

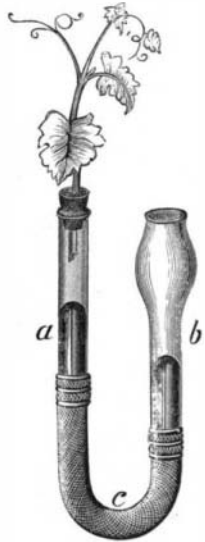
8 cents an hour. In removing the fleece no effort is made to clean the wool, and frequently the material is not only gummy but filled with fine sand, yet the work can be done so neatly that when the fleece is removed, the skin is not even scratched.

The live stock raiser who owns a flock of a thousand sheep, can do all his shearing with the aid only of a boy to turn one of the hand machines. This is one reason why the machine's use has become so extensive not only on the large ranches of the West and Southwest but on the smaller places where only hand power can be utilized to advantage. This mechanism has been substituted so extensively for the ordinary hand shears, that the latter implement must become in the near future as obsolete as many other tools, which ten years ago were considered indispensable in carrying out agricultural work.

THE WATER-ABSORBING PROPERTIES OF PLANTS.

The consumption of water in the cultivated plants is very considerable. It has been found that Indian corn, during its period of vegetation, uses up 31 pounds of water, while hemp and sunflower require 59 pounds and 145 pounds respectively. Still larger, of course, are the quantities for the trees whose leaves take up a very large surface and are capable of exhaling enormous quantities of water. The water which leaves in the form of vapor through the stomata of the leaves and circulates in the smallest plant as well as the largest tree, up into the extreme ends of the branches, has to be raised to this height. When we consider the large quantities of water that are given off by even a medium-sized tree, we recognize the fact that a huge force is required to lift the large volume of water and expedite it. We only need to tear off a leaf or the stem of a herb-like plant, to become convinced that the water is not conducted in the form of vapor, but in the liquid state. What powers, therefore, are at work performing this gigantic task?

This question is also answered by the physiology of plants in conjunction with physics. Through every plant, beginning in the finest, hair-like roots, runs a connected system of canals, the fibro-vascular strings (vascular bundle) which ramify into all parts of the plant and meet our eye in the leaves as ribs and nerves. These strings are the water conduits, but we have yet to look for the pumps by means of which differences of height are overcome between root and crown, sometimes amounting to as much as 328 feet. When we contemplate such a fibro-vascular string, we observe that it is reinforced in many places by peculiar formations, by spiral vessels, etc. These structures serve no other purpose than to increase the solidity. Furthermore, the vascular bundles, which are usually lignified themselves and no longer carry any living protoplasm, are surrounded by the vascular sheath consisting of thin-walled, live cells. These cells are nothing more or less than osmotic apparatus; it is they which cause by means of the osmotic force the ascension of the sap current.



Demonstration of the Absorbing Power of Transpiring Leaves.

a, b, Glass tube filled with mercury. c, Rubber tube.

Their action is exercised in two different ways; they are able to press as well as absorb, and by the co-operation of both forces, considerable quantities of liquid are dispatched in the plants. If plenty of liquid is supplied to these cells from the environs, as is the case especially in the roots, they will force a portion of this liquid with strong pressure into the vessel. On the other hand, if they are situated in the water-exhaling leaves, water will be abstracted from them by the adjoining cells, and in order to fill up again, they will absorb water from the vessel.

Both co-operating forces, the pressure emanating from the roots and the absorbing power occasioned by the evaporation of water from the leaves, are considerable. We can easily convince ourselves of this fact by observing a well-known process, the so-called bleeding, i. e., exudation of sap from wounds made on plants in the spring before the formation of foliage. Then it will be seen how large an amount of liquid flows from the places, and when the stem of a plant is cut off smoothly and fixed in a manometer filled with mercury, the quicksilver is lifted to great heights. In the grapevine, for instance, a root pressure has been found, capable of keeping the balance of a mercury column $3\frac{1}{2}$ feet high. The absorbing power is likewise very great, and if a leaf-bearing twig is inserted in a manometer filled with mercury, and the space between the cut and the quicksilver filled with

water, the mercury is drawn up in proportion as the twig exhales water. This may take place to such an extent that the mercury in the two legs of the manometer will show a difference in height of 30 centimeters. For the engraving as well as the foregoing text we are indebted to *Der Stein der Weisen*.

Electrical Notes.

News comes from abroad that a German company is running a number of electric tug boats for touring purposes regularly between Zehrdeuck and Berlin. The dimensions of the boats are from 46 feet to 49 feet long and 10 feet wide, and they have a draft of 3.4 feet. We understand that these boats are also used for towing barges up and down the canal, their displacement being considerably less than that of steam tugs of equivalent drawing power, and they are therefore peculiarly suited to towing purposes in shallow and winding canals. We regret that no information is given as to how the electrical energy is obtained—whether from accumulators on the boats or from an overhead line. Electric haulage on canals on the Continent and in America is usually accomplished by tractors running along the banks and receiving current from overhead trolley wires.

At a recent meeting of the British Institution of Electrical Engineers in London the results of the experiments with the Nernst electric light for public lighting purposes were given. A mile of a street in Hackney, one of the London suburbs, has been lighted by means of these lamps to obtain conclusive data regarding their durability, efficiency and suitability for such work. The main difficulty experienced was in connection with the starting of the light. This, however, was overcome by means of the automatic heater, which is put out of action directly the lamp lights up. But the result of this attachment was not attended with absolute success, since considerable uncertainty exists in connection with the durability of the glower. Some glowers lasted only 15 hours, while others remained efficient for 1,070 hours, but the average life was 305 hours. This lack of uniformity constitutes one of the greatest objections to the wider utilization of the Nernst lamp for public lighting, despite its superiority in many other important features, and will necessitate considerable improvement before it is extensively adopted for illuminating the streets, with that economy which is essential for such purposes.

Alfred Cowles read a paper before the Electro-Chemical Society at Niagara Falls, the subject of which related to the rather remarkable fact that an even 100-ampere current in one sidereal day liberates by electrolysis just one cubic meter of hydrogen under standard conditions. These agreements are so close that they should be of great practical value, for the reason that it becomes easy for students to master the table of electro-chemical equivalents. Mr. Cowles has kindly sent us a memorandum giving the exact data upon which his calculation is based, and the exact results. If the atomic weight of hydrogen be taken as one, and the calculation is based on Dr. Edward W. Morley's determination of the weight of a liter or cubic decimeter of hydrogen, 0.089873 ± 0.0000027 gramme, as given in Dr. Morley's paper on the Atomic Weights of Hydrogen and Oxygen, in the Smithsonian Contributions to Knowledge for 1896, we must then attribute to silver an atomic weight of 107.11. Lord Rayleigh's determination of the electro-chemical equivalent of silver is 0.001118 gramme per coulomb. This would make the electro-chemical equivalent of hydrogen 0.00001043786 gramme. Under these premises, the kilocritichol, or 100 international amperes for one sidereal day, liberates 1.00071 cubic meters under standard conditions of pressure and temperature. The meter is not exactly one ten-millionth part of the quadrant of the earth from the pole to the equator. The most reliable data as to the distance from the pole to the equator, is the determination made by Clarke in 1880, based upon all the arcs of the earth that had been measured up to that time. He found the distance from the pole to the equator to be 10,001,868 meters. We correct the length of the meter in the light of this more reliable data, the cubic meter would then become a trifle larger, and the 100-ampere current would then give 1.00015 cubic meters of hydrogen at 0 deg. C. at the pressure of the atmosphere at sea level and 45 deg. latitude in one sidereal day. The sidereal day is 86,164.091 mean solar seconds, and measures the true revolution of the earth on its axis. This agreement is so close that it is well within the limits of error of the determinations of the various constants, and it naturally raises the very important question as to whether the agreement is absolute or not. Taken in connection with the law of Avogadro and the valencies of the elements, this agreement reaches to every element in chemistry. Hence, if this connecting link could be proved fundamental, the periodic law, the law of gravitation, and Coulomb's law of attraction between electrically-charged bodies, could all probably be brought within the scope of some broader generalization.

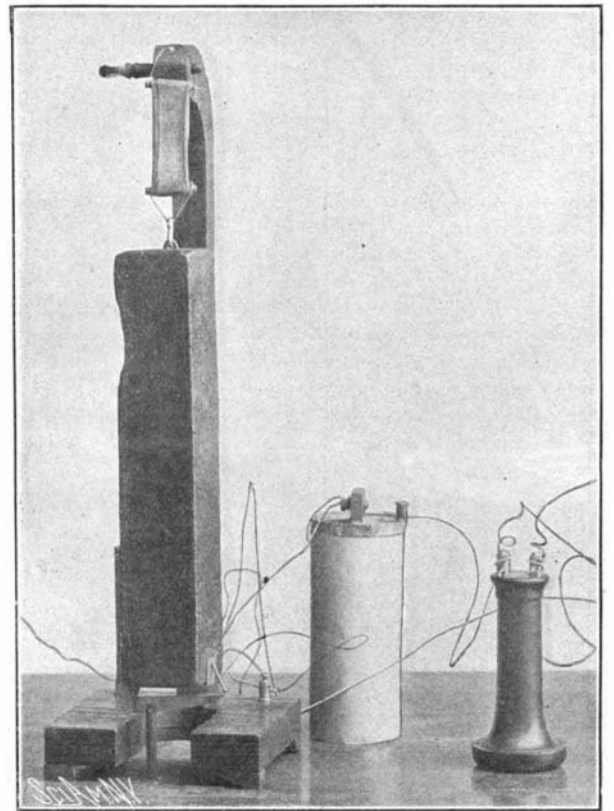
AN INSTRUMENT FOR DETECTING DELICATE ACOUSTIC VIBRATIONS.

BY SHIRL HERR.

Students of acoustics have found that the lowest number of successive vibrations per second that will produce sound is sixteen. Slow vibrations of solid bodies may be detected by the sense of touch, provided they are of considerable amplitude, but delicate vibrations having a rate lower than sixteen in a second produce no sensation whatever. The writer has constructed an apparatus that renders audible many of these insensible vibrations. This apparatus, however, can be used only for detecting the vibrations of solid masses which present a horizontal surface such as floors, pavements, etc. It is constructed in the following manner:

A weight of about ten pounds is suspended from the arm of a standard by means of a stout rubber band, and has cemented to its side in a vertical position a small carbon plate. A carbon block is placed directly on the surface of the vibrating body, and on this is set a slender graphite pencil which is inclined at a slight angle against the carbon plate on the weight. The carbon plate and the carbon block are then connected with a battery and a Bell telephone.

If this apparatus is placed on a wood floor the jar of the heart beat of any one standing near it will cause it to produce distinctly audible vibrations in the telephone. It is also sensitive to the jar of a distant concussion, such as thunder at a great distance. Delicate tremors and vibrations from any source produce audible vibrations in the telephone, but such audible vibra-



A MODIFIED MICROPHONE FOR DETECTING FEEBLE VIBRATIONS.

tions are not in any case a reproduction of the original vibrations. These sound-producing vibrations are the result of the rapid variations in the current caused by the graphite pencil rubbing against the carbon plate.

This rubbing is due to the fact that the graphite pencil and the carbon block on which it rests vibrate with the surface on which they are placed, while the weight and the carbon plate secured to it, because of their elastic support, remain practically motionless. The sensitiveness of this apparatus can be slightly increased if, instead of the carbon block, the graphite pencil is permitted to rest on a bit of platinum secured to the free end of a small lever. This lever, which is fulcrumed in a rigid arm projecting downward from the weight, is connected with the vibrating body by means of a small rod so that its free end vibrates with increased amplitude.

Experiments cannot be conducted satisfactorily at a time when there is any wind blowing, or in the neighborhood of any constant jarring such as that caused by the traffic on a city street, a waterfall, etc.

Gifts to American Libraries in 1902.

At the twenty-fifth annual meeting of the American Library Association, a report was read by J. L. Harrison, from which it would appear that 96,247 volumes were given to the libraries of the United States during the year 1902, in addition to \$10,306,407.61. Mr. Carnegie's gifts for the year number 158 and amount to \$6,679,000. They were for buildings, and were given subject to the usual conditions that a site be provided and that ten per cent of the amount of the gift be pledged for annual maintenance.