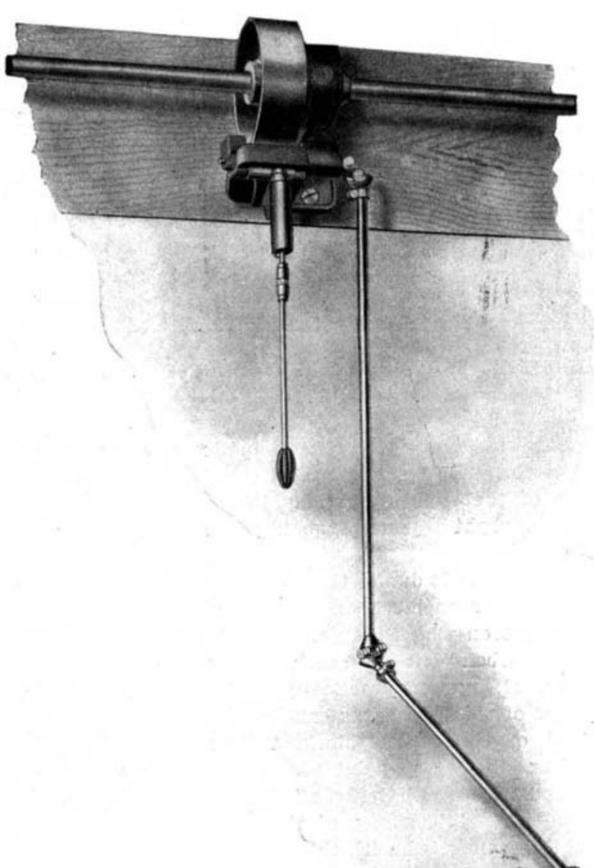
de Boulogne, carrying a trail rope 100 feet long. The balloon could be steered with ease and went through a number of evolutions, going first in one direction, then in the opposite, turning about and traveling against the wind, rising and descending, and seeming to be fully under the control of the aeronaut. A second series of trials similar to the first were made on the 21st of May over the same ground and lasted an hour and a half. After sailing in different directions the airship alighted on the grounds of the Polo Club, taking its flight again, and after another series of evolutions, in which it was controlled with ease, it landed finally near the balloon shed. One of the engravings shows the airship ready to start from the balloon shed on its trial trip, with Santos-Dumont in the car, while the second shows it sailing over the Bois de Boulogne, the aeronaut being shown in the act of shifting the sand-bags which are used to balance the car. The position of the propeller and the rudder will be clearly observed.

The new No. 9, which was described at the time of its construction (in the SCIENTIFIC AMERICAN of December 20, 1902) is not intended to make any great speed, as the balloon body is of egg-shaped form and travels with the large end foremost. This construction makes it steadier than the pointed form. Hence the balloon is not as likely to pitch. The experimental No. 9 having proved so successful, the new No. 10, which is to be the largest airship yet built, and which will carry ten persons, will be constructed on the same lines.

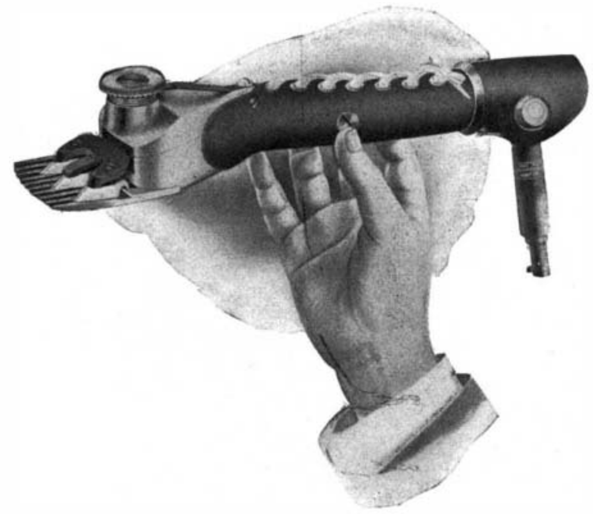
Santos-Dumont has erected a vast balloon shed on the bank of the Seine just outside the city. It consists of a framework of beams covered at the sides as well as the top with a red and white striped awning. One feature is the ease with which the front may be opened to let out the airships. The two frames which form the sliding doors and uncover the whole end of the shed are mounted on rollers upon an upper framework, and are guided below on rollers, so that they can be easily slid back and forth. In our engraving the aeronaut will be noticed in front of the shed, on the extreme left.

The new Clement gasoline motor used on the No. 9 has proved especially satisfactory. The little motor with its two cylinders joined in the form of a V to a round aluminium crank box, seems like a toy and weighs but 26½ pounds, although it will develop 3 horse power. The weight per horse power (8.8 pounds), the smallest that has yet been reached, is the result of a long experience in racing cars, where



SHEARER DRIVEN FROM AN OVERHEAD SHAFT.

the weight must be cut down to the minimum. Current for the spark is supplied by a battery and induction coil of the motor-bicycle pattern. The motor is connected through a light friction clutch to the long shaft which passes back of the propeller. A bicycle wheel with a heavy rim (without the tire) forms the flywheel and lies next the motor. The main framework remains about the same, but has been shortened by about two feet at the front end and is now rounded off. The position of the gasoline tank (containing 2½ gallons) has been changed, and is now hung on the rear of the basket. The rudder is formed of canvas stretched on a very light bamboo framework and measures about 10 feet square. The pilot wheel which controls the rudder is mounted just in front of the basket, and on the same shaft is a second and smaller grooved wheel carrying the cord which mounts up to the balloon body and then passes back over a set of pulleys to the rudder. The wheels are of aluminium, as in fact are most of the metal parts outside of the motor cylinders, and main shaft. The aeronaut has also at hand the cord of the escape valve as well



THE CLIPPER.

as the different levers for operating the motor. An air-bag of 60 cubic yards lies along the inside of the balloon at the bottom, forming a pocket which can be filled out with air by a fan mounted on the motor shaft. The balloon is always kept in shape as the gas escapes. The propeller, 12 feet in diameter, makes 200 revolutions per minute. The balloon body is only 45 feet long, while the framework is now but 27 feet. The complete airship weighs only 200 pounds.

Alongside the balloon shed has been installed a hydrogen generator of large capacity to be used for this and the future balloons. Tubes of compressed hydrogen are at hand for emergencies. One of the engravings shows the inside of the balloon shed with the No. 9. The shed will soon contain as many as three new airships, as Santos-Dumont is now building two new ones, the large No. 10 which is to be a touring balloon, and the new racer No. 7 with which he is to enter the St. Louis contest of next year.

The work on the No. 7 is already well advanced. The car which is 97 feet long is almost finished and will be observed on the left. The design of the new racer is almost entirely fixed upon. It will have a capacity of 1,650 cubic yards and will have the form of an elongated ellipsoid measuring 159 feet long and 23 feet across the middle, thus giving a ratio of 1 to 7. The two ends will be pointed. The envelop of the balloon will have 850 square yards surface. It is composed of two thicknesses of French silk pasted together and the whole will weigh 528 pounds. The balloon is divided into three compartments each having a volume of 550 cubic yards. The two partitions, which are of unvarnished silk, have a surface of 75 square yards and weigh 15 pounds. Near the center of the balloon are two interior air-bags of unequal size and communicating with each other by a canvas sleeve. The surface of the air-bags is 150 square yards and their weight 62 pounds. The car-frame, 67 feet long and 4 feet high in the middle, will be suspended from the balloon by 102 steel wires. A Clement petrol motor of 60 horse power will drive two propellers of 12 feet diameter, both having the same screw pitch. The propellers will be fixed at the front and rear of the car-frame. The basket of the aeronaut will be placed in the center of the car-frame. This new arrangement will tend to increase the pitching of the airship, and to overcome this, two pairs of horizontal planes will be placed to the forward and rear of the center of the framework, each lying on one side of the axis. These planes will measure 6 by 6 feet or 36 square feet each, or in all 144 square feet; they are to be movable and will be controlled by a set of levers. The rudder, whose axis will be vertical, will have a surface of 10 square yards. It is expected that the new racing balloon will make a speed of 60 feet or more per second. Santos-Dumont expects to finish it about the first of July, when it will be put through its trial tests.

A MECHANICAL SHEEP-SHEARER.

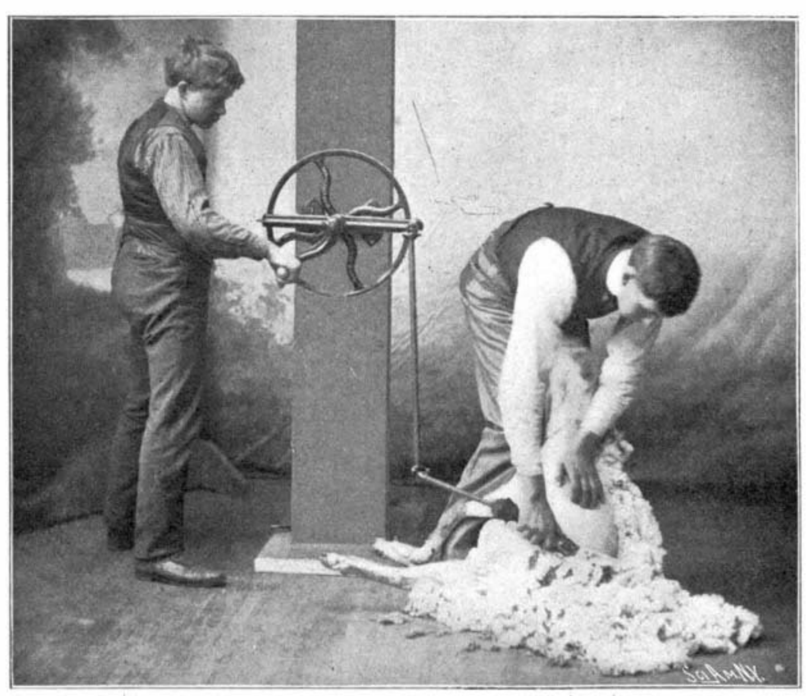
Among the variety of labor-saving apparatus which have been invented in recent years for the benefit of the farmer, one of the most interesting machines is that which relieves him of the work of removing the fleece of his sheep by means of the ordinary hand shears. A mechanism is now being used on the sheep farms of the West as well as other portions of the United States which performs a remarkable amount of work when contrasted with the method which has been used in the past. It works by means of a flexible shaft. The knives or shears can be operated as rapidly as the gearing contained in the shaft can be moved.

The sheep-shearing machinery can be operated by hand, by steam, or electric power, as desired. The cutting instrument proper is quite similar to the familiar clipper used by hair dressers and also for clipping horses, but varies in size according to the requirements. It includes a steel comb for separating the wool and allowing the knives to sever it closely to the skin. The cutter consists of three teeth or blades bolted to the framework of the shears in such a manner that they play freely, as shown in the illustration. They can be removed readily for sharpening whenever necessary. The cutting apparatus is connected to the lower of a series of steel spindles incased in tubular sheaths. The upper spindle terminates in a cog wheel which engages the teeth of a similar wheel at the end of what might be called the driving shaft. When the apparatus is operated by steam or electric power, this shaft is belted to a pulley.

Where power is furnished by hand, a crank is used to turn a driving wheel. The rim of this bears a series of cogs whose teeth fit into the driving shaft connected with the flexible shaft. By turning the handle of the crank wheel, a man or a boy can furnish sufficient power to operate two shearing machines at once.

The operation of shearing is performed so rapidly by this method that the workman can remove the wool practically as fast as he can push the cutter through it. Usually the plan followed is to guide the shears with the right hand, holding the animal in proper position with the left hand and the knees. As a rule the wool is first removed from the lower portions of the body, gradually working up the sides in such a manner that the skin is prevented from wrinkling and offers a smooth surface to the cutter. An expert shearer by this method can crop off the fleece almost completely, leaving the animal clean, as shown in the accompanying photograph. Some of the records made by expert shearers with the apparatus have been really remarkable, one man taking off 2,650 pounds of wool from 360 animals in less than 15 hours with such a cutter, shearing over 20 sheep per hour. The average shearer, after he has become familiar with the machinery, can without difficulty cut from 150 to 200 fleeces in a day of 10 hours.

Where a power plant is installed it is usually placed in a building large enough to carry shafting and pulleys, from which are suspended the shafts working the cutters. As a single cutter can be operated at full speed by ⅛ or 1-6 horse power, an engine of 8 or 10 horse power is sufficient to drive an extensive plant. One which has been installed on a ranch in Wyoming contains fifty machines, which have a capacity for shearing over 1,000 animals an hour. It is estimated that the entire expense, including labor, fuel for the engine, and wear and tear of the mechanism, averages between $20 and $25 for 100,000 head of sheep shorn, the average price paid the operator being



SHEARING A SHEEP BY HAND MACHINE.

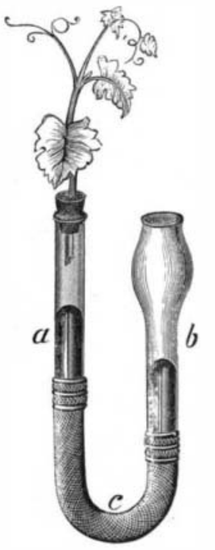
8 cents an hour. In removing the fleece no effort is made to clean the wool, and frequently the material is not only gummy but filled with fine sand, yet the work can be done so neatly that when the fleece is removed, the skin is not even scratched.

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 3½ 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 Zehrdeuick 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 illumining 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 kilocrith col, 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. Were we to 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.

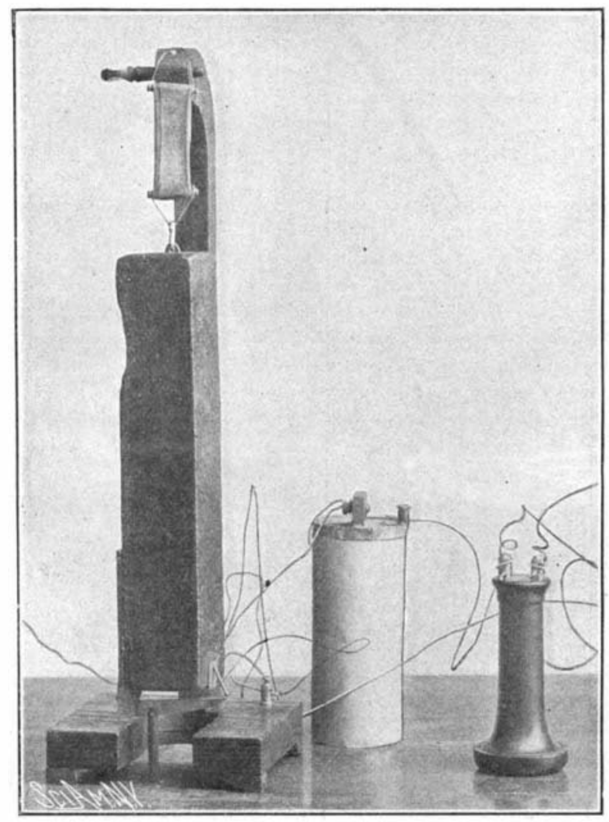
AN INSTRUMENT FOR DETECTING DELICATE ACOUSTIC VIBRATIONS.

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 vibrations 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.



A MODIFIED MICROPHONE FOR DETECTING FEEBLE VIBRATIONS.

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.