air-free water and dried at 80° C. without much change by oxidation ; if it be heated in carbon dioxide the black SnO remains. Precipi­tated stannous hydrate dissolves readily in caustic potash; if the solution is evaporated quickly it suffers decomposition, with forma­tion of metal and stannate, 2SnO+2KOH = K2SnO2+Sn+ H2O. If it is evaporated slowly, anhydrous stannous oxide crystallizes out in forms which are combinations of the cube and dodecahedron. Dry stannous oxide, if touched with a glowing body, catches fire and burns to stannic oxide, SnO2. Stannous oxalate when heated by itself in a tube leaves stannous oxide.

*Stannic Oxide,* SnO2.—This, if the term is taken to include the hydrates, exists in a variety of forms. (1) *Tinstone* (see above and also Cassiterite) is proof against all acids. Its disintegration for analytical purposes can be effected by fusion with caustic alkali in silver basins, with the formation of soluble stannate, or by fusion with sulphur and sodium carbonate, with the formation of a soluble thiostannate. (2) A similar oxide *(flores jovis)* is produced by burn­ing tin in air at high temperatures or exposing any of the hydrates to a strong red heat. Such *lin-ash,* as it is called, is used for the polishing of optical glasses. *Flores stanni* is a finely divided mixture of the metal and oxide obtained by fusing the metal in the presence of air for some time. (3) *Metastannic acid* (generally written H10Sn5O15, to account for the complicated composition of meta- stannates, *e.g.* the sodium salt H3Na2Sn5O15) is the white compound produced from the metal by means of nitric acid. It is insoluble in water and in nitric acid and apparently so in hydrochloric acid; but ií heated with this last for some time it passes into a compound, which, after the acid mother liquor has been decanted off, dissolves in water. The solution when subjected to distillation behaves very much like a physical solution of the oxide in hydrochloric acid, while a solution of orthostannic acid in hydrochloric acid behaves like a solution of SnCl4 in water, *i.e.* gives off no hydrochloric acid, and no precipitate of hydrated SnO2. Metastannic acid is distin­guished from orthostannic acid by its insolubility in nitric and sul­phuric acids. The salts are obtained by the action of alkalies on the acid. (4) Orthostannic acid is obtained as a white precipitate on the addition of sodium carbonate or the exact quantity of precipitated calcium carbonate to a solution of the chloride. This acid, H2SnO3, is readily soluble in acids forming stannic salts, and in caustic potash and soda, with the formation of orthostannates. .Of these sodium stannate, Νa2SnO3, is produced industrially by heating tin with Chile saltpetre and caustic soda, or by fusing very finely powdered tinstone with caustic soda in iron vessels. A solution of the pure salt yields fine prisms of the composition Na2SnO2+loH2O, which effloresce in the air. The salt is used as a mordant in dyeing and calico-printing. Alkaline and other stannates when treated with aqueous hydrofluoric acid are converted into fliostannates (e.g. K2SnO3 into K2SnF6), which are closely analogous to, and isomorphous with, fluosilicates.

A *colloidal* or *soluble stannic acid* is obtained by dialysing a mixture of tin tetrachloride and alkali, or of sodium stannate and hydro­chloric acid. On heating it is converted into colloidal metastannic acid.

A hydrated *tin trioxide,* SnO2, was obtained by Spring by adding barium dioxide to a solution of stannous chloride and hydrochloric acid ; the solution is dialysed, and the colloidal solution is evaporated to form a white mass of 2SnO3∙H2O.

*Stannous Chloride,* SnCl2, can only be obtained pure by heating pure tin in a current of pure dry hydrochloric acid gas. It is a white solid, fusing at 250° C. to an oily liquid which boils at 606°, and volatilizing at a red heat in nitrogen, a vacuum or hydrochloric acid, without decomposition. The vapour density below 700° C. corresponds to Sn2Cl4, above 800o C. to nearly SnCl2. The chloride readily combines with water to form a crystallizable hydrate SnCl2∙2H2O, known as “ tin salt ” or “ tin crystals.’’ This salt is also formed by dissolving tin in strong hydrochloric acid and allowing it to crystallize, and is industrially prepared by passing sufficiently hydrated hydrochloric acid gas over granulated tin contained in stoneware bottles and evaporating the concentrated solution produced in tin basins over granulated tin. The basin itself is not attacked. The crystals are very soluble in cold water, and if the salt is really pure a small proportion of water forms a clear solution ; but on adding much water most of the salt is decomposed, with the formation of a precipitate of oxychloride, 2Sn(OH)Cl∙H2O. According to Michel and Kraft, one litre of cold saturated solution of tin crystals weighs 1827 grammes and contains 1333 grammes of SnCl2. The same oxychloride is produced when the moist crystals, or their solution, are exposed to the air. Hence all tin crystals as kept in the laboratory give with water a turbid solution, which contains stannic in addition to stannous chloride. The complete conversion of stannous into stannic chloride may be effected by a great many reagents—for instance, by chlorine (bromine, iodine) readily; by mercuric chloride in the heat, with precipitation of calomel or metallic mercury; by ferric chloride in the heat, with formation of ferrous chloride; by arsenious chloride in strongly hydrochloric solutions, with precipitation of chocolate-brown metallic arsenic. All these reactions are available as tests for "stannosum ” or the respective agents. In opposition to stannous chloride, even sulphurous acid (solution) behaves as an oxidizing agent. If the two reagents are mixed a precipitate of yellow stannic sulphide is produced. A strip of metallic zinc when placed in a solution of stannous chloride precipitates the tin in crystals and takes its place in the solution. Stannous chloride is largely used in the laboratory as a reducing agent, in dyeing as a mordant.

*Stannic Chloride,* SnCl4, named by Andreas Libavius in 1605 *Spiritus argents vivi sublimait* from its preparation by distilling tin or its amalgam with corrosive sublimate, and afterwards termed *Spiritus fumans Libavii,* is obtained by passing dry chlorine over granulated tin contained in a retort; the tetrachloride distils over as a heavy liquid, from which the excess of chlorine is easily removed by shaking with a small quantity of tin filings and re-distilling. It is a colourless fuming liquid of specific gravity 2·269 at0°; it freezes at -33° C., and boils at 113∙9°. The chloride unites energetically with water to form crystalline hydrates (e.g. SnCl4∙3H2O), easily soluble in water. With one-third its weight of water it forms the so-called “ butter of tin.” It combines readily with alkaline and other chlorides to form double salts, *e.g.* M2SnCl5, analogous to the chloroplatinates; the salt (NH4)2SnCl5 is known industrially as “ pink salt" on account of its use as a mordant to produce a pink colour. The *oxymuriale of tin* used by dyers is SnCl4·5H2O. The plain chloride solution is similarly used. It is usually prepared by dissolving the metal in aqua regia.

*Stannous Fluoride,* SnF21 is obtained as small, white monoclinic tables by evaporating a solution of stannous oxide in hydrofluoric acid in a vacuum. *Stannic Fluoride,* SnF4, is obtained in solution by dissolving hydrated stannic oxide in hydrofluoric acid; it forms a characteristic series of salts, the stannofluorides, M2SnF3, iso­morphous with the silico-, titano-, germano- and zirconofluorides. *Stannous bromide,* SnBr2, is a light yellow substance formed from tin and hydrobromic acid. *Stannic bromide,* SnBr4, is a white crystalline mass, melting at 33° and boiling at 201 °, obtained by the combination of tin and bromine, preferably in carbon bisulphide solution. *Stannous iodide,* SnI2, forms yellow red needles, and is obtained from potassium iodide and stannous chloride. *Stannic iodide,* SnI4, forms red octahedra and is prepared similarly to stannic bromide. Both iodides combine with ammonia.

*Stannous sulphide,* SnS, is obtained as a lead-grey mass by heating tin with sulphur, and as a brown precipitate by adding sulphuretted hydrogen to a stannous solution ; this is soluble in ammonium poly­sulphide, and dries to a black powder. *Stannic sulphide,* SnS2, is obtained by heating a mixture of tin (or, better, tin amalgam), sulphur and sal-ammoniac in proper proportions in the beautiful form of *aurum musivum* (mosaic gold)—a solid consisting of golden yellow, metallic lustrous scales, and used chiefly as a yellow “ bronze ” for plaster-of-Paris statuettes, &c. The yellow precipitate of stannic sulphide obtained by adding sulphuretted hydrogen to a stannic solution readily dissolves in solutions of the alkaline sulphides to form *thiostannates* of the formula M2SnS3; the free acid, H2SnS3, may be obtained as an almost black powder by drying the yellow precipitate formed when hydrochloric acid is added to a solution of a thiostannate.

*Analysis.*—Tin compounds when heated on charcoal with sodium carbonate or potassium cyanide in the reducing blow-pipe flame yield the metal and a scanty ring of white SnO2. Stannous salt solutions yield a brown precipitate of SnS with sulphuretted hydrogen, which is insoluble in cold dilute acids and in real sulphide of ammonium, (NH4)2S; but the yellow, or the colourless reagent on addition of sulphur, dissolves the precipitate as SnS2 salt. The solution on acidification yields a yellow precipitate of this sulphide. Stannic salt solutions give a yellow precipitate of SnS2 with sulphuretted hydrogen, which is insoluble in cold dilute acids but readily soluble in sulphide of ammonium, and is re-precipitated therefrom as SnS2 on acidification. Only stannous salts (not stannic) give a precipitate of calomel in mercuric chloride solution. A mixture of stannous and stannic chloride, when added to a sufficient quantity of solution of chloride of gold, gives an intensely purple precipitate of gold purple (purple of Cassius). The test is very delicate, although the colour is not in all cases a pure purple. Tin is generally quantita­tively estimated as the dioxide. The solutions are oxidized, precipi­tated with ammonia, the precipitate dissolved in hydrochloric acid, and re-thrown down by boiling with sodium sulphate. The precipitate is filtered, washed, dried and ignited.

Bibliography.—For the history of tin and statistics of its production, &c., see Bernard Neumann, *Die Metalle* (1904); A. Rossing, *Geschichte der Metalle* (1901). For its chemistry see Roscoe and Schorlemmer, *Treatise on Inorganic Chemistry,* vol. ii.; H. Moissan, *Traité de chimie minérale;* O. Dammer, *Handbuch der anorganischen Chemie.* For its production and metallurgy see Sydney Fawns, *Tin Deposits of the World; A.* G. Charleton, *Tin Mining;* Henry Louis, *The Production of Tin,* and C. Schnabel, *Handbook of Metallurgy* (English trans. by Louis, 1907). General statistical information, and improvements in the metallurgy, &c., are recorded annually in *The Mineral Industry.*

**TINAMOU,** the name given in Guiana to a certain bird, as stated in 1741 by P. Barrère *(France équinoxiale,* p. 138), from whom it was taken and used in a more general sense by Buffon *(Hist. nat. oiseaux,* iv. 502). In 1783 J. Latham *(Synopsis,* ii. 724) adopted it as English, and in 1790 *(Index,* ii. 633) Latinized