Fused silica is quite transparent to ultra-violet rays down to $\lambda = 0.226\mu$ to 0.220μ , and to some extent down to $\lambda = 0.189\mu$ ($\mu = 10^{-3}$ mm.). Thus, a screen of fused silica allows the passage of ultra-violet radiations, so as to discharge an electrically charged zinc plate, while the substitution of a glass screen prevents the discharge. Similarly, a solution of potassium iodide and starch

FIG. 6.—Transmission of light through silica rod.

contained in a fused quartz vessel is rapidly discoloured by the ultra-violet light from a mercury arc, while a similar solution in a glass vessel is unaffected, owing to the absorption of the active rays by the glass. This property of fused silica has found useful application in America in the sterilisation of water and other liquids by the action of ultra-violet light from mercury vapour

lamps. The refractive index of fused silica ranges from 1.4561 for the lithium "r" line (670.8μ) to 1.5743 for the aluminium line at 185.2μ .

Apart from chemical uses, the most important commercial field for fused silica at the present time is in the manufacture of globes for incandescent gas burners (Fig. 5, No. 6). These, though considerably more expensive than glass, are entirely unaffected by heat changes, and also allow of a higher flame temperature (due to the reduction of excess of air round the flame), so as to produce an increased lighting efficiency. In the case of globes and laboratory ware, the material is glazed on both sides by a subsequent heat treatment. Fig. 4 (No. 3) shows the moulding of a cluster of small laboratory crucibles before the operations of cutting off and reheating.

Transparent fused silica envelopes are especially suitable for large thermionic valves for wireless telegraphy. Fig. 4 (Nos. 14 and 15) shows the Admiralty type of 5 kw. and 10 kw. valves respectively, the larger valve being due to Morris Airey, and manufactured by the Mullard Radio Valve Co. Messrs. Kelvin, Bottomley and Baird have successfully developed optical fused quartz for various purposes, and have specialised on silica mercury vapour lamps, and silica enveloped gas-filled lamps. The earliest fusion made by the Thermal Syndicate in 1904 is shown at Fig. 5 (No. 1); their latest fusion, a flask of 170 gallons capacity, is shown at No. 7 of the same figure, and indicates the advance made during the first twenty years of the industry.

My thanks are due to Dr. Drane, Research Engineer to the Thermal Syndicate, for the experiments and many of the data described.

The Mineral Resources of the British Empire.

By THOMAS CROOK.

DURING recent years there has been much incentive to the study of natural resources of every description. The manifold and complex needs of industrial civilisation are such as to make it invidious to select any aspect of natural resources as being of more vital significance than the rest; but it requires only a little consideration to realise how very important to any country its reserves of mineral wealth must be. These reserves have been described very aptly as "wasting assets," in contrast with those yielded by the soil, which are reproductive. The quantities of minerals available are limited, and are so small as to justify the suspicion that in two or three generations from the present time it may be difficult, if at all possible, to obtain supplies of many important minerals at a rate sufficiently cheap to ensure industrial expansion, or even to maintain industries at their present level of prosperity. The importance of this prospective impoverishment of resources as regards base metals has been duly emphasised on various occasions recently by Sir Richard Redmayne, Sir Thomas Holland, and Prof. Thomas Turner.

Minerals, indeed, are fundamental requisites in the production of power and power machinery, on which the foundation of all industrial efficiency is based. Without an ample supply of coal, iron, and base metals, no country can travel far on the path of

industrial progress, however efficient its human equipment may be. On the contrary, for any country adequately equipped with these primary needs of industrial development, there is scarcely any limit to trade expansion. In this connexion, and showing the value of outputs of fuels, iron ore, and base metals as indicators of commercial prosperity, it is noteworthy that the wealthiest and industrially the most prosperous country in the world at present (the United States) is the world's leading producer of coal, petroleum, iron ore, copper, aluminium, lead, and zinc. Moreover, the United States outputs of coal, petroleum, iron ore, and aluminium are consumed largely in its own productive industries; while without the base metal supplies of the United States, which are largely in excess of its own requirements, many another country would find its industries handicapped.

The world's industries, however, are still at the developing stage. The investigation and development of the resources of the United States are much more advanced than those of the British Empire. This is due in large measure not merely to the energy of the United States citizen, but also to the compactness of his country. The area of the United States is enormous, and the distribution of its resources is such as to present serious difficulties in the commercial co-operation of the western and eastern parts of the

country. Large as it is, however, it is all in one piece, and in this respect it has had much the same advantage as formerly made Great Britain commercially supreme.

The British Empire as a whole, on the contrary, is in scattered pieces, and citizens of the Empire are proud of the fact that these pieces are to be found in all the ends of the earth. It is scarcely to be wondered at if, in these circumstances, the investigation and development of the Empire's resources are in a comparatively backward state as a whole; but it is important that this fact should be realised, for it has an important bearing on future possibilities.

For the present, the British Empire Exhibition gives large scope to those who wish to learn something of the Empire's mineral resources, so far as we know them at present, from both the educational and business point of view, and offers a favourable opportunity of reviewing these resources. The various countries of the Empire have made excellent provision for the display of their mineral wealth, and nothing seems to have been forgotten. The exhibits are scattered, but wonderfully complete. An enthusiast in the study of resources may be excused for wishing to see a mineral grouping in preference to a geographical one, since the latter presents obstacles to a complete view.

In anticipation of this difficulty, however, the Imperial Mineral Resources Bureau has issued a useful publication entitled the "Minerals of the Empire." This publication gives a summary of information as to the Empire sources of the various useful minerals and metals. A section is devoted to each mineral or metal, and the sections are arranged alphabetically. In each section an account is given of the Empire deposits of the mineral. The descriptive account for each product of the Empire is followed by a list of the products shown at the British Empire Exhibition by various governments and firms, the position of each exhibit being indicated. Mention is made of the uses and commercial grades of mineral and metals. Each section concludes with a statistical summary of production, imports, and exports, showing the extent to which the different parts of the Empire are concerned in the production and consumption of mineral products.

The following table, compiled from data available at the Imperial Mineral Resources Bureau, shows approximately the British Empire's share of the world's output of the more important minerals during 1922:

	Per cent.		Per cent.
Coal	25	Silver ore	18
Petroleum	2	Diamonds	71
Iron ore	9	Graphite	11
Manganese ore	44	Magnesite	6
Nickel ore	68	Asbestos	96
Cobalt	95	Mica	55
Chrome ore	81	Corundum	92
Tungsten ore	19	China clay	60
Molybdenum ore	90	Felspar	28
Aluminium ore	2	Barium minerals	14
Copper ore	5	Strontium minerals	85
Lead ore	28	Fluorspar	20
Zinc ore	29	Gypsum	13
Tin ore	37	Fuller's earth	20
Bismuth ore	2	Phosphates	8
Antimony ore	6	Monazite	53
Arsenic	16	Salt	21
Gold ore	68	Talc	5

The extent to which the different parts of the Empire contribute to the outputs of these and other

minerals of economic importance is shown clearly in summary form in "Minerals of the Empire," which those interested in Empire resources will find useful as a supplement to the information available at the Exhibition. It is not possible in the space here available to do more than mention briefly the various pavilions in which are to be seen some of the more important exhibits bearing on mineral resources. These are as follows:

GOVERNMENT PAVILION (UNITED KINGDOM).—In this pavilion the Imperial Mineral Resources Bureau has a display of raw materials and manufactured products illustrative of the mineral industry. A large map of the world shows the geographical positions of the more important of the Empire's mineral deposits. Below this are placed statistical diagrams, showing the mineral outputs of the different parts of the Empire for the year 1922, and also a comparison of the outputs of the British Empire as a whole with foreign countries. The Imperial Institute has an exhibit of various Empire minerals. The Geological Survey of Great Britain has a good display of minerals and photographs illustrating the mineral resources of Great Britain. The work of the Fuel Research Board is also well illustrated.

Near the Government Pavilion is a full-sized representation of a modern coal mine, showing actual working conditions. This exhibit is by the Mining Association of Great Britain, and includes a hall devoted to coal resources.

UNION OF SOUTH AFRICA.—Here are gold-mining exhibits, with a trophy illustrating the distribution of the wealth arising from gold production by the mining industry, as between dividends, wages, etc.; diamonds, including an apparatus for the treatment of diamantiferous earth, showing the way in which diamonds are concentrated by washing and trapping on grease tables. Other exhibits are coal, copper ore, corundum, asbestos, mica, magnesite, talc, and vanadium ore, the last mentioned including particularly fine specimens of descloizite from South-West Africa Territory.

RHODESIA.—There are exhibits of coal, gold, chrome ore, mica, asbestos, together with ores of tungsten, lead, zinc, and vanadium.

GOLD COAST COLONY.—Gold, diamonds, manganese ore, and bauxite constitute the mineralogical exhibits.

NIGERIA.—Tin ore, coal, and phosphates are shown.

CANADA.—Canada's metal exhibits include the following in order of importance as regards output values: gold, silver, lead, nickel, copper, and zinc. These and other metals represented about a third of the value of the total mineral production in Canada during 1922. The remaining two-thirds represented by the exhibits are non-metals, including the following in order of importance as regards output values: coal, cement, clay products, building stone, natural gas, asbestos, lime, sand and gravel, gypsum, salt, and numerous other minerals such as mica, graphite, magnesite, talc, pyrites, and fluorspar.

BRITISH GUIANA.—Gold, diamonds, and bauxite. British Guiana's bauxite output commenced in 1919 with an output of 1967 tons, and reached 22,084 tons in the following year. In 1923 the output was 100,346 tons, or about 10 per cent. of the world's output for that year. Bauxite mining in British Guiana seems

thus likely to become an important feature of the Empire's mineral industry.

NEWFOUNDLAND.—Ores of iron, copper, and lead are shown. Of these the iron ore represents an important and flourishing industry.

INDIA.—The exhibits include ores of gold, iron, manganese and chromium; coal, petroleum, mica, magnesite, monazite, and bauxite. The iron ore exhibits are of special interest in relation to recent developments in iron-smelting in India, where extensive deposits of high-grade ore have been discovered in Bihar and Orissa. The bauxite deposits are also of special interest as representing large and scarcely touched resources of much potential importance.

BURMA.—There are exhibits of ores of lead, zinc, tin, and tungsten; petroleum, jadeite, and ruby.

CEYLON.—Graphite, monazite, and precious stones are among the exhibits. Attention may be also directed to a fine exhibit of Ceylon graphite in the Imperial Mineral Resources Bureau Section of the Government Pavilion, illustrating the excellence of Ceylon graphite and its unrivalled quality as material for the manufacture of crucibles.

MALAY STATES.—Ores of tin, tungsten, gold, and iron; coal and china clay are shown. The exhibit illustrating the tin-mining industry in the Malay States is one of the more attractive features of the Exhibition, and of special interest as illustrating an important Empire industry.

BRITISH BORNEO.—Coal, petroleum; ores of gold, iron, and antimony are being shown.

AUSTRALIA.—Australian exhibits include ores of gold, silver, osmiridium, iron, manganese, copper, lead, zinc, cadmium, bismuth, tin, tungsten, molybdenum, uranium, arsenic, antimony, and cobalt; coal, oil-shale, bauxite, asbestos, mica, fluorspar, gypsum, graphite, magnesite, alunite, and phosphates. Visitors to the Australian section will find much to interest them in the exhibits illustrating the remarkable progress made by Australia towards making the Empire independent of foreign supplies of zinc. It is well known that during the War the Empire found itself dependent on foreign supplies of zinc in spite of the fact

that it had large reserves of zinc ore. This unfortunate state of things no longer obtains, and the Empire will henceforth be independent as regards supplies of zinc.

NEW ZEALAND.—There are exhibits of ores of gold, silver, quicksilver, and iron; coal, petroleum, phosphates, and sulphur.

An important feature in connexion with Empire mineral resources at the British Empire Exhibition is the Empire Mining and Metallurgical Congress which has been arranged to take place at the Exhibition on June 3-6 inclusive, with the Prince of Wales as honorary president.

The inaugural session of the congress will open in Conference Hall No. 1 at the Exhibition with an address by the president, Viscount Long of Wraxall, on "Mineral Resources, and their Relation to the Prosperity of Development of the Empire." A large and varied programme has been arranged, including papers on mining, petroleum, metallurgy of iron and steel, and non-ferrous metallurgy. The general secretaries of the congress are Messrs. C. McDermid and G. C. Lloyd, at Cleveland House, 225 City Road, London, E.C.1.

A visit, or rather a series of visits, to the British Empire Exhibition, together with the above-mentioned evidence of the resolve on the part of British Empire engineers to press forward in the work of development, fills one with a feeling of confidence in the possibilities of this development. The next half-century will bring with it many serious problems as regards the resources available for industrial requirements, but it will presumably also bring with it much strenuous effort on the part of British Empire workers to ascertain the full extent of the Empire's resources, and to develop them. Already investigation has gone far enough to prove how wide are the possibilities of future discoveries, and how serious the need for such discoveries. In all parts of the Empire there are resources awaiting development, and large tracts of territory awaiting adequate exploration by scientific methods of prospecting, for the benefit of the Empire and of the whole world.

Obituary.

PROF. S. G. SHATTOCK, F.R.S., F.R.C.S.

BY the death of Samuel George Shattock, the Royal College of Surgeons of England loses an outstanding personality and the world of science a most distinguished man. Born on November 3, 1852, Samuel Shattock received his education at University College School and University College, where he entered the Medical Department, after matriculation at the University of London, in 1869. He was Liston Gold Medallist in 1875, and became M.R.C.S. in January 1875 and fellow by examination in December 1881.

Morbid anatomy having attracted Shattock from the first, he determined to devote himself to its study, and therefore he did not register as a medical practitioner, but soon after qualifying began work in the Museum of University College. Here Marcus Beck, then surgical registrar of University College Hospital, associated him with himself in the monumental task of supervising and cataloguing the surgical pathological

specimens in the University College Museum. This catalogue when published proved of great value to pathologists, but the formidable task of compilation owed not a little to Shattock, and, later on, to Charles Stonham, whose names for some reason are not mentioned by the biographers of the 'eighties. The "Descriptive Catalogue of the Specimens illustrating Surgical Pathology in the Museum of University College, London," Part I., by Beck in collaboration with S. G. Shattock, was published in 1881, and Part II., by Shattock, in collaboration with C. Stonham, followed in 1887. This labour was the preliminary to his well-known edition of the Pathological Catalogue of the Royal College of Surgeons, begun with Mr. Beadles in 1909.

So early as 1878, Shattock had begun his long connexion with the Museum of the Royal College of Surgeons of England by assisting Sir William Flower, the Conservator. In 1880 his name appears in the