THE PHARMACEUTICAL INDUSTRY OF FRANCE.

BY JACQUES BOYER.

The pharmaceutical industry of France is now monopolized by a few large firms, which supply all the retail dealers. The accompanying photographs illustrate the operations of the largest of these establishments, in whose works, at Paris and at St. Denis, quinine and other medicines which are given in minute doses are made by hundredweights and tons. The modest apparatus of the old-fashioned apothecary would appear quite insignificant beside the gigantic vats in which sulphite of magnesia is crystallized, enormous retorts in which quinine and cocaine are purified, and the heavy pestles which are always grinding benzoate of soda in great mortars. For the raw materials which nature supplies to the pharmacist are seldom available for immediate use in medicine. They must be subjected to various manipulations in order to facilitate their administration—or, in other words, to gild the pill. Let us, then, examine the principal modern methods of preparing various *classes* of pharmaceutical products such as *espèces*, or simple mixtures of dried parts of plants, solutions, distillates, extracts, sweetened pastes, pills, granules, and *cachets*, pomades, ointments, plasters, and other remedies intended for external use.

The manufacture of *espèces* requires only mechanical operations without the addition of any reagent. In the large herbarium where woods, barks, etc., are stored, the freshly-gathered plants are spread out or hung up to dry and after complete desiccation are tied in bundles and labeled. When wanted for use they are comminuted in various ways—by shaving with planes (quassia, sandalwood); by triturating (Peruvian bark); by passing through fanning and grinding mills (flaxseed); by pulverizing in mortars with machine-driven pestles, arranged usually in batteries of four, eight, or ten; by grinding under millstones; and, finally, by sifting in order to give the powders the fineness prescribed by the "Codex."

The mortars are of cast iron and are mounted on stone bases and covered with leather hoods in order to prevent the powder from scattering. The millstones are of granite. "Medicated waters" and "spirits" are obtained by distillation. In the former water, in the latter alcohol is the vehicle of the medicinal principle. Both are made, in most cases, from vegetable substances, either fresh or dried, which are allowed to macerate for a period of from one to several days and are then put into a retort and distilled over a water bath. Sometimes the distillation is effected in a vacuum in order to lower the temperature of ebullition and prevent the decomposition of the essential oils.

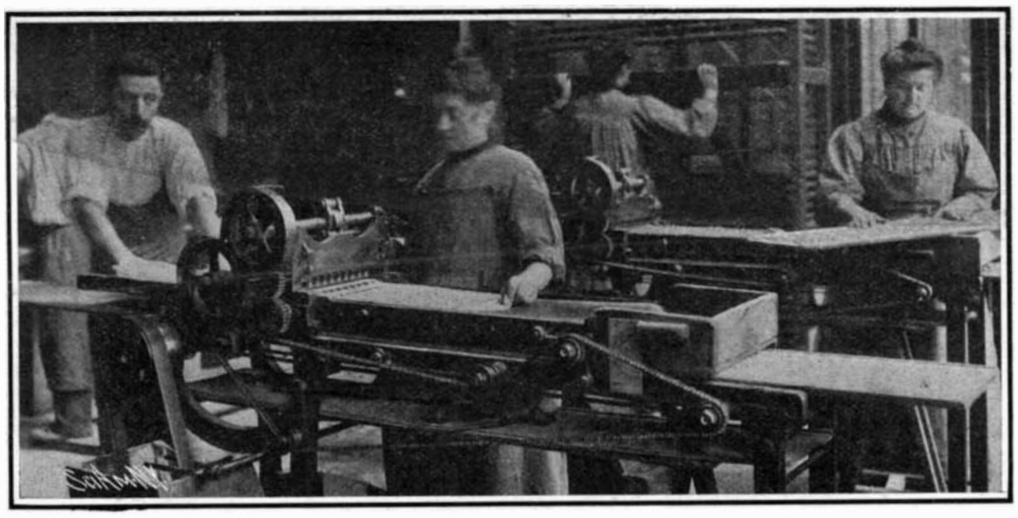

Fig. 8.—Cutting Out Pastilles by Machine.

Fig. 9.—Casting Marshmallows in Molds of Starch.

Fig. 10.—A Pill-Making Machine.

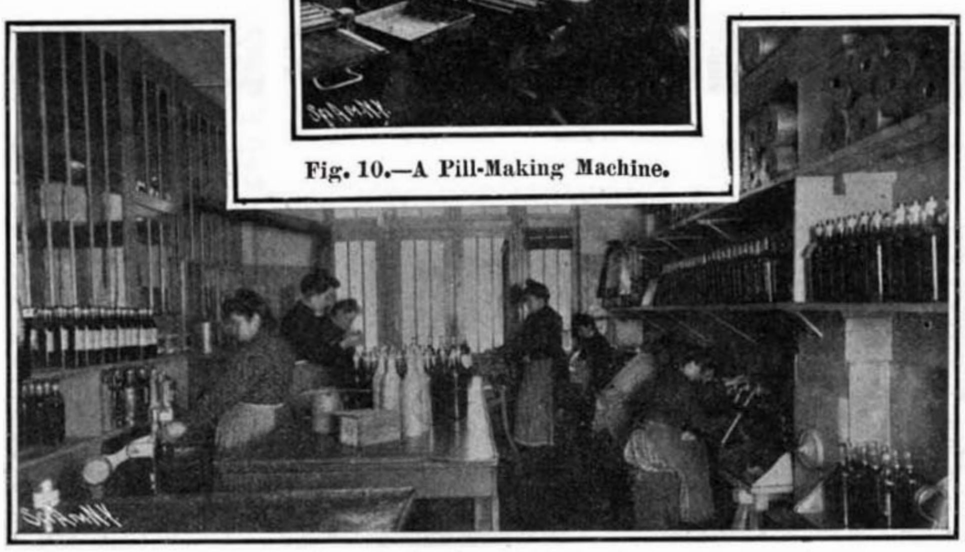

Fig. 11.—Bottling Cod-Liver Oil.

As a typical example we may take the preparation of quinine, the invaluable febrifuge discovered by Pelletier and Caventou in 1820. Peruvian bark, the source of this alkaloid, is first broken up, pulverized, and sifted by machines and then, mixed with a certain proportion of lime, is heated with heavy petroleum oils *in vacuo* (Fig. 1). Usually, the oil required is pumped daily from a great tank, through underground pipes, to the apparatus, in order to avoid the accumulation of a large quantity of the inflammable hydrocarbons in the factory. Peruvian bark contains, besides quinine, another alkaloid, cinchonine. Both are dissolved and extracted by the hot petroleum which deposits them on cooling. They are separated by converting them into sulphates and crystallizing the mixed solutions in immense vats (Fig. 2). The sulphate of quinine crystallizes out, while the more soluble sulphate of cinchonine remains in solution in the mother liquor. The former is purified by successive crystallizations, after each of which it passes through a centrifugal machine which rapidly removes the adhering mother liquor. Finally, the pure sulphate of quinine is spread on trays covered with absorbent paper which are taken to the drying ovens. When completely desiccated it is packed in boxes or in bottles.

Solid extracts, dry or moist, are made by evaporating vegetable and animal infusions, more or less completely, in order to obtain the active principles of the drugs in comparatively small bulk. Although the discovery of alkaloids, acids, glucosides, and other definite chemical compounds in medicinal plants has diminished the importance of extracts, pans holding from 250 to 500 liters (70 to 140 gallons) each, and retorts, one of which has a capacity of 1,500 liters (413 gallons), are in constant use for the preparation of aqueous extracts of coca, kola, digitalis, and opium, alcoholic extracts of colchicum and hyoscyamus, and essential extracts of cantharides and male fern. The extracts

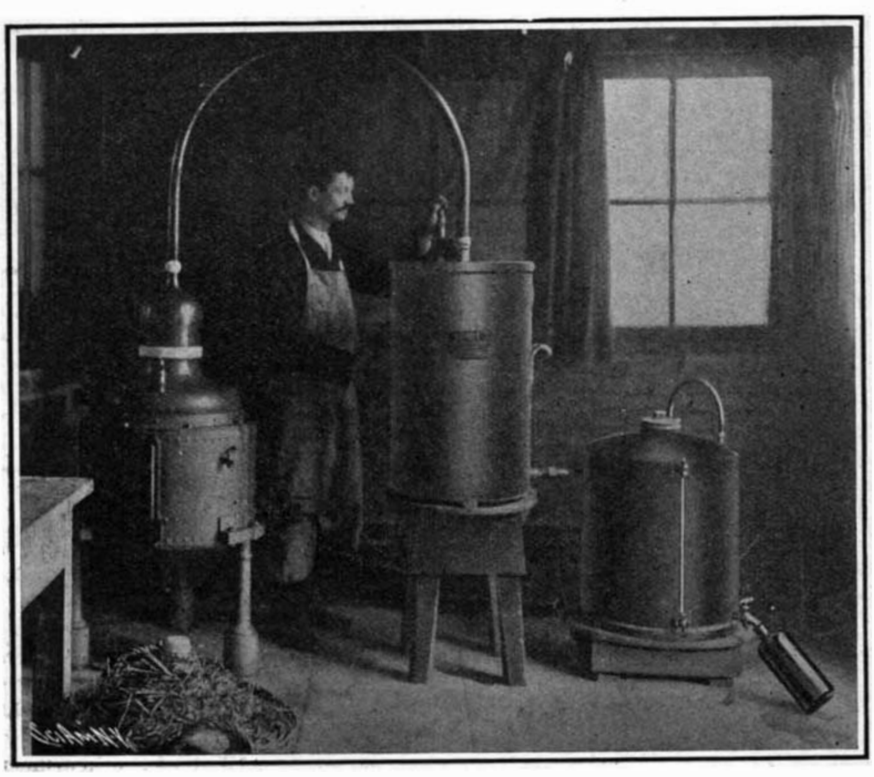

Fig. 5.—Distilling Chloroform.

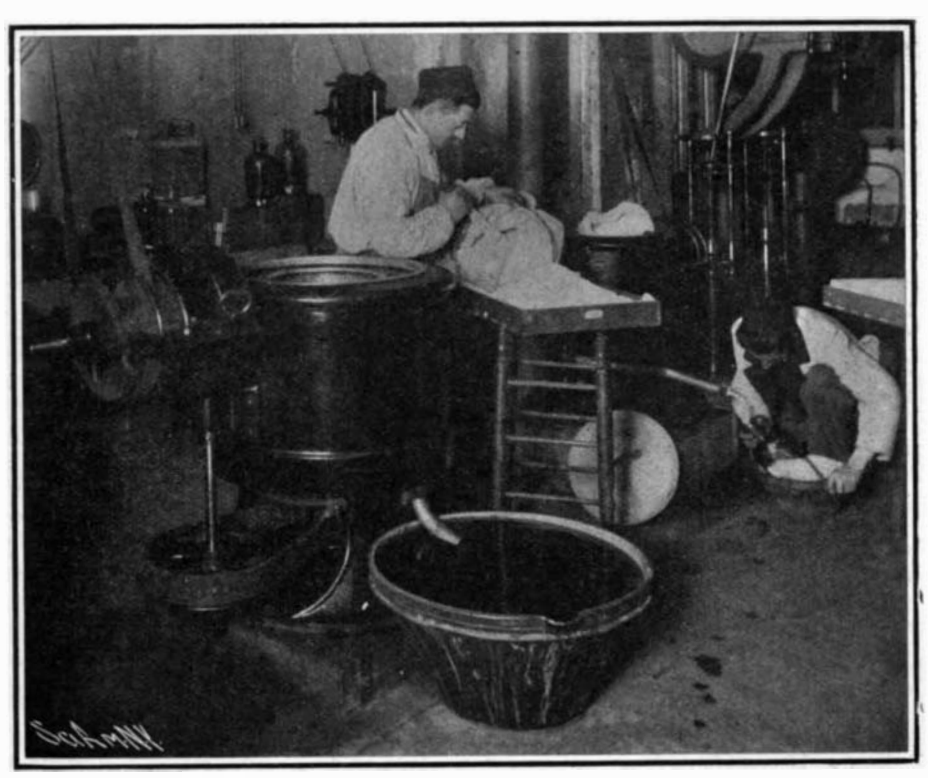

Fig. 6.—A Centrifugal Drying Machine for Cocaine.

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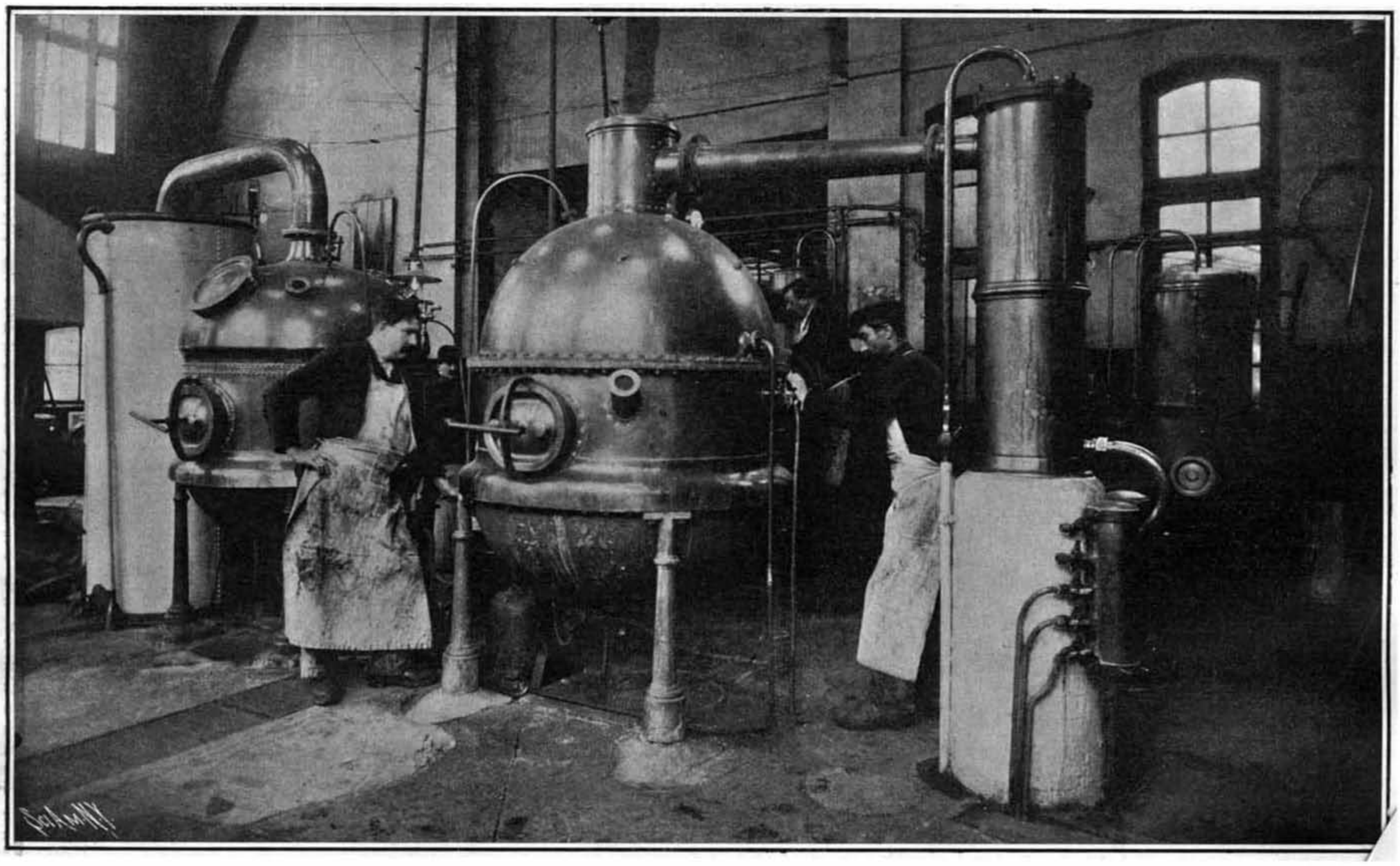

Fig. 1.—Extraction of Peruvian Bark Alkaloids by Hot Petroleum in Vacuo.

Fig. 7.—Making Gelatine Capsules.

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which are known as "robs" are obtained by the direct evaporation of the natural juices of certain plants, including lettuce, aconite, belladonna, and hemlock.

Some idea of the quantities in which certain medicines of mineral origin are produced may be gained by visiting the room devoted to the manufacture of kermes mineral (Fig. 3). Here we find twenty-five sheet-iron kettles, each of the capacity of 1,200 liters (330 gallons), which are connected by large pipes provided with stopcocks so that any kettle can be shut off from the rest at will. The kettles contain a mixture of sulphide of antimony, carbonate of soda, and water, which is boiled for an hour and then drawn off into evaporating pans of 5,000 liters (1,375 gallons) capacity. The liquid is filtered while hot. On cooling it deposits a light, velvety brown powder which, after being dried on wooden trays covered with paper, constitutes kermes, an expectorant which is given in doses of from 5 to 20 centigrammes (about 1 to 3 grains).

Near the kermes pavilion stands a kiln in which 5,000 or 6,000 kilogrammes (5 or 6 tons) of magnesia are calcined annually—enough to purge half a million persons. Twenty vats of 2,000 liters (550 gallons) capacity are used in washing the carbonate of magnesia which, formed into loaves, is dried on shelves in an immense oven or hot room (Fig. 4).

The solution of sulphate of magnesia is concentrated in steam-heated kettles of equally great size. Thence, the liquid flows, through wooden gutters, to the crystallizing pans, from which workmen shovel the beautiful white crystals. Eighty thousand kilos (80 tons) of sulphate of magnesia (Epsom salt) are produced annually at the St. Denis works.

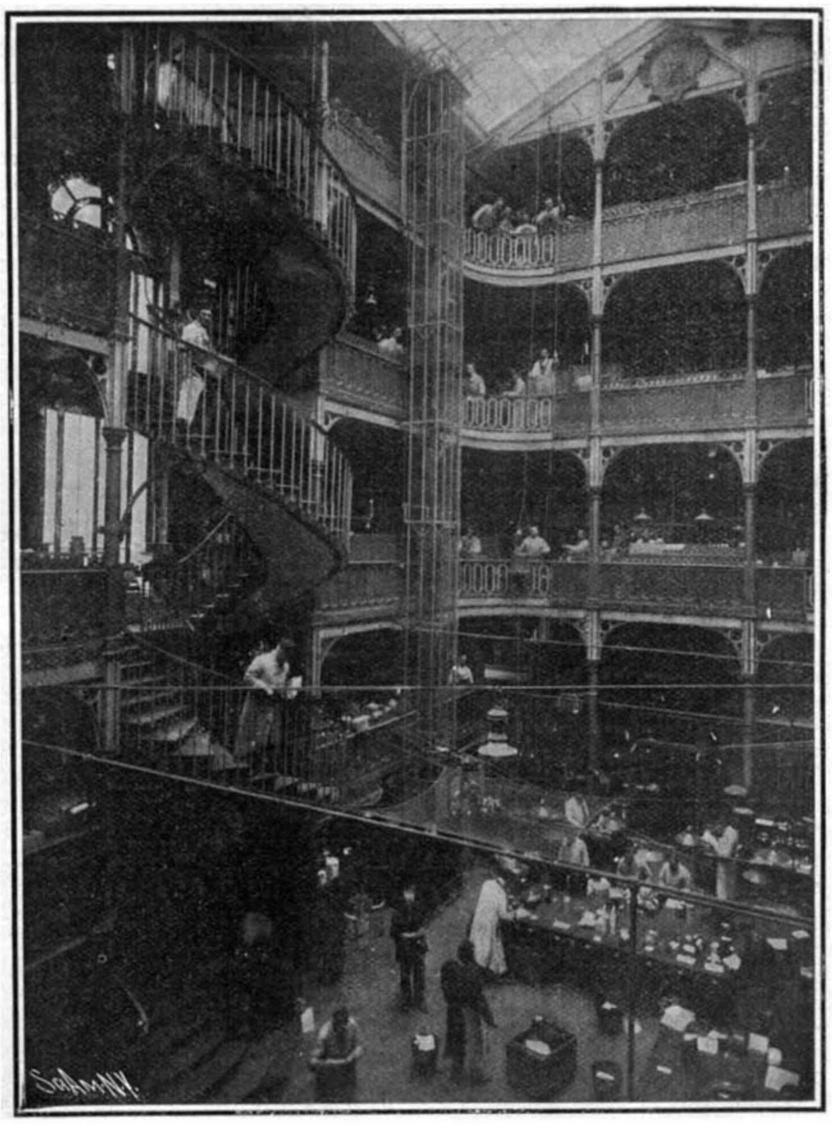

Fig. 12.—Sales Department of a Large French Drug House.

Chloroform occupies a special building, the windows of which are darkened by black curtains (Fig. 5). It is made by mixing, in a large retort, 10 kilos (22 pounds) of chloride of lime with 3 kilos (6.6 pounds) of lime slaked in 80 liters (22 gallons) water, adding 2 kilos (4.4 pounds) of alcohol and passing a current of steam through the mixture, which should occupy not more than one-third of the capacity of the retort. At about 80 deg. C. (176 deg. F.) the mass swells and disengages almost pure oxygen. At this moment the fire is extinguished and the distillation begins. As soon as the swelling has subsided an additional quantity of the same mixture is introduced and this process is repeated until the retort is full. The heating is then resumed, and a mixture of chloroform, water, and alcohol condenses in the worm, whence it flows into a metallic receiver. The chloroform, being heavier than the other liquids, is easily separated from them. It is then washed by shaking with water and carbonate of potash, again separated, and dried over calcium chloride. As the finished product must be very pure, to avoid the possibility of accidents in the course of surgical operations, the chloroform is rectified by shaking with sulphuric acid, washed with a solution of soda, thoroughly mixed with pure poppy oil and redistilled, the first and last portions of the distillate being rejected.

Modern surgeons use cocaine so much that, before leaving the anæsthetics, we will glance at the apparatus employed in the extraction of cocaine from the leaves of the coca plant. The infusion is filtered and precipitated by adding acetate of lead. The precipitate, after the excess of acetate of lead has been removed by sulphate of soda, is shaken with ether, which dissolves the cocaine. The alkaloid is then converted into a hydrochlorate which is recovered in a pure state by means of a centrifugal separator. In one of the illustrations (Fig. 6) a workman is shown removing the linen bag of precious crystalline flakes and spreading them on sheets of filter paper laid on wooden trays which will next go to the drying oven.

Now let us examine the various forms in which medicines of disagreeable taste and odor are conveniently administered. Long ago, bitter powders were disguised in unleavened bread, suitably moistened. About 1872 Limousin, a pharmacist of Paris, conceived the idea of inclosing powders in envelopes made of unleavened bread. These *cachets* are now made in a mold resembling a waffle iron and consisting of two iron plates marked with little depressions. Starch paste is introduced between the plates, which are heated by a gas furnace.

A similar purpose is served by gelatine capsules which, though not attacked by the medicine, dissolve in the digestive fluids. Into a solution of gelatine and gum, kept hot by a water bath, a girl dips a number of little olive-shaped iron forms, polished and oiled, which are attached by their stems to holes in a plate, which the operative turns to and fro in order to secure a uniform coating of the viscous fluid (Fig. 7). The mold is then removed from the bath and, as soon as the coating of gelatine has cooled and "set," it is taken to a drying room

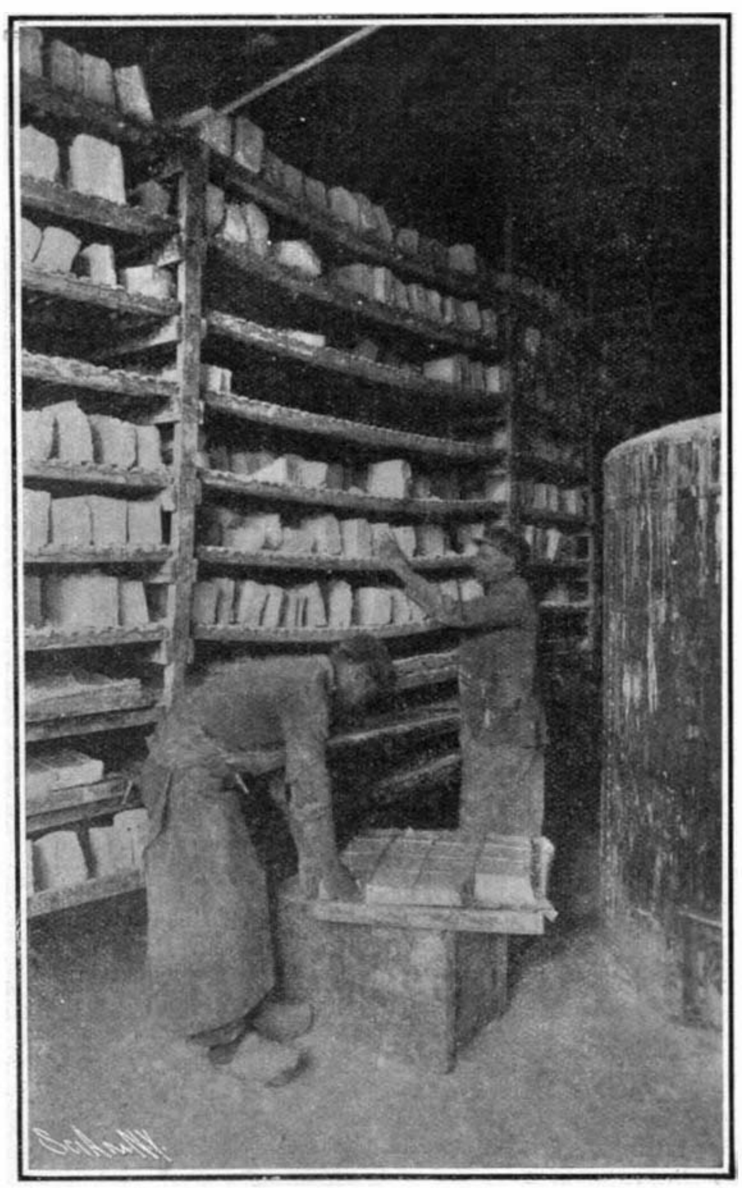

Fig. 4.—The Magnesia Drying Room.

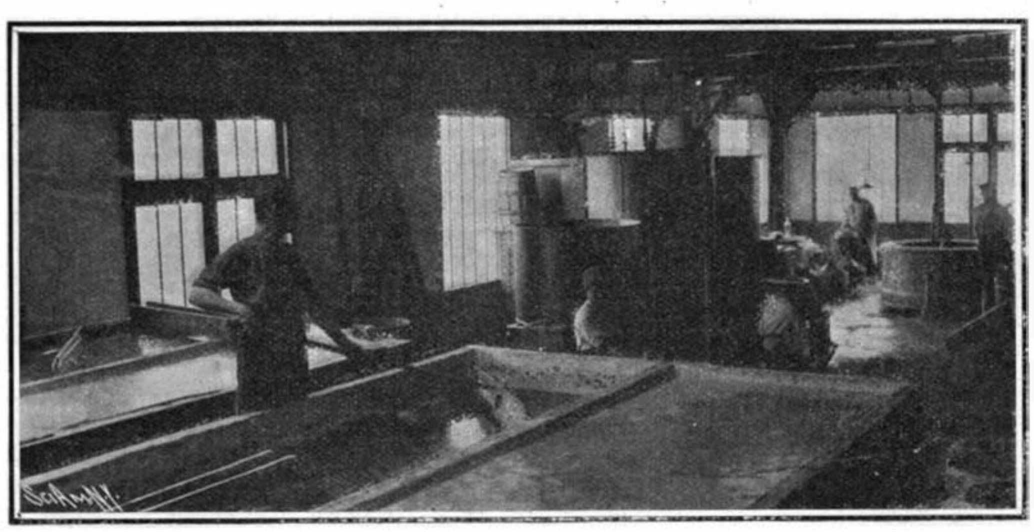

Fig. 2.—Crystallizing Salts of Quinine.

Fig. 3.—The Kermes Room.

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which is very gently heated. When the capsules are partly dry, but still elastic, they are removed from the forms and set, mouth upward, in little hemispherical depressions in wooden boards, each of which accommodates one hundred capsules.

Women now fill the capsules with liquid medicines by means of pointed pipettes or very fine tubes attached to reservoirs, opening and shutting the stopcock for each capsule. This operation appears very simple, but considerable dexterity is required to perform it without spilling the liquid. The filled capsules are then closed by brushing the orifices repeatedly with the hot solution of gelatine.

Another method, much used for ether, oil of turpentine and other very volatile substances, was invented by M. Thérenot. The liquid is poured between two sheets of gelatine which are then pressed together between two plates of metal marked by small and opposite indentations. The sheets of gelatine being welded together around the indentations, the result is a sheet of flattened beads, or pearls, filled with liquid, which are connected by their edges when they come from the mold, but are easily separated with the fingers.

Pastilles, troches, or lozenges are made by the ingenious apparatus which is shown in operation in Fig. 9. A paste, formed by mixing the medicine, in powder or solution, with sugar and gum tragacanth, is kneaded and rolled into a layer of the desired width and thickness. This is carried, by a moving apron, to and between the opposing punches of the pastille machine (Fig. 8). As the pastilles are cut out they are arranged in wooden trays which are placed on racks to allow the pastilles to dry. The scraps of paste are kneaded over and again passed through the machine. In this way are made the Vichy pastilles used in dyspepsia and the pastilles of kermes, sulphur and chlorate of potash, which are prescribed in bronchial affections.

Iceland moss and marshmallow pastes are made by adding the medicinal substance to melted sugar and slowly dropping the liquid mixture, from a dipper furnished with a spout, into peculiar molds (Fig. 9) in which they remain during their stay in the drying room. The molds are made by filling wooden boxes with fine dry starch and putting them under a press containing metal plungers, or forms, which make in the starch the cavities or molds into which the liquid paste is poured.

Pills are now made by machinery. The active ingredients are ground and mixed together in mortars by pestles formed of great wooden beams heavily shod with iron, which are moved by cams on a revolving shaft. Then, if the contents of the mortar, after being thoroughly ground and mixed, are pulverulent, glycerine, honey, syrup, a vegetable extract, or some other agglutinant is added to give the necessary consistence. If, on the contrary, the mass is liquid or very soft and wet, it is thickened by stirring in an inert powder such as licorice or marshmallow, which is called an excipient.

A stiff paste having been produced by either of these methods, it is rolled out into thin rods called "magdaleons." The pill-making machine (Fig. 10) consists essentially of two grooved plates, one of which, sliding over the other, divides the "magdaleons," which lie at right angles to the grooves, into approximately spherical pills.

The pills are perfected and tested by rolling them between a wooden disk and a metal plate and the perfect ones are kept in lycopodium powder to prevent them from adhering to each other.

Medicinal dragees are made by the process used by confectioners in making sugared almonds, the almond being replaced by a lump of stiff paste containing iron, mercury, anise, digitaline, atropine, or other medicine. The little medicated balls are put in a basin called a "shaker," which is heated and caused to vibrate. A thick solution of gum is added and then, slowly, a scented syrup. The dragees, polished smooth by mutual friction, become covered with a coating of sugar. They are whitened by sprinkling starch over them in the "shaker" and then go to the drying oven.

Leaving the confectionery department, let us visit the cellars in which oils, pomades, balsams, and ointments are prepared. Our attention is first attracted by fourteen round tanks of galvanized iron, each containing 1,200 liters (330 gallons) of cod liver oil which is poured into the tanks through holes in the floor of the building above. After remaining in these tanks for a time the oil is drawn off into great cemented cisterns, two of which have a capacity of 6,000 liters (1,650 gallons). From the cisterns it is pumped, as required, to the ground floor, where it passes through filters into a row of vats lined with zinc. From these it flows, through pipes that traverse the partition, to the adjacent bottling room shown in Fig. 11. Here the oil, which flows clear and limpid from a row of faucets over a zinc-covered table, is bottled, corked, capped, and labeled by girls. This rather unpleasant and repulsive work is done at St. Denis with the most scrupulous cleanliness, although the annual output of the establishment averages 150,000 kilogrammes (150 tons) of cod liver oil.

In other cellars ointments and pomades are made, by simple mixture, by solution, or by heating the active medicament with the fatty vehicle. The mixture is usually contained in a copper basin, which has a machine-driven stirrer and may or may not be heated over a water bath. The vehicle most commonly used is vaseline, which possesses the great merit of not becoming rancid.

Of other external remedies the most important are plasters, or cloths covered with an adhesive composition. The foundation generally used is unbleached muslin, which has a downy surface that adheres well to the plaster, but silk is also employed. The material is cut into strips 5 meters (5½ yards) long and 20 centimeters (8 inches) wide. On these the melted plaster is poured and distributed uniformly by passing the strips between two beveled scrapers, with their edges separated by a space equal to the desired thickness of the finished plaster. The coated strips, after drying in the air, are rolled up and packed in boxes.

A glance at the lavatory will complete our review of these pharmaceutical workshops. This is a large room with walls and floor of cement. The center of the room is occupied by cast-iron basins of a capacity of 600 liters (165 gallons), heated by steam. The waste pipes are stopped with plugs of copper. Machine-driven brushes of various forms, including bottle brushes, complete the equipment of the lavatory.

A word should be added about the sales department of the house with which this article deals. The department occupies the great hall of the Paris establishment (Fig. 12). The three galleries are connected with each other and the floor of the hall by electric elevators which stop automatically at each story. In addition, there is a powerful freight elevator which runs from the cellar to the roof.

To facilitate the rapid execution of orders, the establishment is divided into twenty departments, each of which has charge of a different class of goods and has its own separate organization, stores, and personnel, under the charge of a responsible chief. The departments of exotic drugs and rare products are located on the ground floor. In the first gallery are the chemical products and essential oils. The poison department occupies a room to which only persons engaged in that department are admitted. On the same floor is the department of galenic pharmacy. Plasters, health foods, antiseptics, medicinal confectionery, and various specialties occupy the second story, while the third contains the department of powders and the herbarium. The center of the ground floor is occupied by numerous clerks engaged in checking and transmitting orders. Here a very animated scene is presented during certain hours of the day. The lifts and elevators are continually bringing down parcels which, however, are not allowed to accumulate, but go as quickly as they come. It is a commercial hive of intense activity.

In order to eliminate every source of error in the quarter of a million orders that are filled annually—from 500 to 600 are received daily—every order, as it arrives, is copied on a sheet of paper the color of which indicates the method of forwarding (mail, freight, express, or export) and marked with a serial number which thenceforth serves to identify it. After being registered, the sheets go to the city clerk, who copies off the articles that are to be purchased from other houses. (These are brought to the hall and entered in the shipping register.) The colored order sheets then receive their shipping numbers and go to the ticket office, where clerks assigned to each of the twenty departments transcribe with manifolding pens the items that belong to that department. The stub of the ticket remains in the office. The other part goes to the proper department, from which it presently returns, attached by a drop of mucilage to the article ordered. The orders are now made up on tables divided into compartments which bear corresponding serial numbers. The checking clerk, as he inspects each article, detaches the ticket and places it in an envelope marked with the number of the order. The envelope then goes with the order to the packer, who again verifies each item at the moment of packing that particular article. This ingenious triple system of checks reduces the chances of error to a minimum and enables orders to be filled with accuracy and dispatch.

Motions in the Sidereal Structure.

BY PROF. EDGAR L. LARKIN.

All corpuscles—electrons—atoms, molecules, particles of interstellar dust, nebulæ, meteorites, uranoliths, comets, asteroids, moons, planets, and suns, move perpetually. In this note the motions of suns, vast masses, only will be considered. Suns are known to be moving in every possible direction, with varying but enormous velocities, for massive motion. In the present state of astronomy the ablest observers and mathematicians cannot detect any cause but gravitation. Many suns are coming toward the earth; while others are receding. These motions are those in the line of sight and can be detected in the telespectroscope only. Velocities of approach and recession are determined by computations based on wave-lengths of light. Other suns traverse paths that make angles with straight lines drawn from the earth to them. The angular displacement of these can be measured with telescope and micrometer, without the aid of the spectroscope. In cases where suns have a parallax large enough to be measured, these angular velocities may be translated into linear—to miles. The proper motions of suns are in every direction. Bees in a flying swarm move in all directions. The insects obey their wills. Suns obey universal gravitation.

Suppose all matter in existence to be condensed into one solid globe—then the words *rest* and *motion* might as well be taken out of the dictionary. Imagine all the atoms to be as close to each other as possible; then the mass would be "dead," unless, indeed, corpuscles revolved around their central suns—atoms. Now, let the sphere be divided into two equal masses, separated by an enormous distance. Gravitation would act and set up motion causing them to draw nearer to each other. Both would approach a point between them—their center of gravity—with ever-increasing speed. Given original distance apart great enough, then the cessation of motion at instant of collision would, by the law of conservation of energy, evolve heat sufficient to dissipate the entire mass back to the primordial cosmical state—the corpuscular. These would expand through an inconceivably wide space. If the tenuity of the expanded mass of corpuscles should equal that resulting from the resolution of the matter now in the solar system, so that a sphere having a radius equal to half the distance to our sun's nearest neighbor would be filled with the electrons—then enough of them to be in mass equal to one grain, would occupy 290,000 cubic miles! If the corpuscles in a little aluminium weight used by pharmacists should be expanded to fill an ordinary room in a house, the rarity of the mass would already be beyond all imagination. Then what will be said of the state of the same quantity of matter diffused throughout 290,000 cubic miles? Our two bodies will strike together; but let a third body appear. All will move toward their common center of gravity, but will not collide. They will form a regular revolving system, and become a "triple star." Suppose that in the case where only two bodies were in existence, some unknowable force had acted at any time in their career, to deflect one away from a straight line joining their centers of gravity; then no collision could take place, they would fall into orbits around their gravitational center and become a fine "double star." A third body acts as the unknown force. If the third mass is so far away that time is had for the two bodies to form a double star before it arrives near enough to produce a pronounced effect, the result will be a double sun revolving around a single. For, let cosmical masses in free space be deflected from a straight line joining their centers of gravity, then impact is impossible. Regular circuits will be made, in stable equilibrium, of necessity. This is owing to centrifugal tendency, one of the most potent agencies in nature. The complex curves traversed by three bodies before they become locked on regular orbits, have not been completely elaborated by mathematicians. The only possible case where an absolutely straight line could be traced by any cosmical body would be where only two were in existence. Hence, with many billions of cosmical bodies, suns and worlds, curves only are moved over. And the curvature of these is continually changing. Thus, our sun is attracted this way and that, by ever-shifting suns, to the right and left, and its pathway is sinuous and wavy. Every sun in existence attracts all others, modifying their motions slightly. Binary and triple suns traverse regular orbits, but solitary suns, like our own, are not in revolution around any stable or permanent gravitating mass. The idea of a vast central mass, whether hot or cold, light or dark, so enormously massive as to be able to dominate the entire universe, has long been exploded. We live on an atom of a world revolving around a lonesome sun, somewhere in the vicinity of the center of the Galactic Ring. A ship in mid-Pacific is not more isolated or lonely. Our sun's nearest neighbor is twenty-five trillion miles away. And on an express train with an incessant speed of one mile per minute, the time to go there would be 48,630,000 years! From our infinitesimal home, we look into the most appalling solitudes and deeps of space, and behold myriads of suns. Many of them, after long-continued and laborious research, are found to be shifting their positions. This displacement has been assigned by the ablest astronomers, for two and one-half centuries, to universal gravitation. Yet, letters have been received at this observatory, disputing this cardinal fact, saying that gravity is not the cause of the motion of suns.

Lowe Observatory, Echo Mountain, Cal.

Aluminium absorbs nitrogen when melted. A lot of aluminium skimmings will give off ammonia when wet. This shows that nitrogen has been absorbed.

The Care and Use of Spark Coils.

BY E. Q. WILLIAMS.

One of the most important considerations with any coil is to keep it dry. Although we hear a great deal about waterproof coils, it is a good plan with any kind to keep them in a dry place, not where they will get hot, but where they do not get damp, as the pressure of the jump spark is so high that it will run along a little streak of moisture almost as well as on a wire, and though it tends to dry up this moisture in so doing it sometimes carbonizes the wood* and makes another path for itself. Too much care cannot be taken, especially on launches, to have a good place for the coil and battery. And here let us sound a note of warning: Do not put on over six cells of dry battery or three cells of storage; if your coil doesn't work with this amount of battery in *good condition*, look for trouble in it; increasing the voltage will only burn out the contact points without helping the secondary spark materially.

Another thing to be guarded against is the tendency to set the vibrator spring too tight, "so as to get a good, big spark." This is tested in the air, and when a big, flaming spark is secured, the operator thinks "that will fire anything," while as a matter of fact it will skip and bother on a quick-moving engine. What is wanted for successful running is a "quick spark," that will get there just when it is needed and every time. Such a spark is usually a small one. The adjustment to secure it is the following: The vibrator screw is drawn back until it does not touch the spring. Then set the spring so that the iron head is from 1/16 inch to 1/8 inch from the core. Now bring the screw up until it touches the spring lightly, and start your engine; if it skips any, try adjusting the screw a little tighter, but leave the spring just *as weak as you can* and not have the engine skip. In this way the engine will run at its highest speed, and the battery will last very much longer. The battery consumption can be frequently increased to three or four times the amount a coil should take, by merely setting the spring stiff and getting a "big spark." On the other hand, there is a danger of setting it too weak, so that when the engine stops the vibrator spring does not touch the contact screw, and the engine will not start.

Another puzzling trouble to find is a wire that is broken inside the insulation. This sometimes happens in the most unlooked-for places, but usually where the wires are moved or bent most, as at the commutator or where there is a great deal of vibration. It can usually be located by bending and pulling, as the wire will be very much weaker and more limber in the broken spot. The writer frequently uses another piece of wire, and "jumps" the suspected wire; this tells the story quickly and surely, when the defective wire is replaced or repaired.

Spark coils when in use almost always have one secondary terminal connected to the primary, or "grounded," as it is called. This is to reduce the number of wires to the engine, and to enable the spark to complete its circuit.

In the dashboard or multiple types this connection is made inside the coil box, but in the ordinary single and some multiple coils, both secondary terminals are brought to the outside, and the ground connection is put on outside. Sometimes when a coil ceases to spark or breaks down, by changing this ground to the other secondary terminal and putting the plug wire on the terminal that was grounded, the coil will work as well as ever and run for a long time.

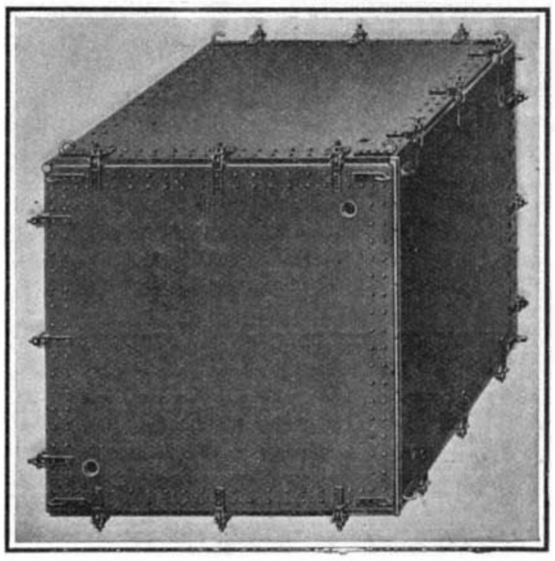
A secondary or plug wire lying over a hot pipe or cylinder is pretty sure to give trouble sooner or later. Block it up with a piece of wood or fiber, or if possible, move it away entirely; also keep oil away from your wiring, as oil rots rubber, and the wires are, or should be, insulated with rubber to guard against dampness. Do not draw the spark out in the air to see how long it is; this strains a coil, and if there is any weakness it will be sure to increase the trouble, even if it does not break down then.

Watch your spark plugs, too, as well as the spark points, as many a coil is blamed on account of the plugs; the outside gets greasy and dirty, then the spark occasionally jumps there and the engine skips, or if the plugs are foul, the spark cannot ignite. If you want solid enjoyment from your ignition system, keep everything clean and dry.

* A peculiar characteristic of wood is that when wet it is a conductor, when dry it is a non-conductor; when blackened by heat or carbonized it becomes a conductor, and when burned to ashes it is again a non-conductor.

THE DE PLUVY DIVING DRESS.

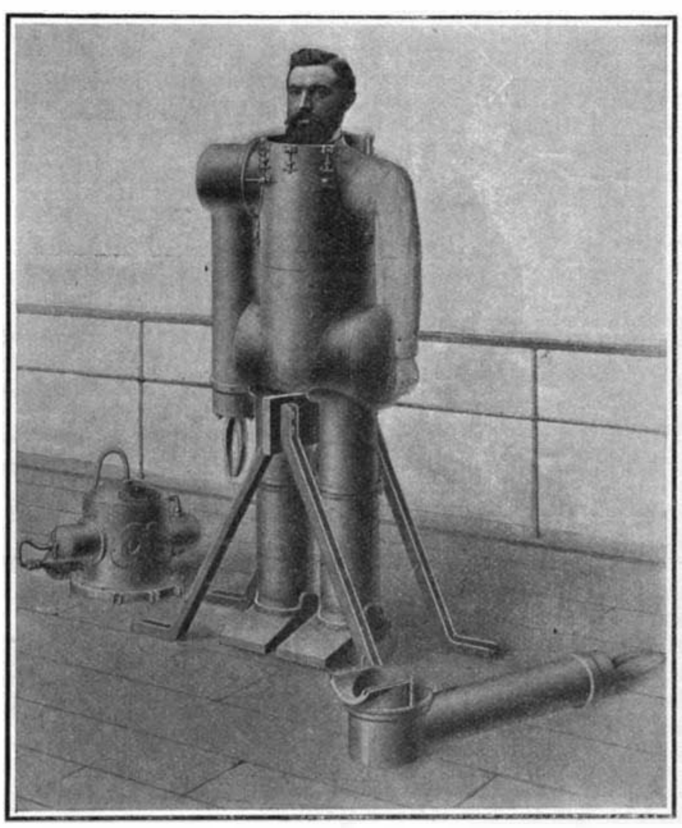
A novelty in the way of diving apparatus is the invention of M. de Pluvy, a prominent hydrographic engineer of Paris. This invention forms the subject of our cover illustration and is one which promises to be



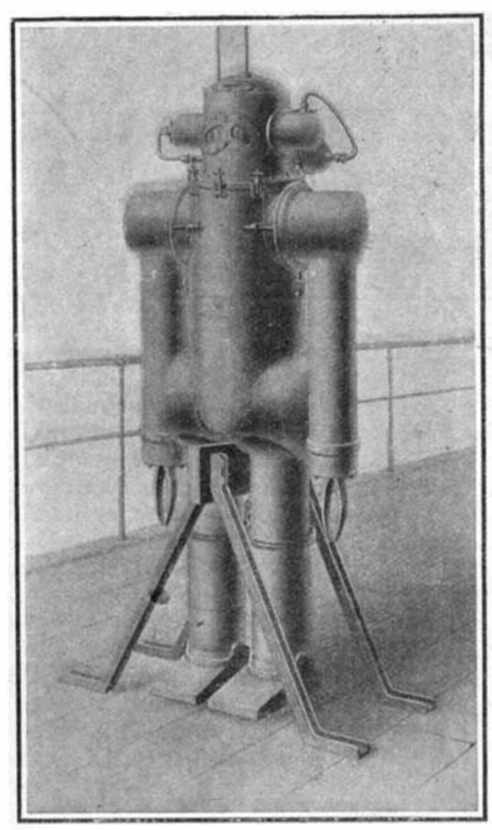
The Collapsible Caisson.

of great value in salvage operations. As De Pluvy has had many years' experience in diving operations, there is no doubt that the apparatus is of practical value. He uses a metallic diving suit which is made somewhat on the plan of the ancient coat-of-arms, being built of light and strong sheet metal having a thickness varying from 0.2 to 0.3 inch according to the position of the pieces. The joints and coupling points are made of pressed leather and rubber, and a special form of hydraulic joint is employed. On the top of the armor is fixed the helmet, which is the principal feature of the apparatus. The air is not brought to the diver from the outside, as usual, but the air he breathes is sent by a tube into a special regenerating chamber containing certain chemical products which renew the supply of oxygen and the air is then sent to the interior of the helmet by another tube. The air-renewing apparatus is contained in a pair of cylindrical chambers attached to each side of the helmet. Regulating valves keep the air pressure within the helmet at the right amount and always constant, no matter what the depth may be below the surface. Mounting and descending are effected by a drum and cable worked by an electric motor. At the same time the cable serves to carry the current which is needed for the respiratory apparatus. The diver communicates with the surface by a telephone, and a number of wires run from the armor up to a set of colored lamps, showing how the different parts are working. There are many advantages to be secured from the new apparatus, and we expect to give a more complete and illustrated description of this interesting device. M. de Pluvy has personally been able to go down to a great depth, and during the 115 descents which he has already made with the new diving suit he reached depths varying from 150 to 300 feet. This far exceeds the depth to which an ordinary diver can go.

Besides the new diving dress, M. De Pluvy is also the inventor of a collapsible caisson which may be used in connection with the diving suit.



The Helmet and One Arm Piece Removed.



Ready for the Descent.

THE DE PLUVY DIVING DRESS AND CAISSON.

Pure Alloys of Tungsten and Manganese and Their Properties.

A method of obtaining tungsten, or alloys of this metal, is presented by a French chemist, G. Arrivaut. By reacting with aluminium upon a mixture of oxides of these metals, it is possible to obtain alloys of tungsten and manganese which are rich in tungsten, but it is difficult to have a complete separation from the slag, and to do this it is necessary to operate on a large scale. But the author is able to obtain good results with reacting masses which are relatively small, by using tungstic anhydride and bioxide of manganese added to the right amount of lower oxides. The heat of the reaction is thus increased by the excess of oxygen in the mass. Alloys which are low in tungsten can be also obtained by the Schloesing furnace by using a current of hydrogen in which are heated the metals in powder mixed and compressed, but the value of 25 per cent in tungsten can hardly be exceeded. The author succeeds in forming alloys ranging from tungsten = 12; manganese = 87.34, up to the value tungsten = 60.05; manganese 39.20, making seven alloys in all.

The properties of the alloys are as follows: These bodies appear in the form of hard and brittle masses with a granular section and a steel-gray color. They are not magnetic. Air acts upon them slowly, forming brown spots of manganese oxide. Sulphuric acid, concentrated and boiling, or better still, bisulphates in fusion, will dissolve them entirely. Dilute acids, acetic, hydrochloric, etc., attack them energetically, even in the cold, but the action is always incomplete, and there remains a residue which contains all the tungsten. The latter finally contains no manganese. Preparation of tungsten by the alumino-thermic process is hard to carry out owing to the relative infusibility of this metal, but it is easier to form the alloys of it with manganese and the former can be then separated as above. Mixing oxide of manganese 360 parts, tungstic anhydride 100, bioxide of manganese 40, oxide of tungsten 100, and powdered aluminium 150, he obtained a mass which is well melted and homogeneous, free from slag and weighing half a pound. It contained about 45 per cent tungsten. When broken up and treated with hydrochloric acid it set free about one-half the weight in tungsten which was very nearly pure (99.55 per cent). This is seen as a steel-gray metallic powder, very heavy and presenting the usual properties of tungsten. Its density at 0 degrees C. is 15.28 compared with Moissan's value for cast tungsten of 18.7.

Flake graphite lubrication has been tested by Prof. Goss at Purdue University in comparison with neat kerosene lubrication. For this purpose one part by weight of flake graphite was mixed with two parts of kerosene. The immediate effect of adding the graphite was to permit an increase of load from 50 pounds to 110 pounds per square inch, and to reduce the coefficient of friction from 0.00547 to 0.00296. Another result was the excellent running of the bearing with kerosene alone after the rubbing surfaces had been cleaned; this was due probably to the enduring effect of the graphite in the microscopic pores of the metal.

A brass solution should be run slightly warm, but not smoking hot. The results are then not as good. A temperature of about 120 degrees is excellent. A solution that is hotter drives off the ammonia rapidly, evaporates the water, and does not give any better results than when a lower temperature is used.