—to assure permanent communication between the interior and the exterior. One instrument is placed in the working chamber, the other in the superintendent's booth on the platform of the caisson.

Engineering Notes.

What is probably the highest dock in the world has recently been completed at Port Florence, on the Victoria Nyanza, in Uganda, at an altitude of 3,700 feet above sea level. The dock has been constructed to accommodate the Nyanza fleet plying on the lake in conjunction with the Uganda railroad. It measures 250 feet in length by 48 feet wide and 14 feet deep. It is excavated out of the solid rock by native labor, and occupied twelve months in construction, at a cost of $20,000. Both the time occupied and the cost of the undertaking were increased owing to plague visitations, which seriously interfered with the work.

After an accident which occurred to a flywheel in a large European electric station, the superintendent designed and had constructed a flywheel of wood more than 35 feet in diameter and 10 feet wide at the rim. The thickness of the rim is about 12 inches and is constituted of 44 thicknesses of beech planks with staggered joints. The boards are glued together and the whole is bolted. The inside of the flywheel is formed of a double wheel with spokes and the latter are fastened to two hubs. The twenty-four spokes and the hubs are of cast iron. The weight of the flywheel is nearly 50 tons. On the first trial it attained a speed of 76 revolutions per minute, which corresponds to about 120 feet per second at the rim. It is probable that this is the highest peripheral speed which has yet been obtained with a wooden wheel, and it is one of the highest even from an absolute standpoint. As to size, the flywheel seems to hold the record.

In European countries the development of canal traffic is receiving special attention from the various governments, according to a recent report, published by the British Foreign Office. In Germany these waterways are to be brought up to date, for which purpose an expenditure of $83,643,750 has been sanctioned this year. Of this total, $62,687,500 is to be devoted to the construction of a canal from the Rhine to the Weser, including the canalization of the Lippe, and various other accessory works. The balance is to be expended upon the construction of a large canal for barges between Berlin and Stettin, the improvement of the waterway between the Oder and the Vistula, and the canalization of part of the Oder. In France the modernization of existing, and the construction of new, canals will absorb $41,200,000. The new works include the Canal du Nord, one from Cette to the Rhone, and another from Marseilles to the Rhone. A similar development is being carried out in Belgium, Austria-Hungary, and the Netherlands, for which large sums have been appropriated by the governments.

Owing to the success that has attended the inauguration of the steamship service with the vessel "Coya" on Lake Titicaca in Peru, the highest navigable sheet of water in the world, another and much larger boat "Inca" is now in course of erection upon the shores of the lake. This latest acquisition is 220 feet in length by 30 feet beam and 14 feet draft, of 550 tons displacement, and propelled by twin-screw engines developing 1,000 I. H. P., capable of giving a speed of 12 knots. The vessel was erected in England, complete in every detail, and was then dismantled, every section being packed and carefully numbered, and shipped in 3,000 cases to the port of Mollendo. From the seaport the parts were conveyed to the shores of the lake by railroad—a distance of 150 miles, and involving a climb of over 12,000 feet. The "Inca" is modern in every respect, being complete with elaborate passenger accommodation, electric lighting, and steam heating. There is accommodation for 24 passengers and every possible arrangement and facility for working freight.

At the last annual meeting of the Gas Association known as the Markischer Verein at Berlin, two interesting papers were read by Messrs. Pfudel, of Charlottenburg, and Bremer, of Berlin, concerning the replacing of cast-iron by wrought-iron pipes in the Berlin system. The cast-iron pipes, owing to the frequent breaks which occurred, gave rise to serious accidents, and they were then replaced by wrought-iron pipes without, however, taking the necessary precautions against rusting. At the end of a few years the pipes were entirely eaten through, and in their place was found an envelope which was mostly made up of rust. Then the company tried protecting the pipes by a coating formed of a mixture of tar, sand, lime, powdered clay, and pitch. A very good result was obtained with this coating, and it is found that pipes which have been buried for twelve years are perfectly preserved. The municipality of Berlin, after the disastrous explosion which took place in Handelstrasse, had the proprietors replace all the cast-iron branch pipes by the new system, so that soon there will be little danger of explosion.

THE SIZE OF MOLECULES.

By the term molecule the smallest possible particle of a chemical substance is understood. For example, if a piece of cane sugar is broken into smaller and smaller fragments, a point is finally reached beyond which the subdivision cannot be carried without producing something different from cane sugar. At this point we have reached the cane-sugar molecule.

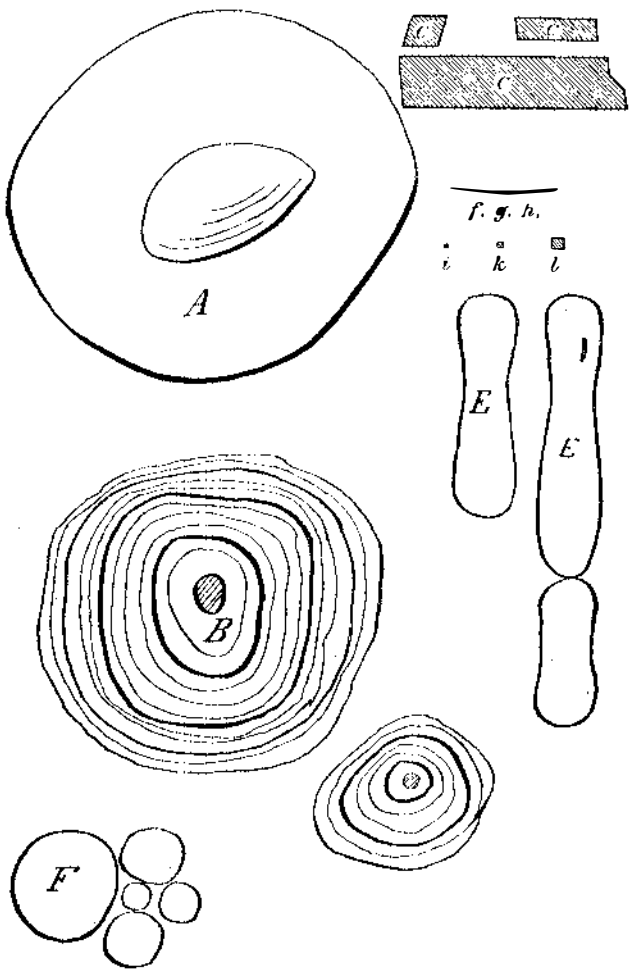

Fig. 1.—MAGNIFIED TEN THOUSAND TIMES.

A. Human blood corpuscle. *B.* Rice starch grain. *C.* Kaolin suspended in water. *E, F.* Bacteria. *f, g, h.* Particles of a colloidal solution of gold. *i, k, l.* Particles of a gold solution in the act of precipitation.

Now, molecules are composed of atoms, which are the smallest possible particles of the chemical elements, and the dimensions of molecules vary greatly according to the number and character of the atoms of which they consist. The hydrogen molecule is a very small one, for it is composed of only two atoms of hydrogen. The molecule of cane sugar is comparatively large, containing 12 atoms of carbon, 22 of hydrogen and 11 of oxygen. But there are molecules of much greater size. The molecule of albumen is believed to contain nearly 1,000 atoms.

The subdivision of a lump of sugar, described above, is purely hypothetical, but many substances can be so divided very easily by dissolving them in water or some other liquid. In solution they are resolved either into separate molecules, as is the case with cane-sugar, or into larger or smaller groups of molecules. In the case of substances with very complex molecules especially, it must not be supposed that all the particles in the solution are equal in size; on the contrary, there

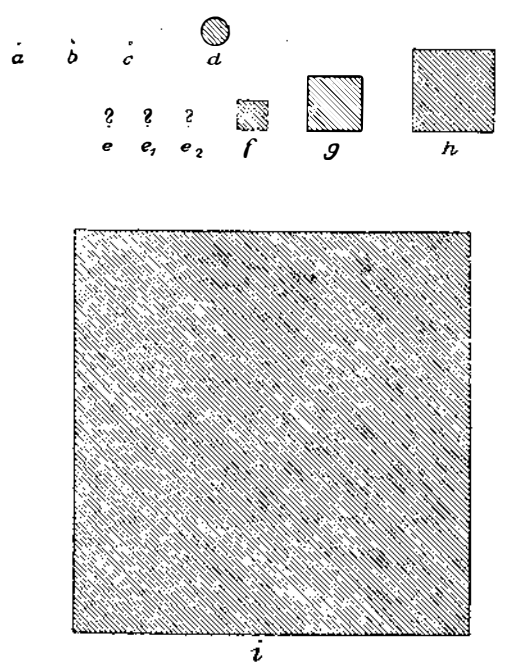

Fig. 2.—MAGNIFIED ONE MILLION TIMES.

a. Molecule of water. *b.* Molecule of alcohol. *c.* Molecule of chloroform. *d.* Molecule of soluble starch. *e–h.* Particles of colloidal solution of gold. *i.* Particle of gold in the act of precipitation.

are many reasons for believing that the groups of molecules are in various stages of disintegration.

The "ultra microscope," invented by Siedentopf and Zsigmondy, has made it possible to detect, in a solution, solid particles of a diameter of 4 millionths of a millimeter. (The limit of the best microscopes is 75 times as great, or 3 ten-thousandths of a millimeter.) This new optical instrument has brought the largest molecules, such as those of albumen and soluble starch, into the realm of visibility. The accompanying diagrams, from a recent publication* of Dr. Zsigmondy, may serve to give a vague idea of the dimensions of this ultramicroscopic world. If one of the largest of molecules, that of soluble starch, could be actually magnified 10,000 times in every direction, so that its volume would be multiplied 1,000,000,000, it would still be smaller than a pea. One of the five million corpuscles which are contained in a cubic centimeter of blood would, if enlarged in the same proportion, fill a large room, for its diameter would measure six meters.

In the Scientific American of November 11, 1905, some account was given of inorganic colloidal solutions, which consist of metals and other insoluble substances, in a state of extremely fine subdivision, held in suspension by water or other liquids. Zsigmondy has studied one of these solutions, colloidal gold, with especial care and has found that the suspended particles of gold differ very greatly in size.—Dr. Bechhold in Umschau.

The Current Supplement.

The current Supplement, No. 1572, opens with a description of some new bogie transport cars which were especially constructed to transport traction engines and motor-driven plows. Excellent illustrations accompany the article. Rear-Admiral George Melville's splendid paper on liquid fuel for naval and marine uses is concluded. For experimental purposes it is often desirable to have at hand an alternating current of low voltage. To secure this from a line circuit a transformer is necessary. Edmund S. Smith describes a small transformer that any one at all familiar with tools can easily build. The total cost of materials will not exceed $3.50, while the only machine tool necessary is a small drill. T. R. Hopper writes on some simple experiments with currents of high frequency. The general question of solution has always been of importance to the metallurgist. J. H. Stansbie gives his views on the solution of solids and solid solutions in a way that cannot but be of help to metallurgists. F. M. Feldhaus gives an illustrated description of some old inventions. Among these may be mentioned a very early magic lantern, a lamp with a glass chimney invented in 1500; Leonardo da Vinci's parachute; a very modern-looking diving suit, dated 1500; a diving bell attributed to Alexander the Great; a paddlewheel boat of 1430, a turbine which bears the date 1575, and a rapid-fire gun which goes back to the fourteenth century. How natural and artificial patinas are produced is told by B. Setleg. The practice of the cyanide process of gold extraction presents us with several new and interesting aspects of the problem of solution. These Mr. G. F. Beilby has considered in an article that bears the title "Gold Molecules in Solution." "Recent Foreign Methods for the Production of Celluloid and Similar Substances" is the title of an article which has been compiled and translated from French, German, and Italian periodicals. Alexander W. Roberts presents graphically some idea of the sun's distance.

A New Sweet Compound.

A new compound described by Dr. T. Gigli has appeared in the European chemical trade which is designed to imitate saccharine. It is known as "banana essence." The taste of this syrup liquid is at first caustic and then bitter, but soon after very sweet. Its specific gravity is 1.188 at 20 deg. C., and it gives an acid reaction. Analysis shows it to contain 54 per cent of saccharine in combination with a base analogous to pyridine. Heated on platinum foil it gives white fumes, then burns with a bright flame, leaving a thin layer of carbon. When the latter is burned, the ash is negligible. The syrup gives a precipitate with Nessler's liquid and most of the alkaloid reagents. Adding dilute mineral acids we can separate the saccharine as a white crystalline precipitate, and ether dissolves it again. By evaporating the ether solution we have white crystals which melt about 225 deg. C. The author tried to prepare a solution of saccharine in pyridine, but did not obtain a product identical with the above.

M. Poincaré, the learned French mathematician and member of the Academy of Sciences, has carried off the John-Boulyai Hungarian prize of 10,000 crowns, or a little over $2,000. This is the first award of the prize which is granted every five years to the author of the most notable mathematical work produced during that period.

* Zur Erkenntniss der Kolloide. Jena, 1905, G. Fischer.