which many hundred words are transmitted and recorded in a minute, and also the abolition of the duplex and quadruplex instruments (by means of the latter four messages are sent over one wire at one time, thus answering the purpose of four distinct wires), and the duplex answering for two distinct wires, and last of all, which has suddenly come upon us, the telephone, with its still more sensitive apparatus.

After all these electrical difficulties are overcome or dispensed with, the practical difficulties still remain, the main one being that of cost, while convenience must also be considered.

In this practical age convenience is regarded more than cost in many instances. In this instance the cost of placing all telegraph lines under ground in cities and towns with anything like the present convenience and facilities will be such as to make it too expensive for popular use, which in the end would be a practical prohibition of its use.

Without detailing the manner of its construction in London, which is on the elevated railroads and taken down at stations, and Paris, which is in its sewers, we can say that none of the advantages and modes of its construction in those cities exists in any of our American cities.

We will take New York city as an example. In Paris there are only 80 miles of underground lines. In New York city there are 9,000 miles of line in the streets and on house-tops. Of these over 3,500 belong to and are used by the Metropolitan Telephone Company. The Gold and Stock Telegraph Company have many miles upon which the automatic instruments are used. The Western Union has 1,200 miles of wire, of which only about 300 miles are on the main trunk lines, and the remaining 900 supply the little local offices. It is the many local offices and places where instruments are set that is to be considered in this question of laying underground cables. If one man in a block desired communication by telephone, or the use of the Messenger Telegraph or Stock Indicator, the whole expense of digging a trench from the main office must be considered. This would greatly narrow their use. The expense for digging the trench for one wire only would be almost as great as for many of them. Then again there must be places near together on the lines by which any wire could be taken out for repair and replaced if necessary.

The Western Union Telegraph Company has now three lines of underground cables in New York city. They are in three iron tubes about three inches in diameter each, and lead from the main office of the company to Pier 18, foot of Cortlandt street, North River. In these three tubes is a cable of thirty wires each. These are conducted under the Hudson River to Jersey City.

When first laid, about five years ago, there were only the two tubes and the two cables in them. The expense of laying them from the main office to the river was at the rate of $15,000 per mile, the cables each costing at the rate of $5,250 per mile. About one year ago some of the wires in the cable failed to act, and one cable was entirely taken out and replaced by a new one. Another tube and cable was also then placed in the trench. The expense of often replacing must also be considered, for if some of them fail it may be necessary to entirely renew the cable. The sum of $7,500 per mile for laying underground cables is great when compared with the cost of a line of poles in the city, which rarely exceeds $150 per mile, capable of carrying many wires. In places where smaller and shorter poles can be used the expense is very much less, even as low as $75 per mile in cities, and much less in the country. Increase of expense implies a necessary increase of rates. The interest on the cost of a mile of underground line will be sufficient to build at least four new lines the same length every year, which will last from twelve to fifteen years each, the wire costing only $15 per mile.

The popular objection urged against the present system is that the poles and wires are "unsightly." When this is closely examined it shows it to be mere clap-trap and without any reasonable foundation, and it will more strongly apply to every means of economical and convenient carrying of merchandise and passengers in cities, without any of the chief annoyances which appertain to the latter.

Surely, the means of the conveyance of intelligence is as important and as great convenience in a community as the conveyance of persons and of merchandise. Indeed, this mode of carrying news saves much personal travel by messenger or otherwise.

The day has not yet arrived when underground telegraph lines in American cities will prove a convenience and be a popular success, as some will try to make others as well as themselves believe. The facts of science are stubborn things and cannot be removed or dispensed with by popular opinion or legislation.—*Journal of the Telegraph.*

M. Gaiffe's Sulphate of Copper Battery.

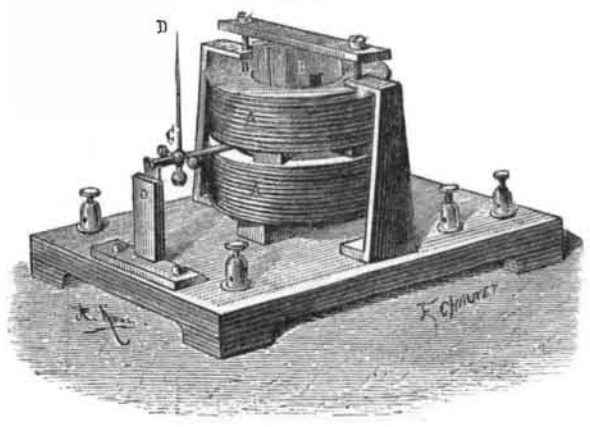
This is an improvement on the Daniell element, and is intended to put a stop to the reaction of the zinc on the sulphate of copper when the circuit is open The apparatus consists of a glass cell, at the upper part of which is the zinc, constructed as in a Calland element. The central vessel has a porous upper portion fixed upon a non-porous lower portion, which may consist of an ordinary drinking glass. The copper cylinder placed in the central cell has a prolongation which is bent down so as to reach down to the bottom of the outer cell, where it terminates in a ring. This element is charged by means of a concentrated solution of zinc sulphate of magnesium sulphate, while some crystals of copper sulphate are placed in the bottom of the central cell. On dissolving, the copper sulphate first saturates the liquid in the non-porous part of the central cell, and when the copper solution reaches above the top of the non-porous part it traverses the porous cell, and falls, in virtue of its superior density, to the bottom of the outer cell, beyond the reach of the zinc. This passage of the copper sulphate is effected slowly, and the circuit may be left open for weeks without any deposit of copper being perceived on the zinc. When the circuit is closed this element first reduces the sulphate of copper which has fallen to the bottom of the outer cell, the liquid in which soon resumes its original purity, and the action then continues as in an ordinary Daniell element.

RHEOMETRIC APPARATUS.

BY MARCEL DEPREZ.

As an example of the arrangements of rheometric apparatus belonging to the different classes cited in a preceding article, I shall describe two instruments that I had constructed some time ago. The first of these (Fig. 1) consists of a soft iron needle mounted on a horizontal axis movable

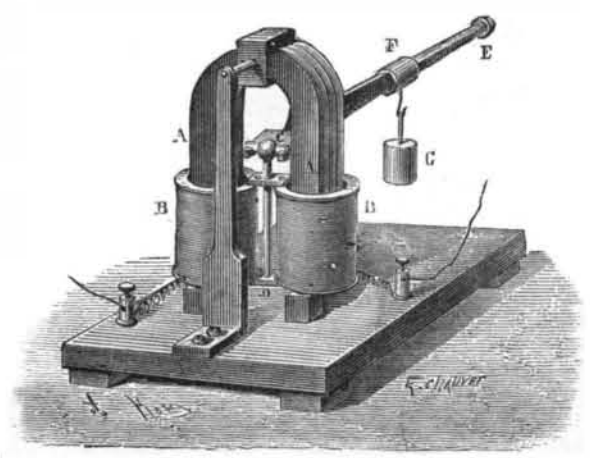
Fig. 1.



about two knife edges, and inclosed within a galvanometric helix, B B. The helix is placed within a pair of large bobbins, A A, wound with a wire of pretty large diameter, into which is sent a current from a Bunsen pile. The axis of the iron needle terminates at C in an index, and in a system of small masses movable on screws, the purpose of which is to balance the whole.

To employ this instrument, there is first sent into the wire of the bobbins, A A, a current from some energetic and constant source, such as a Bunsen element. The result is that the soft iron needle becomes magnetized to saturation, and places itself spontaneously in such a manner as to coincide with the axis of the bobbins, A A; but it is proper to remark, also, that it is directed at the same time as magnetized. If, afterwards, the galvanometric helix, B B, be put in relation with any source whatever, the needle will behave like the magnetized needle of an ordinary galvanometer, and its deflection will depend upon the intensity of the second current and of the directing force developed on it by the bobbins, A A. Now, this directing force may be rendered as feeble as may be desired in two ways: (1) by increasing the diameter of the bobbins, A A; and (2) by acting upon one of the regulating masses in such a way as to place the center of gravity over the axis of rotation until the equilibrium is almost indifferent, when the bobbins, A A, will be traversed by a magnetizing current, while the bobbins, B B, will be traversed by none at all.

Fig. 2.



It will be seen, then, that this instrument is a galvanometer in which the needle may be magnetized with great energy, while the directing force may be rendered very feeble, these being conditions that we always try as much as possible to obtain.

It will also be seen that it constitutes likewise a *comparer of currents;* that is to say, an apparatus giving the relation of the intensities of two currents and not their absolute value. In fact, if two currents are simultaneously sent, one into the bobbins, A A, and the other into the galvanometric helix, B B, and if care has been taken to destroy every species of foreign directing force, by causing the center of gravity of the movable system to coincide with the axis of the knife edges, and by placing the latter in the magnetic meridian, the soft iron needle will assume a position of equilibrium, which will not change whether each of the currents be doubled, tripled, or quadrupled. But this position of equilibrium will change, on the contrary, if the intensity of a single one of the currents be altered. In order to demonstrate this property experimentally, the two bobbins, A A, B B, may be united in derivation on a same curve; when, the law of the division of the current between the two bobbins depending only on their respective resistances, the deflection of the needle will be seen to remain the same as long as these respective resistances are not altered, whatever be the intensity of the total current. If, on the contrary, by any means whatever, the resistance of one of them be altered, the position of equilibrium of the needle will immediately change. Owing to this property, this instrument might become a measurer of resistance which should indicate, by a simple reading, the resistance of a wire into which was sent a current of any intensity whatever.*

Becquerel's Balance, modified.—The second instrument is based on the same principle as the Becquerel balance. It consists (Fig. 2) of a powerful magnet, A A, whose arms are surrounded by the two bobbins, B B, in such a way that the distance between the pole of each arm and the lower armature of the corresponding bobbin is equal to about a third of the total length of the latter. The two bobbins are mutually interdependent, and are connected with a knife edge, C, supported by the small lever arm of a steel yard, C F, whose long arm carries a weighing slide, F, to which may be hooked a supplementary weight, G. The magnet is stationary and the bobbins movable, and receive the current, either through mercury cups or through a very fine and flexible wire, wound in the shape of a helix, whose elastic force is altogether feeble and yet constant. This apparatus possesses an advantage over the Becquerel balance in having a very intense magnetic field, while in the latter the magnets are formed of small iron bars 4 to 5 millimeters in diameter. It might be objected that the weight of the bobbins being much more considerable than that of the bars of the Becquerel balance, there would be lost, as a consequence of this surcharge imposed on the balance, the benefit resulting from the increase of the mechanical action of the current. But it is necessary to remark that the weight of the entire movable portions of the balance is greater than that of the movable bobbins, and that, consequently, in these two instruments, the balance is placed perceptibly under the same conditions of sensitiveness, while the absolute mechanical effort, at an equal intensity with the current, is much greater in this apparatus than in that of Becquerel. The model shown in Fig. 2, although roughly constructed, has in fact exhibited a remarkable sensitiveness. I think, then, that this apparatus, when better made, might render genuine services.—*La Lumière Electrique.*

MECHANICAL INVENTIONS.

An improvement in machines for making dough into cakes has been patented by Mr. Daniel M. Holmes, of Cincinnati, O. The object of the inventor is to secure an even and constant feed and pressure to the valves and cutters. With the use of the ordinary dough box and plunger in cake machines considerable time is lost in the intermittent action of the feed. Mr. Holmes has, therefore, provided means of accomplishing an even and constant feed and delivery, whereby the time usually consumed in recharging the machine is saved, and a consequently larger yield of goods in a given time is effected.

Mr. Henry H. Norrington, of West Bay City, Mich., has patented an improvement in the class of punches or perforating stamps designed for use in banking and other similar establishments for the purpose of puncturing or cutting out portions of a check or other written instrument to prevent fraud by alteration. This inventor has obtained Letters Patent of the United States for stamps or punches of this class, and the present invention is in the main an improvement upon that which forms the subject of patent No. 223,161, granted to the same inventor December 30, 1879.

Messrs. Levi L. Lukens, of Chester, and Henry Holcroft, of Media, Pa., have patented an improvement in shuttle boxes for looms which consists in a peculiar construction and arrangement of the parts, by which the second spindle, as ordinarily used, is dispensed with, which permits of an increasing width of the picker strap. There are other points in the invention which cannot be described without an engraving.

An improvement in the class of machines adapted for soldering the heads of paint cans and other cylindrical vessels to their bodies has been patented by Mr. Henry R. Robbins, of Baltimore, Md. It is more particularly an improvement in machines which are adapted for using solder wire, the latter being wound upon a reel, from which it may be drawn off as required and fed into contact with the heated soldering irons and can seams. In this machine the wire reels and mechanism for drawing off the wire are operated simultaneously with the rotation of the can by means of friction gearing, which is put in operation by treadle mechanism. The soldering appliances are also arranged for a certain simultaneous and automatic action. The soldering irons are pivoted and adapted to vibrate between the can-holders and an open furnace, so that they may be swung forward to press on the can seams, and backward to enter the furnace, where they are heated preparatory to the next operation.

An improved car brake, patented by Messrs. William A. Kearney and Joseph G. Davis, of Logansport, Ind., consists in a novel arrangement of a cam for drawing the brake chain

* Mr. Carpentier has recently constructed a resistance measurer based on an analogous principle.

with an increasing leverage, and in levers, pawls, and ratchets for operating the brake.

Mr. William W. Whitmore, of Defiance, O., has patented improvements in that class of tire setters and coolers in which a table carrying a wheel is raised and lowered in a tank containing water to cool and set the tire. The inventor dispenses with the center post ordinarily employed, and is readily enabled by operating the lever to immerse the table and wheel in the water in the tank and hold it in any desired position.

An improved vehicle axle has been patented by Mr. Henry Dugan, of Mount Pleasant, Mich. This invention consists in an axle having a bearing thimble screwed on its outer end and a sleeve with an annular shoulder screwed on the inner end of the beveled part of the axle, passing into the axle box, the axle box being held on the axle by a threaded collar screwed into the rear end of the box and resting against the shoulder of the sleeve at the inner end of the beveled part of the axle.

A lifting-jack for wagons, of improved and simplified construction, has been patented by Mr. John C. Beard, of Newtonville, Ind. This invention consists of a bifurcated upright frame carrying a vertically sliding bar, provided at its upper end with a stepped head-block, the bar and head-block being adapted to be raised and supported in its elevated position for holding the load by a hand lever pivoted at its end to the vertically moving bar, in connection with a swinging connecting bar pivoted to the frame and to the lever.

The Dangers of Hydrofluoric Acid.

[The subject of this distressing accident was Mr. Robbins, assistant in the chemical laboratory of the Institute of Technology, Boston, Mass. The patient is a man of very acute observation as well as a considerable degree of medical information, and I urged him to prepare an account of his experience with this acid, as it was the first case of injury of this kind I had ever seen. He acceded to my request, and the following paper, with a few unimportant changes, is his own account of this rare occurrence.

ALBERT N. BLODGETT.]

"Fluorine as an element is as yet unknown, it never having been isolated. The reason of this is that it is so destructive to all apparatus used for the purpose. It has been studied in its compounds and reactions, and its atomic weight has been determined indirectly. It is the only element which has no known compound with oxygen. It unites with many other elements as a monatomic acid radical, and forms fluorides and also forms quite a number of double salts. Nearly all these compounds affect glass in the presence of moisture. Its hydride is a strong acid like that of chlorine and is a gas. It dissolves many of the metals to form fluorides, is easily absorbed by water, and the liquid acid is obtained by saturating distilled water with the gas. It has little effect upon platinum or lead, and is transported in gutta percha bottles as it affects neither this nor wax nor paraffine, but its action upon other organic substances is often very energetic. I once attempted to redistill some of this acid as it is formed in these bottles, but neglected to dilute it one half as is usually done when it is wished to condense it without a freezing mixture. When heated, the gas began to come over without condensing. It charred the wooded box which surrounded the receiver and dissolved and volatilized a piece of writing paper which was exposed to it, leaving only a slight film of a gelatinous substance, probably the gum from the sizing of the paper. Concerning the action of this acid upon animal tissues little is known. Wurtz's dictionary gives the fullest account of it which I have been able to find. He says, in substance, that it corrodes the skin, giving rise to insufferable pain, and produces a deep ulcer which is very difficult to heal; small drops of it being sufficient to produce white and painful blisters. I had not read this, and was not aware of the great severity of the action of this acid, and I carelessly used the stump of a match, the wood of which was saturated with the acid above referred to, to remove the lime, etc., from the surface of a piece of porcelain so as to obtain the freest action on the part where I desired to etch a hole through it. When I first noticed that it was getting upon my fingers I washed them and greased them with tallow, and thinking they were sufficiently protected I went on with my work. For about an hour and a half I had the match in my fingers the greatest part of the time. Just before I got the hole through I noticed that the ends of my forefinger and thumb were beginning to be unsensitive, and I felt a curious sort of dull pain that perhaps might best be described by saying that my fingers "hurt" a little. When through, I washed them well, applied dilute ammonia water and washed that off, and then applied bicarbonate of soda, but these measures did not relieve the pain from soon becoming very uncomfortable, and I dressed the fingers in a mixture of linseed oil and lime water, as it felt more like a burn than anything else. This was done between eleven and twelve A. M. That afternoon I made an organic combustion, and the pain gradually increased till toward the last it seemed a question whether the furnace or my fingers were hotter. In the evening I began to feel alarmed, and consulted Dr. Blodgett.

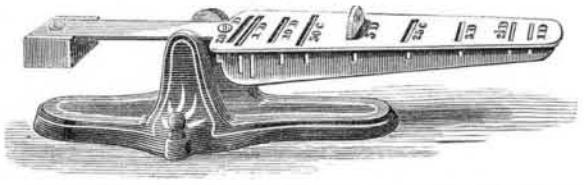
"At this time the ends of the fingers were white and very hard, so hard indeed as to dull the scalpel with which he endeavored to cut away some of the skin. The action was still going on; and as the depth to which it had penetrated could not be determined a dressing of cold cream was applied, and later vaseline was used, but neither seemed to allay the steady increase of the pain, which now most nearly resembled the sensation of a burn when held near the fire. The only relief obtained was by the application of cold, and this was only partial, and the only variation in it was from bad to worse, and at last it became the most severe pain I can imagine, and it was not till four o'clock the next morning, and with the aid of one hundred and ten drops of laudanum, that I was enabled to obtain sufficient relief for a broken nap. The next day the pain had subsided and the acid had penetrated quite a distance below the skin, rendering the flesh totally insensible and hard, having abstracted all the water from it. The other fingers were only slightly swollen, and the swelling did not extend back as far as the hand, showing that the blood was not poisoned at all. My usual good health was only temporarily and slightly impaired by the laudanum, but no other medicine was given. The course of treatment was to remove the destroyed tissue. This it was thought best not to do with the knife, but poultices, alternating with frequent soakings in very hot water, were constantly employed, which proved effectual, although slow in its operation, it being fully twenty days from the time of the injury till the slough was all removed. It was very dry and tough, and by no means inclined to separate from the surrounding tissues. In four weeks I abandoned all dressings to the fingers and was able to use them a little. Only a small permanent loss of tissue has resulted, but now, after three months, the scars are tender and the sensation is perhaps permanently destroyed. This agrees with the action of this acid as stated by Wurtz, especially as regards the pain, but he does not mention the very important fact that no pain is felt for some time after contact with the acid, which in my case was between one and one and a half hours, and by this time the surface has become so hard that it is difficult, if not impossible, to check the action underneath, so that the damage is for the most part done before one finds it out.

"The difficulty in healing appears to consist in removing the slough, as it heals very quickly when this is out of the way, and after the first siege of pain, which is a long and severe one, the sore is no more painful than any other of equal size. I think that should I meet the same accident again I should lose no time in washing it off as thoroughly as possible and then apply water glass if this were accessible; if not, I should use an alkali, and if possible soak the part in water as hot as could be borne, and apply cold cream or some other dressing which will keep the part soft and also exclude the air.

"I have also heard of two other persons who have had misfortune with this acid. They were Dr. C. F. Folsom and a Mr. Lodge. The latter had the end of his thumb badly burned. It was three months in healing, and quite a loss of substance resulted. I think that books on chemistry and teachers of the science should give greater precautions as to the use of this dangerous reagent. From the fact that this acid so effectually hardens animal tissue without distorting it, I think it might perhaps be employed by the histologists as a hardening agent for the soft tissues, especially of the nervous system, as a means of preparing them for microscopical study. I having never known this experiment to be tried, and it would be necessary to use it in very dilute form, but as far as my own observation extends, the action on the tissues would be exactly what is desired."—*Boston Med. and Surg. Journal.*

NEW COIN SCALE.

The return to hard money as a circulating medium has given to counterfeiters a new field for operation, which they have occupied and are energetically working. All gold coins



McNALLY'S COIN SCALE AND COUNTERFEIT COIN DETECTER.

and the larger silver coins are counterfeited extensively, and genuine coins are debased to a considerable extent. It is said that there are in circulation in the United States over two million of dollars' worth of spurious and altered coins. Counterfeit, altered, and light coins are detected by three methods, by weighing, by measuring the thickness, and by measuring the diameter.

We give an engraving of an instrument that applies these three tests at one operation. The operation is obvious, the slot is exactly filled by a coin of standard size, and the scale is tipped by a coin having the standard weight.

The slots are marked for the various kinds of coin, and the scale is adapted to both gold and silver.

This device is indorsed by bankers and business men generally, and by the United States Treasurer, by the chief clerk of the Post Office Department, and by a large number of influential and prominent business men.

For further information address J. T. McNally & Co., 311 Broadway, New York city.

MAST, FOOS & Co., manufacturers, Springfield, O., were awarded the large gold medal on the "iron turbine" wind engine at the exposition lately held at Adelaide, South Australia, for superior merit. This medal is of the finest Australian gold, and very valuable.

Nature of the Diphtheritic Contagium.

In the spring of 1880, Drs. H. C. Wood and H. F. Formad, under the auspices of the National Board of Health, began a series of experiments upon rabbits with a view of determining the nature of the contagium of diphtheria. The animals were inoculated with diphtheritic membrane taken from the throats of human patients.

In the course of these researches, it was determined that there is nothing specific in the production of false membrane in the trachea, and that traumatic pseudo-membrane accurately resembles the diphtheritic, except that micrococci are not quite so abundant in it. The experimenters conclude that the disease produced by the diphtheritic inoculation was really rabbit diphtheria, because the poison giving rise to it, the symptoms during life, and the *post-mortem* lesions were identical. In addition to this, the contagiousness of the disease was retained. They accept the experiments of Curtis and Satterthwaite, showing that the infectious character of diphtheria depends upon the solid particles of the membrane; furthermore, their researches lead them to conclude that the micrococci are in close relation with the essential poison of diphtheria, being either the virus itself or the producers of it. The results of culture of these bacteria lead them also to assert that there is no difference between the micrococci of simple sore throat and those of diphtheria, except in activity of reproduction; the two are the same organism, existing under different conditions.

Drs. Wood and Formad believe that the vitality under artificial culture is in direct proportion to the malignancy of the case from which the plant is taken. They have succeeded in producing diphtheria by the inoculation of cultured micrococci, but never with those of a generation later than the second.

M. Pasteur has indicated that an inert organism may become virulent, and *vice versa*, and in the same way they believe themselves able to prove that the micrococci of the mouth are really identical in species with those of diphtheria. That oxygen may be potent in converting a virulent into a non-virulent organism, they regard as probable, from the effects of exposure of dry membrane. The micrococci of a catarrhal angina or trachitis may, under favorable circumstances, be transformed into micrococci of diphtheria, and a self-generated diphtheria (*i. e.*, endemic) ensue, or external conditions may favor the transformation of inactive into active organisms, and these may lodge in the trachea and also cause diphtheria (*i. e.*, epidemic). In the first instance, the disease may spread by organisms exhaled by the breath. Diphtheria will vary in contagiousness according to the development of the virus—malignant diphtheria will be more contagious than the mild endemic form. The conditions outside of the body which favor the transformation of inactive into active micrococci, and agents destroying these organisms, remain yet to be studied.—*Phila. Med. Times.*

A New Method of Embalming Bodies and Preserving Tissues.

Dr. Virodtzeff (*Balsamirovanie*, xi., 164, St. Petersburg, 1881) recommends the following preparation as an efficient agent in the embalming of bodies and the preservation of tissues: Thymol, 5 parts; alcohol, 45 parts; glycerine, 2,160 parts; water, 1,080 parts.

It is cheap, innocuous, free from unpleasant odor, possesses the property of keeping the body soft, elastic, fresh, and life-like, and does not ruin instruments. Thymol is selected as being superior to other antiseptics, and glycerine is added, both on account of its own preservative qualities and to retard the evaporation of the fluid. For the preparation of tissues the same solution is employed. If the cadaver be quite lean, or the tissues very delicate, equal parts of water and glycerine (1,620 of each) are combined with the above quantities of thymol and alcohol. To inject a body, half its weight of the fluid is necessary. A properly embalmed cadaver may be preserved indefinitely under ordinary circumstances, gradually shrinking and mummifying without putrefaction. Specimens are either to be injected with or macerated in this fluid. Maceration must not be too prolonged—the appearance of the specimen should act as a guide. The part, after having been thoroughly cleansed in water, and prepared, may then be exposed for months to the air without losing its consistency, form, and color. Permanent specimens may be inclosed in a hermetically sealed glass vessel containing a little of the same solution. The *Medical Record* says that Dr. Peabody has used this preserving fluid, with excellent results, in the New York Hospital Museum.

The Cedars of Lebanon.

Regulations were lately issued by Rustem Pasha for the guidance of travelers and others visiting the Cedars of Lebanon. These venerable trees have now been fenced in, but, with certain restrictions, they will continue to be accessible to all who wish to inspect them. In future no encampments will be permitted within the inclosure, except in the part marked out for that purpose by the keeper, nor may any cooking or camp fires be lighted near the trees, a regulation that has been rendered specially necessary by the partial destruction by fire of three of the largest cedars. Lastly, no animals will be allowed to enter the inclosure and the keeper of the ground has orders to hold the dragomans and tourists' guides responsible for any infraction of the regulations.