ide-of-mercury solution, 1-2,000, can be sparingly used.

"The mistake of civilization is having lost sight of the fact that the hair is ample for the immediate covering of the head, so it has instituted the custom of wearing hats or caps.

"The English tourist's hat is an ideal hat both for winter and summer.

"When possible no hat should be worn. The opportunities for leaving the hat off are many more than one would think.

"The leaders of fashion could do much toward bringing to pass the leaving off of the hat. The only specific advice that can be given, is to take off your hat whenever possible."

Correspondence.

The Teaching of Science in Schools.

To the Editor of the Scientific American:

The study of elementary science, or "nature study" as it is often called, is a branch of steadily-gaining popularity in the modern school. In many curricula it absorbs perhaps a third of the pupil's time, and probably much more than half his interest. Classes in elementary ologies of all kinds are supplanting the classics and more formal studies of the past. Whether this is an advantage or not is a question I shall not discuss; but no one will deny that it is of the utmost importance that these new studies, if they are to be of any real value, if they are to produce mental fiber of any strength, must be taught thoroughly and well. Grave doubts of such thoroughness inevitably assail many a college examiner after he has waded through the dreary morasses of mental confusion found in numerous entrance papers.

Last June the writer set an examination in physics based upon a well-known college textbook with questions of a fundamental character, and no more difficult than those asked of freshmen who have completed the first year's college course. The result was most discouraging. Many of the candidates did not attempt to answer but one or two of the ten questions required. Those who were more courageous floundered hopelessly through part of the examination, but showed a confusion of mind that spoke ill for the methods of teaching used in the schools they came from.

Before quoting from the papers of these candidates, it will be well to explain that physics is not one of the entrance requirements at Trinity, but like certain other subjects it may be offered to make up the requisite number of courses for admission. The candidate who passess it is then eligible to the second year's college course. In fact, he would not be allowed to take the first course, and count that toward his degree, on the assumption that he has already covered that ground once by his entrance examination. It is thus essential that the questions asked shall be similar to those put to students who have completed Physics I.

The first question was one on fundamental units, and here are some of the replies, taken not from the worst papers, but from an average selection:

"Angular velocity is the distance an object travels when it is thrown up in the air or on its downward course."

"Angular velocity is the distance a body covers in centimeters when moving in another direction to that which gravity would tend to make it go." (This was on the best paper handed in.)

"Acceleration is the speed with which an object travels."

"The unit of the C. G. S. system is the dyne, of linear velocity is the foot, of acceleration is the foot per second, of force is the foot-pound, work is the horse-power, of potential and kinetic energy is the foot per second."

"Energy is the power which *every* body has for doing work." (The universality of this dictum is delicious.)

"The momentum of a body is the rate of speed of that body per second over a certain space."

"The C. G. S. is the unit of force."

Two problems in mechanics were asked, one on a ball projected at an angle of 30 deg. to the horizontal, involving of course a very simple trigonometric solution. This naturally was beyond the ken of those who had not yet learned the meaning of sine and cosine. Another involved the calculation of the moment of inertia of two weights at the extremities of a revolving weightless bar. Neither problem was solved correctly by any one.

The theory of the simple pendulum was left untouched by most. Those who attempted it described how a pendulum swings, and said a little about kinetic and potential energy as exemplified by that useful illustration. Archimedes's principle was variously described. One attempt follows: "Archimedes's principle was based upon the fact that if a solid was placed in water, which exactly filled a receptacle, the water which overflowed would exactly equal the weight of the solid. This made it possible to weigh an elephant, for the water could be collected and weighed a little at a time."

Another is of the opinion that on account of the "impenetrability of matter, . . . when a substance is placed in water it must displace its own weight of water." This view of equal masses was quite popular; about half the papers made a similar assertion.

Such questions as the frequency of the note G♯ when C = 256, or the proof of the electrostatic formula

$$\text{Potential} = \frac{Q}{K\,d}$$

were quite beyond the scope of all but one or two, who made feeble attempts to answer them. But one would look for more information when such concrete subjects as the Wheatstone's bridge were called for, for there is at least some form of wire bridge in any school laboratory; so it was a genuine surprise to have a boy who came from an excellent preparatory school say: "Wheatstone's bridge consists of two bars (hor.) some inches from each other. Across them a string is strung, one end hanging over having a weight attached" (diagram here), etc. (Of course an attempt to describe some method for finding the modulus of elasticity of a wire.) Other attempts at the famous bridge gave incorrect diagrams, usually a faulty picture of the piece of apparatus used in the school laboratory; and even the fundamental proportion was often incorrectly stated.

Questions on the electrical and magnetic units produced some amazing information.

"Susceptibility is the power of showing the slightest current."

"Magnetizing force is the power which does the magnetizing measured in volts and amperes."

"The magnetizing force is the force required to magnetize a body."

"Magnetic induction is the magnetism excited inside a helix, although no electrical connection has been formed." One sees in this last reply what ideas were groping in the poor confused brain, but the wonder is how the clear-cut mental focus of a future bank president or manufacturer can evolve from such vagueness and inability of expression.

Apparently no one had ever heard of the diffraction grating, and the spectra of incandescent solids and gases are both hazily described as having "lines," by the few who ventured into the realm of optics at all.

These samples taken almost at random give an idea of the sort of paper that was handed in. Of course, some questions were answered correctly, but the impression left in the examiner's mind was one of having come in contact with an intellectual fog, and his belief in school science has been (perhaps unfairly) correspondingly shaken.

As physics is the author's department, this discussion must necessarily take its departure from that subject, and I am convinced that work in what might be called the more descriptive sciences, such as botany or geology, or even chemistry, is of a more satisfactory nature. Physics, next to mathematics, is the most exact science in the sense that there are known to physics more fundamental laws capable of exact mathematical expression than to any other science. Even astronomy does not precede it, for the exact position of astronomy is a branch of mechanics, and the science of astronomy is still in its infancy. In teaching such a subject, then, one cannot lay too much stress on the underlying principle, the law behind the experiment, that the experiment is only intended to illustrate. When a certain phenomenon follows by an unassailable chain of deductions from a certain great principle, the experimental demonstration of this phenomenon fails entirely in its purpose if the connecting logical links are not understood. And it is this lack of the logical or mathematical background to the experimental course that seems to me most apparent in the papers just discussed. The boy has carefully plotted the field about a magnet with the aid of a compass, but to him it is only the particular case of a compass and a magnet, and underlying notions of magnetic induction, tubes of force, law of inverse squares, etc., have nothing to do with the diverting little task in hand. The teacher perhaps has a class of thirty or more working together in the laboratory, and he is able to do little more than see to it that the experiment is done correctly, a neat report handed in, and certain explanatory references given to the pupil, who goes out with a recollection of only a certain particular example of a great law. If that law is presented to him in a slightly different form, he is utterly at sea, and flounders about for some support from among the concrete experiments that lie scattered about in his mind, unconnected and far apart.

This clinging to the concrete belongs to extreme youth, so the sciences that deal largely with the classification of concrete cases are better taught in our schools, and are usually more palatable to the pupils. But by the time a boy is seventeen or eighteen years old, it is a mistake to let him cling too closely to the concrete. When he thinks of numerical relations, he no longer has to cut imaginary apples into fractions, or distribute oranges in certain ratios among little boys. Why, then, is he not able to grapple with the abstract generalizations of science? I do not mean that he should abandon the laboratory exemplification of the laws he is learning, but the principle should be made the central idea which experiment is only to prove and illustrate. Of course, historically speaking, experiment preceded principle, at least in most cases, but the inductive method in teaching is far too apt to confuse the pupil, who seldom has the maturity of mind necessary for unaided generalization. Moreover, it is the glory of modern science that new phenomena can be predicted from known laws, and the deductive side is to-day as essential to progress as the inductive.

The cause of this unsatisfactory condition, at least in the teaching of physics, lies largely in the textbooks used in schools. Why must the boy taking physics in his last year at school study from the childish book often used, when if he begins the science a year later in college he studies from such authors as Watson, or Hastings and Beach, or Carhart (to mention only a few admirable college textbooks)? Surely, a year cannot make so much difference in his mental equipment! It will be urged that the books named above involve an understanding of trigonometry. True, but the amount of trigonometry needed by the student of Watson, for instance, could be readily mastered in three or four lessons, so this is no serious barrier to the teacher who really wishes to use a "college textbook." In many elementary courses no textbook is used, and the lecture system is followed. This may give satisfactory results in some subjects, but in physics it cannot be too severely condemned. In order to train the student to think, he must be compelled to work for himself; and though the lecturer may give references and advise study, those who have tried it know how hard it is to exact the outside work so necessary in a mathematical science like physics: and the ability to wrestle with a difficult problem or concept is not fostered by what may be termed the "kindergarten method" in science.

Too little time in the classroom, or, what amounts to the same thing, a disproportionate stress on the laboratory end, is also in part the cause of the evils we are discussing. This would not be so if classes were small, and the instructor could devote himself individually to his pupils, thus making the laboratory a more efficient lecture-room; but generally the classes are too large, and the pupil depends upon printed directions, and an inexperienced assistant instructor, so the two or three hours spent in the laboratory are not the equivalent of a well-conducted recitation involving a preparation of an hour or more of hard study.

Among the causes of inefficiency in teaching school science, that which one would least anticipate is the extraordinary opinion which seems to prevail among school boards and principals that any youth who has had a year or two in a science at college is capable of teaching the subject. This careless attitude toward a field rapidly overtopping many more time-honored subjects of school instruction, is almost inexplicable. Why should a teacher of Latin be chosen with so much more care than the teacher of physics and chemistry? With the increasing reaction in favor of science, this is the more surprising. If science is to supplant the classics in popular esteem as a fitting for an active useful life and the development of a well-trained mind, then let the teacher be one of sound knowledge as well as high intellectual ideals, and not merely a genial spirit who can play football with the boys in recess and bluff successfully when cornered by an inquisitive pupil in the classroom. I have seen appointments made by excellent schools that for unfitness on the part of the appointee rival the political appointments of a Tammany administration unchecked by even a pretense of civil service restraint.

The main reasons for teaching science in school are to awaken the pupil's interest in nature, give him some information about its chief laws and phenomena, and to train his mind to think clearly and with concentration. It certainly is open to question whether either of these aims is realized in many otherwise excellent schools. The interest possibly is stimulated in a general sort of way, but the misinformation that seems to remain as an ultimate residuum is worse than valueless, and the power of clear, concentrated reasoning has apparently not been fostered to any very high degree.

If science cannot be taught well, it is far better to let it alone in preparatory courses. The final result will be more satisfactory, even to a boy who means to study engineering in college. The truth of this assertion was well illustrated in the writer's experience by the case of a pupil who, though far from dull or lazy, was almost the poorest in his class. On being questioned, he replied that he had had physics in school, and when he came to study his lesson it seemed familiar, and he was tempted to trust to his recollection of what he had learned in school, although his recitations always showed that knowledge to be valueless. If he had never had the subject before, he would have been forced to work and might have learned something. The school that has a long list of science courses on its catalogue's pages is falling in with a popular fad. I do not say the fad is wrong, but like all fads it is capable of abuse, and unless each of the courses is conducted at least as well as the course in Xenophon or geometry, requiring as much real work by the pupil and with the same definite results, the course is worse than a sham. Let the school authorities face the fact that in science, as in all other activities, good results can only be produced by skilled workers, and the skilled workman is more expensive than the untrained novice. Either the best or not at all should be the policy of every school that contemplates adding a course in science to its list of studies, if that course is to be anything but a bait for the children of unsophisticated parents, and a diversion more or less demoralizing to the pupil.

HENRY A. PERKINS,
Professor of Physics, Trinity College.
Hartford, Conn., October 2, 1905.

A Chance for Inventors.

To the Editor of the SCIENTIFIC AMERICAN:

As at present the price of heniquen is declining in the American market, the imperious necessity makes itself felt of increasing the acreage devoted to the production of this fiber and of realizing savings in its management from the planting to the baling. With the extension of the plantations which is already in actual progress at present, although not to the extent to which it should be carried, there will be secured a material increase in the quantity of fiber produced, and this increase in production will make up in part for the loss that follows the decline in price which began some time ago and which decline in price can be entirely overcome by the economies or superior methods of exploitation which may be introduced into the industry. It is evidently most pressing that these economies be undertaken at once, and this is possible in two directions: First, that of utilizing, in some manner, the refuse which results from the threshing or breaking of the textile, and second, some mechanical method of drying the fiber. In both these directions there is now a real waste of time, of labor, and of money. In respect to the former, there is a great waste in carrying to the place for threshing a great quantity and a great weight of leaves of heniquen, which, reduced in small part, by the operation, must then be transported again, with still greater labor, to the place chosen for deposit to rot. But this is not the only drawback. This place is at once converted into a fearful source of infection which poisons the atmosphere and the water which the plantation must use, and from which contamination is developed disease in various forms to such an extent that plantations that were noted previously for their salubrity have become converted into homes of disease.

Moreover, feeding this refuse to cattle, which is done generally when it is in a rotting condition, makes the milk poisonous and develops also in the calves and young stock different diseases, one of the most common of which is dysentery, as experience teaches us, thus demonstrating the error of the popular belief that this refuse can be used as a good food for cattle.

In order to overcome these obstacles and to diminish as much as possible the cost of production of heniquen, it has occurred to us that, by means of a mechanism invented for the purpose, this refuse might be utilized as a combustible, or for some similar purpose, obviating a waste and producing instead an actual profit to the planter.

The spreading of the fiber in order to dry it in the sun is an operation quite primitive, and which is certainly behind the time, in view of the scientific progress of the age. To do this work requires a considerable force of laborers who must carry the fiber to the place selected for drying, there spread it, then turn it and gather it in, as it may appear to be dried, and finally transport it to the press. This operation, besides being costly, has several drawbacks that make it objectionable. Among these drawbacks it appears to us that the chief are: the loss of fiber that results from spreading and transporting it, as a considerable quantity must necessarily be lost either on the wires, on the grass of the route back and forth, and even on the very ground of the drying place; the deterioration of the fiber by the fall of sudden rains, and finally the loss of time which results in the rainy season, because as the rains are constant during sometimes many days in succession, the planter finds himself obliged to suspend the cutting and the separation of the fiber of the heniquen by reason of having his drying space already overflowing with fiber.

The strong winds which prevail during the fall are equally prejudicial, as the fiber is thus blown from the wires and scattered, some of it carried even beyond the limits of the place for drying.

In order to overcome these inconveniences and others that we have not mentioned because of the necessity of keeping our article within reasonable limits, there might be invented a mechanical dryer, into which the bundles of fiber might be thrown when delivered from the threshing machine, and be delivered by the new mechanism dry and ready for baling.

The points which we have referred to so briefly are so important for the state in general that, in our opinion, they are very well deserving of the special attention of the Heniquen Planters' Union, which should adopt means suitable to attain the object which we have indicated. This union might, without any delay, call a special meeting in order to consider this very important subject. A petition might be formulated to be sent to the governor, who is so firm a friend of progress in our state, requesting that he recommend to the legislature that a prize be provided, to be bestowed upon the inventor of any successful machine contrived for the purpose as explained above. This Heniquen Producers' Union might also do something which, in our opinion, would be the best possible thing to be done, and that is to try to raise by voluntary subscription among the heniquen planters a sum sufficient to provide the prizes referred to for donation to the inventors of the machinery in question, which fund should be used solely for the purpose of rewarding successful attempts to provide such machinery. If this course should be taken or adopted by the union, the writer of this article holds himself ready to provide five hundred dollars toward each prize. VICENTE SOLIS.

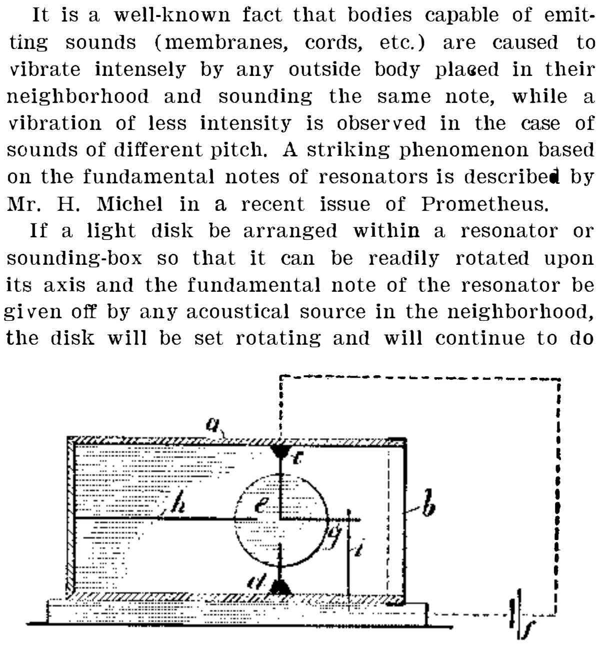
Merida, Yucatan, Mexico.

A NOVEL PROCESS FOR DISENGAGING FORCES BY MEANS OF SOUND.

BY OUR BERLIN CORRESPONDENT.

It is a well-known fact that bodies capable of emitting sounds (membranes, cords, etc.) are caused to vibrate intensely by any outside body placed in their neighborhood and sounding the same note, while a vibration of less intensity is observed in the case of sounds of different pitch. A striking phenomenon based on the fundamental notes of resonators is described by Mr. H. Michel in a recent issue of Prometheus.

If a light disk be arranged within a resonator or sounding-box so that it can be readily rotated upon its axis and the fundamental note of the resonator be given off by any acoustical source in the neighborhood, the disk will be set rotating and will continue to do



A NOVEL PROCESS FOR DISENGAGING FORCES BY MEANS OF SOUND.

so until the sound is discontinued, provided it be adjusted at an oblique angle to the longitudinal axis of the resonator. No effect is observed if the sound be different from the fundamental note of the resonator. Mr. Michel suggests using this effect for disengaging forces by means of sounds of a given pitch. The rotation of the disk can, for instance, be utilized to throw in or out, weaken or reinforce electric currents that might be used to start any special motor.

An arrangement suitable for this purpose is illustrated in the accompanying engraving. *a* is the longitudinal section of a resonator, closed by the membrane, *b*. A light disk, *e*, carrying a lever, *g*, connected with the cell, *f*, is pivoted in the cups, *c*, *d*. The rotation of this disk is limited by the prongs of a fork, *h*, fixed to the bottom of the resonator. An extremely feeble tension due to a weak spring, a magnet, or the like, presses the disk against one of the prongs of this fork, so that the disk is adjusted in a position of rest at an oblique angle to the longitudinal axis of the resonator.

If, now, any instrument, e. g., a piano, be played in the neighborhood of the resonator, the disk will remain at rest until the fundamental note of the resonator is given off. At that very moment it will start to rotate, trying to adjust its surface at right angles to the longitudinal axis of the resonator, and will throw the lever, *g*, against the metal bar, *i*, which is connected to the other terminal of the cell, *f*, thus closing the circuit. As the contact between the lever, *g*, and the bar, *i*, is maintained as long as the sound is continued, the current, being completed throughout this time, will be able to perform some given operation. The effect of the fundamental note of the resonator on the disk is reinforced considerably by means of an acoustic funnel arranged in front of the membrane. In this case the rotation of the disk begins nearly instantaneously and rather energetically, as soon as the note is struck. This novel process would seem to be capable of many practical applications.

A vine now standing in California, which is considered the largest in the world, was planted in 1842 by a Spanish woman. Beneath its spreading branches, which cover nearly half an acre, 800 persons could find protection from the sun's heat. The first election in Santa Barbara County under American rule was held beneath its ripening fruit. The vine is of the Mission variety. In 1893 it bore 8 tons of grapes, and in 1895 over 10 tons. The trunk of the vine is 7 feet 8 inches in circumference. It is now owned by Jacob Wilson, of Carpinteria, Cal.

Electrical Notes.

A novel wireless telephone apparatus has been patented by M. Blondlot, of Paris. The transmitting antenna is excited by the effect of a closed circuit where continuous vibrations of very high frequency are produced by the stepwise discharge of a direct current or alternate current generator connected in parallel to a condenser battery, while the receiving antenna acts on a telephone with or without the use of syntonically vibrating local currents and wave detectors. The sounds to be transmitted act on the closed vibratory circuit by means of a manometric flame or a transformer, the primary coil of which is fed by a strong microphone, a singing arc, or any similar device.

A special wireless telegraph corps has been established for some time past in the German army, where the previous wireless telegraph battalion originally connected with the aeronautical battalion has been attached to the telegraph corps as an independent body, though it be intimately related to aeronautics in so far as captive balloons are required to suspend the sending antennæ. The importance of wireless telegraphy for the signaling service has been illustrated in the Russo-Japanese war and is being evidenced also in connection with the military operations carried out by German troops in Southwest Africa. Wireless telegraphy, while ready to work at a moment's notice, is less liable to be observed or interfered with by the enemy than any other means of communication, quite apart from its other advantages. It may be said messages have been sent for 250 miles in South Africa.

The utilization of electric energy for power purposes in the spinning mills of the Marquess of Larios at La Aurora and La Industria mills at Malaga, in Spain, recently installed, has been attended with some remarkable results. At La Aurora mills, the substitution of steam engines driving gear and belting, by electric motors driving direct on to the line shafts, has reduced the power consumption by 40 per cent. Furthermore, the steadier drive obtained from the motors has increased the yarn production by 20 per cent, owing to the avoidance of yarn breakages. The mills at Malaga are equipped with 72 motors aggregating 2,350 horse-power for three-phase current, and range in power from 15 to 150 horse-power. The average efficiency is 91.1 per cent, and the average power factor 88.1 per cent. The electrical energy is transmitted a distance of some 20 miles at a pressure of 25,000 volts.

Experiments on a new type of telephone cable are said to have been made in Sweden with extremely favorable results. In manufacturing these cables, the intention had been to reduce their capacity to a minimum by passing the bare copper wires through perforated disks of insulating material and introducing the cable thus formed into an iron tube. The distance of the two conductors of the same line is 17 millimeters, that of two lines 28 millimeters, and the distance of the conductor and iron sheath in the most unfavorable case 5 millimeters. By this arrangement the capacity of the internal conductors of 2 millimeters diameter was reduced to 0.00985 microfarad for 1 kilometer and that of the outer conductors to 0.0182 microfarad per kilometer. The copper wires are of course wound helicoidally to avoid induction effects. If the above distances be increased to 20, 36.5, and 10 millimeters respectively, the capacity will be 0.00935 and 0.0125 microfarad. Excellent results have been obtained in connection with the experiments made on these cables, especially those relating to the insulating resistances.

The Current Supplement.

The maple sugar industry is thoroughly described and illustrated in the opening article of the current SUPPLEMENT, No. 1555. A possible source of future fuel is to be found in the vast peat bogs in some sections of the world. How this peat may be commercially utilized, is explained. A full description of Sir Oliver Lodge's fog-dispelling apparatus is given. Mr. Walter P. White describes a new form of cell. Mr. Edward F. Chandler describes in a practical way the construction of a hydrometer. Dr. A. F. Cuzner writes on the origin and control of yellow fever. Exceedingly interesting is a well-illustrated article on jelly fishes. The agricultural application of the gasoline automobile is made the subject of an instructive article by the English correspondent of the SCIENTIFIC AMERICAN. Mr. J. H. Morrison, the author of "American Steam Navigation," gives a splendid historical summary of iron and steel hull steam vessels of the United States. Of practical interest is an article on a folding Malay kite. An excellent paper by Prof. Albert Granger on the manufacture of Sèvres ware is presented.