more than 24 per cent. of magnesium chloride, since with a higher concentration, after the crystallisation of the potassium chloride, artificial carnallite would also be deposited, whereby the purification of the potassium chloride, by covering with water, would be rendered more difficult. In order to reclaim the potassium chloride in the mother lye the latter is steamed in vacuum to that degree of concentration, when carnallite in the form of artificial carnallite crystallises out, only 5 per cent. remaining in the solution. The artificial carnallite is dissolved in hot water or lye and on the solution cooling, a second crystallisation of potassium chloride is obtained. The potassium chloride from both crystallisations is purified from magnesium chloride and partly from sodium chloride by washing with water at the ordinary temperature. It is then steam heated in the calcinating ovens, passed through rotating cylinders and other drying apparatus, whereby it is made ready for export. It then contains 50 per cent. of actual potash. The remaining lye and washing waters are employed in dissolving the crude salts or the artificial carnallite. Of the potassium chloride present in the crude salts, 85 to 92 per cent. is extracted while the rest is lost in the residual solution and sediment. The sediment, according to the quality of the crude salts employed, may be very rich in potash, so that it sometimes pays to calcine this residue and use it in the preparation of "potash manure salts."

Potassium sulphate is now chiefly prepared by the action of magnesium sulphate on potassium chloride in a dilute solution. Its formation does not take place quantitatively but is dependent on the quantity and the conditions of the two salts and on the concentration of the solution. The reaction, in presence of magnesium chloride, formed therewith, may even go in the opposite direction, and therefore, as a rule, potassium-magnesium sulphate is first formed, since with the formation of a double salt the backward action is less to be feared. The preparation of potassium sulphate then follows from the potassium-magnesium sulphate, under the action of potassium chloride in excess.

The factory process is as follows:—The estimated quantity of double sulphate is dissolved in hot water and stirred in a tossing tub with an excess of potassium chloride, the potassium sulphate forming as a fine crystalline pulp. To prevent the precipitation of potassium chloride the temperature must not fall below 50° C. The deposited potassium sulphate is then separated from the mother lye by tip-buckets, covered with water and calcined. It is put on the market with 90 to 95 per cent. of potassium sulphate and not exceeding 2½ per cent. of chlorine, or with 96 per cent. of potassium sulphate and not exceeding 1 per cent. of chlorine, the former being used for industrial purposes and the latter finding an extensive application in agriculture.

Glauber salt, bromine, and magnesium chloride.

The manufacture of Glauber salt, which is confined to the winter season, is based on the reaction which takes place at temperatures below freezing point, in a dilute solution containing sodium chloride and magnesium sulphate. The residue from the manufacture of potassium chloride is dissolved in hot water and the resulting concentrated lye, after clarifying, is exposed to the winter cold in elevated shallow wooden cooling tanks. With moderate cold the crystallisation is accomplished in one night. The Glauber salt produced in this way is very pure, being free of iron, and therefore especially suited for the preparation of white glass.

The large quantities of final lye from the manufacture of potassium chloride partly serve for the production of bromine and are then run into the rivers, or they may be used in the manufacture of magnesium chloride. The bromine distillation takes place from the heated lye by means of manganese dioxide and sulphuric acid in granite or sandstone vessels, or by the introduction of gaseous chlorine. Now electrolytic methods are also employed in bromine production, but liquid chlorine is mostly used on account of its present low price.

Magnesium chloride is produced by steaming the final lye, whereby the iron present is deposited, and then running the clarified, somewhat cooled solution into

iron or wooden vessels. It is employed in the textile industry, but also in the preparation of flooring. For this purpose it is worked into a mass with water, burned magnesia, and a filler, is stroked over in the same way as ordinary cement and quickly hardens.

Industrial application of the potash salts.

The preparation of caustic potash and potashes employs about one half of the potassium chloride used in industry. Both are chiefly employed in soap manufacture. Potashes are also employed in glass and paper manufacture, in the preparation of colours, in printing and photography.

The next important product is *salt-peter*, in the manufacture of which one-third of the total industrial potassium chloride is used.

The three products, caustic potash, potashes, and salt-peter, used up five-sixths of the industrially employed potassium chloride. The remaining sixth part is divided amongst a few other products, of which the more important is *potassium chlorate*, claiming one-eighth of the total potassium chloride. Its chief use is in the preparation of matches, and since there is a growing tendency to produce matches free of sulphur and phosphorus, its use is on the increase. For example, in 1880 8000 tons were prepared for this purpose, and in 1903, 14,000 tons.

In the manufacture of *potassium chromate* one-twentieth of the industrial potassium chloride is employed. This is used in the textile and colour industries and in modern photographic printing and reproduction processes.

In 1880, rather more than half the total production potash salts was still used for industrial purposes; in 1885 the agricultural was equal to the industrial consumption. In 1888 53 per cent. of the potash salts was used in agriculture, in 1905 84·3 per cent., until at the present day industries use less than 15 per cent. of the total production of potash.

London Section.

Meeting held at Burlington House on Monday, April 5th, 1909.

MR. E. GRANT HOOPER IN THE CHAIR.

BOGHEAD CANNEL OR "TORBANE HILL MINERAL," AND OTHER SO-CALLED "BITUMINOUS COALS."

BY WATSON SMITH.
(ABSTRACT.)

After exhibiting a fine specimen of this now extinct coal given him by the late Dr. Jas. Young, F.R.S., and after a brief historic and chemical description, the author pointed out that whereas in the celebrated trial of 1853, it was decided that the mineral in question was a coal, immediately afterwards, a similar trial conducted in Berlin under the auspices of the Zollvereinindirection, yielded just the contrary result, so that whereas in Britain the substance was "coal," in Germany it was regarded as "a bituminous substance, but not coal." He then drew attention to the fact that not only is "coal" a term involving some ambiguity, as being strictly a commercial or trade term, but so likewise, even to a greater extent, is the word "bituminous" as applied to coal, the amounts of actual bituminous matter soluble in benzene and similar solvents in the richest cannels, being mostly below 1 per cent. and too small to appreciably affect the physical properties of the mineral. Among all the known coals, a great exception is the Japanese Miike coal (a lignite), with 9·5 per cent. of bitumen (this J., 1892, 591; also 1891, 976). In this case the physical properties are affected by the presence of so much bitumen, for the coal yields volumes of intensely black smoke when it is used for firing up. The term "bituminous" has doubtless been chiefly applied in the past to cannels and caking coals, etc., because of the external pitchy or bitumen-like appearance they have been thought to present, and because in burning, certain of them undergo a kind of semi-fusion, with decomposition. To remove a dangerous

ambiguity which might, in contracts, etc., give rise to disputes, the author proposed the entire abolition of the term "bituminous" as applied to coals.

DISCUSSION.

Mr. O. GUTTMANN said that this mineral played at one time a certain part in connection with the manufacture of explosives. The early dynamite was absorbed by kieselguhr, and between 1865 and 1870, it was thought that silica played an important part in the constitution of dynamite. During the siege of Paris, when it was required to produce dynamite, the necessary silicious material was obtained in the ashes of Boghead coal.

VAPOUR-GALVANISING.

BY S. COWPER-COLES.

Vapour-galvanising is distinctive from all other forms of galvanising inasmuch as the vapour of zinc is employed for coating metal surfaces instead of dipping them into molten zinc or into an aqueous solution through which a current of electricity is passed.

Vapour-galvanising can be subdivided under two heads, namely, the zinc dust process and the molten zinc vapour process.

Zinc dust, which is an essential feature of the first process, is the product formed during the distillation of zinc from its ores, but, as the demand now exceeds the supply obtainable, by the ordinary process of distillation from the ore, it is made by distilling zinc from the crude metal. Zinc dust usually contains about 80 per cent. of metallic zinc, coated with a film of oxide, which prevents the metallic zinc from running into a molten mass when heat alone is applied. It is therefore

FIG. 1.—Furnace for vapour-galvanising.

particularly suitable for the process about to be described, as all risk of fusing and coating the iron under treatment with molten zinc is thus obviated. Zinc dust volatilises at a low temperature, due no doubt to its unstable physical condition. This fact was observed when some experiments were being made in connection with the annealing of cast iron in 1902. Zinc dust, when in contact with another metal, such as iron or copper, volatilises at a much lower temperature than it would otherwise; a piece of iron placed in zinc dust and heated to a temperature several hundred degrees below its melting point is quickly coated with zinc; if a similar piece of iron is suspended just above the zinc dust, no deposit of zinc takes place. In the former case an electric current is generated which probably reduces the volatilising point.

The process of vapour-galvanising with zinc dust in practice is carried into effect in the following manner:—The zinc dust and the iron articles to be coated are placed in an air-tight iron drum, which is heated in a gas-fired furnace, as shown in Fig. 1, to obtain a temperature within the drum of about 600° F., that is to say, the zinc dust is brought to about this temperature. The length of time at which the drum is kept at this temperature depends

FIG. 2.—Method of discharging contents of drum.

on the thickness of the coat required, a few hours usually sufficing. The drums are emptied over an iron grid, Fig. 2, which retains the zinc-coated articles and allows the zinc dust to fall into a receptacle from which it is carried by a bucket elevator to a bin ready for recharging the drums. The iron articles, when cleaned from the zinc dust by means of a steam jet, are found to be coated with an even distribution of zinc which is alloyed with the iron surface, as shown in Fig. 3, the depth of the alloy depending both on the temperature and the length of time the minimum working temperature is maintained. The zinc iron alloy is non-corrosive, and does not rust even when the zinc surface has been removed by abrasion.

A complete apparatus for coating small articles such as bolts, nuts, and screws, is shown in Fig. 4, and consists of an iron drum, heated by gas and rotated by hand, or by suitable gearing. It is found in practice that the iron drum does not become coated with zinc even after being in use for several years, due to the high temperature of the drum as compared with the temperature of the zinc dust. When it is desired to obtain a thin even distribution of zinc, as for instance on thin steel plates, which are being used in place of lithographic stones, it is advantageous to mix the dust with some inert material such as finely-divided silica, excellent results being obtained with 9 parts of silica to one of zinc dust. The amount of zinc oxide present can vary considerably and yet give good results, the percentage can readily be controlled by adding hydrocarbon, by greasing some of the articles to be zinc-

FIG. 3.—Photomicrograph of zinc-iron alloy.