From this we get the ratio of the torsional rigidity of the spider line to that of the silk fibre to be 1 : 710.

The diameters of the fibres were microscopically measured, and gave the following values:—

Silk fibre....................	0·00091 cm.
Spider line	0·00028 ,,

If the elastic qualities of these fibres were the same, the ratio of the torsional rigidity would have come out $(28)^4 : (91)^4$, or 1 : 112; and hence the torsional rigidity of spider line is less than one-sixth of that of silk fibre of the same thickness.

The above result gives us only a relative value of the rigidities between the two fibres. If we take the mean value of the torsional rigidity of silk fibre to be 0·0012 C.G.S. on a length of 1 centimetre (not per square centimetre), as found by Mr. T. Gray,* the torsional rigidity of the spider fibre of the above experiment will be $\frac{0{\cdot}0012}{710} = 0{\cdot}000002$ C.G.S., the mode of reckoning being the same.

Mr. Gray's silk fibre may have had a slightly higher rigidity, as he states that it was boiled in water, while the fibre of the experiment just described was taken from those boiled in dilute potash water, as is the usual practice of preparing "mawata," which is a very soft kind of silk.

IV. "Specific Inductive Capacity of Dielectrics when acted on by very rapidly alternating Electric Forces." By J. J. Thomson, M.A., F.R.S., Cavendish Professor of Physics, Cambridge. Received June 17, 1889.

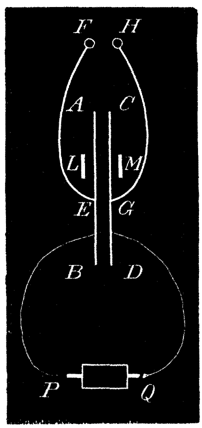
The researches of Dr. John Hopkinson have shown that in some dielectrics, of which the most conspicuous example is glass, the refractive index is not, as it ought to be on Maxwell's theory, equal to the square root of the specific inductive capacity, when the latter is measured for steady forces, or such as are reversed only a few thousand times a second. It is therefore desirable to measure the inductive capacity under circumstances which approach as nearly as possible to those which, according to Maxwell's theory, occur when light passes through a dielectric. This will be when the forces are reversed as rapidly as possible. In the following experiments the forces were reversed about 25,000,000 times per second.

The method consists in measuring the wave-length of the electrical vibrations given out by a condenser whose plates are in electrical connexion. If C is the capacity in electrostatic measure of the con-

* 'Phil. Mag.,' 1887.

denser, L the coefficient of self-induction in electromagnetic measure of the circuit connecting the plates of the condenser, the wave-length, if it is long compared with the length of this circuit, equals $2\pi\sqrt{(LC)}$. Thus, if we can measure the wave-length of the vibrations executed by such a system, we can find the specific inductive capacity of a dielectric. For, if we determine the wave-length of the system first when the plates of the condenser are separated by air, and then when they are separated by a slab of the dielectric whose specific inductive capacity we wish to measure, the ratio of the squares of the wave-lengths will be the ratio of the capacities of the condenser in the two cases, and if we know this ratio we can deduce the specific inductive capacity of the dielectric interposed between the plates.

Fig. 1.

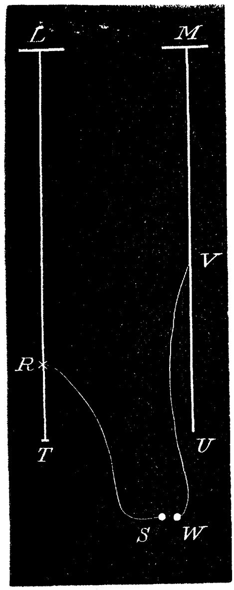


The arrangement of the experiment was as follows:—

The condenser consisted of two circular zinc plates, AB, CD, 30 cm. in diameter; these were supported on an insulating stand, and the distance between them could be altered at pleasure. To these plates wires, EF, GH, each about 25 cm. in length, terminating in the highly polished balls, F, H, were attached. The plates were also connected with the poles P, Q, of an induction coil, and when this was in action a succession of sparks passed between the balls F and H. The periodic distributions of electricity thus produced over the plates sent electrical waves down two insulated wires, each about 20 metres in length, attached to the small zinc plates, L and M, placed close to the plates of the condenser.

The wave-length of the vibrations transmitted along the wire was determined by the method I described in a former paper ("Note on the Effect produced by Conductors in the Neighbourhood of a Wire on

FIG. 2.



the Rate of Propagation of Electrical Disturbances along it," 'Roy. Soc. Proc.,' vol. 46, p. 1). Two wires RS, VW, of equal length, had the ends S and W fastened to the poles of a spark micrometer, while the other ends, R, V, could slide along the wires LT, MU respectively. At first R was placed at T, and V was moved until the sparks in the micrometer were as small as possible; suppose that α was the position of V when this was the case. T and α will be at the same potential. The end V was now kept fixed at α, and R moved until the sparks again became as faint as possible; suppose that β was the position of R when this was the case, then β and α, and therefore β and T, are at the same potential; so that, since T is a place of maximum potential, βT equals a wave-length.

By starting from β and proceeding further up the wire we can get another determination of the wave-length.

Since from the nature of the case other conductors besides the two disks were in the field, the capacity of the condenser was in excess of the value given by the formula $S/4\pi t$, where S is the area of one of the plates and t the distance between them; but this is the only part of the capacity which is increased when the slab of dielectric is interposed between the plates. The capacity when the disks were 2 cm. apart was determined by the tuning-fork method given in Maxwell's "Electricity and Magnetism," vol. 2, p. 385, and was found to be

40 in electrostatic units; the formula $S/4\pi t$ would, where $S = \pi \times 15^2$ and $t = 2$, give 28, so that of the 40 units of capacity, 28 are due to the two disks and 12 to the presence of the other conductors. This was verified by determining by the tuning-fork method the capacity of the condenser when the distance between the disks had a series of values.

When the distance between the disks was 2 cm., the mean of several determinations of the wave-length along the wire was 8·25 metres. The value calculated by the formula $2\pi\sqrt{(LC)}$, where $C = 40$ and $L = 2l\left(\log \frac{8l}{\pi d} - 2\right)$, where l = length of circuit (supposed circular) = 50 cm., and d the diameter of the wire = 0·3 cm., is 8 metres. When the plates were separated by pieces of plate glass 2 cm. thick, the wave-length was 11·75 metres. Thus, if K is the specific inductive capacity of the glass,

$$\frac{11 \cdot 75}{8 \cdot 25} = \sqrt{\frac{28K+12}{40}},$$

$$K = 2 \cdot 7, \qquad \text{and} \quad \sqrt{K} = 1 \cdot 65.$$

The determination of the specific inductive capacity of the glass by the tuning-fork method was difficult, owing to electric absorption; the values for K obtained in this way varied between 9 and 11. We see, therefore, that for vibrations whose frequency is $3 \times 10^{10}/11 \cdot 75 \times 10^2$, or 25,000,000 per second, the specific inductive capacity is very nearly equal to the square of the refractive index, and is very much less than the value for slow rates of reversals. The discrepancy is probably due to the cause which produces the phenomenon of anomalous dispersion in some substances, and indicates the existence of molecular vibrations having a period slower than 25,000,000 per second. The behaviour of the glass under electrical oscillations of the critical period would form a very interesting subject of investigation.

The specific inductive capacity of ebonite was determined in a similar way; the wave-lengths, when the plates were separated by air and ebonite respectively, were 8·5 metres and 10·75 metres, giving as the specific inductive capacity of ebonite 1·9. The value determined by the tuning-fork method was 2·1.

The specific inductive capacity of a plate made of melted stick sulphur was also tried: the wave-length without the sulphur was 8·25, with it 11·5, giving as the specific inductive capacity of sulphur 2·4. The value determined by the tuning-fork method was 2·27. Thus, for ebonite and sulphur the values determined by the two methods agree as well as could be expected, while for glass the results are altogether different.

Fig. 1.

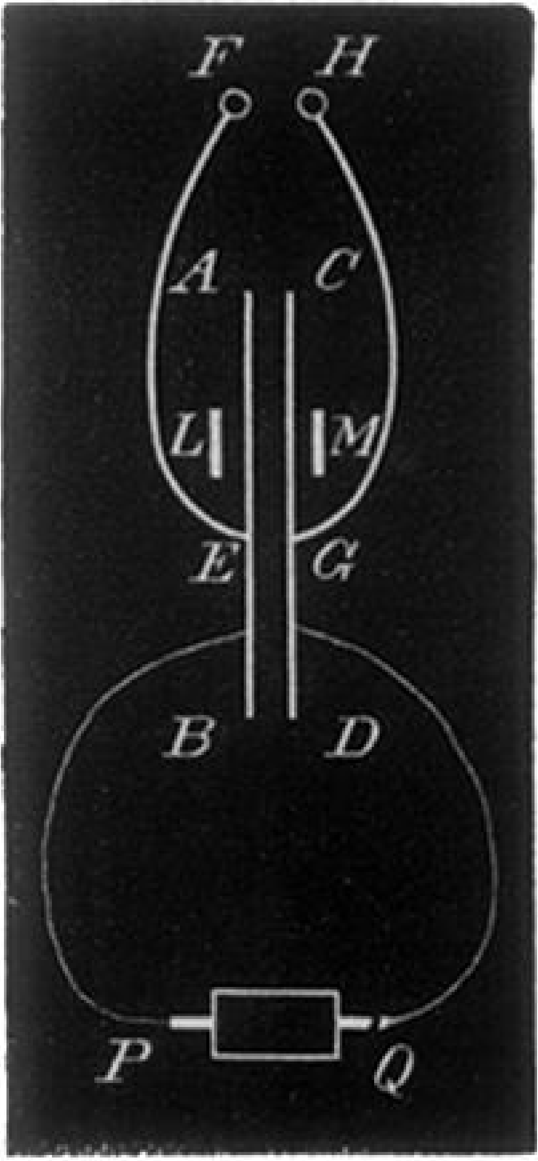


FIG. 2.