without the operator having to maneuver an acid-cock. The latter he only has to open when he sets the apparatus in operation, and to close it when he stops it.

The arrangement of the washer is the same as in the preceding apparatus, save that a larger cylindrical copper reservoir, G', is substituted for the lower flask. The pump and saturator offer nothing peculiar.

A bent tube, u, which communicates with the generator, D, on one side, and with a cylindrical tube, V, ending in a glass vessel on the other, serves as a safety-valve for both the generator and the acid vessel.

The consumption of chalk is about 2.5 kilogrammes, and the same of acid, for charging 100 siphons or 150 bottles. The apparatus shown in the figure is capable of charging 600 siphons or 900 bottles per day.

An Apparatus Completely Mechanical in Operation (Fig. 11).—This apparatus consists of two very distinct parts. The saturator, pump, and driving shaft are supported by a hollow base, in whose interior are placed a copper washer and the water-inlet controlled by a float-cock. This part of the apparatus is not shown in the plate. The generator, partially shown in Fig. 11, is placed on a base of its own, and is connected by a pipe with the rest of the apparatus. It consists of two similar generators, D, made of copper lined with lead, and working alternately, so as to avoid all stoppages in the manufacture when the materials are being renewed. The pipe, d, connecting the two parts of the apparatus forks so as to lead the gas from one or the other of the generators, whence it passes into the copper washer within the base, then into the glass indicating washer, and then to the pump which forces it into the saturator.

Each of the generators communicates by special pipes, a, with a single safety vessel, V', that operates the same as in the preceding apparatus. The agitator, Q, is of bronze, and is curved as shown in Fig. 11.

The production of this type of apparatus is dependent upon the number of siphons that can be filled by a siphon filler working without interruption.—*Machines, Outlets et Appareils*.

DETECTION AND ESTIMATION OF FUSEL OIL.

UNTIL quite recently we have had no accurate method for the determination of fusel oil in alcohol or brandy. In 1837 Meurer suggested a solution of one part of silver nitrate in nine parts of water as a reagent for its detection, stating that when added to alcohol containing fusel oil, a reddish brown color is produced, and in case large quantities are present, a dark brown precipitate is formed. It was soon found, however, that other substances than amyl alcohol produce brown colored solutions with silver nitrate; and Bouvier* observed that on adding potassium iodide to alcohol containing fusel oil, the solution is colored yellow, from the decomposition of the iodide. Subsequently Büttger† proved that potassium iodide is not decomposed by pure amyl alcohol, and that the decomposition is due to the presence of acids contained in fusel oil. More accurate results are obtained by using a very dilute solution of potassium permanganate, which is decomposed by amyl alcohol much more rapidly than by ethyl alcohol.

Dupré† determines fusel oil by oxidizing a definite quantity of the alcohol in a closed vessel with potassium bichromate and sulphuric acid. After removal of excess of the oxidizing reagents, the organic acids are distilled, and, by repeated fractional distillation, the acetic acid is separated as completely as possible. The remaining acids are saturated with barium hydroxide, and the salts analyzed; a difference between the percentage of barium found and that of barium in barium acetate proves the presence of fusel oil, and the amount of difference gives some idea of its quantity. Betelli‡ dilutes 5 c. c. of the alcohol to be tested with 6 to 7 volumes of water, and adds 15 to 20 drops of chloroform and shakes thoroughly. If fusel oil is present, its odor may be detected by evaporating the chloroform; or, by treatment with sulphuric acid and sodium acetate, the ether is obtained, which can be readily recognized. Jorissen§ tests for fusel oil by adding 10 drops of colorless aniline and 2 to 3 drops of hydrochloric acid to 10 c. c. of the alcohol. In the presence of fusel oil a red color is produced within a short time, which can be detected when not more than 0.1 per cent. is present. But Förster¶ objects to this method because he finds the color to be due to the presence of furfural, and that pure amyl alcohol gives no color with aniline and hydrochloric acid.

Hager** detects fusel oil as follows: If the spirit contains more than 60 per cent. of alcohol, it is diluted with an equal volume of water and some glycerine added, pieces of filter paper are then saturated with the liquid and exposed to the air. After the evaporation of the alcohol, the odor of the fusel oil can be readily detected. For the quantitative determination he distills 100 c. c. of the alcohol in a flask of 150 to 200 c. c. capacity connected with a condenser, and so arranged that the apparatus does not extend more than 20 cm. above the water bath. This arrangement prevents the fusel oil from passing over. If the alcohol is stronger than 70 per cent., and the height of the distillation apparatus is not more than 17 cm., the residue in the flask may be weighed as fusel oil. With a weaker alcohol, or an apparatus which projects further out of the water bath, the residual fusel oil is mixed with water. It can, however, be separated by adding strong alcohol and redistilling, or by treating with ether, which dissolves the amyl alcohol, and distilling, the temperature being raised finally to 90°.

Marquardt,†† like Betelli, extracts the fusel oil from alcohol by means of chloroform, and by oxidation converts it into valeric acid. From the quantity of barium valerate found he calculates the amount of amyl alcohol present in the original solution; 150 c. c. of the spirit, which has been diluted so as to contain 12 to 15 per cent. of alcohol, are shaken up thoroughly with 50 c. c. of chloroform, the aqueous layer drawn off, and shaken with a fresh portion of chloroform. This treatment is repeated several times. The extracts are then united, and washed repeatedly with water. The chloroform, which is now free from alcohol and contains all the fusel oil, is treated with a solution of 5 grammes of potassium bichromate in 30 grammes of water and 2 grammes of sulphuric acid, and then heated in a closed flask for six hours on a water bath at 85°. The contents of the flask are then distilled, the distillate saturated with barium carbonate, and the chloroform distilled; the residue is evaporated to a small volume, the excess of barium carbonate filtered off, and the filtrate evaporated to dryness and weighed. The residue is dis-

solved in water, a few drops of nitric acid added, and the solution divided into two portions. In the first portion the barium is determined; in the second the barium chloride. The total per cent. of barium minus that of barium chloride gives the amount present as barium valerate, from which is calculated the per cent. of amyl alcohol. By this process the author has determined one part of fusel oil in ten thousand of alcohol. To detect very minute quantities of fusel oil, the chloroform extracts are treated with several drops of sulphuric acid and enough potassium permanganate to keep the solution red for twenty-four hours. If allowed to stand in a test tube, the odor of valeric aldehyde will first be noticed, then that of amyl valerate, and lastly that of valeric acid.—*Amer. Chem. Journal*.

ON SILICON.

It is known that platinum heated in a forge fire, in contact with carbon, becomes fusible. Boussingault has shown that this is due to the formation of a silicide of platinum by means of the reduction of the silica of the carbon by the metal. MM. P. Schützenberger and A. Colson have produced the same phenomenon by heating to white heat a slip of platinum in the center of a thick layer of lampblack free from silica.

The increase in weight of the metal and the augmentation of its fusibility were found to be due, in this case also, to a combination with silicon. As the silicon could not come directly from the carbon which surrounded the platinum, MM. Schützenberger and Colson have endeavored to discover under what form it could pass from the walls of the crucible through a layer of lampblack several centimeters in thickness, in spite of a volatility amounting to almost nothing under the conditions of the experiment. They describe the following experiments as serving to throw some light upon the question:

1. A thin slip of platinum rolled in a spiral is placed in a small crucible of retort carbon closed by a turned cover of the same material. This is placed in a second larger crucible of refractory clay, and the intervening space filled with lampblack tightly packed. The whole is then heated to white heat for an hour and a half in a good wind furnace. After cooling, the platinum is generally found to have been fused into a button, with a marked increase in weight due to taking up silicon, which has penetrated in the form of vapor through the walls of the interior crucible.

2. If, in the preceding experiment, the lampblack be replaced by a mixture of lampblack and rutil in fine powder, the slip of platinum remains absolutely intact, and does not change in weight. Thus the titaniferous packing recommended by Sainte-Claire Deville for preventing the access of nitrogen in experiments at high temperatures also prevents the passage of silicon. A mixture of carbon and finely divided iron is, on the contrary, ineffectual. These facts seem to indicate that nitrogen plays a part in the transportation of the silicon, as this is only prevented by the same means made use of in order to prevent the passage of nitrogen.

3. The volatility of free silicon at a high temperature is too slight to account for the alteration of the platinum at a distance. This can be shown by placing several decigrammes of crystallized silicon on the bottom of a small crucible of retort carbon, covering the silicon with a small flat disk of retort carbon upon which is placed the slip of platinum. The crucible, closed by its turned cover, is then enveloped in a titaniferous packing and kept at a brilliant white heat for an hour and a half. The metal is found to have only very slightly increased in weight, and its properties remain unaltered. This experiment was repeated several times with the same result. If, however, the crystallized silicon be replaced by powdered calcined silica, the platinum, placed upon the carbon disk, fuses and increases in weight, while the silica loses weight. The theory of these curious phenomena is very difficult to establish on account of the high temperatures which are necessary for their manifestation, but it may be concluded, at present, that nitrogen and probably oxygen also play some part in the transportation of the silicon across the intervening space, and that the carbosilicous compounds recently described by MM. Schützenberger and Colson also take part in the phenomenon.—*Comptes Rendus*, xciv., 1,710—*Amer. Chem. Journal*.

STANNOUS NITRATES.

At the Royal Powder Works at Spandau, Prussia, frequent ignition of the powder at a certain stage of the process led to an examination of the machinery, when it was found that where, at certain parts, bronze pieces which were soldered were in constant contact with the moist powder, the solder was much corroded and in part entirely destroyed, and that in the joints had collected a substance which, on being scraped out with a chisel, exploded with emission of sparks. It was suspected that the formation of this explosive material was in some way connected with the corrosion of the solder, and the subject was referred for investigation to Rudolph Weber, of the School of Technology, at Berlin. The main results of his investigation are here given.

The explosive properties of the substance indicated a probable nitro-compound of one of the solder metals (tin and lead), and as the lead salts are more stable and better understood than those of tin, it was resolved to investigate the latter, in hope of obtaining a similar explosive compound. Experiments on the action of moist potassium nitrate on pure tin led to no result, as no explosive body was formed. Stannous nitrate, $\text{Sn}(\text{NO}_3)_2$, formed by the action of dilute nitric acid on tin, has long been known, but only in solution, as it is decomposed on evaporating. By adding freshly precipitated moist brown stannous oxide to cool nitric acid of sp. gr. 1.20, as long as solution occurred, and then cooling the solution to -20° , Weber obtained an abundance of crystals of the composition $\text{Sn}(\text{NO}_3)_2 \cdot 20\text{H}_2\text{O}$. They resemble crystals of potassium chlorate. They cannot be kept, as they liquefy at ordinary temperatures. An insoluble basic salt was obtained by digesting an excess of moist stannous oxide in solution of stannous nitrate, or by adding to a solution of stannous nitrate by degrees, with constant stirring, a quantity of sodium carbonate solution insufficient for complete precipitation. Thus obtained, the basic salt, which has the composition $\text{Sn}_2\text{N}_2\text{O}_7$, is a snow-white crystalline powder, which is partially decomposed by water, and slowly oxidized by long exposure to the air, or by heating to 100° . By rapid heating to a higher temperature, as well as by percussion and friction, it explodes violently, giving off a shower of sparks. This compound is also formed when a fine spray of nitric acid (sp. gr. 1.20) is thrown upon a surface of tin or solder. It is also formed when tin or solder is exposed to the action of a solution of copper nitrate, and thus formed presents the properties already described.

In this, then, we have a probable cause of the explosions occurring in the powder works; but the explanation of the

formation of the substance is wanting, as potassium nitrate was shown not to give an explosive substance with tin. A thin layer of a mixture of sulphur and potassium nitrate was placed between sheets of tin and copper foil, and allowed to stand, being kept constantly moist. After a time the copper was found to have become coated with sulphide, while the tin was largely converted into the explosive basic nitrate. The conditions are obviously the same as those found in the powder machinery, where bronze and tin solder are constantly in contact with moist gunpowder. The chemical action is probably this: the sulphur of the powder forms, with the copper of the bronze, copper sulphide; this is oxidized to sulphate, which reacts with the niter of the powder, forming potassium sulphate and copper nitrate; the latter, as shown above, then forms with the tin of the solder the explosive basic nitrate, which, being insoluble, gradually collects in the joints, and finally leads to an explosion.—*Journal für Praktische Chemie*.

METALLIC THORIUM.

By L. F. NILSON.

THE density of thorium as obtained by reducing the anhydrous chloride by means of sodium was found by Chydenius, 7.657 to 7.795. The author has obtained metallic thorium by heating sodium with the double anhydrous thorium potassium chloride, in presence of sodium chloride in an iron crucible. After treating the residue with water there remains a grayish, heavy, sparkling powder, which under the microscope appears to consist of very small crystals. Metallic thorium is brittle and almost infusible; the powder takes a metallic luster under pressure, is permanent in the air at temperatures up to 120° , takes fire below a red heat either in air or oxygen, and burns with a dazzling luster, leaving a residue of perfectly white thorium. If heated with chlorine, bromine, iodine, and sulphur, it combines with them with ignition. It is not attacked by water, cold or hot. Dilute sulphuric acid occasions the disengagement of hydrogen, especially if heated, but the metal is acted on very slowly. Concentrated sulphuric acid with the aid of heat attacks the metal very slightly, evolving sulphurous anhydride. Nitric acid, strong or weak, has no sensible action. Fuming hydrochloric acid and aqua regia attack thorium readily, but the alkalis are without action. The metal examined by the author behaves with the reagents in question the same as did the specimens obtained by Berzelius. The mean specific gravity of pure thorium is about 11. Hence it would seem that the metal obtained by Chydenius must have contained much foreign matter. The specific gravity of pure thorium is 10.2207 to 10.2198. The equivalent and the density being known, we may calculate the atomic volume. If we admit that the metal is equivalent to 4 atoms of hydrogen, we obtain the value 21.1. This number coincides with the atomic volumes of zirconium (21.7), cerium (21.1), lanthanum (22.6), and didymium (21.5). This analogy is certainly not due to chance; it rather confirms the opinion which I have put forward in connection with my researches on the selenites, on certain chloro-platinates and chloro-platinites, etc., that the elements of the rare earths form a series of quadrivalent metals.

[AMERICAN CHEMICAL JOURNAL.]

FRIEDRICH WÖHLER.

No one but a chemist can appreciate the full significance of the brief message which came to us a month ago without warning—"Wöhler is dead!" What need be added to it? No chemist was better known or more honored than Wöhler, and none ever deserved distinction and honor more than he. His life was made up of a series of brilliant successes, which not only compelled the admiration of the world at large, but directed the thoughts of his fellow workers, and led to results of the highest importance to science.

It is impossible in a few words to give a correct account of the work of Wöhler, and to show in what way his life and work have been of such great value to chemistry. Could he himself direct the preparation of this notice, the writer knows that his advice would be, "Keep to the facts." So far as any one phrase can characterize the teachings of Wöhler, that one does it; and though enthusiasm prompts to eulogy, let us rather recall the plain facts of his life, and let them, in the main, speak for themselves.*

He was born in the year 1800 at Eschersheim, a village near Frankfurt-on-the-Main. From his earliest years the study of nature appears to have been attractive to him. He took great delight in collecting minerals and in performing chemical and physical experiments. While still a boy, he associated with a Dr. Buch, of Frankfurt, and was aided by this gentleman, who did what he could to encourage in the young student his inclination toward the natural sciences. The first paper which bears the name of Wöhler dates from this period, and is upon the presence of selenium in the iron pyrites from Kraslitz. In 1820 he went to the University of Marburg to study medicine. While there he did not, however, neglect the study of chemistry. He was at that time particularly interested in an investigation on certain cyanogen compounds. In 1821 he went to Heidelberg, and in 1823 he received the degree of Doctor of Medicine. L. Gmelin became interested in him, and it was largely due to Gmelin's influence that Wöhler gave up his intention of practicing medicine, and concluded to devote himself entirely to chemistry. For further instruction in his chosen science, Wöhler went to Stockholm to receive instruction from Berzelius, in whose laboratory he continued to work from the fall of 1823 until the middle of the following year. Only a few years since, in a communication entitled "Jugenderinnerungen eines Chemikers," he gave a fascinating account of his journey to Stockholm and his experiences while working with Berzelius. On his return to Germany, he was called to teach chemistry in the recently founded municipal trade school (Gewerbschule) at Berlin. He accepted the call, and remained in Berlin until 1832, when he went to Cassel to live. In a short time he was called upon to take part in the direction of the higher trade school at Cassel. He continued to teach and work in Cassel until 1836, when he was appointed Professor of Chemistry in Göttingen. This office he held at the time of his death, September 23, 1882.

In 1825 Wöhler became acquainted with Liebig, and an intimate friendship resulted, which continued until the death of Liebig, a few years ago. Though they lived far apart, they met during the vacations at their homes, or traveled together. Many important investigations were conceived by them as they talked over the problems of chemistry, and many papers appeared under both their names, containing the results of their joint work. Among such papers may be mentioned: "On Cyanic Acid" (1830); "On Melilithic Acid" (1830); "On Sulphotartaric Acid" (1831); "On

* See Kopp's "Geschichte der Chemie," iv., 440.

* Zeitschrift f. Anal. Chem., xi., 343.
† Dingler's Polytech. Jour., ccvii., 516.
‡ Pharm. J. Trans. [3] vi., 867.
§ Berichte d. Deutschen Chem. Gesellsch., viii., 72.
¶ Pharm. Centralhalle, xxii., 3.
‡ Berichte d. Deutsch. Chem. Gesellsch., xv., 230.
** Pharm. Centralhalle, xxii., 236.
†† Berichte d. Deutsch. Chem. Gesellsch., xv., 1,370 and 1,663.