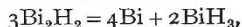


### Bismuth Trihydride and Silver Bismuthide.

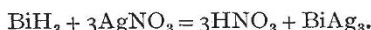
GASEOUS bismuth hydride was first prepared by Paneth (*Ber.*, 1918, 51, 1704), who obtained it by treating an alloy of magnesium and thorium C or radium C with 0.2 normal hydrochloric sulphuric acid. He afterwards (*ibid.* p. 1728) prepared somewhat larger quantities of the gas by the action of either of the above acids (but of four times normal strength) upon an alloy of bismuth and magnesium, carrying out the reaction in a heated iron crucible and in a stream of hydrogen. A mirror of bismuth was obtained when the issuing gas was heated as it passed through a glass tube. The gas was, however, never obtained in large quantities, and we have endeavoured to make a considerable amount of this hydride and from this substance to isolate the silver bismuthide, analogous to silver antimonide (*vide* Weeks, *Chem. News*, 1923, 127, 319; Weeks and Lloyd, *ibid.* p. 362).

In view of our results with the solid hydrides of arsenic and antimony (Weeks and Druce, *Trans. Chem. Soc.*, 1925, 127, 1069 and 1790) it seemed likely that bismuth trihydride could be obtained by reduction of bismuth dihydride with hydrogen.

Thus, when the dihydride was heated *in vacuo*, it decomposed evolving bismuthine :

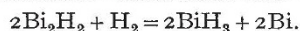


which could be decomposed on heating, with the formation of a mirror of bismuth. The gas was also drawn through solutions of silver nitrate to produce silver bismuthide,  $\text{Ag}_3\text{Bi}$ . The apparatus used in these experiments has been described in our communication to the Chemical Society on bismuth dihydride (*loc. cit.*). The most suitable reagent for absorbing bismuthine is ammoniacal silver nitrate solution, with which it forms a precipitate which was proved to contain only silver and bismuth. Analysis indicated that the composition of this compound corresponded closely with that demanded by the formula  $\text{Ag}_3\text{Bi}$ . The reaction is probably similar to the case of stibine and silver nitrate, namely :

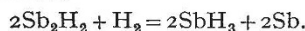


Since the gas could never be obtained in large quantities by this method, we directed our attention to the reduction of the dihydride with hot hydrogen. For this purpose hydrogen was generated in the usual way and was purified by passing through solutions of lead nitrate, silver sulphate, potassium hydroxide, and potassium permanganate, and before being dried with concentrated sulphuric acid, it was passed through bulbs containing silver nitrate solution. These were inserted to ensure that the hydrogen contained nothing that would cause a precipitate to form with the silver nitrate used to react with the bismuthine which was obtained on heating the dihydride in this purified hydrogen. The gas issuing from the silver nitrate bulbs was ignited, and when the silver nitrate was largely decomposed, the flame assumed a steely grey colour and thin clouds of bismuth oxide were produced. Meanwhile, the silver nitrate slowly darkened with the formation of an almost black precipitate of silver bismuthide. It may be noted here that the bismuth dihydride must be free from traces of chloride, or silver chloride might be precipitated along with the bismuthide. This led us to prepare the dihydride by reducing a solution of a bismuth salt with aluminium and potassium hydroxide instead of the method described by us previously (Weeks and Druce, *Trans. Chem. Soc.*, 1925, 127, 1790). This product gave us a precipitate of silver bismuthide

uncontaminated with any silver chloride. The dihydride was reduced in accordance with the equation :



Paneth has pointed out that the yields of bismuthine prepared from his alloys were very variable, and he concluded that the action of acids upon the alloys cannot be one of simple decomposition, since the best yields were obtained from magnesium which was merely coated with fused metallic bismuth. A possible explanation of this is that Paneth made a coating of bismuth dihydride upon the magnesium as soon as the acid acted upon the alloy. This view is supported by the work of one of us (E. J. W., *Chem. News*, 1923, 127, 87), in which it was shown that the yields of stibine from alloys of antimony and zinc appear to be independent of the composition of the alloy. It appears that the first action of the acid upon the alloy is the formation of the solid antimony hydride, which then decomposes in the following manner :



Silver bismuthide is an almost black crystalline compound, similar in appearance and properties to silver antimonide. It can be melted in a bunsen flame, and is unaffected by water or hydrochloric acid. It dissolves in warm dilute nitric acid giving but little bismuth trihydride, since further oxidation of this gas takes place.

The action  $\text{Ag}_3\text{Bi} + 3\text{HNO}_3 = 3\text{AgNO}_3 + \text{BiH}_3$  is thus a reversible one, and this accounts for the difficulty experienced in absorbing the gas with aqueous silver nitrate. For this reason we employed ammoniacal solutions in order to remove the nitric acid as soon as it was formed. Silver bismuthide was also soluble in fairly strong hot sulphuric acid.

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October 20.

### Flowering Plants as Epiphytes on Willows and Alders.

SINCE April, when trout fishing on many occasions in the river Chew, which enters the Avon between Bristol and Bath, I have been impressed with the large number of flowering plants, or Phanerogams, growing as epiphytes on pollard willows and alders by the river-side. I have listed about 103 species, in addition to the common Polypody fern. Some of these are of considerable interest in their strange habitat; and a single plant of *Lysimachia vulgaris* and two of *Nasturtium sylvestre* appear to be unrecorded species from the whole valley. The latter was also seen in the bed of the river during the drought of June.

The Chew extends from Chewton Mendip and East Harptree, Somerset, to Keynsham, a distance of about nineteen miles, or ten as the crow flies, and with a fall of about 400 ft. It is subject to heavy floods, and the average rainfall in the upper region is several inches greater than that at Clifton (35 inches) or Bath (30.84). The river rises rapidly, and occasionally to a height of eight or even ten feet above the normal summer level.

Doubtless the majority of the plants have been brought down and left stranded by floods; but not a few have been brought by birds, which are frequent in the valley, and several by wind dispersal of the seed. Cows, drinking and wading in some of the shallows, may be responsible for others. Many of