recorded on the maps, and he has carried out this work with a care, skill, and patience beyond all praise. The observations have in nearly every case been checked also by myself. Mr. Taylor, the Demonstrator of Astronomy, has been chiefly responsible for looking up the literature and mapping the results, in which he has been aided by Mr. Richards.

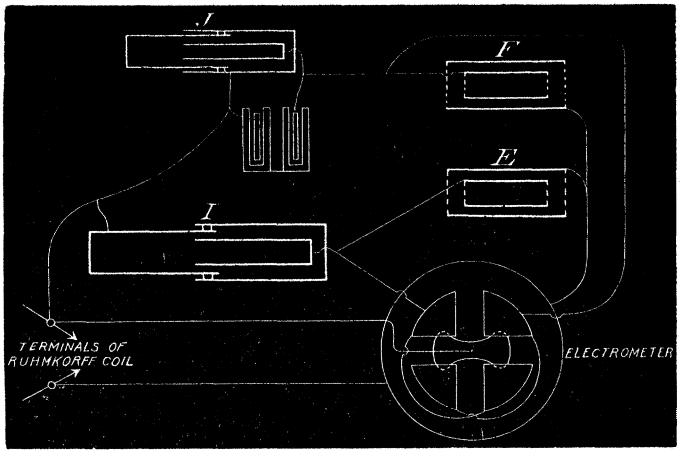
II. "Specific Inductive Capacity." By J. Hopkinson, M.A., D.Sc., F.R.S. Received October 14, 1887.

The experiments which are the subject of the present communication were originally undertaken with a view to ascertain whether or not various methods of determination would give the same values to the specific inductive capacities of dielectrics. The programme was subsequently narrowed, as there appeared to be no evidence of serious discrepancy by existing methods.

In most cases the method of experiment has been a modification of the method proposed by Professor Maxwell, and employed by Mr. Gordon. The only vice in Mr. Gordon's employment of that method was that plates of dielectrics of dimensions comparable with their thickness were regarded as of infinite area, and thus an error of unexpectedly great magnitude was introduced.

For determining the capacity of liquids, the apparatus consisted of a combination of four air condensers, with a fifth for containing the liquid arranged as in a Wheatstone's bridge, fig. 1. Two, E, F, were

Fig. 1.

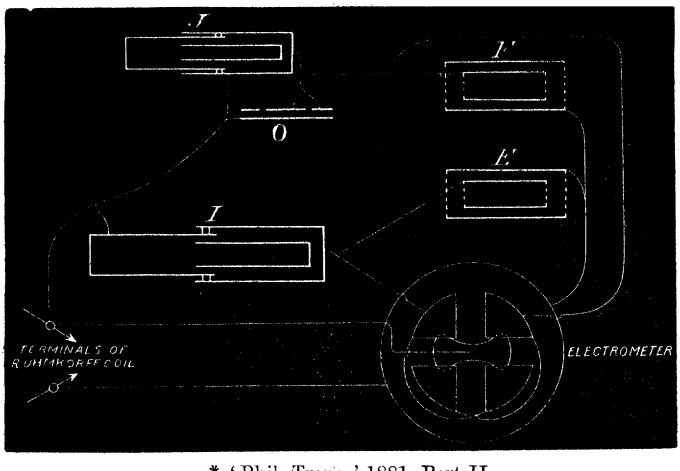


of determinate and approximately equal capacity; the other two, J, I, were adjustable slides, the capacity of either condenser being varied by the sliding part. The outer coatings of the condensers E, F, were connected to the case of the quadrant electrometer, and to one pole of the induction coil; the outer coatings of the other pair, J, I, were connected to the needle of the electrometer and to the other pole of the induction coil. The inner coatings of the condensers J, F, were connected to one quadrant, and I, E, to the other quadrant of the electrometer. The slide of one or both condensers J, I, was adjusted till upon exciting the induction coil no deflection was observed on the electrometer. A dummy was provided with the fluid condenser, as in my former experiments, to represent the necessary supports and connexions outside of the liquid. Let now x be the reading of the sliding condenser when no condenser for fluid is introduced, and a balance is obtained. Let y be its reading when the condenser is introduced fitted with its dummy, z when the full condenser is charged with air. Let z_1 be the reading when the condenser charged with fluid is introduced, then will K, the specific inductive capacity of the liquid, be equal to $(y-z_1)/(y-z)$.

Three fluid condensers were employed, one was the same as in my former experiments.* Another was a smaller one of the same type arranged simply to contain a smaller quantity of fluid. The third was of a different type designed to prove that by no chance did anything depend on the type of condenser; this done it was laid aside as more complicated in use.

To determine the capacity of a solid, the guard-ring condenser of

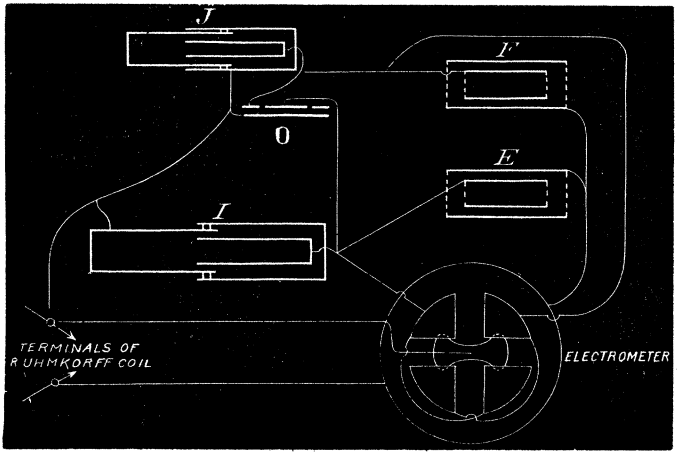
FIG. 2.



* 'Phil. Trans.,' 1881, Part II.

my previous experiments* was used. Advantage was taken of the fact that at the time when there is a balance the potentials of the interiors of all the condensers are the same. Let the ring O of the guard-ring condenser be in all cases connected to J, let the inner plate of the guard-ring be connected to J as in fig. 2, and let a balance be obtained. Let the inner plate be now transferred to I as in fig. 3, and again let a balance be obtained; the difference of the

Fig. 3.



two readings on the slide represents on a certain arbitrary scale the capacity of the guard-ring condenser at its then distance.

In some cases it was necessary to adjust both condensers to obtain a balance, then the value of a movement of the scale of one condenser in terms of the other was known from previous experiment. In some cases it was found most convenient to introduce a condenser of capacity known in divisions of the scale of the sliding condenser coupled as forming part of the condenser J. The old method of adding the opposite charges of two condensers then connecting to the electrometer and adjusting until the electrometer remained undisturbed was occasionally used as a check; it was found to give substantially the same results as the method here described when the substance insulated sufficiently well to give any results at all.

Colza Oil.—This oil had been found not to insulate sufficiently well for a test by the method of my former paper. Most samples, however, were sufficiently insulating for the present method. Seven samples were tested with the following mean results:—

* 'Phil. Trans.,' 1878, Part I.

No. 1. This oil was kindly procured direct from Italy for these experiments by Mr. J. C. Field, and was tested as supplied to me—

$$K = 3{\cdot}10.$$

No. 2 was purchased from Mr. Sugg, and tested as supplied—

$$K = 3{\cdot}14.$$

No. 3 was purchased from Messrs. Griffin, and was dried over anhydrous copper sulphate—

$$K = 3{\cdot}23.$$

No. 4 was refined rape oil purchased from Messrs. Pinchin and Johnson, and tested as supplied—

$$K = 3{\cdot}08.$$

No. 5 was the same oil as No. 4, but dried over anhydrous copper sulphate—

$$K = 3{\cdot}07.$$

No. 6 was unrefined rape purchased from Messrs. Pinchin and Johnson and tested as supplied, the insulation being bad, but still not so bad as to prevent testing—

$$K = 3{\cdot}12.$$

No. 7. The same oil dried over sulphate of copper—

$$K = 3{\cdot}09.$$

Omitting No. 3, which I cannot indeed say of my own knowledge was pure colza oil at all, we may, I think, conclude that the specific inductive capacity of colza oil lies between 3·07 and 3·14.

Professor Quincke gives 2·385 for the method of attraction between the plates of a condenser, 3·296 for the method of lateral compression of a bubble of gas. Palaz* gives 3·027.

Olive Oil.—The sample was supplied me by Mr. J. C. Field—

$$K = 3{\cdot}15.$$

The result I obtained by another method in 1880 was 3·16.

Two other oils were supplied to me by Mr. J. C. Field.

Arachide.—K = 3·17.

Sesame.—K = 3·17.

A commercial sample of *raw linseed oil* gave K = 3·37.

Two samples of *castor oil* were tried; one newly purchased gave

* 'La Lumière Électrique,' vol. 21, 1886, p. 97.

K = 4·82; the other had been in the laboratory a long time, and was dried over copper sulphate—

$$K = 4{\cdot}84.$$

The result of my earlier experiments for castor oil was 4·78; the result obtained subsequently by Cohn and Arons* is 4·43. Palaz gives 4·610.

Ether.—This substance as purchased, reputed chemically pure, does not insulate sufficiently well for experiment. I placed a sample purchased from Hopkin and Williams as pure, over quicklime, and then tested it. At first it insulated fairly well, and gave K = 4·75. In the course of a very few minutes K = 4·93, the insulation having declined so that observation was doubtful. After the lapse of a few minutes more observations became impossible. Professor Quincke in his first paper gives 4·623 and 4·660, and 4·394 in his second paper.

Bisulphide of Carbon.—The sample was purchased from Hopkin and Williams, and tested as it was received—

$$K = 2{\cdot}67.$$

Professor Quincke finds 2·669 and 2·743 in his first paper, and 2·623 in his second. Palaz gives 2·609.

Amylene.—Purchased from Burgoyne and Company—

$$K = 2{\cdot}05.$$

The refractive (μ) index for line D is 1·3800,

$$\mu^2 = 1{\cdot}9044.$$

Of the benzol series four were tested: *benzol*, *toluol*, *xylol*, obtained from Hopkin and Williams, *cymol* from Burgoyne and Company.

In the following table the first column gives my own results, the second those of Palaz, the third my own determinations of the refractive index for line D at a temperature of 17·5° C., and the fourth the square of the refractive index:—

			μ.	μ^2.
Benzol	2·38	2·338	1·5038	2·2614
Toluol	2·42	2·365	1·4990	2·2470
Xylol	2·39	—	1·4913	2·2238
Cymol	2·25	—	1·4918	2·2254

For benzol Silow found 2·25, and Quincke finds 2·374.

The method employed by Palaz is very similar to that employed by myself in these experiments; but, so far as I can ascertain from his paper, he fails to take account of the induction between the case of

* 'Wiedemann's Annalen,' vol. 28, p. 474.

his fluid condenser and his connecting wire; he also supports the inner coating of his fluid condenser on ebonite; and, so far as I can discover, fails to take account of the fact that this also would have the effect of diminishing to a small extent the apparent specific inductive capacity of the fluid. Possibly this may explain why his results are in all cases lower than mine. Determinations have also been made by Negreano ('Comptes Rendus,' vol. 104, 1887, p. 423) by a method the same as that employed by myself.

Three substances have been tried with the guard-ring condenser —double extra dense flint-glass, paraffin wax, and rock salt. The first two were not determined with any very great care, as they were only intended to test the convenience of the method. For double extra dense flint-glass a value 9·5 was found; the value I found by my old method was 9·896. For paraffin wax 2·31 was obtained—my previous value being 2·29. In the case of rock salt the sample was very rough, and too small; the result was a specific inductive capacity of about 18, a higher value than has yet been observed for any substance. It must, however, be received with great reserve, as the sample was very unfavourable, and I am not quite sure that conduction in the sample had not something to do with the result. In the experiments with the guard-ring condenser the disturbing effect of the connecting wire was not eliminated. My thanks are due to my pupil, Mr. Wordingham, for his valued help in carrying out the experiments.

Presents, November 17, 1887.

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FIG. 1.

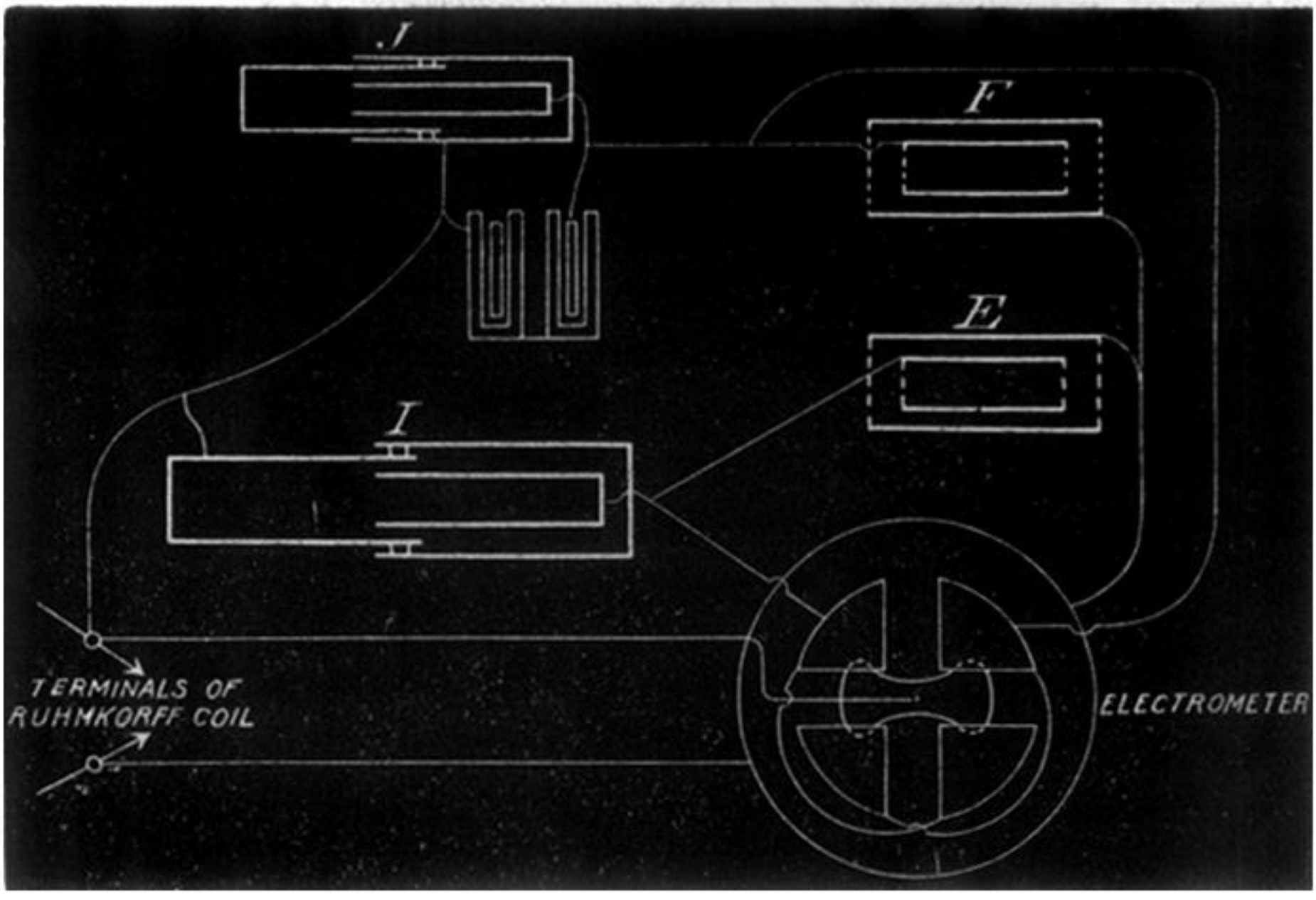
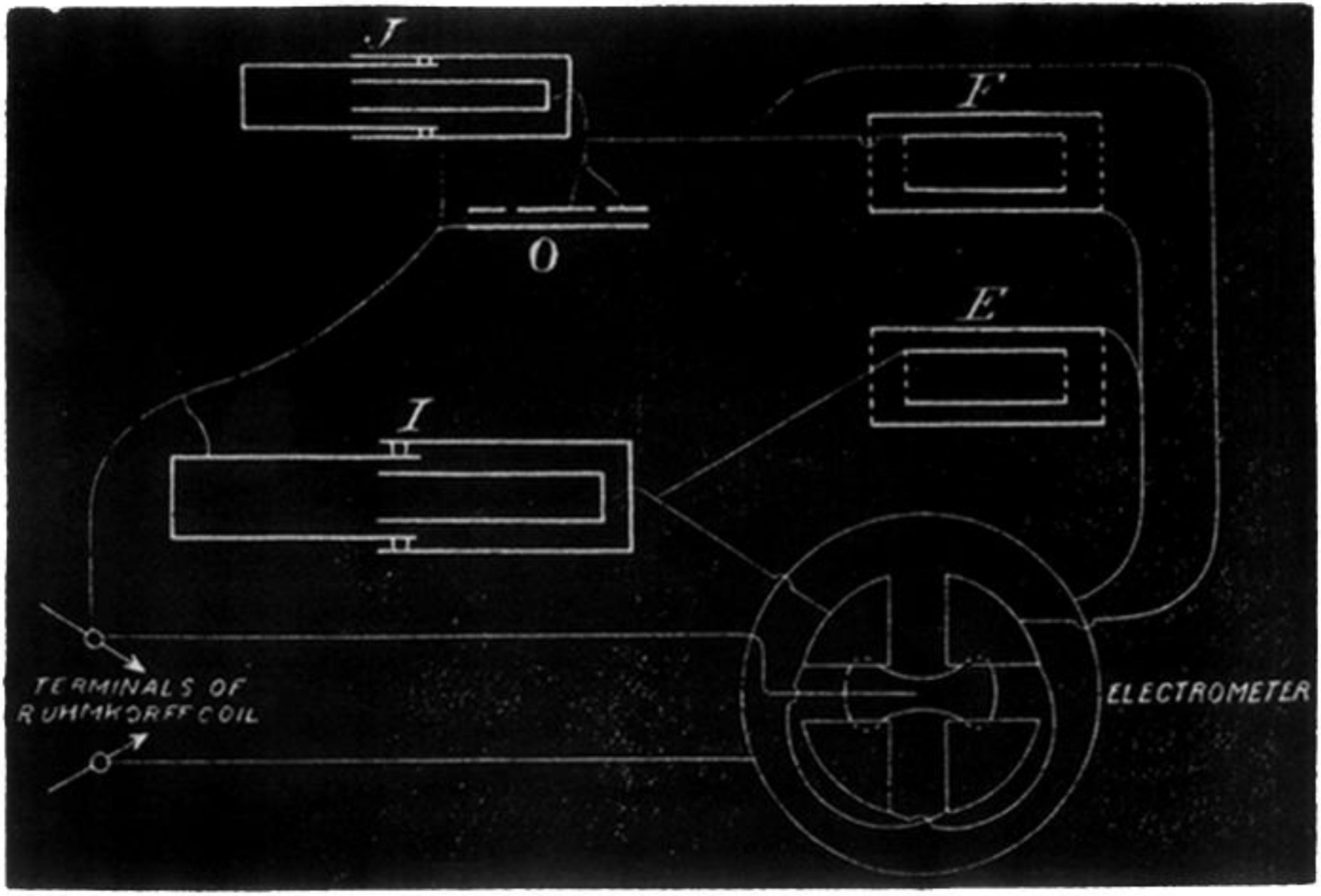


FIG. 2.



* 'Phil. Trans., 1881, Part II.

FIG. 3.