forces of crystallization, other forces, differences in osmotic (diffusion) pressure, are present, forms are obtained which in their outward appearance resemble certain inferior organisms. As the solid tissues of organisms are produced by solidification from the solutions above referred to, their shape and structure necessarily are influenced by the force of crystallization (Fig. 9).

When drops of a solution are introduced into the same solution at different concentration, these drops at first spread out in all directions; owing, however, to the effect of molecular attraction (or cohesion) there soon takes place a granular segmentation of the liquid (Fig. 10). In fact, as this cohesion between the various molecules is different, those between which the attraction is greatest will combine into spherical grains as soon as the force of attraction exceeds the force of diffusion, while the other molecules fill the intervals between the grains. In this way the phenomena of segmentation observed in germinating eggs, which had previously seemed so puzzling, are not only accounted for but can be readily imitated by an artificial process.

From Lehmann's researches on apparently living crystals it is inferred that certain crystallized structures show a behavior quite analogous to inferior organisms, moving, growing, feeding, and propagating themselves like the latter. The investigations by Prof. Leduc which have been described above, on the other hand, prove that the fundamental element of animal and vegetable organisms, viz., the cell, is exclusively controlled in its vital functions by the same physical laws that govern the forms of the mineral kingdom. From both sides there is thus being constructed a bridge between the province of inert matter and that of living matter, and in the place of the strict barriers previously supposed, we are warranted in presuming the existence of a multitude of gradual transitions and intermediary stages.

It should be observed that the Leduc phenomena were first observed by Traube in 1867 (Archiv. f. Anatomie u. wissenschaftliche Medizin, 1867, p. 67), who produced them. Such artificial cells have long been known as Traube cells. Traube also produced them by means of tannin and lead acetate, water glass and lead acetate, gelatine and tannin, and the like. In repeating Leduc's experiments Prof. Hans Molisch found that the acetate and the chloride of copper produce better results than the sulphate. The sugar, salt, and gelatine serve to increase the growth and ramification, but it should be pointed out that Reinke described branched and tree-like artificial growths more than twenty years ago.* If crystals of copper sulphate are thrown into a solution of water glass they become enveloped in light blue pellicles of copper silicate and these silicate cells develop into tree-like forms if sufficient water glass is present.

Even Leduc's discovery that artificial cells, like natural cells, are affected by various influences was anticipated by Traube, who described the effects of light and gravitation and the variations in form and rapidity of growth produced by adding grape sugar, salt, etc. In Molisch's opinion Leduc's experiments mark no advance beyond the results obtained by Traube in 1867. His artificial cells teach nothing new and they are no more like living organisms than a paper flower is like a real flower or a wax doll is like a living child.

Prof. Gaston Bonnier, of the Académie des Sciences and the University of Paris, entertains very skeptical views of the biological value of Leduc's experiments. These views he has voiced as follows in La Science au XXme Siècle:

"I pointed out to the Academy, in the meeting of December 24, 1906, that these tubular precipitates had long been known and possessed no organization comparable with that of living things. I also repeated before the Academy, some interesting variations of these amusing experiments devised by one of my pupils—a minor. In La Revue of January, 1907, I showed that this alleged discovery was only a repetition of Traube's classical experiments.

"At the meeting of January 7, 1907, Prof. Leduc made a rejoinder to which I replied on January 14, as follows:

"In a lecture just published M. Leduc expresses his amazement that Pasteur's researches have for thirty years silenced the discussion of spontaneous generation, and the *brochure* ends with the words: 'To complete the synthesis of life only one function remains to be realized—successive reproduction. I regard this problem as of the same order with the preceding.' In his communication of last week M. Leduc asserts that his note of July 24, 1905, began with a mention of Traube's work. Here is the mention: 'We have an artificial cell similar to Traube's but differing from it in possessing the power, not only of expansion and enlargement, but also of emitting prolongations analogous to roots and stems, which grow visibly and slowly.' This sentence demonstrates Leduc's ignorance of Traube's writings,* from which I quote as follows:

"'Forms which sometimes resemble a rhizoma with long stemlike upward and rootlike downward extensions.'

"'Soon afterward the cell begins to grow exclusively at the top, so that it passes from a rounded to an elongated form. If the vessel is tipped the extremity continues to grow vertically.'

"'When the pellicle is ruptured the escaping solution soon becomes inclosed in a membrane of precipitate resembling a graft, excrescence, or branch of the cell.'

"Traube's forty-eight series of experiments made in 1865-7, and his later researches, published in 1875, include Leduc's results and many others. And these experiments have been varied almost *ad infinitum* by others. I need mention only Pfeffer's arborescent forms.†

"The conclusion to be drawn from all these experiments is that the form obtained depends on the medium and, to some degree, on the shape of the vessel.

"I have also obtained the Leduc forms by following Traube's general directions. The various salts were thrown into a 5 per cent solution of potassium ferrocyanide or a 10 per cent solution of sodium or potassium silicate. The production of these precipitates is a common lecture experiment. Leduc asserts that all forms obtained by earlier experiments were stunted, unstable, and shapeless but that his culture liquids produce large, stable growths with sharply differentiated roots, stems, and apical organs. But the descriptions cited above show that all of Leduc's results were obtained before him.

"Our colleague, M. Gerner, has produced growths which could be preserved in paper like dried plants and which were mistaken for seaweeds by amateur botanists. Some of these arborescent forms have long been exhibited in apothecaries' windows, especially at Nancy.

"It is difficult to see what new fact is brought out by Leduc's experiments. I am not now speaking of the curious experiments in which he reproduced the structure of organized tissues—that is a different question.

"In his notes to the Academy, Leduc asserts that his pretended artificial plants give evidence of cellular structure, circulating system, thermotropism, osmotropism, and nutrition.

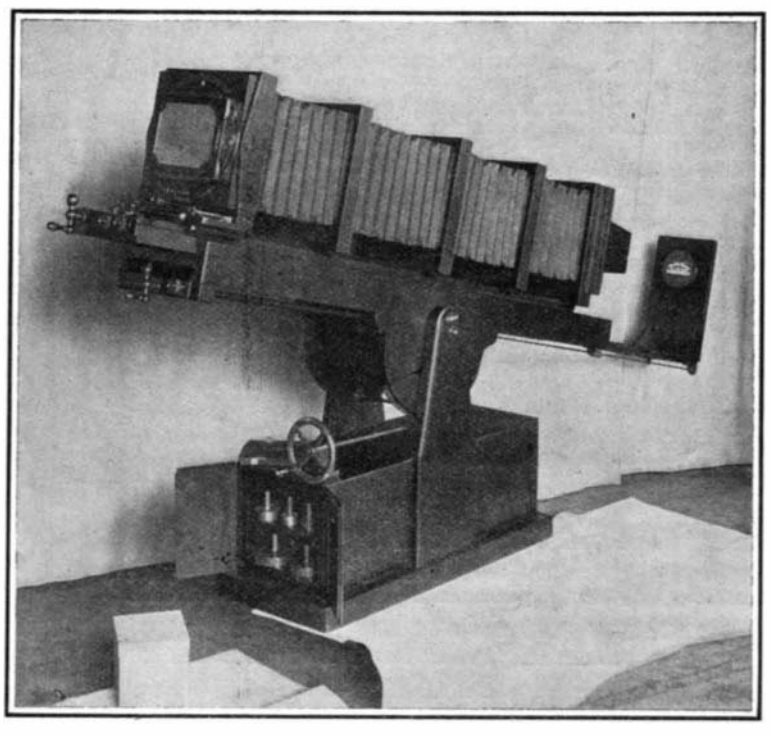
"It is well known that the forces which act in living beings are simply physico-chemical forces. Traube and others have studied the effect of these forces on semi-permeable membranes and Leduc has added nothing to their results. As for cellular structure and circulatory system nothing of the sort is to be found in these tubular precipitates.*

"It has been maintained that Leduc has made no claim to the creation of life by spontaneous generation, but this assertion is contradicted by his own words, quoted above.

"The net result of the whole affair is simply *nil*."

AN EXPERIMENT IN ACOUSTICS.

As the running boys pass the bell there is a distinct drop in pitch



SPECIAL CAMERA FOR COPYING AND ENLARGING.

AN EXPERIMENT IN ACOUSTICS.

BY GUSTAVE MICHAUD.

The school bell and good legs are all that are needed for this experiment. Students who make it find it easier, as a rule, to understand the relation between pitch, wave length, and the number of vibrations. Where elementary astronomy is taught, the same experiment may prove to be a helpful as well as a healthful diversion during the study of a rather abstruse chapter—the application of the spectroscope to the determination of the radial motion of stars.

Select the swiftest runner of the school. Give him a bell, and place him on level ground at some hundred feet from the rest of the class. At a signal, the students run as fast as they can toward the bell bearer, while he himself runs toward the students, without ceasing for a moment to ring his bell. So long as some distance remains between the students and the bell, nothing abnormal seems to occur, although the students, without being aware of it, perceive a sound of a somewhat higher pitch than that which strikes the ear of the bell bearer. But at the precise moment when the runners pass the bell, and instead of running toward it begin to run away from it, there is an instantaneous and very distinct dropping of the pitch of the sound, which remains graver as long as the distance increases between the runners and the man who rings the bell.

While the hearers are running toward the source of vibrations, they meet, in a given time, a greater number of these than if both the bell and the boys had remained in the same place. When the bell bearer and the students ran away from each other, the hearers go in the same direction as the vibrations, and the reverse phenomenon occurs—the number of vibrations which reach the ear in every second is smaller than it would have been had all the participants remained on the spot. As the pitch of a sound depends upon the number of its vibrations per second, that of the bell will drop at the very moment when the distance between bell and hearers ceases to decrease and begins to increase.

If the man who rings the bell can be provided with a bicycle, the fall in the pitch of the sound is of course still more pronounced.

SPECIAL CAMERA FOR COPYING AND ENLARGING.

The camera illustrated here is one that was designed and built for the United States Geological Survey for photographing fossils or other similar objects. In photographing fossils the Survey uses a process known as the Williams process. This method was worked out by Prof. Henry S. Williams and Norman W. Carkhuff, and consists in an elimination of the color of the fossil by a process of sublimation.

Fossils cannot be photographed for scientific purposes in a haphazard manner. There are certain characteristics that must always be orientated in relatively

* Reinke, Botanische Zeitung, 1875, p. 432.

* Moritz Traube, Centralblatt für medizinische Wissenschaft, 1865. Archiv. für Anat., Phys. und wissenschaftliche Medizin, 1867, p. 87. Botanische Zeitung, 1875, p. 56.

† Pfeffer, Osmotische Untersuchungen, 1877, p. 11. Botanisches Institut, Tübingen, 1886, vol. ii., p. 30.

* Prof. D'Arsonval, who presented Leduc's note, has recently (January 21, 1907) presented a communication from Charrin and Goupil describing experiments which prove that no phenomenon analogous to nutrition occurs in the production of these arborescent growths.

the same position and illuminated in the same way, in order to produce results of any practical value to the scientist. Some of these fossils are photographed to the same size as the original, while others are much enlarged; great accuracy is required in this particular. As some of these fossils are exceedingly small and delicate, it is obvious that to do the work economically special apparatus is required. Could a comparison be made between the first piece of apparatus used by the original experimenters and the apparatus just completed, the remarkable evolution in scientific camera building would make old camera operators wonder at the change.

The camera is mounted on a tilting base, so arranged that either end may be elevated or lowered to any desired position, in order to secure the proper lighting of the subject. The operator can make any of the following adjustments on the camera or subject without leaving his natural position at the back while observing the focusing screen: either move the subject back or forth from the lens or revolve the subject support; move the camera back or forth on the tilting stand; raise, or lower, or shift the front of the camera in either direction; revolve the back from a horizontal to a vertical position, or to any intermediate point; elevate or lower the subject support, in order to secure the proper lighting, all by mechanical devices. It will be observed that the rod running along under the base operates a mechanism below at the front for rotating the subject base.

The base of the stand contains two cabinets for storing lenses or small parts. The focal capacity of the camera, including cone extension, is 7½ feet; length of stand top, with subject support and camera extended, 11 feet; size of plate, 6½ x 8½, with kits to 3¼ x 4¼. We are informed that the apparatus was specially made for the purpose mentioned above by the Folmer & Schwing Company, of Rochester, N. Y. The design reflects much credit as an excellent example of American workmanship.

The Deadly Electric Wire and the Conditions Under Which It Is More or Less Dangerous.

The danger incurred in touching an electric circuit does not depend wholly on the voltage or electric tension. Two-thousand-volt circuits have been touched with impunity, and contact with incandescent-light circuits of only one hundred and twenty volts has caused instant death.

The physiological effects of electricity are due partly to electrolysis or decomposition of the blood and other fluids and partly to paralysis of vital organs. Both actions are proportional to the strength of the current that actually passes through the body and this current strength is equal to the voltage of the circuit touched divided by the electric resistance of the body. The average resistance measured between a hand and the feet, when the hand is moist and the shoes are soaked with water, is about 5,000 ohms. A current of one-twentieth of an ampere—one-tenth of the current used in an incandescent lamp—may cause death. Hence, the question is, Under what conditions will contact with an electric wire send such a current through the body?

If the right hand touches one wire and the left hand simultaneously touches the other wire of a 110-volt incandescent lighting circuit, the body, assuming its resistance to be 5,000 ohms, will be traversed by a current of 110/5,000 ampere, or little more than one-fiftieth of an ampere, which is within the limit of safety. But if the hands are dry the resistance measured from hand to hand is fully 10,000 ohms, so that both wires of even a 220-volt circuit, such as is used in some incandescent lighting systems, can be touched without danger of serious injury. In certain factories, however, where the air is damp, warm, and laden with acid vapors, the skin becomes softened and the resistance so greatly diminished that it is not safe to touch both wires of even a 100-volt circuit.

The writer's left hand once came so near the terminals of a 1,000-volt transformer that it drew luminous electric arcs from them. The current, having so small a resistance—less than two inches of the hand—to overcome, was very strong, but it caused no injury except local burns because it did not traverse a vital part. In instructive contrast to this case is the experience of the inventor of an electric bath tub containing metal plates that could be connected with a 220-volt lighting circuit. The inventor tested the device on himself and was instantly killed because soaking in water had so reduced the resistance of his body that even this low voltage produced a deadly current.

If a man, standing on a trolley rail or even on the ground, touches a broken trolley wire carrying the usual pressure of about 500 volts, a current of one-tenth of an ampere will pass through his body, if its resistance is 5,000 ohms, and will probably cause death. In this case the ground or the rail represents the second or return wire. It is much less dangerous to touch a single wire of a double-wire circuit, well insulated from the ground, for in order to reach the other wire the current that traverses the body must flow through or over some of the insulators, that is to say, through a very great resistance, so that the current is very weak. But in a very long line the sum of these little leakage currents through many insulators may be too great for a human body to carry with safety. Hence, the danger is proportional to the length of the line. Simultaneous contact with *both* wires of a high-voltage circuit is, of course, fatal.

The static electric charge of the wire, as distinguished from the flowing current, is another source of danger, at least in alternating circuits. In continuous-current circuits this charge acts only once, at the first instant of contact, but in alternating-current circuits the charge is changed from positive to negative and back to positive usually about one hundred times a second, and when a man touches the wire the electricity which forms these charges surges back and forth through his body. Most of the casualties produced by touching alternating circuits are due to this cause. The danger is proportional to the electric "capacity," and therefore to the length of the wire. Burying the wires increases their capacity and makes them still more dangerous to handle, but it effectually keeps the average citizen away from them.

The danger is proportional to the frequency of alternation, if the frequency is not very great, but currents of several hundred thousand alternations per second, such as Tesla employed in his amazing experiments, do not penetrate deeply, so that when they traverse the human body their effects are confined to the skin and are not serious. The facts that high voltages and high frequencies have been commonly associated in experiments and that extremely high frequencies have been shown to be harmless have led to the widespread belief that exceedingly high *voltages* are quite free from danger. This is entirely erroneous, as the curious reader may easily prove to his own satisfaction—or, at least, that of his heirs.—Condensed from Herman Zipp in Die Umschau.

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

CORSET.—E. SAVOYE, Rue du Caire, Paris, France. The corset is so cut out as to enable the whole of the front and the whole of the upper part of the corset to be made up of a single piece, the continuity of which affords great advantages both in the way of comfort and facility of manufacture. This mode also obtains a continuous ornamentation, by means of embroidery, designs in colors, and the like, without any of the difficulties resulting heretofore from the construction of the parts in several pieces stitched together.

Electrical Devices.

TELEPHONE-MAGNET. — A. E. HARRISON, New York, N. Y., and C. M. HASLETT, Jersey City, N. J. The objects of the invention are, to confine the effect of a plurality of magnetic poles upon one or more pole-pieces; to give the pole-pieces such conformity as will enable the windings to be placed directly upon them rather than upon the magnets proper; to shape the pole-pieces so as to accommodate a large number of turns of the wire and also to decrease the loss of effective magnetic lines; to increase efficiency of magnets, and to provide a more direct path for the magnetic lines of force and also to concentrate their effect within a small area.

WIRING-KNOB.—W. C. GORDON, Windsor, Vt. The principal objects of the inventor are to provide for more securely holding wires than has been the case with prior inventions, and especially for so constructing the cap with which these insulators are usually provided that it will grip the wire equally at all times independently of the position in which it may be placed on the base of the knob so long as it is centered with respect thereto.

Of Interest to Farmers.

REELING DEVICE.—C. A. HADLAND, Bennington, Minn. This device is designed to be mounted upon a wagon-body so that the wire may be reeled or unreeled as the wagon moves; and the purpose of the invention is to improve upon the construction of the device for which Letters Patent were formerly granted to Mr. Hadland, the improvement being such as to simplify the construction and to render the action more positive and reliable.

HAY-STACKER. — B. F. POWELL, Manzanola, Col. One purpose of the invention is to provide a portable hay-stacking device in which a sled or hay-frame previously loaded upon the field is drawn up an incline and received upon a tipple of simple, light, and durable construction and wherein when the load is automatically dumped from the sled by means of the tipple the empty sled will slide down the incline in the ground of its own accord.

WAGON.—J. RUPPERT, Glencoe, Minn. This type of farm-wagon is capable of being quickly converted into shape for use as an ordinary box farm-wagon, a hay-rack, a stock-rack, or a wood wagon. The body is so constructed that it need not be changed under any condition of adjustment of the necessary added parts and so that such parts can be expeditiously and readily locked in position or removed, as required.

BALING-PRESS.—C. E. FIELD, Slater, Mo. One purpose of the improvement is to provide a construction of press in which a plunger is not employed and wherein the feed mechanism is such that the press can be fed at any time while in operation, it not being necessary to await the return of the plunger, as required in presses known to the inventor.

STALK-CUTTER. — F. P. CHAPA, Alice, Texas. In this patent the invention relates to devices for cutting cotton, corn, or other similar stalks, and has for its object to provide a device adapted to be drawn along between two rows of standing stalks and cut them by novel and improved means. The device in use is drawn by manual, horse, or other power.

Of General Interest.

DRY-GOODS MARKER.—P. H. STEWART and E. A. MILLER, Hopkins, Mo. The marker is designed to be applied to the center board of a bolt of cloth at one end thereof and automatically engage the same, holding it in fixed position. A card of celluloid or like material is held to the front face of the marker by inturned retaining-cleats, the latter having nibs extending at each end, which are bent in such a manner as to prevent the celluloid card from sliding from the cleats.

NON-REFILLABLE BOTTLE.—H. N. ROTHWEILER, Seattle, Wash. The bottle is designed for containing spirituous liquors, proprietary preparations, table condiments—such as catsup, sauces, etc.—and any other materials in liquid form in which the refilling of the bottles with a surreptitious substance is to be prevented. The invention consists in the construction and arrangement of the bottle in combination with a valve, a sealing cap, and dispensing devices designed to be filled and also discharged under an air-pressure.

ROLLER-SUPPORT FOR EDGEWISE-MOVABLE DOORS.—G. GEORGENSON and J. E. HENNEN, Fond du Lac, Wis. The invention is characterized particularly by an operating-handle convenient as a handle for pulling the door open or closed and also for shifting the rollers on which the door slides, so that when the handle is in idle position the shoes at the lower edge of the car-door rest upon the track on which the door slides, so that it will not accidentally slide open; but when the handle is operated the rollers are pressed down upon the track to lift the door and shift the weight onto the rollers, so that the door will readily move.

FLOWER-BAND MOLD.—A. M. LOCKARD, Herrin, Ill. This molding apparatus is for producing a flower-band from molded or cementitious material. The flower-band referred to is a device made in circular form and either in one piece or in sections for use in surrounding and protecting flowers, shrubbery, or young trees.

AUTOMATIC GRAPPLING-HOOK. — B. LANGLEY, Woodward, Oklahoma Ter. The object of the inventor is to provide a device which will grapple and automatically take hold of objects with which it comes into contact. It may also be used as a means for returning lost tools, buckets, casings, etc., from wells and cisterns, and for use in removing safes and other valuables from burning ruins and other places inaccessible by usual methods. It may be used for removing stumps, logs, and all heavy foreign matter from lakes, etc.

BUFFER.—S. M. GOLDBERG, New York, N. Y. The principal object of this invention is to provide a toilet article with a buffing-surface which can be readily removed and replaced, so that when worn the entire article does not have to be discarded, also to provide means for securely holding the buffing material upon a base, and to provide a removable handle.

BOBBIN.—G. POPPLEWELL, Louisville, Ky. The invention refers to bobbins, more particularly such as are used on drawing, spinning, and twisting frames. The object is to provide a bobbin which is simple in construction, exceeding strong to stand all ordinary wear and allow repeated use of the bobbin. While extremely hard the bobbin is slightly flexible and well adapted to withstand rough usage.

DEVICE FOR EXHIBITING HATS, BONNETS, AND THE LIKE.—F. W. NUNN, Guilford, New South Wales, Australia. The object of the inventor is to furnish a device on which the article to be displayed can be quickly and firmly fastened and also readily removed, while it can be quickly changed from an upright to an inverted position or placed at any angle in order to show the article to its best advantage, according to its position in a show-room or shop-window.

FASTENING DEVICE FOR ORNAMENTS.—J. L. PAUL, Chicago, Ill. A purpose of the improvement is to provide a fastening device for ornaments adapted for application at the seam in any piece of metal work or cabinet work to cover the seam, being particularly for use on picture-frames, the application being made without danger of marring the ornament or the article to which it is applied.

AIR-SHIP.—J. A. ELSTON, Jefferson City, Mo. The purpose in this case is to provide an air-ship or vessel very light and strong, and wherein the operator will be comfortably seated and able to manually operate it with ease and slight bodily exertion. Another purpose is to provide a construction in which wings are employed as a motive power, with or without assistance of balloon or gas-bag or its equivalent, and wherein the operator will be protected from the elements.

LIQUID MEASURING AND REGISTERING FAUCET.—W. M. DAVISON, Government Road, Port Pirie, South Australia, Australia. The device consists, essentially, of a measuring plug or chamber fitted within a body or case, at one end of which is a registered mechanism operated by the movement of the measuring plug. The body has on one side a tubular inlet projection, whereby it is fitted to the neck of the bottle, the barrel, or other liquid-containing vessel and has on the other side an outlet-spout, from which the liquid is delivered into the glass or other receptacle.

POINTING-TOOL.—B. F. DAVIS, Miami, Fla. The aim of this improvement is to provide a tool especially adapted for pointing up masonry and other structures where liquid or semi-liquid mortar or cement is to be applied at the finishing operation and to so construct the device that it will be simple and economic and capable of operation by one hand.

CRYPTOGRAPH.—H. BURG, Mollkirch, Canton de Rosheim, Alsace-Lorraine, Germany. In this apparatus each change of combination is produced by the displacement of a carriage which is reciprocated directly by hand, the extent of such reciprocation varying automatically each time, according to a predetermined law, and this reciprocation of the carriage is transmitted to a crown of letters movable concentrically with respect to a fixed crown of letters, the said crowns serving to make the cryptographic translations.

PROCESS OF FORMING OIL-CUPS.—J. TOWERS, Albuquerque, Ter. New Mex. Generally stated, the process consists in taking a round bar of iron or steel, upsetting the end in a die of suitable fashion to form the base and stem of the cup, and thereafter welding a pipe thereto and further shaping the upset portion in a second set of dies to form the complete cup.

Hardware.

MITER-BOX.—J. PEACH, Traverse City, Mich. In the present patent the invention has reference to wood-sawing, and its object is the provision of a new and improved miter-box arranged to permit of cutting the wood or other material at any desired angle and without changing the position of the saw in the saw-guides.