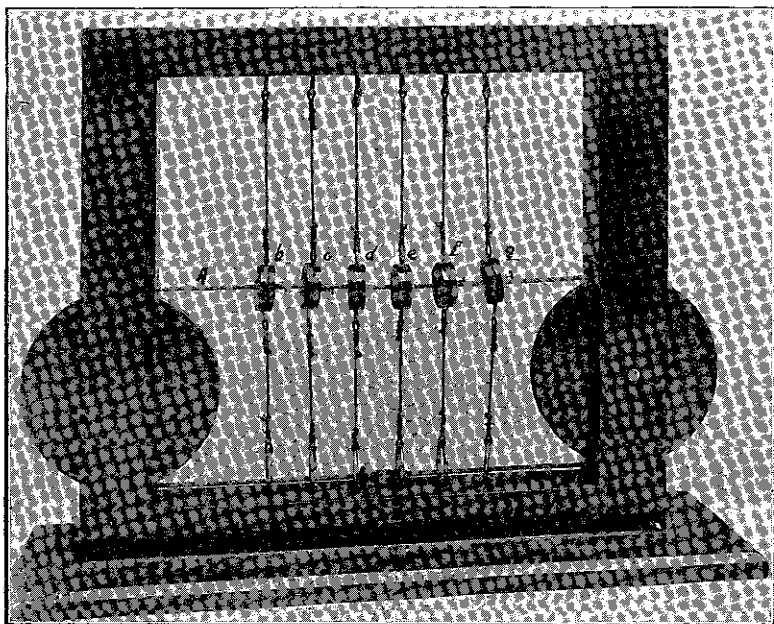


**CHARGE AND DISCHARGE OF CONDENSERS ILLUSTRATED
BY MEANS OF AN EASILY CONSTRUCTED
MECHANICAL MODEL.**

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Mechanical models to picture to the eye the processes attending the charge and discharge of condensers have been constructed by Sir Oliver Lodge, the famous English physicist, but the one shown in the accompanying cut, designed and constructed by the author along the general lines advocated by the former, is believed to be the only one of the kind in the country. In the work of teaching classes in physics or tracing the mysteries of the entrancing field considered under the great caption of "Potential," for the benefit of those other than science students, this little contrivance has been found to be of the utmost utility and a description of its construction and use is given herewith that others engaged in this work may design similar instruments if they wish.



In the figure, A is an endless cord, heavy fish line, and represents a current of electricity. *b, c, d*, etc., are successive atoms of the conductor or nonconductor, according as the case may be, and consist of short wooden cylinders, punctured in the

center along the axis and held from above and below by elastic bands attached to small screw eyes. The two center "atoms" are made of iron to give the system inertia and are made to resemble closely the wood counterparts by being coated with base and graining colors.

The elastic bands form the simplest picture now possible of the medium surrounding bodies. The lower set of bands is broken near the bottom to permit of the passage of the endless cord, this result being obtained by inserting small rings through which the cord threads. This cord, representing the current of electricity, passes around small grooved, wooden pulleys at each side. The punctures in the wooden "atoms" are of such size that the cord will slide through without much friction, representing by this action the free passage of an electric current through a conductor. The heat of friction may be taken to stand for the ohmic resistance of the circuit.

When considering the case of a nonconductor the atoms must be clamped to the cord, for the current in such a case is unable to flow through. This is done by inserting into the openings, alongside the cord, small wedges which prevent the rope from moving. The model now represents a condenser and it is given its charge by a battery whose E. M. F. is represented by a force used to move the cord. The strain of the dielectric or medium is indicated by the distension of the elastic bands. Clamping the cord corresponds to making the resistance infinite.

If now this resistance be suddenly made very much smaller, in the case of a condenser by allowing a spark to pass from one coating to another or in the case of the model by unclamping the cord, the condenser discharges. Following this process as depicted by the model, it is seen, as might have been expected, that when the knobs fly back from their strained position they do not stop immediately at the central point, but oscillate back and forth several times, a state of affairs brought about by virtue of the inertia of the moving masses and the elasticity of the cords supporting them. In an electric condenser the same conditions are to be observed. The discharge is essentially oscillatory, only very much more rapid in movement and shorter in duration.

Upon what does the rate of oscillation depend? Consider the model. The stronger the elastic cords and the less the weight of the "atoms," the faster the vibrations. Given this data, it is not difficult to show how for a perfect machine the period might be computed beforehand. The electrical problem and its solution are

precisely analogous, only that instead of elasticity static capacity must be used and in place of the inertia of the "atoms," the electromagnetic inertia or self-induction, must be used. It is readily seen that increasing either of these quantities diminishes the frequency of the oscillations. The making larger of the capacity is the same as making the elastic bands longer, while increasing the inductance corresponds to the making heavier of the knobs.

The static capacity may be increased at will by making use of larger plates or a larger number of them. In making use of the latter method it must be remembered that there are two ways of connecting up condensers and which have widely different results. If two equal condensers are coupled up in series, so that the inside coating of one of the jars is connected with the outside of the other, it is found that the combination has but one half the combination of one of them. If, on the other hand, they be hitched in parallel, the combined capacity is twice that of either one alone. The former method is useful where we have condensers not able to stand a voltage under which it is desirable to use them. A number may be arranged in a series or cascade and the pressure upon each thereby split up. An example of this would be in the case of a transformer such as is used in wireless telegraphic work, and giving a secondary voltage of 30,000. The condensers on hand are constructed so as not to stand more than 20,000 volts. If two of these are connected in series, each will have to stand but 15,000 volts.

Referring back to the model, increasing the electromagnetic inertia of self-inductance, is analogous to affording the current more space to magnetize, since it depends upon this action of the current upon the surrounding medium. This result is obtained by inserting coils of wire in the circuit.

The well-known equation for simple harmonic motion is well known from physics text-books and is to the effect that

$$T = 2\pi \sqrt{\frac{m}{k}}$$

After making the necessary substitutions as just outlined we find that $T = 2\pi \sqrt{LC}$, where L is the inductance in henries and C the capacity in farads. This is called the "fundamental equation" in wireless telegraphy and is used, after being reduced to more simple units, in every wireless experiment station in the land.

One does not need to be an expert carpenter to build a condenser model. The one shown in the picture is made of soft wood.

The expense is trifling and after the little machine is given a coat of shellac or cherry stain, then varnished and baize cloth gummed to its base to prevent the scratching of a lecture table, it will be not only an ornament to the furniture of a class room but a useful implement in inculcating the facts in the subjects of condensers and oscillators.

A CONVENIENT FORM OF LIQUID RHEOSTAT.

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Many small laboratories often want an electric current of small ampereage but a voltage larger than the few dry cells at their disposal will give. The electric lighting circuit is usually available but unless a proper resistance is put in series with the circuit the safety fuses are liable to go.

The following form of a liquid rheostat has been found so useful in the laboratory for the above and other purposes that I take this opportunity to describe it. It may be familiar to others although I have never seen any description of such a modification.

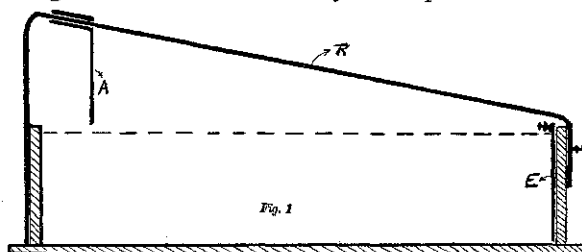
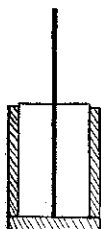


Figure 1 shows a cross section, lengthwise, of a wooden box, 40 inches long, 5 inches wide



and 6 inches deep, made from ordinary pine boards. A and E are the two electrodes which may be made from copper strips or from the carbon plates one finds in a wornout dry cell. E is attached to the inside of one end piece of the box while the other is fastened to a short piece of gas pipe which slides on an iron rod, R, bent in the shape indicated in Figure 1. I have used one half inch rods for R and found they worked satisfactorily. Of course brass would

be better. As A moves toward E the resistance of the portion of electrolyte between the two electrodes decreases, both by decreasing the length and increasing the cross-section of the conductor. If currents of a few tenths of an ampere are wanted, I have found that ordinary tap water worked well for