by the combustion of the least sufficient quantity of sulphur, the rest is liquefied. The molten sulphur accumulates on the sole, whence it is from time to time run out into a square stone receptacle, from which it is ladled into damp poplar-wood moulds and so brought into the shape of truncated cones weighing no to 130 lb each. These cakes are sent out into commerce. A calcarone with a capacity of 28,256 cub. ft. burns for about two months, and yields about 200 tons of sulphur. The yield is about 50%. The immense volumes of sulphurous acid evolved give rise to many complaints; all the minor pits suspend work during the summer to avoid destruc­tion of the crops. A calcarone that is to be used all the year round must be at least 220 yds, from any inhabited place and 110 yds. from any field under cultivation.

More efficient is the Gill kiln which uses coke as a fuel. The kiln consists of two (or more) connected cells which are both charged with the ore. The first cell is heated and the products of combustion are led into the second cell where they give up part of their heat to the contained ore, so that by the time the first cell is exhausted the mass in the second cell is at a sufficiently high temperature to ignite spontaneously when air is admitted. Other methods have been employed, but with varying commercial success. For example, in the Gritti and Orlando processes the ore is charged into retorts and the fusion effected by superheated steam, the sulphur being run off as usual; or as was suggested by R. E. Bollman in 1867 the ore may be extracted by carbon bisulphide.

Crude sulphur, as obtained from kilns, contains about 3% of earthy impurities, and consequently needs refining. The following apparatus (invented originally by Michel of Marseilles and improved subsequently by others) enables the manufacturer to produce either of two forms of “ refined ” sulphur which commerce demands. It consists of a large stone chamber which communicates directly with two slightly slanting tubular retorts of iron. The retorts are charged with molten sulphur from an upper reservoir, which is kept at the requisite temperature by means of the lost heat of the retort fires. the chamber has a safety value at the top of its vault, which is so balanced that the least surplus pressure from within sends it up. The first puff of sulphur vapour which enters the chamber takes fire and converts the air of the chamber into a mixture of nitro­gen and sulphur dioxide. The next following instalments of vapour, getting diffused throughout a large mass of relatively cold gas, condense into a kind of “ snow,” known in commerce and valued as “ flowers of sulphur ” *(flores sulphuris).* By conducting the distillation slowly, so that the temperature within the chamber remains at a sufficiently low degree, it is possible to obtain the whole of the product in the form of “flowers.” If compact (“roll”) sulphur is wanted the distillation is made to go on at the quickest admissible rate. The temperature of the interior of the chamber soon rises to more than the fusing-point of sulphur (113° C.), and the distillate accumulates at the bottom as a liquid, which is tapped off from time to time to be cast into the customary' form of rods.

The Louisiana deposits are worked by a process devised by Herman Frasch in 1891. it consists in sinking a bore-hole, after the manner of a petroleum well, and letting in four pipes centrally arranged, the outer pipe being 10 in. in diameter, the next 6 in., the next 3 in. and the innermost 1 in. The operation consists in forcing down the 3-in. pipe superheated steam at 330° F. to melt the sulphur. Compressed air is now driven down the 1-in. pipe and bubbles into the melted sulphur and water; the specific gravity of which is greatly diminished, so that it rises to the surface through the outer pipes; it is then run off to settling tanks. The sulphur so obtained is 98% pure.

In some places sulphur is extracted from iron pyrites by one of two methods. The pyrites is subjected to dry distillation from out of iron or fire-clay tubular retorts at a bright red heat. One- third of the sulphur is volatilized—3FeS2 = Fe3S4 + 2S—and obtained as a distillate. The second method is analogous to the calcarone method of liquation: the ore is placed in a limekiln-like furnace over a mass of kindled fuel to start a partial combustion of the mineral, and the process is so regulated that, by the heat gener­ated, the unburnt part is decomposed with elimination of sulphur, which collects in the molten state on an inverted roof-shaped sole below the furnace and is thence conducted into a cistern. Such pyrites sulphur is usually contaminated with arsenic, and conse­quently is of less value than Sicilian sulphur, which is characteris­tically free from this impurity.

Large quantities are also recovered from alkali waste (see Alkali Manufacture) ; another source is the spent oxide of gas manufacture (see Gas).

The substance known as “ milk of sulphur ” *(lac sulphuris)* is very finely divided sulphur produced by the following, or some analogous, chemical process. One part of quicklime is slaked with 6 parts of water, and the paste produced diluted with 24 parts of water; 2∙3 parts of flowers of sulphur are added; and the whole is boiled for about an hour or longer, when the sulphur dissolves. The mixed solution of poiysulphides and thiosulphate of calcium thus produced is clarified, diluted largely, and then mixed with enough of pure dilute hydrochloric acid to produce a feebly alkaline mixture when sulphur is precipitated. The addition of more acid would produce an additional supply of sulphur (by the action of the H2S2O3 on the dissolved H2S) ; but this thiosulphate sulphur is yellow and compact, while the polysulphide part has the desired qualities, forming an extremely fine, almost white, powder. The precipitate is washed, collected, and dried at a very moderate heat.

*Properties.—*Sulphur exists in several allotropic modifications, but before considering these systematically we will deal with the properties of ordinary (or rhombic) sulphur. Commercial sulphur forms yellow crystals which melt at 113° and boil at 444·53° C. under ordinary pressure (H. L. Callendar, *Chem. News,* 1891, 63, p. 1); just above the boiling point the vapour is orange-yellow, but on continued heating it darkens, being deep red at 500° ; at higher temperatures it lightens, becoming straw-yellow at 650°. These colour changes are connected with a dissociation of the molecules. At 524° Dumas deduced the structure S6 from vapour-density determinations, whilst for the range 860° to 1040°, Sainte-Claire Deville and Troost deduced the formula S2. Biltz *(Ber.,* 1888, 21, p. 2013; 1901, 34, p. 2490) showed that the vapour density decreased with the tem­perature, and also depended on the pressure. G. Preuner and W. Schupp *(Zeit, phys. Chem.,* 1909*,* 69, p. 157), in a study of the dissociation isotherms over 300°-850°, detected molecules of S8, S6 and S2, whilst S1 appears to exist below pressures of 30 mm. Boiling and freezing-point determinations of the molecular weight in solution indicate the formula S8. the density of solid sulphur is 2∙062 to 2∙070, and the specific heat 0·1712; it is a bad conductor of electricity and becomes negatively electrified on friction. It ignites in air at 363° and in oxygen at 275-280o (H. Moissan, *Compt. rend.,* 1903, 137, p. 547), burning with a characteristic blue flame and forming much sulphur dioxide, recognized by its pungent odour. At the same time a little trioxide is formed, and, according to Hempel (*Ber*., 1890, 23, p. 1455), half the sulphur is converted into this oxide if the combustion be carried out in oxygen at a pressure of 40 to 50 atmospheres. Sulphur also combines directly with most of the elements to form sulphides. The atomic weight was determined by Berzelius, Erdmann and Marchand, Dumas and Stas. Thomsen *(Zeit, phys. Chem.,* 1894, 13, p. 726) obtained the value 32-0606.

*Allotropic Modifications.—*Sulphur assumes crystalline, amor­phous and (possibly) colloidal forms. Historically the most important are the rhombic (Sα) and monoclinic (S3) forms, discussed by E. Mitscherlich in 1822 (see *Ann. chim. phys.,* 1823, 24, p. 264). The transformations of these two forms are discussed in Chemistry: *Physical.* Rhombic sulphur may be obtained artificially by slowly crystallizing a solution of sulphur in carbon bisulphide, or, better, by exposing pyridine saturated with sulphuretted hydrogen to atmospheric oxidation (Ahrens, *Ber.,* 180o, 23, p. 2708). It is insoluble in water,@@1 but readily soluble in carbon bisulphide, sulphur chloride and oil of tur­pentine. The common monoclinic variety is obtained by allowing a crust to form over molten sulphur by partially cooling it, and then breaking the crust and pouring off the still liquid portion, whereupon the interior of the vessel will be found coated with long needles of this variety. Like Sα it is soluble in carbon bisulphide. Three other monoclinic forms have been described. By acting upon a solution of sodium hyposulphite with potassium bisulphate, Gcmez *(Compt. rend.,* 1884, 98, p. 144) obtained a form which he termed *nacré* (or pearly) sulphur; the same modification was obtained by Sabatier (ibid., 1885, 100, p. 1346) on shaking hydrogen persulphide with alcohol or ether. It is readily transformed into rhombic sulphur. Another form, mixed with the variety just described, is obtained by adding 3 to 4 volumes of alcohol to a solution of ammonium sulphide saturated with sulphur and exposing the mixture to air at about 5°. Engel’s monoclinic form *(Compt. rend.,* 1891, 112, p. 866) is obtained by mixing a solution of sodium hyposulphite with double its volume of hydrochloric acid, filtering and extracting with chloroform; the extract yielding the variety on evaporation. A triclinic form is claimed to be obtained by Friedel *(Bull. soc. chim.,* 1879, 32, p. 14) on subliming ordinary sulphur.

@@@1 It is a common practice of keepers of dogs to place a piece of roll sulphur in the animal’s water but this serves no useful purpose owing to this property.