consolidated Gold Fields	3	11	3	3	11	3
Cons. Gold Fields of N.Z. (4s.)		4	3		4	3
Consolidated Mines Selection (10s.)	2	1	3	2	3	9
Eastern Trans. Consolidated (5s.)		8	6		8	0
General Mining and Finance	6	2	6	6	3	9
Gold Ex. and Fin. of Australia (10s.)		10	9		10	3
Gold Fields Rhodesian (10s.)		11	9		12	9
H.E. Proprietary (10s.)	1	18	9	1	17	6
Henderson's Trans. Estates (4s.)		9	3		10	3
Johannesburg Consolidated	4	6	3	4	11	3
London & Rhod. M. & L. (5s.)		5	9		5	9
London Tin Corporation (4s.)		5	6		5	6
Marsman Investments (10s.)		12	6		12	0
Minerals Separation	5	1	9	5	5	0
New Central Witwatersrand (5s.)		17	3		16	3
Oroville Dredging (4s.)		16	9		17	3
Rand Mines (5s.)	6	10	0	6	8	9
Rand Selection (5s.)	2	3	6	2	3	9
Rhodesian Anglo American (10s.)	1	4	3	1	6	3
Rhodesian Corporation (5s.)		6	6		7	0
Rhodesian Selection Trust (5s.)		18	0		18	0
Selection Trust (10s.)	2	2	9	2	0	9
South West Africa Co. (13s. 4d.)	1	1	9	1	2	6
Union Corporation (12s. 6d.)	12	5	0	12	11	3
Venture Trust (6s. 8d.)		5	0		5	0
West Rand Ind. Trust (10s.)	2	0	6	1	19	3
Zambesia Exploring	1	3	6	1	4	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.

Tests with Shaped Charges

A recent *Bulletin* of the University of Utah[1] contains a paper by R. S. Lewis and G. B. Clark describing tests on steel and rock carried out in the course of an investigation into the "Application of Shaped Explosive Charges to Mining Operations."

Following an account of the "Munroe effect" and a brief discussion of the mechanism of detonation in explosives the authors proceed to describe the University of Utah tests. They point out that the first problem was to find an explosive which has satisfactory properties for use in shaped charges; 100% Oilwell Explosive had satisfactory explosive characteristics, but owing to its para rubber-like consistency it was difficult to load by hand in containers at low temperatures. 60% straight dynamite, which is like wet sawdust, was tried and was easier to load, but it has a detonation velocity of only some 20,000 ft./sec. as compared with 26,000 ft./sec. for 100% Oilwell Explosive. Most of the experimentation was performed with the 60% straight dynamite. Later, when warmer weather came, it was found to be possible to load Oilwell Explosive into the containers and some comparative tests were made with this explosive.

Due to limitation of time only a few of the features of shaped charges could be investigated, it is stated. Consequently it was decided to determine the effect of (1) stand-off, (2) amount (height) of explosive for a given diameter of charge, and (3) the effect of partial confinement. Targets used were both steel plates and rock, steel plates being used to measure penetration and rock to measure both penetration and breakage effects. Cast iron was chosen as metal for the liner of the cavity of the shaped part of the charge on the basis of its breaking characteristics.

Theory of Shaped Charges

The total energy of the explosive in shaped charges is not increased by the form of the explosive, but the hollow cone or other shape that may be used acts to redistribute and concentrate the energy of the portion of the charge nearest the cavity liner. The explosive forces on the periphery of the cavity liner, which presumably act with equal force in all directions, will have a resultant force normal to the surface of the liner working progressively down from its apex. If the cavity is symmetrical about its axis these forces will meet at the axis, will be additive in magnitude and will thus effect a concentration of kinetic energy that would otherwise be spread over a considerable area of the sphere of explosive effect.

The factors which affect the performance of shaped charges are not all known, but it is reasonable to suppose that the following would have an effect on the performance of the charges: (1) Type of explosive—detonation velocity and brissance; (2) height of explosive above cavity liner; (3) width of explosive around cavity liner; (4) uniformity of explosive—no air pockets, etc.; (5) type, shape, and thickness of cavity liner; (6) degree and type of confinement of explosive; (7) method of detonation, and (8) stand-off.

Of these factors none, it is stated, can be denoted as more important than any other. It is logical to say that the greater the explosive energy of the explosive the greater will be the energy of the jet. It is not only necessary that the cavity and cavity liner be geometrically symmetrical with respect to the axis of the charge, but that the liner must also be dynamically symmetrical. In other words, internal stresses in the liner should be uniform throughout its mass. With 1½-in. linear charges either residual or induced stresses in part of the liner caused the formation of erratic jets. To avoid this difficulty all liners were annealed and were made separately from the other metal parts of the charge.

The existence of stresses in the cavity liner causes a diversion of the explosive forces which act on the liner. This causes local asymmetries in the resultant forces giving rise in turn to forked jets. This splitting of the jet causes an unequal dispersion of the energy. The resulting penetrative effects are considerably reduced as compared to those of a uniform jet. Recovered portion of conical liners composed of about 2 in. of the apex portion of the cone from tests with 6-in. charges conducted at the University of Utah show that as the detonation wave progresses downward through a shaped charge and reaches the top of the cast-iron conical cavity liner it exerts a pressure normal to the surface of the liner, forcing it to collapse upon itself as it forms a Munroe jet. It would appear that in the case of hemispherical liners the lining, being acted upon by explosive forces normal to its surface, would collapse by a different mechanism.

This type of lining probably turns inside out as the explosive force reaches its surface. It is a reasonable hypothesis also that conical liners would collapse in the same manner as hemispherical liners as the apex angle approaches 90°.

In the case of conical liners (and probably other shapes of liners) this type of collapsing and breaking would lead to the conclusion that the effective part

[1] Vol. 37, No. 5, July, 1946. (Bulletin No. 1.) Salt Lake City, Utah.

of the jet itself is formed of particles from the liner. This conclusion is borne out by the fact that sponge-like masses of cast iron have been found in the bottoms of holes drilled in rock by 6-in. shaped charges.

Army tests have shown that the Munroe jet is formed from particles which break away from the liner as it collapses, the tiny fragments possessing very high velocities, and acting as the penetrating agents in the drilling of holes in solid masses. Ten-pound TNT shaped charges have been used to punch holes 1¼ in. in diameter through 8 in. of armour plate. Thus, if a portion m of the total mass M of the liner is contained in the Munroe jet, its kinetic energy would be $\frac{1}{2} m v^2$ according to the Newtonian laws of motion. The velocity v would be the velocity of the jet which would probably be closely related to the velocity of detonation of the explosive used, the type of material in the liner, and the shape of the liner itself. For 100% Oilwell Explosive the jet probably possesses a velocity of over 8,000 m./sec. and exerts pressures of high intensities. It was estimated that the thickness of the liner should bear the relationship to the diameter of the charge of about 1 to 20. Cast iron was used because it is brittle and easy to machine.

The effect of liners, thicker and thinner, it is suggested, should be investigated, although the above ratio which was used in the tests proved satisfactory.

It would appear that if the explosive energy of the upper portion of the charge, which is ordinarily partly wasted, could be directed inward along the axis of the charge into the jet the efficiency of the charge would be increased accordingly. If such a charge could be completely confined in a short breach block, as an artillery propellent is confined, it is believed that a portion of this energy might be captured and redirected.

An interesting characteristic of the shaped charge is that it is more effective when held at a short distance (stand-off) from a target than it is when placed immediately on a target. The magnitude of the stand-off for a particular charge is peculiar to the given design of that charge. It follows that as the jet is formed the point of the jet experiences a short period of acceleration, which carries it beyond the cavity in the explosive, and reaches a maximum velocity at a point well beyond the cavity, at which point its penetrating effect is a maximum.

If the explosive in a charge is well packed and of uniform density the charge gives much better results than otherwise. Thus it is reasonable to believe, it is stated, that such uniformity causes the detonation wave to progress through the explosive in a plane wave. If this wave could be made hyperbolic or conical in section, thus causing a conical liner to collapse nearly all at once, the effective energy of the jet might possibly be enhanced considerably.

The kind of metal used in liners also probably affects the performance of the charge. Throughout the tests described plate steel and cast iron were employed in the cavity liners. It is believed, however, that other heavy metals or their alloys should give results comparable to those obtained from cast iron. Steel conical liners should also give good results. The height of charge has a direct effect on charge performance.

The relationship between penetrating power and rock-breaking power of Munroe jets has not been definitely established, the authors say, but it is believed that the relationship is approximately linear—that is to say, the breaking power of a shaped charge increases in approximately direct proportion to the depth of penetration. Charges which are not correctly designed for achieving maximum penetration will not utilize the full possible energy of the explosive. Thus, for secondary breaking, as well as for penetration effect, liners must be annealed, optimum stand-off used, and high-powered explosives employed, properly packed in the charge, as well as incorporating other features of design discussed below.

Linear charges loaded with 60% N G dynamite fired against steel targets gave erratic results, due to the fact that the case and the liner of the charge were made in one continuous piece of steel. This permitted the explosion wave to push out the sides of the charge case and induce stresses or bending in the liner (inverted trough) at the bottom of the charge before the detonation wave reached the apex of the liner. When fired on rock these charges tend to break the rock along the line of the charge but due to the fact that their penetration power is limited (7/8 in. for steel) their rock-breaking power is less than for subsequently tested types of charges (conical or hemispherical). It appears that this type of charge would have an application in quarry work for directional breaking of rock and should be investigated further.

Cylindrical Charges.—Both 45° and 30° cones were designed to fit into a standard 1¼-in. pipe as a casing. The top of the charge was left open, both for loading and placing the cap, as well as for simplification of design. The first problem was to determine the optimum stand-off for this type of charge. The results obtained could then serve as criteria for fixing stand-off distances for other size charges of the same type.

Steel plates ¼ in. thick and 4 in. by 4 in. square were used as targets for these charges as they give an accurate quick method of determining the penetration power of the jet. Plates were piled in stacks of desired height for a given charge and then the charge was placed on top. After the charge was fired the depth of penetration was then determined by counting the plates with holes through them.

A survey of the curves plotted from the values obtained reveals several points of interest. It is noted that there is considerable variation in penetration power of these two types of charges for a given stand-off, especially with the 30° cone charge. This was probably due in part to the fact that the charge was of the " open end " type. The portion of the curve for stand-off values of over 2 in. indicates the magnitude of penetration that might be expected for completely-closed charges comparable to those used in later tests. Larger charges with covered ends investigated later showed much more consistent performance. Also it seems a reasonable hypothesis that the consistency of performance of jets is also a function of the distance of the target from the apex of the cone rather than from the base of the liner. Thus, with a 30° liner, the apex was approximately an inch higher than for the 45° liner. This is a possible explanation of the greater dispersion at stand-off values for 30° cones. In addition the method of loading the charges did not permit obtaining a uniform density throughout the body of the explosive. This was probably another source of variation in performance.

From the geometrical shape of 30° liners it would be expected that they would make a deeper hole than the 45° liners—that is, a hollowed explosive tends to produce a mirror image of the hollow in the target that is fired against. This, however, does not appear to be the case. Both curves are of approximately the same shape with the maximum ordinate. It is believed, however, that with a charge designed to eliminate sources of error a difference might become apparent. In general the 45° cone gave more consistent results than the 30° cone, even though the optimum penetration and crater volume were about the same. Consequently an apex angle of 45° was chosen for the large-size charges (3 in. and 6 in.). Two of this size (1-in.) charges were fired against solid rock (quartzite). The only effect was to spall the rock at the point of the explosion to a depth of 2 and 3 in. The size of the charges was too small to furnish enough penetrative power to go beyond spalling depth.

Two variations of 3-in. charges were investigated, one with a cone screwed in the end of a 6-in. length of 3-in. pipe and the same with a " bell " or cast-iron cover screwed on the top. The first type were used to determine optimum stand-off distance for this size of charge and the covered type were used to determine the relationship between amount (height) of powder in the charge and its penetrative power.

As with 1-in. cylindrical charges with open ends the results were somewhat erratic. Two of this type of charge were fired against steel targets at 3-in. stand-off. A maximum penetration of 4½ in. was obtained. Due to the high cost of steel for targets for such large charges the remainder were fired against solid granodiorite as a target. A maximum penetration of 16 in. was obtained at a 2-in. stand-off. Total penetration was measured as the sum of (1) spall, the amount of rock broken off by the explosion, and (2) depth of holes, the actual depth of hole left in solid rock.

Two of this size of charge were tested for their ability to break rock. When the charge was fired it broke the rock radially to a parting plane and split off a piece below the plane. The jet actually penetrated to about 10 in., but split the rock to about 16 in. It is believed that if there had been no parting in the rock it would have been split through its entire vertical dimension.

It is especially noteworthy, the authors say, that there is considerable less variation in results with a covered charge. This is probably due to a reactive force created at the top of the charge as the detonation waves start through the explosives. With this type of charge loaded with 60% N G dynamite the maximum penetration obtained in solid granodiorite was 16 in.

Hemispherical Charges.—Charges with hemispherical cast-iron liners were designed to test the effect of jets from hemispheres. A case of cast aluminum was so designed as to give a uniform height of explosive over the top portion of the hemisphere. By varying the height of the casing the charge could be tested for most economical amount of explosive, as well as for optimum stand-off for this type of charge on steel.

For tests with varying amounts of powder the aluminum cases were machined to heights of decreasing steps of ¼ in.

Hemispherical charges were also tested for their ability to break rock. A stand-off of 2½ in. was used and the charges contained 195 grams. of explosive (60% N G dynamite), or about 1 stick 1¼ in. by 8 in. of powder, using a margin of safety. With the correct amount of explosive and the correct stand-off for this size charge being known the charges were fired on separate boulders of granodiorite of various dimensions. Three charges were placed on rock, being held in place by a piece of cord counter-weighted over the upper edge with a small rock. The rock was wedge-shaped, being 12 in. thick under charge 1, 16 in. thick under charge 2, and 26 in. thick under charge 3. The blast broke the rock at charge 1, broke out a small piece and cracked the rock longitudinally at charge 2, and made a 4-in. crater only at charge 3, thus illustrating the point that the weight of charge should be proportioned to the thickness of rock to be broken.

From the results on rocks it was seen that the magnitude of the two smallest dimensions at the point of application will determine the type of breakage or if the rock will break at all. In rock " a " a thickness of 12 in. broke along the least dimension while a thickness of 16 in. failed to break. Rock " b," with a thickness of 13 in., broke, but only along the least dimension. Rock " c," of 1-ft. thickness and approximately square horizontal section, broke radially into several directions roughly perpendicular to the four sides. It would appear, then : (1) That the maximum breakage thickness for this size of charge is about 13 in. or about 3 times its depth of penetration for granodiorite ; (2) that the charge should be placed perpendicular to the two longest dimensions of a rock, and (3) 100% Oilwell Explosive increases the effect of the charge considerably over 60% straight dynamite.

Conclusions

(1) Linear charges exhibit a marked tendency to break rock of relatively small thickness along the line of the charge. This property should be further investigated.

(2) Liners and cases should not be made in one continuous piece because this may permit the case to induce stresses in the liner before the detonation wave reaches the top of the liner.

(3) One-inch charges were too small to be effective for mining work and exhibit a tendency to be erratic if the explosive is left uncovered at the top of the charge. This size of charge, however, is valuable for laboratory tests on steel plates.

(4) Three-inch *open* charges are also erratic. The most effective height of charge appears to be a little over two charge diameters for 45° cones. This type of charge also seems to be effective in breaking rocks of comparatively greater thickness than other types of shaped charges. It is also effective in drilling holes in solid rock.

(5) Hemispherical charges produce a larger crater in steel plates than conical charges. They also proved effective in breaking rock, their breaking power being a function of the two shortest dimensions of the rock at the point of application. For effective results the charge should be placed perpendicular to the two longest of the rock's dimensions. Charges placed on ridges in rocks tend to spend their energy on the ridge and fail to penetrate or break the rock effectively.

(6) Six-inch cylindrical charges loaded with 100% Oilwell Explosive proved effective in drilling a 2-in. hole 33 in. into solid granodiorite, which is of

adequate size for loading and shooting as a normal blasting hole in underground operations.

(7) The use of granodiorite rock for comparative tests proved very satisfactory as the rock was surprisingly uniform in nature. Experienced miners stated it was much tougher to drill and break than any ores they had blasted.

(8) The above conclusions lead to a final conclusion that shaped charges have a definite and useful application in mining operations both in secondary rock breakage and drilling holes for blasting solid faces of rock. When fully developed and properly applied, the use of this type of charge will expedite blasting operations by saving time and labour, with a proportional reduction in cost.

It should be borne in mind, the authors say, that the investigations have only laid the foundation for further study of this problem. The field of investigation of shaped charges is a very extensive one and will require much research to make the principles involved fully applicable to mining operations.

The problem that lies ahead will be to incorporate all the principles of design (which must be determined by research and investigation) that will make the most efficient types of charges and then to use these same principles in charges which can be produced most economically on a commercial scale.

The results of this research indicate that the application of shaped charges to mining is not only feasible but will prove economical as well.

Closed-Circuit Screening

In a paper read at the recent Annual Western Meeting of the Canadian Institute of Mining and Metallurgy held in Vancouver W. M. Stephen discussed "Fine Screens in a Grinding Circuit." This paper is published in the *Canadian Mining and Metallurgical Bulletin* for September and extracts are reproduced here. The author says that before the development of vibrating screens and stainless-steel screen cloths the millman had not much choice in the method of closing a grinding circuit. The reliability of both mechanically- and electrically-vibrated screens has reached a point now, however, where the millman can now seriously consider the use of either screens or classifiers. This statement, the author says, is not to be construed to mean that all problems are solved by the use of screens in place of the customary classifier; just as there are conditions that make a classifier superior to screens, the reverse is also true.

One of the fundamental differences between the two methods of closing a grinding circuit, the author goes on to say, is that specific gravity plays an important rôle in classifiers and none whatever in sizing by screens. A screen makes a separation of ore particles entirely on their size. Either a grain goes through a screen opening or it passes into the oversize and is returned to the mill. A classifier, influenced by specific gravity, will return to the grinding circuit clean mineral grains fine enough for flotation, which results in over-grinding. In some mills this is desirable and required, but in others it is detrimental.

To set forth the exact conditions that would call for screens in place of classifiers to close a grinding circuit would be rather lengthy and on the hypothetical side and, for his paper, the author sets two general conditions that would indicate the selection of screens over classifiers :—

(1) The product of the grinding circuit to be about 5% on 65 mesh and with a minimum of *minus* 200-mesh material.

(2) A minimum of overgrind on the high specific gravity minerals.

During 1939, it is stated the W. S. Tyler Company developed a new screen known as the "re-pulping screen." It differs from their mechanically-vibrated "Ty-Rock" screen only in the placing of the screen cloth. The test re-pulper screen was 3 ft. wide by 5 ft. long, with the screen cloth in three 20-in. pieces, with a re-pulping section between the screens. This feature is important, it is suggested, inasmuch as the data secured point to the advisability or possibility of using different mesh cloth on each section of the screen.

An experimental run was made in the Copper Cliff concentrator of the International Nickel Company, using one 6½-ft. by 15½-ft. Marcy rod-mill. This circuit was closed with five of the Standard 4-ft. by 5-ft. Hum-mer screens and one 3-ft. by 5-ft. re-pulper. The adjoining Marcy mill and classifier handling the same ore and on the same tonnage were used for securing comparative data. During these tests the experimental unit handled from 1,050 to 1,150 tons ore per day. As the re-pulper had an effective screen area only 75% that of a Hum-mer its rate of feed was 75% of that sent to a Hum-mer. The feed per square foot of screen cloth was thus maintained at the same rate on both types of screen.

In the screening of a mill discharge one of the principal points to remember, says the author, is the delivery of the feed to the screens. After many attempts to secure an even distribution, which is vital, the result was a giant-sized "spray" of the same type as used for a water spray. This "feeder" delivered a uniform thin sheet of the pulp the full width of the screen. Until this method of feeding had been developed the use of the full screen area was not secured. Another point that should be remembered in working on a fine wet-screening test is that, as soon as the water in the pulp has passed through the screen cloth, screening stops. The re-pulper overcomes this by being so constructed that, in the flow of the pulp across the machine, it can be re-pulped twice with a water spray. No difficulty was encountered in maintaining a high pulp density in the total screen undersize which in this case was the flotation feed.

In view of data secured in earlier work [1] the screen cloths shown in Table 1 made of stainless-steel wire were used. Through the tests the

Table 1

Tyler Co. Ton-Cap No.	*Width of Opening.*	*Size of Wire.*	*Mesh.*
2,475	0·0093 in.	0·018–0·025 in.	41 × 10
166	0·0168 in.	0·018–0·025 in.	31 × 8

[1] STEPHEN, WALTER M., "65-Mesh Grinding in Closed Circuit with Stainless-Steel Screen." A.I.M.E. Tech. Pub. No. 901, 1938.

Table 2

Screen Analyses of Screen Undersize and Classifier Overflow

	% Weight.				
	+ 48	*+ 65*	*+ 100*	*+ 200*	*− 200*
4 Hum-mer screens	6·24	11·89	13·84	22·17	45·86
1 Re-pulper screen	8·71	13·37	14·51	20·88	42·53
5 Hum-mer screens	8·40	13·00	16·20	21·00	41·40
1 Re-pulper screen	9·20	13·80	16·35	19·70	40·95
Classifier overflow .	8·13	9·52	13·35	22·91	46·09

Hum-mers were covered with No. 166 cloth. The re-pulper was covered with the same cloth for part of the tests and for one test it was also operated with No. 166 cloth on the top section and No. 2475 on the middle and the lower sections. This run gave some very interesting results that are set forth later.

The flow-sheet used throughout the tests was: Original feed, *minus* ½-in. to Marcy rod-mill; mill discharge pumped at 70% solids to the Hum-mer and re-pulper screens; screen undersize to flotation, and screen oversize returned to mill. The only variation was in the screen cloth on the re-pulper; all other conditions were maintained as nearly uniform as possible. For a check against the work of the screens the adjoining Marcy mill and classifier were used with the same feed rate as the experimental unit.

Table 2 summarizes the results obtained during a test in which all the screens were covered with the No. 166 Ton-Cap screen cloth and in which a feed rate of 1,050 tons per day was maintained. The table shows the effect of increasing the tonnage per screen and also affords a comparison between the product from a standard circuit with a classifier and that from a circuit closed with screens. The lower rate of feed when five Hum-mers and the re-pulper were operating gave a coarser undersize product, due to the fact that more near-mesh grains were produced in this undersize.

The effect of the additional Hum-mer on screen-oversize analysis is shown in Table 3. These tests indicate that the re-pulper screen is more efficient than the Hum-mer, but an installation of two units with screens of each type would have to be made to get the true picture. The Hum-mers undoubtedly affected detrimentally the work of the re-pulper.

Table 3

Screen Analyses of Screen Oversize

	% Weight.			
	+ 48	*+ 65*	*+ 100*	*− 100*
4 Hum-mers	55·19	14·18	7·96	22·67
1 Re-pulper	74·33	9·85	5·00	10·82
5 Hum-mers	60·40	13·13	8·22	18·25
1 Re-pulper	74·85	11·02	6·11	8·02

After a set of screen analyses had been made on the screen undersize from each of the three screen sections on the re-pulper, it was decided to put a finer screen cloth on the two lower sections. The effect of this change was rather startling and is well worth serious thought. The results are set forth in Table 4. It will be noted that, with three sections of No. 166 cloth, the screen undersize is 8·71% *plus* 48 mesh and with the top section covered with No. 166 and the other two sections with the No. 2475, the amount of this size was reduced to 5·48%. More than 60% of the screen undersize goes through the top screen, making it possible to do the bulk of the work on the coarser screen cloth. This feature of the re-pulper gives a close control

Table 4

Screen Analyses of Re-Pulper Oversize and Undersize

Screen Section.	*Screen Cloth.*	% Weight. *+ 48*	*+ 65*	*+ 100*	*− 100*
SCREEN UNDERSIZE:					
Top	No. 166	5·80	12·57	15·88	65·75
Middle	No. 166	11·65	12·80	13·25	62·30
Bottom	No. 166	14·35	13·01	13·08	59·56
Total		8·71	13·37	14·51	63·41
Top	No. 166	7·00	14·78	16·63	61·59
Middle	No. 2475	2·35	11·28	14·27	72·10
Bottom	No. 2475	3·77	10·45	12·55	73·23
Total		5·48	13·43	15·58	65·51
SCREEN OVERSIZE:					
No. 166 Ton-Cap		74·33	9·87	5·00	10·82
Nos. 166 and 2475 Ton-Cap		64·53	13·68	7·52	14·27

Table 5

Distribution of Values in Screen Undersize and Classifier Overflow

Mesh.	*No. 2475 Screen Undersize.* % *Weight this mesh.*	% *of total weight of Cu + Ni.*	*Classifier Overflow.* % *Weight this mesh.*	% *of total weight of Cu + Ni*
+ 48	0·72	0·55	2·61	0·18
+ 65	6·99	5·43	6·21	2·37
+ 100	12·93	12·25	10·63	7·10
+ 200	31·27	30·83	31·13	33·74
− 200	48·09	50·94	49·42	56·61

over the screen analysis of the total undersize product.

In the paper already referred to the statement was made that "sieve analysis of their final product shows a distribution of values practically identical with the weight distribution itself." This point did not receive the emphasis it should have had. It had always been the author's belief that the softer a high specific gravity mineral is, the greater the amount of overgrinding it will get going through the usual ball- or rod-mill. This is, of course, true, he says, when a mill is operating in closed circuit with a classifier, but what, he asks, happens in the mill itself when not under the influence of a classifier? This point was well answered in the tests in which the mill was in closed circuit with screens and where the undersize material was removed from the circuit by a method not affected by specific gravity. The author suggests that in a given pass through a rod-mill—to limit it to actual conditions—there is no preferential grinding of the soft sulphide minerals over the harder rock minerals. This may be a debatable statement, he says, but its basis is indicated by the data in Table 5.

In some recent tests, with a grind of 47·19% through 200 mesh, the classifier overflow contained almost 60% of the total weight of copper *plus* nickel. Unfortunately the same information is not available for the re-pulper screen undersize.

The author believes that fine wet-screening has a definite field in which it should be used in closing a grinding circuit.

Placer Gold in British Columbia

The following notes on the geology of British Columbia and the history of placer mining in the Province are abstracted from Bulletin No. 21 of the British Columbia Department of Mines. This carries notes "intended primarily for those becoming interested in placer mining in the Province for the first time" and following the sections given here "Placer-Mining Areas" and "Individual Placer-Mining Methods" are well described.

Geology

The north-eastern corner of the Province, east of the Rocky Mountains, lies within the Great Plains region and is underlain by sedimentary rocks chiefly of Mesozoic age. No igneous rocks are known. Deposits of coal are known, some gas has been discovered, and it is possible that oil may be discovered. In the light of present knowledge it is not considered likely that many metalliferous deposits will be found in this region.

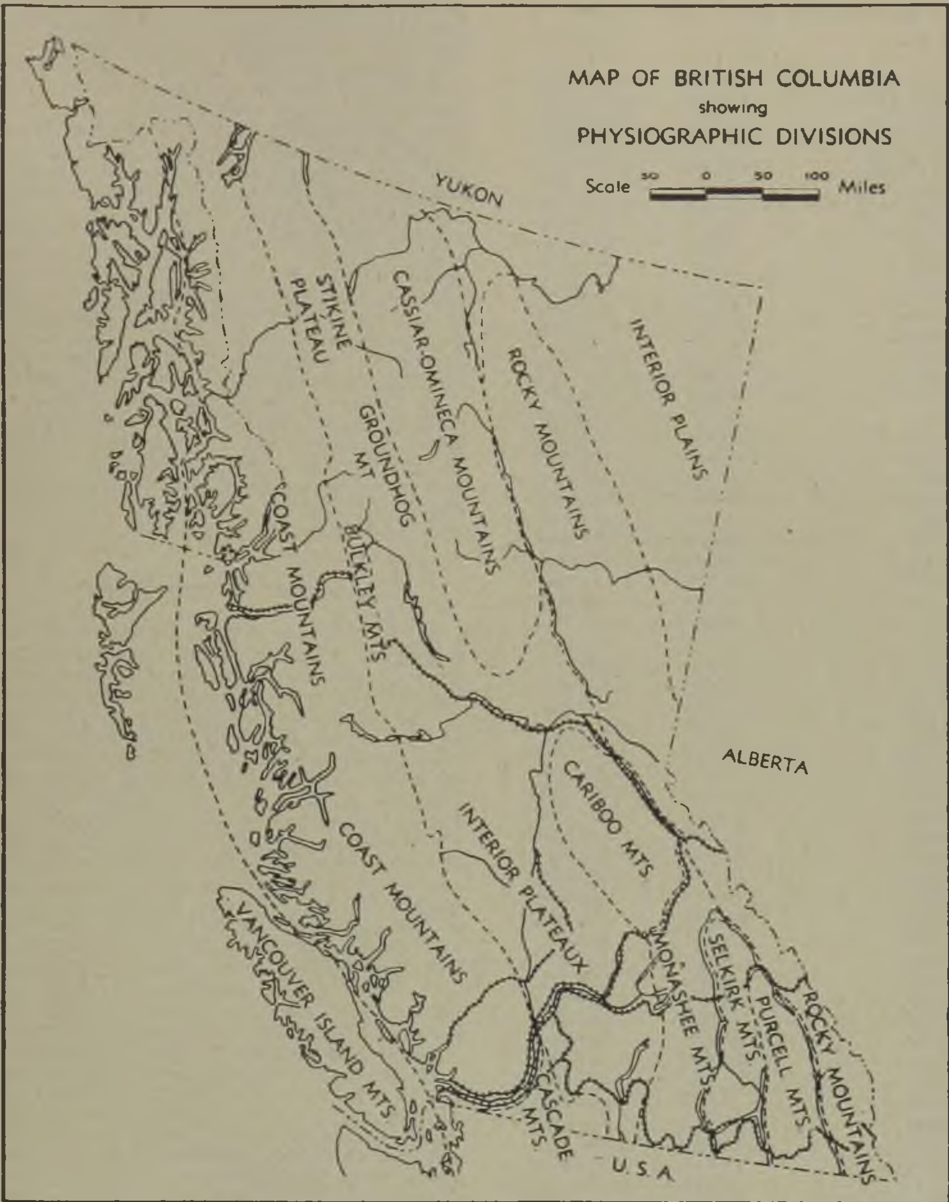
The Rocky Mountains are largely made up of sedimentary rocks of Palæozoic and Mesozoic age. A few small bodies of igneous rock are known at Ice River, but the amount of igneous rock in the entire mountain chain is believed to be almost negligible. Some lead-zinc and some copper-bearing deposits have been found but few gold-bearing deposits. The Rockies have long been considered relatively unfavourable for prospecting, but coarse placer-gold in the south has come from Wild Horse River and Bull River and placer-gold is known to occur in small quantities in a few westerly flowing streams in the northern part of the mountains.

The Cassiar-Omineca Mountains contain granitic rocks throughout most of their length. A batholith about 400 miles long extends through the central part of the range and separate intrusives occur near the Yukon boundary and in the south-eastern Omineca Mountains.

The granitic rocks intrude sedimentary rocks of diverse ages and volcanic rocks chiefly of Mesozoic age; the structure is complex. Tertiary lavas cover the older rocks at a number of points. Although the region has not been fully explored the main geological facts are known and prospectors have covered a good deal of the ground during the past seventy years. Difficulties of transport make prospecting of many parts difficult, but interest has re-awakened during the last few years and some discoveries have been made. Although there has been no production from them gold-bearing veins have been found at many points and there is a variety of metallic mineralization.

The Cariboo Mountains are largely made up of sedimentary rocks. A few small granitic stocks and a few dykes are known in the central and southern parts of the mountains. Sedimentary rocks of Pre-Cambrian age, which extend throughout the central part of the mountains, are overlain by Mesozoic rocks on the south-west and by Palæozoic rocks on the north-east. The central part of the Cariboo Mountains has been the most productive placer ground in the Province and although quartz veins in abundance were known for years it was only in the early 1930's that lode mining was established. The Cariboo area is now one of the major producers of lode gold.

In the Monashee, Selkirk, and Purcell Mountains extensive areas are underlain by granite and allied rock, between which sedimentary and volcanic rocks of diverse ages are folded, faulted, and to a greater or lesser extent metamorphosed. The same general conditions extend right across the southern part of the Province, almost to the Rocky Mountain Trench. There is no clear distinction between granitic rocks referred to as the Nelson batholiths on the east and to the Coast Range batholiths on the west. This general region has been and is the most productive of metallic minerals in the Province.



Within it lie the gold camps of Rossland, Sheep Creek, and Hedley, as well as important silver, silver-lead-zinc, and copper or copper-gold mines, and many smaller camps of diverse mineralization. Unlike the Cariboo, however, the gold camps were not accompanied by exceedingly rich placers.

The Interior Plateau region does not differ greatly geologically from the mountainous regions to the east. A great diversity of sedimentary and volcanic rocks is intruded by igneous rocks of many sorts. The structure as a whole is complex, but the rocks of parts of the Chilcotin plateau are less deformed than most. Lavas of Tertiary age are widespread, more so that in any other part of the Province. The areas of lava, many of which are extensive, blanket the country and effectively hide from view the older rocks, which at many points may well be mineralized. Although erosional effects of glaciation are not prominent in the plateau region as a whole glacial deposits are widespread. Most of the major valley bottoms and much of the upland surfaces are blanketed by glacial drift. Metalliferous deposits are varied in the plateau region and placer deposits have been discovered at many points.

The Coast Mountains contain much granitic rock. This is the Coast Range batholith, now known to

British Columbia Placer Gold Production

Year.	*Crude Oz.*	*Value.* $
1858–1862	580,680	9,871,634
1863–1867	957,860	16,283,592
1868–1872	582,080	9,895,318
1873–1877	530,540	9,019,201
1878–1882	328,230	5,579,911
1883–1887	225,970	3,841,515
1888–1892	148,550	2,525,426
1893	20,950	356,131
1894	23,850	405,516
1895	28,330	481,683
1896	32,000	544,026
1897	30,210	513,520
1898	37,840	643,346
1899	79,110	1,344,900
1900	75,220	1,278,724
1901	57,060	970,100
1902	63,130	1,073,140
1903	62,380	1,060,420
1904	65,610	1,115,300
1905	57,020	969,300
1906	55,790	948,400
1907	48,710	828,000
1908	38,060	647,000
1909	28,060	477,000
1910	31,770	540,000
1911	25,060	426,000
1912	32,680	555,500
1913	30,000	510,000
1914	33,240	565,000
1915	45,290	770,000
1916	34,150	580,500
1917	29,180	496,000
1918	18,820	320,000
1919	16,850	286,500
1920	13,040	221,600
1921	13,720	233,200
1922	21,690	368,800
1923	24,710	420,000
1924	24,750	420,750
1925	16,476	280,092
1926	20,912	355,503
1927	9,191	156,247
1928	8,424	143,208
1929	6,983	118,711
1930	8,955	152,235
1931	17,176	291,992
1932	20,400	395,542[1]
1933	23,928	562,787[1]
1934	25,181	714,431[1]
1935	30,929	895,058[1]
1936	43,389	1,249,940[1]
1937	54,153	1,558,245[1]
1938	57,759	1,671,015[1]
1939	49,746	1,478,492[1]
1940	39,076	1,236,928[1]
1941	43,775	1,385,962[1]
1942	32,904	1,041,772[1]
1943	14,600	462,270[1]
1944	11,433	361,977[1]
Totals	5,087,580	$91,899,360

[1] Canadian funds.

consist of a complex of several intrusives and of small and large areas of older rocks. The intrusives range in age from Jurassic to early Tertiary. The older rocks, consisting of sediments and volcanics, are for the most part greatly altered and deformed, particularly where closest to the intrusive bodies. Most of the sedimentary-volcanic assemblages are of Jurassic age. The gold camp of the Bridge River and the gold-silver camp of the Portland Canal are amongst the most important in the Province. Other gold deposits occur at various points along both sides of the batholithic area. A great deal of the Provincial copper production has come from Britannia and Anyox and metallic deposits are widespread throughout the region.

Vancouver Island, the Queen Charlotte Islands, and other islands of the coastal area are similar geologically to the Coast Mountains. Palæozoic and Mesozoic sediments and volcanics are intruded by igneous rocks of various sorts. Much gold has been produced from the Zeballos camp and older production came from Texada Island. Other metallic deposits are principally of copper and iron.

In Pleistocene times the entire Province was covered by ice which caused some erosion and which on melting left vast quantities of drift to blanket the land. Many peculiarities of drainage are traceable to the erosional and depositional effects of glaciation, evidences of which are to be seen in all parts of the Province.

History of Placer Mining

Before the discovery of placer gold the white population of British Columbia consisted of a few hundred men who trapped or bartered with the Indians, chiefly along routes established by the earliest explorers. In 1855 placer gold was discovered at Fort Colville in Northern Washington and the news quickly reached the attention of placer miners spreading north from the rich but already waning goldfields of California. At about the same time flour gold was found on the gravel bars of the lower Fraser River but attracted relatively little attention. The news of the discovery in 1857 of coarse gold on the Nicoamen River above Lytton quickly reached San Francisco and by 1858 the rich bars at Yale were being worked and hundreds of miners were pushing their way up the river in search of what they believed must be even richer diggings.

In 1860 the first important discoveries in the Cariboo were made at Quesnel Forks, Keithley Creek, and Antler Creek, and in 1861 the celebrated Williams and Lightning Creeks were found.

The penetration of the Cariboo, first by hundreds and soon by thousands, was extremely rapid, considering the physical difficulties entailed. Men were active in many other districts as well. Placer gold was discovered in 1860 at Rock Creek on the Kettle River and within the next five years in the Okanagan, at Fort Steele, on the Big Bend of the Columbia River, probably at Scotch Creek on Shuswap Lake, the Peace River, and at many other points in the southern section of the Province. The next important discovery was made at Dease Lake in 1873 and other discoveries have been made from time to time since then.

The army of miners that invaded the country in the early 60's had to be fed, clothed, and supplied with tools. In order to carry on the greatly expanding trade it became necessary to construct trails and roads. The famous Cariboo Trail first went by way of Harrison, Anderson, and Seton Lakes to Lillooet, and over Pavilion Mountain to Clinton. Later the Royal Engineers built a road through the

Fraser Canyon that enabled wagons to be hauled the entire distance by way of Cache Creek and Clinton. After the Canadian Pacific Railway was completed in 1886 a road from Ashcroft connected with the original road at Cache Creek.

In the early '60's the Dewdney Trail was built across the mountains from Hope to Princeton and through to the Kootenays. It was the first trans-Provincial trail and was constructed primarily to serve the placer miners in the Southern Interior and enable them to travel to Victoria without crossing the boundary line into Washington. Other trails were built and a more or less regular boat service was provided on some of the waterways—such as, Kootenay, Okanagan, and Arrow Lakes, and Columbia River.

During this period large tracts of country were rapidly opened up, but unfortunately the diggings rich enough to support hundreds of individual miners were soon worked out. The greatest recorded placer production was in 1863, which meant that the diggings reached their peak three years after discovery. The Cariboo continued to prosper, owing principally to the fact that hydraulic mining was introduced there in 1879, but by that year activity in most of the other camps had dwindled and over half of the few men remaining in them were Chinese. The heyday of placer mining for the individual miner was over by 1885, with the single exception of the important Atlin field, discovered in 1898.

On many creeks company operations followed those of the individual miners, chiefly by hydraulicking but also by underground mining, dredging, and in later years by mechanical methods or dragline dredges. In the Cariboo Lowhee Gulch has been worked continuously for 80 years, first by surface washing, later by drift mining on bedrock, and finally by hydraulicking. This sequence has been common, particularly in the Cariboo, the final stage being the sniping activity of individuals who comb the sites of former operations in search of gold which has been lost or overlooked.

Chronology of British Columbia Placers

The following chronological table gives the discovery dates of the principal creeks and diggings :—

1852—Chief Trader McLean purchased gold dust from Indians at Kamloops.

1855—Gold discoveries on the Columbia at the mouth of the Pend d'Oreille River.

1857—Coarse gold discovered on the Nicoamen River, tributary to the Thompson, above Lytton.

1858—Gold first discovered in quantity on the lower Fraser, at Yale.

1860—Rock Creek in Boundary District discovered.

1860—Cariboo and Quesnel areas first opened.

1861—Williams Creek and Lightning Creek strikes made.

1861—Gold discovered on the Parsnip River.

1863—Placers found on Wild Horse River, East Kootenay.

1863—This was the year of greatest development and output of the Cariboo. Maximum official recorded production in the history of the Province.

1864—Leech River placers discovered on Vancouver Island.

1865—Gold discovered on French Creek in the Big Bend of the Columbia River.

1869—Vital Creek, tributary of Omineca, discovered.

1873—Gold discovered on Dease and Thibert Creeks.

1879—Hydraulic mining on a large scale commenced in Cariboo.

1885—Placer strike made at Granite Creek, Tulameen River.

1898—Atlin placer fields discovered.

1921—Rich strike made at Cedar Creek.

1924—Gold found on Goldpan Creek.

1927—Coarse gold found by Indians on Squaw Creek.

1932—Initial discovery of gold on Wheaton (Boulder) Creek.

Mining French Slate

The French slate industry is described by S. Gradel in a comprehensive article appearing in the *Compressed Air Magazine* for September. The slate in the Angers-Trelage district of north-western France is now mined on what is known as an "ascending" method, which has been employed since 1880. It is essentially a pillar and stall method, in which the original shaft or pit is put down to some 1,300 ft. This shaft goes down alongside the vein. From the bottom of the pit and parallel to the vein is driven a horizontal gallery, called a collector, from which cross-cuts are advanced to the vein at suitable intervals. The slate is brought out through these and thence through the collector to the shaft bottom for hoisting to the surface.

When a cross-cut reaches the slate vein it is widened to 20–25 metres (65 to 82 ft.) and is then carried forward to the opposite vein wall, attaining a length of from 20 to 30 and even 50 metres (65 to 164 ft.) and a height of about 6½ ft. After this work is done it is said that so many square metres of vaulting have been opened. A rib or pillar of slate 20 ft. wide is left between adjacent chambers to support the overlying material. This ensures that a landslide in one will not affect the others, which can go on producing.

With the initial opening of a chamber completed exploitation of the deposit can proceed. This is done by removing the overhead slate in tiers, working progressively upward until the unsplittable schist is reached. From six to eight chambers are ordinarily opened up from the collector and all are served by the one pit or shaft. The total vaulted area will range from around 7,200 to 14,350 sq. yd. Assuming that the extraction of slate is carried upward to within 100 metres (328 ft.) of the surface the gross volume of material removed will range from around 2,000,000 to 4,700,000 cu yd. It is obvious, then, that the operations will extend over many years and the equipment must therefore be of a very substantial and durable nature.

After a chamber has been opened to a height of 6½ ft. throughout its entire area the system of extraction is started that will thenceforth be followed. The first step is to excavate an overhead channel, beginning where the cross-cut meets the slate vein and continuing across the vein. This slot determines the thickness of the bank or tier of slate that is to be brought down. Depending upon local conditions its height may be 13, 16, or even as much as 26 ft. It is just wide enough—around 5 ft.—to provide room for attacking the slate on each side of it. The work of bringing down the first bank is begun in this central channel by driving horizontal " mines " or drifts into the vertical face of the exposed stone. These mines are 1 metre (39 in.) apart and an advance of 1·2 metres (3·9 ft.) is made at a time. Similar mines are driven into the sides or *chefs* of the first mines after they have been opened up. These secondary mines, which run parallel to the central channel, are spaced 0·8 metre (2·6 ft.) apart. This procedure results in a checkerboard pattern that brings down the slate in rectangular blocks. After a series of these " rounds " has been drilled they are loaded and fired simultaneously. The primary mines are charged with a slow-acting explosive and the cross mines with a brisant or quick-acting explosive. Intervening blocks of stone left in place between the criss-crossing mines also are drilled and blasted down as the work proceeds.

Following the shot footbridges or *ponts* are suspended from the roof to enable the workmen to reach the rock overhead and to bar down loose pieces that would otherwise endanger the men below. This operation is called *decalabrage*. Until it is completed and the workings are deemed safe or, as the French say, perfectly *decalabree*, other members of the crew are not permitted to approach the stone that was blasted down. This material is " worked " on the spot. Big blocks are reduced to pieces that will clear the shaft and that can be hoisted by the available machinery, the aim always being to obtain the largest possible number of blocks of maximum size. The waste is left where it is, thus building up the floor so that it can be kept close to the roof as overhead extraction progresses.

Three successive banks are brought down in the manner described and then the collector is abandoned and a new one is driven at the higher level. Another set of cross-cuts is advanced to the vein from the new collector, after which the cycle of operations is repeated. If the three banks broken down are each 6 metres (19·68 ft.) high there will be a collector and system of cross-cuts every 18 metres ; if the banks are 3 metres high the vertical interval between collector and cross-cuts will be 9 metres. In the latter case and with a chamber having an area of 1,000 square metres (1,196 sq. yd.) 9,000 cubic metres (9,771 cu. yd.) of stone, in the solid, will be brought down. The proportion of this total that is of suitable size and of good enough quality to be raised to the surface for finishing into marketable products determines the monetary return.

It is apparent from the foregoing that the operator must fix the dimensions of the chambers so as to ensure an output of sufficient quantity to yield a profit. Inasmuch as one dimension of the chamber is limited by the width of the vein the size of the opening is determined by the length to which it is extended along the vein. No general yardstick can be applied because the character of the slate also influences the size of the chamber. Variation in *doux* (splittability and freedom from faults) necessarily has to be considered, as well as the tendency of the stone to break out or otherwise to undergo geological accident. Accordingly the technical knowledge of the engineer in charge, the skill with which he plans the work both as regards extraction and subsequent manufacturing operations, is a big factor in conducting the enterprise on a favourable cost basis. Chambers with their longer dimension reaching 40 or even 50 metres (131 to 164 ft.) have been worked successfully, but most of those now being exploited are in the range of 20 to 30 metres.

The thickness of the banks to be broken down depends upon the nature of the stone. The softer it is, the more fragile, and the more likely it is to fracture badly upon impact with the floor. For this reason some banks now being worked are only 2 metres (6·5 ft.) high and this permits keeping the floor close to the rock in place so that the latter has to fall only 1 metre or less, instead of 5, 8, or even 11 metres as in the case of thicker banks. Shock and, consequently, rupturing will obviously be less. Under these conditions there are other benefits. When the floor is close to the roof it is unnecessary to erect bridges to give access for trimming after blasting. This saves not only labour but also the wood and iron of which those structures are made.

The extent to which the mines are advanced at each working likewise is subject to change. If the grain of the rock becomes unfavourable at a certain distance from the face the blast-holes are stopped at that point. Instead of being uniformly 1·2 metres in length they may range from 0·95 metre up to 1·90 metres. In addition the spacing between mines may be reduced better to meet conditions. As a result the intervening slab of stone is sometimes so narrow that a small charge of powder is sufficient to detach it.

Only the development of power machinery made this mining method possible and there has been a growing tendency to adopt more and more mechanical aids. To-day all the chambers are well lighted with electricity, the large blocks are handled underground by power-driven hoists, and transportation to the pit bottom has been speeded by the use of rail cars designed for the purpose. Compressed air serves to advantage in numerous ways and all drilling is done with mechanical rock-drills. When hand drilling was practised two men could drive mines at the rate of 3 metres (9·8 ft.) per shift, whereas one drill operator can now put in holes for 20 to 25 metres (65 to 82 ft.) of advance in the same period. The modern rock-drill has also made it practicable to work banks that are only 2 metres thick. This would not have been economically feasible with manual methods because of the greatly increased number of drill holes required. The applications of compressed air on the property described are so extensive that three 200-h.p. compressors are needed to furnish it.

Every block of slate that is suitable for the making of usable products is hoisted to the surface and then transported to workshops for processing. The manufacturing procedure has undergone evolutions just as has the extraction of the stone. In the beginning the tools utilized were so crude that only thick slate could be turned out. This was " dressed " to a geometric pattern by allowing each edge to overlap a bar of iron or block of wood and then striking the projecting material to trim the stone evenly. The advent of steel chisels with thin and flexible blades permitted finer splitting, until, finally, the prevailing thickness of 3 millimetres (0·118 in.) was arrived at.

Then came the dressing machine which is now used in all slate-producing centres. It works on much the same principle as the machine that is employed for trimming photographic prints and that has a movable knife held in fixed position at one end. This blade is raised and then brought down to act shearlike against the outer steel-clad edge of a table on which the slate is placed. The first units were operated by hand, but to-day they are controlled by a foot pedal, thus permitting the worker to use both hands to hold the slate. A scale marked on the table enables him to trim each thin slab to the exact dimensions of the various standard shingles.

The manufacturing process involves three stages. Blocks coming from underground are first cut into thick plates, called *repartons*. These are next split into slabs having the thickness of finished shingles.

Geology at Eldorado, Great Bear Lake

A review of operations of Eldorado Mining and Refining, the Crown Company now operating this silver-gold-uranium producer on Great Bear Lake, in the Canadian Northwest Territories, appears in the *Canadian Mining and Metallurgical Bulletin* for September. The following notes are abstracted from the section on geology and mineralogy contributed by R. Murphy, who says that it has been shown that in the largely granitic country along the east side of Great Bear Lake the Echo Bay district is one of several underlain by older rocks. These have been divided into the Echo Bay and Cameron Bay groups. The former are strongly altered sediments, porphyries, and lavas; the latter and younger group is predominantly sedimentary and far less altered.

Associated with the granite, which everywhere intrudes the sediments and volcanics, are earlier differentiates. Later than all these rocks are various basic intrusives, collectively termed diabase. All the rocks are of Pre-Cambrian age.

The rocks in the vicinity of the mine may be tabulated as follows, numbered from oldest to youngest: *Intrusives*: (9) Late diabase; (8) early diabase; (7) aplite; (6) granite; (5) diorite. *Echo Bay Group*: (4) Porphyritic lavas and pyroclastics; (3) felspar porphyry; (2) sediments; (1) massive tuff.

At LaBine point the principal rocks are the lowest recognized members of the Echo Bay group, a series of fine to dense, dark, uniform rocks of uncertain origin, but presumed to be tuffs. Very little is known as to their relationship with the succeeding sedimentary member, which is highly quartzose and varies widely in appearance.

Structure

The structure in the Echo Bay group is monoclinal. The strike of the series is north-easterly and the general dip is about 40° to the south-east, away from the granite. Steep dips and local folding, as at LaBine point, are found near the granite contact, but away from the granite average dips decrease until the beds are nearly horizontal.

In the mine area the recognized structure involves only the three lowest members of the Echo Bay group—the massive tuff, the sediments, and the porphyry. These three members are folded on axes striking north-north-east, with folds plunging slightly to the north. The details have been determined principally by tracing the porphyry bands, although some supporting evidence has been found by mapping in the sediments. A cross-section through the mine would show on the west a syncline with porphyry enclosing sediments to a depth of 1,000 ft. and on the east an open anticline with the gently rolling porphyry sheet outcropping over a wide zone.

From the disposition of the folds with respect to the margin of the granite it would appear that the folding is a consequence of the intrusion of the batholith. No such obvious association can be claimed for the major faults in the area, to which the vein fractures are related. These faults fall roughly into two groups, striking east of north and north-east, respectively. They have a strong topographic expression and dislocations are measured in miles. Numerous lesser faults and fractures are developed in complex pattern over a wide area. These "breaks," deeply eroded, form the many narrow valleys, clefts, and crevices which are so noticeable a feature of the topography. The majority have a north-easterly bearing, but some strike south of east, particularly where the fractures fan out in horsetail arrangement from a main break. The faults are often sealed by mineralization of the quartz-hæmatite type, in extreme cases forming veins hundreds of feet in width.

The period of faulting was sufficiently extended to affect all the rocks in the area, though the later diabase has suffered only minor displacement. Where diabase cuts through a fault zone there are always certain mud seams which displace it a few feet.

The complexity of the faulting and the brecciated "open" appearance of the fault zones suggest that the movements have taken place at shallow depths. It seems unlikely that the faulting can be ascribed to the deep-seated forces favouring the emplacement of the granite.

The vein fractures at the mine are clearly a related group. They are regularly disposed across LaBine point at about 600-ft. intervals, dipping to the north and with strikes converging to the north-east. No. 1, the most southerly, is a strong shear zone up to 40 ft. in width, which has been followed by workings and diamond-drill holes for over 5,000 ft. The apparent horizontal displacement is 300 ft. and the movement is left-handed. No. 2 and No. 3 are structurally minor breaks. They consist of narrow sub-parallel shearings and related tension members. Displacements do not exceed 20 ft. and movements in opposing directions have been observed in different parts of the zones. The northerly vein, called the Dumpy vein, is another strong shear, roughly parallel to No. 1. There are other lesser fractures but all fit into the pattern, fanning out through the block of ground between the main shear zones. This pattern of shearing and supplementary fractures is frequently repeated in the area, but no other group within a radius of three miles has been recognized as of equal economic importance.

Mineralogy

The mineralogy of the pitchblende deposits has been treated in detail by Kidd and Haycock, who have identified more than forty metallic minerals and described the paregensis.[1] The following description is concerned only with observations in the field.

The veins are composed primarily of quartz, carbonate, and hæmatite in varying proportions, with a minor amount of chlorite. Pitchblende, chalcopyrite, nickel-cobalt minerals, bismuth, silver, argentite, galena, and pyrite are the metallic minerals readily identified. Deposition has taken place probably in four distinct stages and has produced diverse types of veins, depending on the conditions of the fracture zones. In large shear zones stockworks have formed ; in narrow fractures there are clean-cut persistent veins. All veins carry numerous inclusions of the wall-rocks and, as an extreme instance, No. 3 vein is a breccia cemented by a little vein material.

The No. 1 zone shows the most complex relations. The earliest filling has been quartz with seams and inclusions of chlorite and a little carbonate. These veins carry some pyrite, but no other metallic minerals. The quartz shows no banding and may, in fact, be hypothermal. The succeeding quartz-hæmatite mineralization is the most abundant in the zone. Veins of this type are up to 10 ft. wide and form stockworks up to 40 ft. wide. The quartz is banded and stained with hæmatite, forming parallel and concentric structures. Numerous vugs, occasionally a few feet in diameter, are lined with crystals of carbonate, hæmatite, quartz, and chalcopyrite. Carbonate, apparently, constitutes the end phase. Parts of the vein are a dense, solid, rose-red chert. Veins of the hæmatitic quartz cut across masses of the chloritic quartz. In detail the contacts show intimate penetration into the earlier quartz and it is probable that, in the process of refilling the zone, the chloritic quartz has been largely replaced.

Narrow bands of sulphides, arsenides, bismuth, silver, and pitchblende are found in the quartz-hæmatite veins. They show a consistent preference for the cherty phases of the vein and are less apt to appear in the prominently banded and vuggy portions. Since these shoots of ore appear only locally in the quartz-hæmatite zone they may represent a separate third stage of mineralization. On the other hand their association with certain phases of the hæmatitic quartz suggests a fairly close relationship.

The segregation of the various metallic minerals separately in lenses in the vein is characteristic, although megascopic intergrowths of these minerals on the scale of a hand specimen are not unusual. Thus pitchblende and nickel-cobalt minerals may occur as separate stringers several inches apart and veinlets of bismuth and calcite may be similarly isolated. This veining with various minerals would appear to offer many opportunities for determining the sequence of the metallic minerals. Such opportunities are rare, however, and the details in observed instances are conflicting.

The metallic minerals are not co-extensive. The nickel-cobalt minerals have a wider distribution in the vein than the pitchblende and the latter may occur with only negligible amounts of the other minerals. Silver, though shown by assay to be present throughout the vein, is, in visible particles, very erratically distributed. It occurs as dendrites in buff carbonate veins, as intergrowths with the nickel-cobalt minerals, and as plates and wires in the pitchblende. On the field evidence some of the silver is surely placed as the youngest of the metallic minerals.

The pitchblende may form solid bands up to a foot wide and masses up to several feet wide. Most commonly, however, it occurs as persistent lensing veins a few inches wide, or as a lacing network of stringers with some coarse dissemination. The limits of the ore are generally well-defined and once beyond those limits only an occasional spot of pitchblende is found. Measurements of the radioactivity in the remainder of the vein show that uranium minerals are absent.

In the last recognized stage of mineralization in the No. 1 zone small veins of quartz, carbonate, and chalcopyrite have been introduced, cutting all other veins. Vugs in the older veins have also been filled, or lined, with brilliant clusters of crystals. This mineralization is younger than the later diabase dyke. Where the latter cuts No. 1 zone it is itself cut by a few veinlets of quartz and carbonate. Carbonate veins in the diabase on Cobalt island contain metallic bismuth and nickel-cobalt minerals. No silver has been found in these veins, but at Gunbarrel inlet, 40 miles south, a calcite vein cutting the younger diabase does carry silver. It is possible that all the silver may be attributed to this last stage. This is true also of galena, which is present with the silver in small amount. Narrow veins of galena, normal to No. 1 zone and offsetting its contacts slightly, are clearly a late phase of the mineralization.

Extensive and prolonged movement has taken place on the No. 1 zone. The foot-wall fault is strongly developed, containing up to 3 ft. of gouge. Branch faults lace their way through the zone from side to side, creating extremely weak ground. Faulting has continued after the intrusion of the later diabase, as indicated by minor displacements of the dyke contacts. A few veinlets of quartz and carbonate, possibly belonging to the youngest stage of mineralization, are found in the gouge. In a few places lenses of massive chalcopyrite several feet wide, with a dense " muddy " appearance, appear to have replaced the gouge.

The Dumpy zone resembles the No. 1 zone, although deposition has taken place on a much lesser scale. The zone is marked by an abundance of chalcopyrite, in irregular masses, of the same type as noted in the No. 1 zone.

No. 2 and No. 3 veins each have their own characteristics. There is no evidence here of the extended period of mineralization recognized in the large shear zones. Various sections of these veins show distinct and different parts of the general mineralization. The openings must have been accessible for relatively brief and critical periods.

In part No. 2 vein is a beautifully banded carbonate, including some rhodochrosite. Pitchblende occurs as seams and botryoidal crusts and a few sections are rich in silver. Hæmatite, chalcopyrite, and nickel-cobalt minerals are common and fluorite may be present. There is no faulting and everything suggests quiet and uninterrupted deposition in an opening probably produced by tension. The remainder of the No. 2 vein lies along narrow chloritic shearings. Strong quartz-hæmatite veins carry some of the pitchblende. Other shoots are sparsely mineralized zones in which pitch-

[1] Kidd, D. F., and Haycock, M. H., " Mineragraphy of the Ores of Great Bear Lake," Geol. Soc. Am., *Bull.*, Vol. 46, No. 6, 1935.

blende is spotted through the schist, accompanied by a few stringers of quartz and carbonate.

No. 3 zone is also sparse in vein material. The breccia, up to 5 ft. wide, is sharply defined and contains numerous fine and coarse angular fragments in a dark matrix. Disseminated pitchblende and chalcopyrite, occasional masses of pitchblende, and a very few quartz and carbonate veinlets have been introduced. The breccia zone may die out, leaving only a thin gouge seam to mark the zone, but the pitchblende may persist as spots in the gouge. The pitchblende in No. 3 zone forms a high proportion of the total mineralization and this is true of many other minor occurrences in the district.

The characteristics of these veins are those of deposits formed under moderate conditions of pressure and temperature. The veins belong in the upper part of the mesothermal group.

An unusual feature of the mineralization consists of coarsely crystalline aggregates which replace sediments, and to a minor degree porphyry, in highly irregular fashion. These aggregates consist of amphibole, epidote, apatite, carbonate, and magnetite, with lesser amounts of garnet, felspar, chlorite, and pyrite. The skarn mineralization is not obviously related to any of the veins nor to the altered zones, but the amount of radioactivity within the areas of occurrence implies some connexion ; perhaps it is a product of reaction between lime-rich phases of the sediments and the invading solutions.

The alteration of the rocks and veins in the mine area is prominent and the " baked " appearance of all formations, except the later diabase, has been frequently remarked. In both rocks and veins the alteration has given rise to widespread discoloration by hæmatite and the obliteration of original textures. This so-called red alteration, undoubtedly related to the quartz-hæmatite period of mineralization, affects the quartzose rocks most severely, but where alteration is intense there is little selectivity. The rocks are then reduced to a dense reddish " jasperoid." The exact nature of the alteration has not been determined, but quartz, hæmatite, magnetite, sericite, chlorite, and carbonate are obvious constituents.

Going away from the mine the degree of alteration falls off, but the mineralization is so pervasive that in no case can it be said that examination has been carried beyond the zone of alteration. The distribution of the alteration points to the mine as being a centre of mineralization in the district and indicates that the veins and alteration have a common hydrothermal source. In a geophysical examination of the area Brant has noted an unusually high magnetite content of the rocks on LaBine point. The percentage of magnetite decreases away from the mine, thus giving further evidence as to the locus of mineralization.

The envelope of reddish " jasperoid " enclosing the veins is the most intense form of alteration. Within 4 or 5 ft. of the vein there are seldom even recognizable remnants of the wall-rock. Although the width of the altered zone is roughly proportional to the width of the vein there are examples of unusual penetration, probably on numerous small mineralized fractures. The red alteration may mark areas in which veins are concealed and is therefore a useful guide in exploration.

In the larger shearings there are, in addition to the red alteration, strongly developed talcose and chloritic zones. The chloritic phase is poorly veined and has probably not been long accessible to the altering solutions. The buff and reddish talcose phases are various advanced stages accompanying abundant vein deposition.

Ore Deposition

The ore-bodies are, for the most part, narrow lensing streaks of pitchblende in a much larger volume of vein material. Shoots of minimum stoping width range in length from 50 ft. to 700 ft. and have been followed vertically for more than 600 ft. The ore-bodies locally widen to as much as 15 ft. because of the occurrence of multiple stringer zones and masses of pitchblende.

There are two recognized factors in ore deposition—the wall-rock and the nature of the openings. The best evidence of their influence is offered in the case of veins in narrow fractures. In the large shear zones, where the proportion of total vein material to ore is very high, it is difficult to demonstrate any effective control.

The optimum of control must have existed during the period of formation of No. 2 vein. The zone is a composite of shear and tension members, over 2,000 ft. in length, each part of which carries some ore. The rocks intersected by the zone are sediments, porphyry, and early diabase. Most of the ore-shoots have been found in sediments, apparently favouring the finely banded phases. Some ore occurs where the shear has followed the contact of the sediments and early diabase. The larger ore-shoots in the sediments may extend a short distance into adjacent porphyry, but apart from this no ore is found in the porphyry. In longitudinal sections the general termination of the ore-shoots at the porphyry-sediment contact is very striking.

The noticeable constriction of the fractures on entering the porphyry has not resulted in the exclusion of vein material and does not, therefore, fully explain the absence of ore. The sediments have been affected by vein alteration to a much greater degree than the porphyry. They must have exercised a correspondingly greater influence, chemically, on the vein-forming reactions. The more favourable chemical environment of the openings in the sediments and the restricted passage of solutions through the porphyry have probably combined to localize the ore-shoots.

The greater proportion of the ore in No. 2 vein occurs in the tension member. This fracture is filled with a well-banded carbonate, carrying a better than average percentage of pitchblende.

In No. 1 zone the large veins have been localized by slight changes in attitude of the shear. At least this is suggested by development work to date.

In shallow-seated deposits changes in the grade and mineralogy of the ore may be expected with depth. Within the range of the mine workings, no significant changes have as yet been recognized. Areas of ore on the lowest developed level are of better than average grade and show the usual suite of minerals. There is noticeably less botryoidal structure in the pitchblende of the lower ore-bodies—the only known change that may be related to depth. The silver ore-shoots, on the other hand, are definitely related to the surface. They do not continue below a few hundred feet and on the field evidence alone the rich silver ore-bodies appear to be the product of secondary enrichment.

It is usually accepted that ore deposits are related in time to one or another of the intrusives in an area.

Sometimes a closer relationship is suggested by the disposal of the ore with respect to an intrusive body, or on mineralogical grounds. There is no evidence at the Eldorado mine linking the pitchblende deposits closely to one particular intrusive. The more general consideration, that the ore solutions have had a common origin with the granite, faces several objections. Principal among these are the following :—

(1) The faults and fractures have been formed at shallow depths, as shown by their brecciated and open appearance, a fact which contrasts with the deep-seated emplacement of the granite.

(2) The faulting is regional in its distribution and cannot be related solely to the mass of granite lying west of the mine.

(3) The faults displace several intrusives younger than the granite, thus introducing the likelihood of a considerable interval between the granite intrusion and the faulting.

(4) Some of the faulting cuts the later diabase and if these final movements are attributable to the same forces as the earlier ones the interval is great enough to make improbable any genetic relationship to the granite.

The major faults have tapped an abundant source of solutions, to which the "giant" quartz veins bear witness. If granite differentiates have originated at the same time they have not been recognized in the area.

The later diabase can be linked with the ore deposits more closely than can any other intrusive. Some of the silver is known to be later than the diabase and the association of the two elsewhere is accepted as evidence of a common source. The diabase, however, clearly intersects the pitchblende veins. It has not been subjected to the processes which have altered the veins and the older rocks. There are no general considerations indicating a possible relationship between the pitchblende ores and the diabase.

The conclusion is that, during an extended period of faulting, solutions from an undisclosed source have risen to form the relatively shallow-seated pitchblende deposits. This period of mineralization came to a close, but activity was renewed during intrusion of the later diabase, with the consequent deposition of silver.

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.

17,801 of 1943 (579,891). Electro Manganese Corporation, Knoxville, Tennessee. Alloys of lead, tin, antimony, and cobalt are used in the manufacture of anodes for the electrodeposition of manganese in order to suppress the anodic formation of manganese dioxide while providing a long life.

21,824 of 1943 (580,280). Mining Engineering Co. and E. Ingham, Worcester. The longwall mining of coal using a cutter loader and conveyor.

5,886 of 1944 (580,015). Cinema Television, Ltd., and S. S. West, London. Electronic detector, for locating buried metal objects.

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.

Principles of Field and Mining Geology. By J. D. Forrester. Cloth, octavo, 647 pages, illustrated. Price 42s. London : Chapman and Hall, Ltd.

Dictionary of Geological Terms. By C. M. Rice. Cloth, octavo, 464 pages, typescript. Price 44s. Princeton, New Jersey : C. M. Rice.

The Metallurgy of Quality Steels. By Charles M. Parker. Cloth, octavo, 248 pages, illustrated. Price 36s. New York : Reinhold Publishing Corporation.

Colliery Explosions and Recovery Work. By J. W. Whitaker and H. L. Willett. Second edition. Cloth, octavo, 230 pages, illustrated. Price 12s. 6d. London : Sir Isaac Pitman and Sons, Ltd.

Application of Shaped Explosive Charges to Mining Operations : Tests on Steel and Rock. By R. S. Lewis and G. B. Clark. University of Utah Department of Mining Engineering *Bulletin* No. 1, July, 1946. Paper covers, 48 pages, illustrated. Price $1·25. Salt Lake City : University of Utah.

Investigation of the German Fuel and Power Industries. Fuel Efficiency Bulletin No. 47. Paper covers, 12 pages. London : Ministry of Fuel and Power.

International Tin Research and Development Council : Statistical Bulletin, Vol. IX, No. 2. Paper covers, 20 pages. Price 1s. The Hague : Statistical Office.

Limestones of Canada : Their Occurrence and Characteristics. Part V—Western Canada. By M. F. Goudge. Paper cover, 233 pages, illustrated, with maps. Price 50 cents. Ottawa : Department of Mines and Resources.

Notes on Placer-Mining in British Columbia. B.C. Dept. of Mines Bulletin No. 21. Paper covers, 42 pages, illustrated. Victoria : Department of Mines.

Ontario : Dept. of Mines 52nd Annual Report, Vol. LII, Part 1, 1943. Paper covers, 277 pages, with tables. Toronto : Department of Mines.

British Columbia : Minister of Mines Annual Report, 1945. Paper covers, 219 pages, illustrated. Victoria : Department of Mines.

The Petroleum Products Industry in Canada, 1944. Paper covers, 20 pages, typescript. Price 50 cents. Ottawa : Dominion Bureau of Statistics.

Census of Western Australian Minerals. By Dr. D. Carroll. Mineral Resources of Western Australia Bulletin No. 1. Paper boards, 72 pages. Perth : Department of Mines.

Tantalum and Niobium.—Mineral Resources of Western Australia Bulletin No. 3. By K. R. Miles, D. Carroll, and H. P. Rowledge. Paper boards, xvi + 150 pages, illustrated, with maps. Perth : Department of Mines.

Northern Rhodesia : Labour Department Annual Report, 1945. Paper folio, 8 pages. Lusaka : Labour Department.

Scottish Engineering Students' Association. *Transactions*, Vol. 1, 1945–1946. Paper covers, 84 pages, illustrated. Port Glasgow : Offices of the Association.

Portugal : Estudos, Notas e Trabalhos do Serviço de Fomento Mineiro. Vol. I, Fasc. 1 E2 and Fasc. 3 E4, 1945. Each part in paper cover and illustrated. Lisbon : Ministerio da Economia.

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

Diamonds, Industry : *Survey*, 1945. The Diamond Industry in 1945. S. H. BALL, *Jewelers' Circular-Keystone*.

Gold, South Africa : *Industry, Organization*. The Rand's Gold Industry: Some Aspects of Its Organization. M. FALCON. *S.A. Min. Eng. Journ.*, Sept. 21, 1946.

Investments, Mining : *Risk, Evaluation*. Risks of Mining Ventures Should Be Evaluated. A. S. LEWIS, *Eng. Min. Journ.*, Sept., 1946.

Power, Canada : *Gold, Ontario*. Hydro-Electric Power and Ontario Gold Mining, Part IV—Relationship between Power Supplier and Mine Customer. R. E. FOSTER, *Can. Min. Journ.*, Sept., 1946.

Production, Canada : *Beryl, Ontario*. The Lyndoch Beryl Deposit. D. C. MCLAREN, *Can. Min. Journ.*, Sept., 1946.

Production, Canada : *Gold, N.W.T.* The Golden Trail to Yellowknife. C. H. VIVIAN, *Comp. Air Mag.*, Sept., 1946.

Production, Canada : *Rare Metals, N.W.T.* The Eldorado Enterprise. *Can. Min. Met. Bull.*, Sept., 1946.

***Production, Czechoslovakia :** *Survey, Post-War*. The Czechoslovakian Non-Ferrous Metals Industry. J. MALKOVSKY, THE MINING MAGAZINE, Nov., 1946.

Production, Italy : *Marble, Carrara*. Notes on Marble Quarrying. C. J. ODLING, G. PILLI, *Mine, Quarry Eng.*, Nov., 1946.

Production, Mexico : *Silver, Zacatecas*. Pachuca—King of Silver Producers. E. JUST, *Eng. Min. Journ.*, Sept., 1946.

Production, Russia : *Survey, Progress*. Law on the Five-Year Plan. London: *Soviet News*.

Production, Tasmania : *Tin, Briseis*. Sluicing Operations at Briseis Consolidated, N.L.—II. H. H. DUNKIN, *Chem. Eng. Min. Rev.* (Melbourne), Aug. 10, 1946.

Production, United Kingdom : *Coal, Open-Cast*. Opencast Coal—2. *Coll. Eng.*, Nov., 1946.

Production, Yugoslavia : *Lead-Zinc, Trepca*. Balkan Base-Metal Enterprise—Trepca Mines, Ltd. *Eng. Min. Journ.*, Sept., 1946.

Resources, Australia : *Mineral, Western*. Census of Western Australian Minerals. D. CARROLL, Min. Res. W.A. Bulletin No. 1.

Resources, Australia : *Mineral, Western*. Tantalum and Niobium. K. R. MILES, D. CARROLL, H. P. ROWLEDGE, Min. Res. W.A. Bulletin No. 3.

***Resources, South America :** *Mineral, Colombia*. Colombian Survey. N. W. WILSON, THE MINING MAGAZINE, Nov., 1946.

Resources, United States : *Copper, Arizona*. Exploration of the Copper Butte Mine, Mineral Creek Mining District, Pinal County. H. D. PHELPS, U.S. Bur. Mines Rep. Inv. 3914.

Resources, United States : *Mica, Beryl*. Mica and Beryl Examination and Exploration in Alabama. U.S. Bur. Mines Rep. Inv. 3905.

Trade, Mineral : *Supplies, American*. Future Mineral Needs Call for International Trade. C. K. LEITH, *Eng. Min. Journ.*, Sept., 1946.

Geology

†**Economic, Canada :** *Rare Metals, N.W.T.* The Eldorado Enterprise. *Can. Min. Met. Bull.*, Sept., 1946.

Genesis, Chromite : *Notes, Quebec*. Some Observations on Chromite. Y. O. FORTIER, *Am. Journ. Sci.*, Sept., 1946.

Genesis, Ore : *Mechanism, Replacement*. On the Nature of Replacement. G. V. DOUGLAS, N. R. GOODMAN, G. C. MILLIGAN, *Econ. Geol.*, Aug., 1946.

Mineralogy, Economic : *Carbonates, Vein*. Microscopic Characters of Vein Carbonates. F. F. GROUT, *Econ. Geol.*, Aug., 1946.

Mineralogy, Economic : *Ores, Copper*. The Rôle of Sulphur Bacteria in the Formation of the So-Called Sedimentary Copper Ores and Pyritic Ore Bodies. C. SCHOUTEN, *Econ. Geol.*, Aug., 1946.

Petrology, Composition : *Abundance, Tungsten*. Abundance of Tungsten in Igneous Rocks, E. B. SANDELL, *Am. Journ. Sci.*, Sept., 1946.

Problems, Structural : *Solution, Graphic*. A Cotangent Ruler for Simplifying the Graphic Solution of Problems in Structural Geology. W. S. WHITE, *Econ. Geol.*, Aug., 1946.

Structural, United States : *Mountain, Arizona*. The Structural Geology of the Dragoon Mountains. D. J. CEDERSTROM, *Am. Journ. Sci.*, Sept., 1946.

Survey, Geophysics : *Studies, Petrological*. Use of Rock "Norms" in Geophysical Investigations. R. A. DALY, *Am. Journ. Sci.*, Oct., 1946.

Metallurgy

Calcining, Lime : *Kiln, Rotary.* Rotary Lime Kiln Practice. W. R. CLIFFE, *Can. Min. Met. Bull.*, Sept., 1946.

Copper, Properties : *Mechanism, Recrystallization.* Observations on the Rate and Mechanism of Recrystallization in Copper. M. COOK, T. LL. RICHARDS, *Journ. Inst. Met.*, Vol. 73, Part I, 1946.

Furnaces, Lining : *Economy, Fuel.* Refractory Materials and Fuel Economy. G. R. RIGBY, *Iron, Coal Trades Rev.*, Oct. 25, 1946.

***Magnesium, Production :** *Industry, Canada.* Canadian Magnesium Production. Letter to the Editor, THE MINING MAGAZINE, Nov., 1946.

***Non-Ferrous, Czechoslovakia :** *Survey, Post-War.* The Czechoslovakian Non-Ferrous Metals Industry. J. MALKOVSKY, THE MINING MAGAZINE, Nov., 1946.

Ores, Magnesium : *Determination, Analytical.* Volumetric Determination of Magnesium in Magnesium Carbonate Ores. L. R. WILLIAMS, *Ind. Eng. Chem.* (Anal. Ed.), Sept. 21, 1946.

Machines, Materials

Belts, Conveyor : *Records, Maintenance.* Conveyor Belt Records. *Coll. Eng.*, Nov., 1946.

Metals, Bearing : *Types, New.* New Developments in Bearing Metals. O. W. ELLIS, *Can. Min. Met. Bull.*, Sept., 1946.

Rails, Steel : *Manufacture, Use.* Steel Rails. C. DINSDALE, *Iron, Coal Trades Rev.*, Sept. 13, 20, 27, Oct. 4, 11, 1946.

Ropes, Wire : *Weights, Strains.* Approximate Weights and Breaking Strains of Wire Ropes. R. MCADAM, *Coll. Eng.*, Nov., 1946.

Steels, Engineering : *Types, Selection.* The Selection of Steels for Industrial Uses. H. TOWERS, *Trans.* Scottish Eng. Students' Association, Vol. 1, 1945–1946.

Mining

Alluvial, Tin : *Sluicing, Tasmania.* Sluicing Operations at Briseis Consolidated, N.L.—II. H. H. DUNKIN, *Chem. Eng. Min. Rev.* (Melbourne), Aug. 10, 1946.

†**Breaking, Explosives :** *Charges, Shaped.* Application of Shaped Explosive Charges to Mining Operations: Tests on Steel and Rock. R. S. LEWIS, G. B. CLARK, Univ. of Utah Dept. Min. Eng. Bull. No. 1.

†**General, France :** *Slate, Industry.* French Slate Industry. S. GRADEL, *Comp. Air Mag.*, Sept., 1946.

General, United States : *Copper, California.* Diamond Drilling Features Mountain Copper's Mining. J. B. HUTTL, *Eng. Min. Journ.*, Sept., 1946.

General, Yugoslavia : *Lead-Zinc, Trepca.* Balkan Base-Metal Enterprise—Trepca Mines, Ltd. *Eng. Min. Journ.*, Sept., 1946.

Handling, Coal : *Conveyors, Underground.* A Survey of Trunk Conveying in the Nottinghamshire and Derbyshire Coalfields. J. T. BARCLAY, P. L. COLLINSON, Rep. Mid. Counties Coll. Owners' Ass. (*Iron, Coal Trades Rev.*, Nov. 1, 1946).

***Hygiene, Ventilation :** *Cooling, Air.* Cooling for the Ultra-Deep Mine. M. MCGUINNESS, THE MINING MAGAZINE, Nov., 1946.

Power, Fuel : *Storage, Coal.* Storage of Sub-Bituminous Slack Coal in Open Pits. J. B. GOODMAN, V. F. PARRY, W. S. LAUDERS, U.S. Bur. Mines Rep. Inv. 3915.

Properties, Rock : *Tests, Standard.* Standardized Tests for Determining the Physical Properties of Mine Rock. L. OBERT, S. L. WINDES, W. I. DUVALL, U.S. Bur. Mines Rep. Inv. 3891.

Prospecting, Drilling : *Wear, Diamond.* What Goes on in the Diamond-Drill Hole ? P. ADAMSON, *Eng. Min. Journ.*, Sept., 1946.

Survey, Correlation : *Surface, Underground.* Correlation of Surface and Underground Surveys. J. T. WHETTON, N. R. PALMER, *Coll. Eng.*, Nov., 1946.

Welfare, Safety : *Devices, Wearing.* Ingenious Devices Reflect Interest in Mine Safety. E. RUNEHJELM, *Eng. Min. Journ.*, Sept., 1946.

Ore-Dressing

General, Canada : *Complex Ore, Quebec.* Ten Months' Milling at Moulton Hill. A. C. KING, T. V. LORD, *Can. Min. Journ.*, Sept., 1946.

General, Lead-Zinc : *Flow-Sheets, Review.* The Dressing of Complex Lead-Zinc Ores. F. B. MICHELL, *Mine, Quarry Eng.*, Nov., 1946.

General, Lead-Zinc : *Trepca, Yugoslavia.* Balkan Base-Metal Enterprise—Trepca Mines, Ltd. *Eng. Min. Journ.*, Sept., 1946.

***Gravity, Coal :** *Jig, Baum.* The Baum Jig, Ore-Dressing Notes, THE MINING MAGAZINE, Nov., 1946.

Grinding, Sizing : *Screens, Classifiers.* Screening and Classification in Grinding Circuits. S. GRAY, P. M. ELLIOTT, *Can. Min. Met. Bull.*, Sept., 1946.

Handling, Ore : *Plant, Coke.* Modern Coke Handling Plant. *Chem. Eng. Min. Rev.* (Melbourne), Aug. 10, 1946.

Layout, Plant : *Use, Models.* Three-Dimensional Model Shows the Shape of Things to Come. H. G. JARMAN, *Mech. Handling*, Nov., 1946.

Plant, Hygiene : *Control, Dust.* The Mill Atmosphere. Ore-Dressing Notes, THE MINING MAGAZINE, Nov., 1946.

Rare Metals, Canada : *Eldorado, N.W.T.* Milling at Eldorado. H. M. HOWARD, *Can. Min. Met. Bull.*, Sept., 1946.

†**Sizing, Screening :** *Use, Closed-Circuit.* Fine Screens in Grinding. W. M. STEPHEN, *Can. Min. Met. Bull.*, Sept., 1946.

Company Meetings and Reports Section

JOHANNESBURG CONSOLIDATED INVESTMENT CO., LTD.

(Incorporated in the Union of South Africa.)

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

General Remarks.—The revenue from gold has been calculated on the basis of gold at 172s. 6d. per ounce fine. In determining the payable development footage gold has been taken at 172s. 6d. per ounce fine. The development figures are the actual results of sampling of development work on reef; no allowance has been made for modifications which may be necessary when computing the ore reserves.

During the quarter working expenditure showed a further increase under various headings, and in particular by reason of the inclusion in the working costs for September of the additional cost of living allowance paid to European employees with retrospective effect from May 1, 1946.

6, Lothbury, London, E.C. 2. *November 11, 1946.*

East Champ d'Or Gold Mining.

Issued Capital - - - £259,875.

Crushed 80,000 tons; yielding **16,330** oz.

		Per ton.
Revenue from Gold	£140,850	£1 15 3
Working Costs	114,562	1 8 8
	£26,288	£0 6 7
Sundry Revenue	895	
Profit for Quarter	£27,183	

Working costs per fine oz. gold produced **£7 0s. 4d.**
Taxation for the Quarter is estimated at **£9,374.**
Expenditure on Capital Account **£429.**
DEVELOPMENT FOOTAGE sampled **2,435** ft. **Payable, 1,380** ft., having average value **10·7** dwt. over **21** in. **Unpayable, 1,055** ft., having average value **2·2** dwt. over **37** in.

Government Gold Mining Areas.

Issued Capital - - - £1,400,000

Crushed 673,000 tons; yielding **118,952** oz.

		Per ton.
Revenue from Gold	£1,025,965	£1 10 6
Working Costs	906,625	1 6 11
	£119,340	£0 3 7
Sundry Revenue	10,989	
Profit for Quarter	£130,329	

Working costs per fine oz. gold produced **£7 12s. 5d.**
Government's share of profits for the quarter estimated at **£15,887.**
Expenditure on Capital Account **£4,015.**
DEVELOPMENT FOOTAGE sampled **9,885** ft. **Payable, 3,550** ft., having average value **7·0** dwt. over **51** in. **Unpayable, 6,335** ft., having average value **1·9** dwt. over **43** in.

New State Areas.

Issued Capital - - - £1,514,037.

Crushed 338,000 tons; yielding **61,250** oz

		Per ton.
Revenue from Gold	£528,279	£1 11 3
Working Costs	386,075	1 2 10
	£142,204	£0 8 5
Sundry Revenue	4,362	
Profit for Quarter	£146,566	

Working costs per fine oz. gold produced **£6 6s. 1d.**
Government's share of profits and taxation for the quarter extimated at **£83,502.**
Expenditure on Capital Account **£1,205.**
DEVELOPMENT FOOTAGE sampled **4,235** ft. **Payable, 1,683** ft., having average value **17·9** dwt. over **15** in. **Unpayable, 2,552** ft., having average value **3·9** dwt. over **10** in.

Randfontein Estates Gold Mining.

Issued Capital - - - £4,083,553.

Crushed 1,077,000 tons; yielding **134,429** oz.

		Per ton.
Revenue from Gold	£1,159,453	£1 1 6
Working Costs	1,039,506	0 19 3
	£119,947	£0 2 3
Sundry Revenue	10,107	
Profit for Quarter	£130,054	

Working costs per fine oz. gold produced **£7 14s. 8d.**
There was no liability for taxation for the quarter.
Expenditure on Capital Account **£51,242.**
DEVELOPMENT FOOTAGE sampled **9,990** ft. **Payable, 4,415** ft., having average value **6.5** dwt. over **33** in. **Unpayable, 5,575** ft., having average value **2·5** dwt. over **37** in.

ROSTERMAN GOLD MINES, LTD.

Directors : G. J. S. Scovell (*Chairman*), Ian Anderson, E. C. Baillie, G. J. F. Forbes-Mangan, A. H. Moreing. *Consulting Engineers and General Managers :* Bewick, Moreing, and Co. *Secretary :* G. Anderson. *Office :* 20, Copthall Avenue, London, E.C. 2. *Formed* 1935. *Capital issued :* £512,635 in 5s. shares.

Business : Operates gold-mining properties in Kenya Colony.

The eleventh ordinary general meeting of Rosterman Gold Mines Ltd., was held on October 22, at 20, Copthall Avenue, E.C., Mr. G. J. S. Scovell presiding.

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

A final dividend of $1\frac{2}{3}$%, making a total of $4\frac{1}{6}$% for the year 1945, and an interim dividend of $1\frac{2}{3}$% for 1946, both less tax at 9s. in the £, will be paid simultaneously on November 22, 1946.

In the profit and loss account the increase of £5,971 in the value of gold recovered over the preceding year has been more than offset by a substantial rise in development of £8,141 and in addition by an increase of £3,667 in the cost of treatment due to a variety of causes, but mainly to heavier costs of chemicals and handling.

The total development work consisted of 4,891 ft. of main and 1,498 ft. of subsidiary development, an increase of some 30% over the previous year. The main work comprised 156 ft. shaft sinking and 848 ft. crosscutting, while the 2,206 ft. driving and 1,681 ft. rising and winzing were mainly on the No. 4 Footwall Reef and what is now known as the Quartz Vein.

During the year 46,970 tons of ore were treated for a recovery of 18,982 fine oz. gold, being an average of 8·08 dwt. per ton, the extraction being 92·22%. Working costs, including development, royalty, and London expenditure, amounted to 50s. 8d. per ton, compared with 45s. 7d. in 1944. This rise of 5s. 1d. per ton is mainly accounted for by expenditure on development, which in 1945 was 8s. and in 1944 was 4s. 6d. per ton.

In his report of his visit to the mine, Capt. A. H. Moreing stated :—

In March this year I paid a visit to the mine. At that time the lowest point reached was a winze from the bottom of the 9th level. Now the shaft has reached the 21st level and in between these two points an immense amount of development work has been done. All this has been accomplished in spite of the dislocations caused by war. During the war years it was not possible to make any additions to plant and machinery and the amount of electric power and compressed air available are becoming inadequate for the depth at which the mine is now working and also for the much greater depths which we expect to reach.

I recommended to the Board on my return that two more generators of similar design to those now in use be installed and that a new compressor of 1,500 cu. ft. be purchased. Later a third generator and additional compressors of the new type should be added. This will mean that the mine will be equipped with a generating and compressor plant of homogeneous design. The Board has agreed with these recommendations and orders have been placed for the first units.

The most disturbing feature is the underground labour position. The African population is in possession of large sums of money and there is a marked tendency for the men to remain in the reserve and not to offer themselves for work. My opinion is that this phase will pass, but it may be a considerable time before it does. I am satisfied that the possibilities warrant sober optimism and that the serious problems with which we are confronted will pass away.

The report was adopted.

NEW CONSOLIDATED GOLD FIELDS GROUP OF COMPANIES.

NOTICE TO SHAREHOLDERS.

NOTICE IS HEREBY GIVEN that the Ordinary General Meetings of the undermentioned Companies will be held in the Board Room, Consolidated Gold Fields Building, 75, Fox Street, Johannesburg, as follows, *viz.* :—

Name of Company (each of which is incorporated in the Union of South Africa)	Date of Meeting	Time	Transfer Books and Registers of Members will be closed from (both days inclusive)
Libanon Gold Mining Co., Ltd.	Wednesday, 13th Nov., 1946	10.15 a.m.	8th to 13th Nov., 1946
Venterspost Gold Mining Co., Ltd.	do.	11 a.m.	do.
West Witwatersrand Areas, Ltd.	do.	12 noon	do.
The Sub Nigel, Ltd.	Wednesday, 20th Nov., 1946	11 a.m.	15th to 20th Nov., 1946

By Order of the Boards,

G. H. WARD,

London Secretary of the Companies.

49, MOORGATE, E.C. 2.

18th October, 1946.

TRONOH MINES, LTD.

Directors : J. H. Rich (*Chairman*), H. A. Hope, E. V. Pearce, Harry Rich, G. W. Simms. *Acting Secretary :* H. E. Barrenger. *Office :* 73, Cheapside, London, E.C. 2. *Formed* 1901. *Capital :* £300,000 in 5s. stock units.

Business : Owns alluvial tin properties in the State of Perak, F.M.S.

The forty-fourth annual general meeting of Tronoh Mines, Ltd., was held on November 12 at 73, Cheapside, E.C., Mr. J. H. Rich presiding.

The following is an extract from the chairman's statement, which was circulated with the report and accounts for the year ended December 31, 1945 :—

The credit balance on profit and loss account brought forward from 1944 was £44,353. After adding taxation refund £1,973 and charging the debit balance for 1945, the unappropriated balance carried forward is £45,894. Turning to the balance-sheet I should like to comment on the subsidiary company, Tin Lay, Ltd., and Harrietville (Tronoh), Ltd. Tin Lay is situated in Siam. The proper maintenance of the property is the responsibility of the Siamese Government. As regards Harrietville (Tronoh), Ltd., production on a limited scale started in June and only recently, owing to labour shortage, has it been possible to start three shifts.

With regard to our property in Malaya from the circular of December 20, 1945, stockholders will have seen that our dredges have not suffered the extensive damage which might have been the case. The most serious damage was to our offices and buildings at the Tronoh section which were completely destroyed. All the dredges were worked by the Japanese for varying periods and we now have information showing that the total amount of ore extracted by them was 34,788 piculs (2,071 tons). The loss of this ore will form one of our claims for compensation.

The policy adopted as regards rehabilitation was to concentrate on those dredges which were the least damaged, viz. Nos. 4 and 8. Delivery of orders placed for replacements of plant has not been as expeditious as we would like, owing largely to the numbers of permits that are still necessary and to shipping difficulties.

The latest information is that the two dredges mentioned are on the eve of starting up. I must issue a warning, however, that it would be unwise to expect normal outputs immediately dredging starts.

The work of rehabilitating No. 5 dredge is now in progerss.

After more than twenty years of service, Mr. T. P. Patterson has decided to relinquish the position of secretary and I would take this opportunity of placing on record our appreciation of the capable manner in which he has discharged his duties and the devoted service he has rendered, not only to this company but to all the other companies in this office. I am sure he takes with him all our best wishes in his retirement.

The report and accounts were adopted.

SUNGEI BESI MINES, LTD.

Directors : G. W. Simms (*Chairman*), H. A. Hope, J. H. Rich, D. W. Thomas, Stanley Wickett. *Acting Secretary :* H. E. Barrenger. *Office :* 73, Cheapside, London, E.C. 2. *Formed* 1909. *Capital :* £163,530 in 4s. shares.

Business : Owns alluvial tin properties in Selangor and Johore, Malaya.

The thirty-fifth annual general meeting of Sungei Besi Mines, Ltd., was held at the offices of the company on November 12, Mr. G. W. Simms presiding.

The following is an extract from the chairman's statement which was circulated with the report and accounts for the year ended March 31, 1946 :—

The balance of profit and loss account at March 31, 1945, was £1,720. After charging the debit balance for the year to March 31, 1946, £10,973 (which includes additional eastern liabilities less amounts recovered relating to 1941–42, £5,306, ascertained since our re-entry into Malaya), and crediting taxation refund of £2,564, there remains a debit balance of £6,689 to be carried forward.

Sungei Besi Section.—Village of New Lombong—Much work remains to be completed before the open-cast is brought back to its pre-war condition. It has been dewatered and much of the floor of the mine has been cleared of slimes.

Old Lombong—The lombong walls have, as in the case of the new lombong, been badly neglected, and though much recovery work has already been carried out, much remains to be done before the walls are brought back to their pre-war condition.

A section of the treatment plant will shortly be ready to operate and one excavator is now under test prior to resumption of mining operations.

Pelepah Section.—Owing to delay in the delivery of spare parts and in securing coal supplies, the dredge did not commence its test run until the middle of July. After such a long period of enemy occupation difficulties must be expected.

Acting on the promise made by the Secretary of State for the Colonies that financial assistance would be provided for the purpose of carrying out an approved programme of rehabilitation, an application for such assistance has been lodged on behalf of this company and it is expected that a substantial advance will be made available at an early date.

As regards the future of the Malayan tin industry as a whole, the first consideration in connexion with its successful re-establishment is that it should be accorded equitable treatment in respect of its claims for rehabilitation and compensation. If such treatment is accorded to it and a Government policy, based upon the principles set out in the recently published White Paper on Commodities, Trade, and Employment is followed, the future may be regarded hopefully.

The report and accounts were adopted.

Professional Directory

PROFESSIONAL DIRECTORY

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Tel.: Whitehall 0422/8.

WYNNE, J. Norman,
Mining Engineer,
Gold, Base-metals, Coal: East Africa, Canada, and General.
Plas Wynne, Glyn Ceiriog, Nr. Chirk, Denbighshire.
Tel.: Glyn Ceiriog 32. Codes: A.B.C. 5th Edn. & Bentley.

BUYERS' DIRECTORY.

BUYERS' DIRECTORY (*continued*).

* October issue. † September issue.

Alphabetical List of Advertisers.

* October issue. † September issue.

THE CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA, LIMITED.

ORDINARY SHARES.

DIVIDEND No. 61 (COUPON No. 60).

At the forthcoming Annual General Meeting to be held at the Chartered Insurance Institute, 20, Aldermanbury, London, E.C. 2, on Thursday, the 5th day of December, 1946, at 12 noon, the Directors will RECOMMEND THE PAYMENT OF A DIVIDEND of 2s. 6d. per share (12½ per cent. actual), less Income Tax at the rate of 9s. 0d. in the £, for the year ended 30th June, 1946.

The TRANSFER BOOKS of the Ordinary Shares will be CLOSED from the 15th to 18th November, 1946, both days inclusive, and the DIVIDEND, subject to confirmation at the Annual General Meeting, will be PAID on or about 17th December, 1946.

R. CARR TAYLOR,
Secretary.

REGISTERED OFFICE:
49, MOORGATE, LONDON, E.C. 2.

7th November, 1946.

The Report and Accounts will be posted to all Shareholders on 25th November, 1946.

THE CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA, LIMITED.

SIX PER CENT. FIRST PREFERENCE SHARES.

DIVIDEND No. 105.

NOTICE IS HEREBY GIVEN that the TRANSFER BOOKS AND REGISTER OF MEMBERS of the Six per Cent. First Preference Shares of the above-named Company will be CLOSED from the 2nd to 4th December, 1946, both days inclusive, for the purpose of balancing the books for payment of the dividend for the half-year ending 31st December, 1946, payable 1st January, 1947.

AND NOTICE IS ALSO HEREBY GIVEN to Holders of Share Warrants to Bearer of the above-mentioned First 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

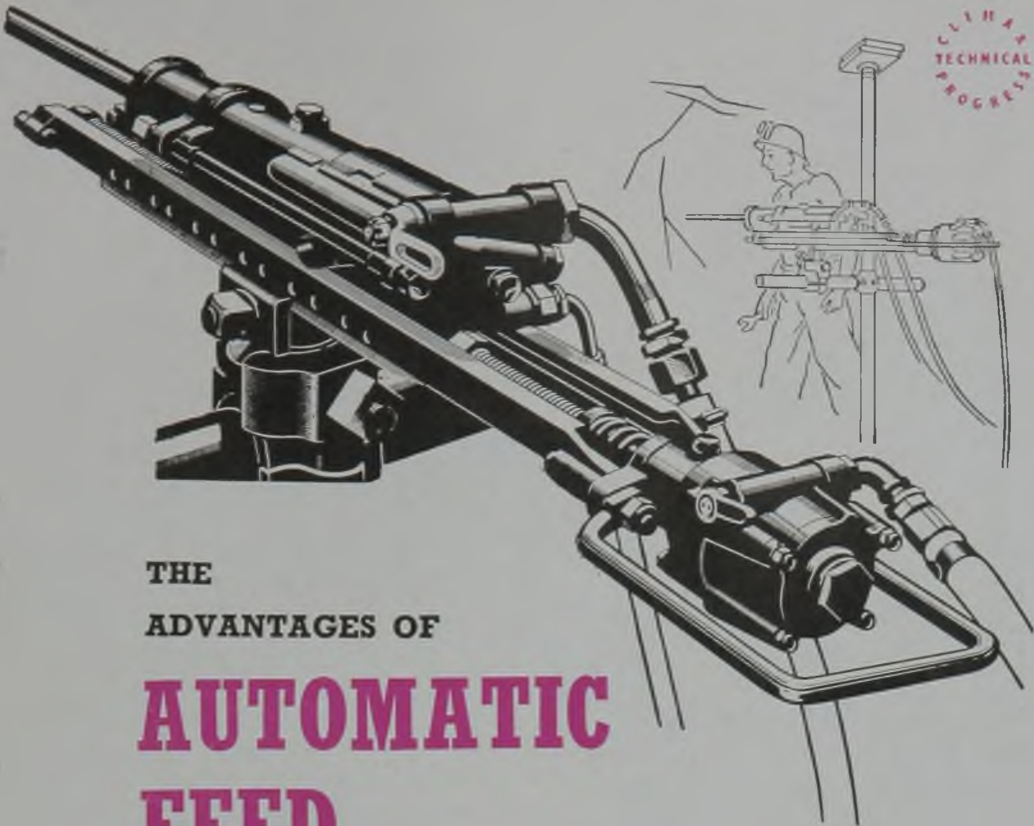
(2) Present their Share Warrants to the Company's Bankers, Midland Bank Limited, at the New Issue Department, Poultry, London, E.C. 2, for marking, five clear days before payment will be made.

Income Tax at the rate of 9s. 0d. in the £ will be deducted from this dividend.

By Order,
R. CARR TAYLOR, *Secretary.*

REGISTERED OFFICE:
49, MOORGATE, LONDON, E.C. 2.

7th November, 1946.



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