Tennantite (sulph-arsenite of copper). Copper, sulphur, arsenic (iron).

Tetrahedrite (gray copper ore, sulphide of copper and antimony, with various other sulphides). Copper, antimony, sulphur (arsenic, bismuth, silver, mercury, zinc, etc).

Torbernite (copper-uranite, phosphate of uranium, and copper). Copper uranium, phosphorus, oxygen (water).

Uranocalcite (oxide of uranium with oxide of copper and sulphate of lime). Copper uranium, oxygen, sulphur, calcium (water).

Vauquelinite (chromate of copper and lead). Copper, lead, chromium, oxygen.

Whitneyite (arsenide of copper). Copper and arsenic.

Of course many of these copper minerals are not such as are worked for copper. The list, which is from the appendix of Brown's Manual of Assaying, is given merely as a matter of reference, so that miners knowing the common name may know the mineralogical name and composition of the mineral.—*Min. and Sci. Press.*

SELF-RECORDING RAIN GAUGE.

MR. A. JACOB, of Salford, has contrived an instrument which gives a perfect record of the rate at which rain descends at any moment during the day and night. *The Engineer* says: The instrument consists of two cylindrical vessels of different heights fixed vertically, and connected with each other at the bottom, so that when a certain quantity of mercury is introduced it will stand at the same level in both vessels. To the top of the shorter cylinder is at-

RECORDING RAIN GAUGE.

tached a tube of the form shown in the engraving, which is connected with an ordinary funnel or rain gauge, either square or circular. The funnel is fixed at a height of several feet above the instrument, for convenience on the roof of the building in which the instrument is placed. Within the tube at the point, A, is fixed a disk of agate or other hard material, which has in it a small perforation, through which the rain water issues after it is caught by the funnel, and passes into the connecting pipe. Within the taller cylinder a float is placed, which rests on the surface of the mercury. To float a stem is attached, which passes between a pair of rollers at the top of the cylinder, and upon the stem is fixed a punch, which presses by the action of a spring upon the surface of a vertical cylinder. This cylinder carries a properly constructed paper diagram, and is caused to rotate by means of a clock, so that one revolution of the cylinder is made in twenty-four hours. The circular motion caused by the revolution of the cylinder, when combined with the vertical motion of the punch actuated by the rise and fall of the mercury, produces a continuous curve, which shows the time and amount of rainfall with accuracy.

When rain begins to fall, it is received by the funnel, which has an area of a definite number of square inches. From the funnel it passes through a small straining chamber down an ordinary service pipe of about $\frac{1}{2}$ in. diameter to the shorter cylinder. Here the water in the pipe exercises a pressure on the mercury due to the charge or height at which it stands in the pipe. The water at the same time escapes through the orifice in the disk fixed at A, at a speed which is proportionate to the pressure, and passes away by an overflow to a vessel in which is measured the total daily rainfall. As the amount of water which escapes bears a fixed propor-

tion to the head in the pipe leading from the funnel, this height may be taken as the measure of the rainfall for the time being. The pressure on the surface of the mercury in the short cylinder raises the column in the longer cylinder to a height which is proportional to the charge of water above the overflow, but in the inverse ratio of the specific gravities of mercury and water.

The float is somewhat peculiar in shape, and it is provided with four small pins or studs which prevent it from touching or coming very near to the inside of the cylinder; thus the deranging effect of clinging to the cylinder by capillary attraction is counteracted.

Several cases of legal proceedings against corporations and local boards have arisen from damage caused by the bursting of sewers during heavy falls of rain. At Manchester, Halifax, and Bolton, within five years past, considerable injury has been caused by excessive falls of rain overloading sewers and destroying private property. It is hardly possible, and seldom advisable, to construct sewers of such capacity as to carry away rain storms of preternatural severity, but when local authorities are on their defense, and endeavor to show that the rainfall which caused the damage was excessive beyond precedent, they nearly always fail for want of adequate means of proving their case. It is not sufficient for judges or juries to show them that the total rainfall for the day was very heavy, unless it can be proved to demonstration that the intensity of the fall immediately before the damage occurred was unprecedented, and therefore greater than it was reasonably possible to provide for. In cases of this kind it is that accurate recording instruments are of so much value.

NATIVE CALIFORNIA WOODS.

FIRST its elasticity. For this test the basis is made for a stick precisely one foot square, and thirty feet between the rests, as shown in Fig. 1.

With this crude drawing we will place 1210-239 pounds pressure and find the stick has reached the first line or V., from which it readily springs back to its original position; but if another ounce or gramme weight be added, its plane is forever destroyed, hence, this 1,210 pounds and a fraction represents its actual elasticity, something remarkable when we take into consideration the natural, brittle texture of the wood. Now, by adding 400-7520 pounds more pressure, the timber bends down to the line marked III., and when again freed rebounds back to V., but would, if another atom of pressure was applied, have its second tension strength as represented by a trifle over four hundred pounds. We have now represented by the two pressures 1,610-991 pounds, and the stick permanently bent to all intents and purposes out of true to the extent represented by the arc in the cut. To bend down to III., requires 390-2711 pounds, when the timber goes back, after the weights or pressure is removed, to III., and it will be noticed with the slight addition of 300 pounds and a fraction, the timber made quite a depression, and we will call this the

a—timber; b, b—points 30 feet apart; c, c—rests; d, d—appliance to balance without weight; e—weights or applied pressure, susceptible of being weighed. I, II, III, IIII, V, are represented by the timber when subjected to pressure at E 3 space, 5555 arcs.

third tension, the best tension really of any timber, as will be shown from another series of tests farther on, inasmuch as the wider the space between these lower arcs and the timber going back to the limit of previous test indicates less liability to break beneath first load, if left with inadequate supports. We have now 1,911-2621 pounds pressure, the timber still whole, unfractured, as proved by its power of rebounding back to IIII., and remaining. The fourth tension required an additional pressure of 500-2113 to crowd down to III., when it rebounded promptly to IIII., showing a readiness to bear a greater load and come back to its original shape when the load was removed. We have now applied 2,412 pounds and over, and the timber's formative fabric uninjured, verified by attaining the lower limit of previous test, by the addition of 113-1112532 the timber settled to II., rebounding to III., and 16-5 pounds more brought it down to one, when it refused to go any better and respond or make any effort to reach its original position; below this, so far as this test is concerned, the less said concerning it the better; right here began the tests to determine other strengths, which we will refer to again at another time.

It may be stated authoritatively, then, that the various tensions to which the wood has been subjected are represented in the aggregate by 2,547 0844882 pounds before the formative fabric has been disturbed; but the timber is not used up yet by any means, for if the bearing weight of a timber falls short when placed horizontally, it may possibly be placed at certain angles, when it will outstrip all competitors for another test; but to return to our subject. It will be noticed that the point where we applied the weights or pressure to determine these tensions of itself is an arc. It is necessary to have represented the entire length of the timber, so far as bent, with a pressure applied by touching the surface of the timber precisely as represented by each arc below, illustrating the various tensions, otherwise, even if it were possible to bring hydrostatic pressure—the means we employ in laboratory practice—the results would not be accurate, inasmuch as, besides an insurmountable difficulty of applying to the center of the timber, it would not press alike along the line of the depression. We wish to explain these various steps as we pass along, for there will something grow out of these that every architect and builder in the entire country should fully understand.

It has been stated that the timber refused to rebound after further pressure. We will now examine into its structure, and try to ascertain why this is so. If we count the grains in the stick, we find it to contain about 158; these are held in place by the constituent elements of the wood itself, there being no mechanical action whatever. When one of these circles are separated in sawing or any division, these do act slightly mechanically, as was stated in a previous article, by their straightening out; this, too, we may have reason to refer to again.

These chemical elements of which we speak consist of cellulose, gum, starch, gluten, and the like, but we have not submitted the wood to chemical analysis yet, neither can we, until the other tests are further along, for apparent reasons, but will

in due time. If any force is brought to bear having a tendency to displace the molecules constituting these elements, the end of the timber, which was previously perfectly square and smooth, will be notched and jagged precisely in proportion to the accuracy of the previous tests, and when these were completed in this case careful counting revealed just as many of these steps on the end as could be counted grains in the timber, hence the test must be accurate, for the substance situated between each two of these grains had been absorbed or set free from the grains, hence each one of these contained just sufficient elasticity, and no more, to sustain its individual weight, and of course could not spring back.—*Lumber Trade Journal.*

THE TELEPHONE.

By EDWIN J. HOUSTON.

THE telephone is a contrivance by which speech, uttered at one end of an electric circuit, can be heard at the other end, even though the circuit be many hundreds of miles in length.

When a bell is struck, the sound produced is carried to the ear of a listener by means of a wave motion, which the bell makes in the air around it.

Differences in sound are caused by differences in the rapidity with which these waves follow one another.

When sound waves, following each other with a certain rapidity, enter the ear of a listener, they produce therein equally rapid shakings, which, being carried by the mechanism of the ear to the brain, cause a sensation of sound corresponding to the peculiarity of the exciting sound waves.

In electric telephones it is not sound waves that are carried along the line; it is an electric current produced by the sound waves.

There are various kinds of electric telephones.

The magneto-electric telephone consists essentially of a contrivance called the transmitter, into which the speaker talks, connected by a conductor of electricity with a receiver, which the listener holds to his ear.

The atmospheric waves produced by the voice of the speaker, striking against the instrument, into which he talks, cause a plate of iron to move toward and from the pole of a permanent magnet, around which is wrapped a coil of insulated wire. An electric current thereby results, which, flowing over the wire, passes into the receiving instrument, and causes in it a movement that exactly corresponds to the movement produced at the transmitting instrument by the voice of the speaker.

A telephone, therefore, is a dynamo-electric machine driven by the voice of the speaker. The receiver is a dynamo-electric motor, whose rapidity of movements, exactly corresponding to the rapidity of the waves produced by the voice of the speaker, reproduces in the air around it the speaker's voice.

In Fig. 1 is shown, in section, a model of the Bell magneto-electric telephone. It consists of a magnetized steel

FIG. 1.—THE TELEPHONE.

bar, F, with a coil of insulated wire, H, wrapped around it near one of its ends. In front of the coil, so as to be able to freely vibrate to and from the pole, a circular disk of iron is securely fastened at its edges.

A conveniently shaped mouthpiece is placed over the plate, sufficient air space being left for its free vibration. If now a speaker talks into the mouthpiece, the vibrations of the air will cause the plate, which is magnetized by its nearness to the magnet pole, to move to and from the magnet. These vibrations produce in the coil an electric current that flows in one direction when the magnetized plate moves toward the coil, and in the opposite direction when it moves away from it. This instrument is called the transmitter. An exactly similar instrument may be employed for the receiver.

Fig. 2 shows how the receiver and transmitter are placed in circuit with each other.

FIG. 2.—MAGNETO-ELECTRIC TELEPHONE.

Let a represent the transmitter, and b the receiver, and suppose them to be joined by a conducting wire.

This wire is represented in the figure as broken, so as to give the idea of distance. Suppose, now, a speaker talks at a; all he utters can be distinctly heard by the listener, whose ear is held at b.

The operation of the instrument is as follows: The effect of the speaker talking into a is to cause the magnetized plate to move with varying rapidity toward and from the coil on the magnetized bar. If we can cause exactly similar movements to be produced in the plate of the receiving instrument at b, a listener, whose ear is placed near b, will hear all that is spoken into a.

For, let us consider a single motion of the plate of a. Suppose that it moves toward the magnetic pole, and in so doing produces an electric current that flows out of the coil of wire at a, and into the coil of wire at b, through the ground. This current, circulating around the coil at b, causes the magnet to become more powerful, and so draw the plate b toward it. If, on the contrary, the plate at a moves away from the magnetic pole, the current flows from a, in the opposite direction, and passing over the line, flows through the coil at b, weakening the magnetism, and thus permitting the plate, by reason of its elasticity, to move from the pole at b. The to-and-fro motion of the transmitter, produced by the speaker's voice, has been followed, therefore, by a similar to-and-fro motion of the plate of the receiving instrument, so that whatever is spoken at a can be heard at b.

In a telephone, therefore, it is not sound that travels along the wires—it is an electric current. The speaker's voice, acting on the transmitter, produces electricity, which, flow

ing over the line, reproduces similar movements in the receiver.

A magneto-electric telephone consists essentially of a coil of wire wrapped on a magnetized steel core, and a plate of soft iron placed so as to be able freely to vibrate very near the pole on which the coil is wrapped, but without touching it.

Telephones are made of a variety of forms. In the case we have considered, the receiver is in all respects the same as the transmitter. In some forms of transmitters, such as the Blake, the current of a voltaic battery passes over the line through a resistance which is varied by the voice of the speaker, so that the magnetization of the receiver is correspondingly varied.

In the electrostatic telephone, a system distinct in itself, invented by Dolbear, the speaker's voice varies the electric charge in two metallic plates placed near each other. These plates move toward and from each other when variations occur in their electric charge.—*Electrical Review*.

MARESCHAL'S ELECTRIC LARYNGOSCOPE.

AN examination of the vocal cords and larynx, situated beneath the base of the tongue, presents a certain difficulty, since they cannot be seen directly. We are obliged to have recourse to a small mirror mounted upon a rod at an angle of 45°. This is placed against the veil of the palate so that it faces the larynx, and the latter is thus seen by reflection. Now, it will be readily seen that for this purpose it is necessary to light up the bottom of the patient's mouth brilliantly, and this is done by projecting therein a luminous fascicle produced by a Carcel lamp or, as in Dr. Fauvel's clinic, by an oxyhydrogen lamp. Such an illumination necessitates an arrangement that the physician cannot carry with him when he is called upon to visit a patient at his home. In order to remedy this state of things, Messrs. Cadot & Corneloup have, according to directions from Dr. H. Mareschal, constructed the little apparatus which we illustrate herewith, and in which the lighting is effected by means of a small incandescent lamp placed near the mirror and in the mouth of the patient.

The apparatus consists of an external silvered copper tube, B, and of a concentric copper tube, A, insulated from the other. The flexible conductor, which traverses a wooden handle, M, is connected by one of its wires with the tube, A, and by the other with B. The lamps are absolutely independent, and may be replaced with the greatest facility. To this end, they are mounted at the bottom of a small flaring tube, E, of silvered copper, which serves as a reflector.

or and is adjusted by friction in the external tube, B. One of the wires of the lamp is soldered to the reflector, while the other is fixed to a small copper rod, H, placed in the center of an ebonite cylinder that fits into the tube, A. There is no need, then, of bothering about the securing of contacts, as these are effected naturally when the lamp is put in place.

The laryngoscope properly so called, that is to say, the mirror, G, and its rod, T, is fixed along the external tube by means of two slides, D D, one of which is provided with an adjusting screw. This arrangement permits of moving the lamp to different distances from the mirror, and of easily removing it for cleaning the mirror, for substituting another of different dimensions for it, or for lighting any other natural cavity.

In sum, the physician has here a portable and simple instrument, whose essential parts may be easily kept in good order and be replaced without the aid of a workman. These are valuable advantages that render it really practical.—*La Nature*.

OIL AND ELECTRIC LIGHTS.

In a paper on "Electric Lighthouses," M. De Meritens gives some very interesting figures in comparing oil and electricity as illuminants. The figures, he states, are taken from two memoirs by M. Allard. As an example, the light at Dunkirk, obtained from mineral oil, is 6,250 candles, which in weather of mean transparency is seen for 53 kilometers. If this be compared with an electric light of 125,000 candles, it is found that the electric light is seen for 75.4 kilometers. Thus an increase in the illuminating power of 20 times only increases the penetrative distance 42 per cent. If we now take a less transparent state, the ratio is reduced to an increase from 24 to 32 kilometers, or 34 per cent. Or, lastly, in very foggy weather the distances are 3.7 and 4.6 kilometers, showing an increase of 24 per cent. From these general figures, M. Allard has calculated that in foggy weather in the Channel the luminous intensity with oil of 6,250 carrels, is 3,805 kilometers; then, if this be increased to an oil illumination of 125,000 carrels, the luminous intensity is 4,740 kilometers. Now, comparing this with an electric light of 125,000 carrels, he finds the luminous distance to be 4,696, or the penetrating power of the electric light is less than 1 per cent. less than mineral oil; while its cost, as computed by both English and French engineers, is from four to six times less than that of oil.

ELECTRICITY IN MACHINE BELTING.

A TROUBLESOME development of electricity sometimes takes place with machine belts driven at a high velocity, under favorable conditions. In a dry atmosphere and between shafting practically insulated by wooden blocks, or other non-conducting means of support for the bearings, the pulleys become veritable frictional electric machines, excited by the rubbing of the belting. This subject has recently been reported on by Herr Bacher, inspector of lighting at the Dresden Theater, who has detailed some interesting experiments conducted by himself. He declares that very powerful effects may be produced by this means. A Leyden jar has been charged in a few seconds, giving sparks 4 millimeters long when discharged. A person standing on a stool having glass legs can draw powerful sparks from a belt charged with electricity, by approaching to it the tip of one of his fingers at a distance of 10 or 15 millimeters. All the other well known experiments of frictional electricity may be repeated, in these circumstances, with perfect success. Unfortunately, the development of electricity in belts and pulleys is dangerous; and it is probable that to this cause

many disastrous fires might be attributed which are generally classified as spontaneous. Flour mills, factories in which the air is heavily charged with floating organic fibers of all kinds, are peculiarly subject to these mysterious conflagrations. All lines of shafting, therefore, should be metallically connected, through their bearings, with other masses of metal or with the earth. In humid climates, such as that of Great Britain, risks from the development of frictional electricity to a dangerous energy are comparatively slight; at the same time the possibility is not one that should be altogether lost sight of.

A GAS CARBON BATTERY.

In a paper on the application of electricity as an illuminating agent in astronomical observations, Mr. W. S. Franks, of Leicester, tells the readers of the *Journal of the Franklin Institute* the story of his experiences with incandescent lighting by battery power. His requirements in the matter of lamps were not large, as he only used two of Swan's 2½-candle type, supplied at first by a 4-cell bichromate battery of the usual kind. Ultimately, however, Mr. Franks decided upon a type of home-made battery, which is worth describing, as it may be readily made by any one connected with gas works wishing to make a small private trial of incandescent lighting. He calls it a "granule carbon" battery, and declares that its performance has been to his entire satisfaction. The outer cell is a wide mouthed, two gallon, salt glazed stoneware jar. In this is placed a carbon plate, sawn out from the raw material as obtained at a gas works; its rough edges being merely cut true. There is also a porous cell containing a zinc plate; and both cell and carbon plate are packed into the jar with pieces of carbon broken to the size of a small nut. The jar is then charged with 1 pound of bichromate of potash, dissolved in 1 gallon of hot water, with 1 pound of sulphuric acid afterward added. The porous cell is charged with dilute sulphuric acid, in the proportion of 1 to 10. The three cells are coupled for intensity. When not in use, the zincs are lifted out of the liquid and suspended by loops in the insulated wire connections, upon small nails. The only preparation of the carbon plate was to thoroughly paraffin the exposed end and place a small clip of platinum foil on it, under the brass clamp. This device effectually prevented the destruction of the clamp by acid creeping up the pores of the carbon. It is stated that for the usual intermittent observatory work, the cells will last

Fig. 1

Fig. 3

Fig. 2

Fig. 4

EXHAUSTION OF BAROMETER TUBES WITHOUT HEAT.

for three months without recharging; though, when required, the lamps can be kept up to full incandescence for hours together. In the ordinary way Mr. Franks put down the expense at about 3d. per week on an average.

EXHAUSTION OF BAROMETER TUBES WITHOUT APPLICATION OF HEAT.

THE defects inherent to the methods at present employed for exhausting barometer tubes have induced V. Klobukow to study the various methods, especially that of Bogen, adopted in meteorological observatories. By a modification of the latter he succeeded in producing a complete vacuum by means of a mercury column without application of heat—Bogen's method. A well dried barometer tube is charged with pure mercury, the imprisoned air removed by shaking, and the orifice closed with the finger, it then is inverted over a mercury trough, partly immersed in the metal, placed in a vertical position, and the surplus of mercury allowed to escape. The tube is again closed by pressing the fingers on to the open end, brought in a horizontal position, and gently shaken for a short time. After a portion of the air embedded in mercury has entered the vacuum, the tube is transferred to the trough, manipulated as before, and the operation repeated twice or three times till the mercury is freed from the adhering air. When the section of the tubing is reduced to that of a capillary tube, the filling with mercury by this method is impracticable; this difficulty is overcome by the following modification.

The barometer tube, B, being filled with mercury in the usual way, is connected by a rubber tubing of from 6 to 8 cm. in length to a glass tube, open at both ends, of the same diameter and length as B; the tubes are placed in the position as shown in Fig. 1, and A filled with mercury. Care being taken that no air remains confined in the bend, C, and few taps should be given to the rubber tubing by the hand, or pressed by the finger of sufficient force to cause the emission of a few drops of mercury. By introduction of an air bubble into the tube, A, and partial closing of the orifice with the finger all air confined in the rubber bend is expelled by compression of the rubber. The compression being maintained for a few seconds, till a small portion of the mercury has been forced out and the tube hermetically closed, when the closed end is immersed in mercury and the finger withdrawn from the orifice, Fig. 2.

The following operation consists in the formation of a vacu-

um: By raising the barometer tube, B, Fig. 3, it then is lowered while A is moved in a nearly vertical position, Fig. 4, which causes a migration of the previously produced vacuum, $f m$, to the opposite portion, $f' m'$, of the tube. The exhaustion of the tube is repeated twice or three times, during which the tube is gently moved until the characteristic sound of the metal, on lowering and raising of the tube, becomes audible. After complete exhaustion, the tubes are disconnected, B is closed and immersed in mercury. The charging of A with mercury is effected by means of a small funnel, Fig. 1, and a complete exhaustion of the tubing is attained within twenty or thirty minutes.

The method is applicable to siphon and cistern barometer, and can also be used for the exhaustion of capillary tubing; the employment of an air pump and application of heat in exhausting the latter will greatly accelerate the operation. The manipulations which the method requires are simple; they can be performed with good results by persons unaccustomed to experimental work, always giving an excellent vacuum.

THE THERAPEUTICAL EFFECTS OF THE INTERNAL ADMINISTRATION OF HOT WATER IN THE TREATMENT OF NERVOUS DISEASES.*

By AMBROSE L. RANNEY, A. M., M. D., Professor of Applied Anatomy in the New York Post-Graduate Medical School and Hospital.

A MUTUAL dependence may often exist between disordered states of the thoracic, abdominal, and pelvic viscera and some forms of functional disturbance of the nervous system. This is well recognized to-day by all neurologists.

The fact has been demonstrated, by a long array of clinical observations and physiological experiments, that the nerve-centers are not to be considered clinically as independent organs. The brain and spinal cord are to a certain extent but servants of the other viscera. On the other hand, the nerve-centers are occasionally the masters. They perform some of the functions (properly attributed to them in one sense) only in response to different forms of impressions conveyed to them from without. By means of vasomotor and other varieties of nerve-filaments, sensory impressions made upon peripheral organs are now known to affect the general blood-pressure; to accelerate and arrest the action of the heart; to induce spasmodic and paralytic

disturbances in special physiological centers of the brain and spinal cord; to create localized phenomena of defective nutrition and assimilation; and to excite reflex nervous symptoms in parts far removed from the seat of peripheral irritation. We also know that the growth of the viscera, as well as their physiological functions, hangs upon a reciprocal relationship between them and the brain and spinal cord.

I mention these facts as a preface to my remarks this evening, because they will be shown to have a direct bearing upon a theory which I shall advance respecting the action of heat (when introduced into the stomach) upon the various organs and tissues.

The tendency of the age, particularly in neurology, seems to me to manifest itself in endeavors to discover new medicinal agents, often to the neglect of simple remedies whose influence upon the system has not yet been thoroughly tested. Among the latter, to my mind, hot water stands pre-eminently at the head.

It may seem a startling assertion, but it is nevertheless a fact, that more persons among the laity are to-day taking hot water for various ailments than any single drug in our Pharmacopœia. In many instances they may be doing so injudiciously and without proper grounds; but that they are employing this agent, for actual or imaginary ills of the flesh, by thousands cannot be denied by any one acquainted with the facts.

The spread of the belief in the therapeutical value of hot water has traveled chiefly by word of mouth, as I know of only two articles in medical literature that have materially helped to popularize it. To employ hot water therapeutically could not have become so universal a custom unless great benefit had been bestowed by it upon many. My own experience with it in the treatment of nervous diseases has led me to call the attention of the profession again to its use as a therapeutical agent, and to point out some of the results that may be expected from it, and also how it should be administered.

In no work upon therapeutics or neurology have I been able to find any record of experiments made to determine either the physiological or therapeutical effects of hot-water drinking. In most of them no reference even is made to it as a remedy.

It was first employed in 1858, according to Dr. Cutter, by

*A paper read before the New York Academy of Medicine, October 16, 1884.