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J. T. ARMSTRONG & A. ORLING.
ELECTROCAPILLARY APPARATUS.

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Fig. 1.

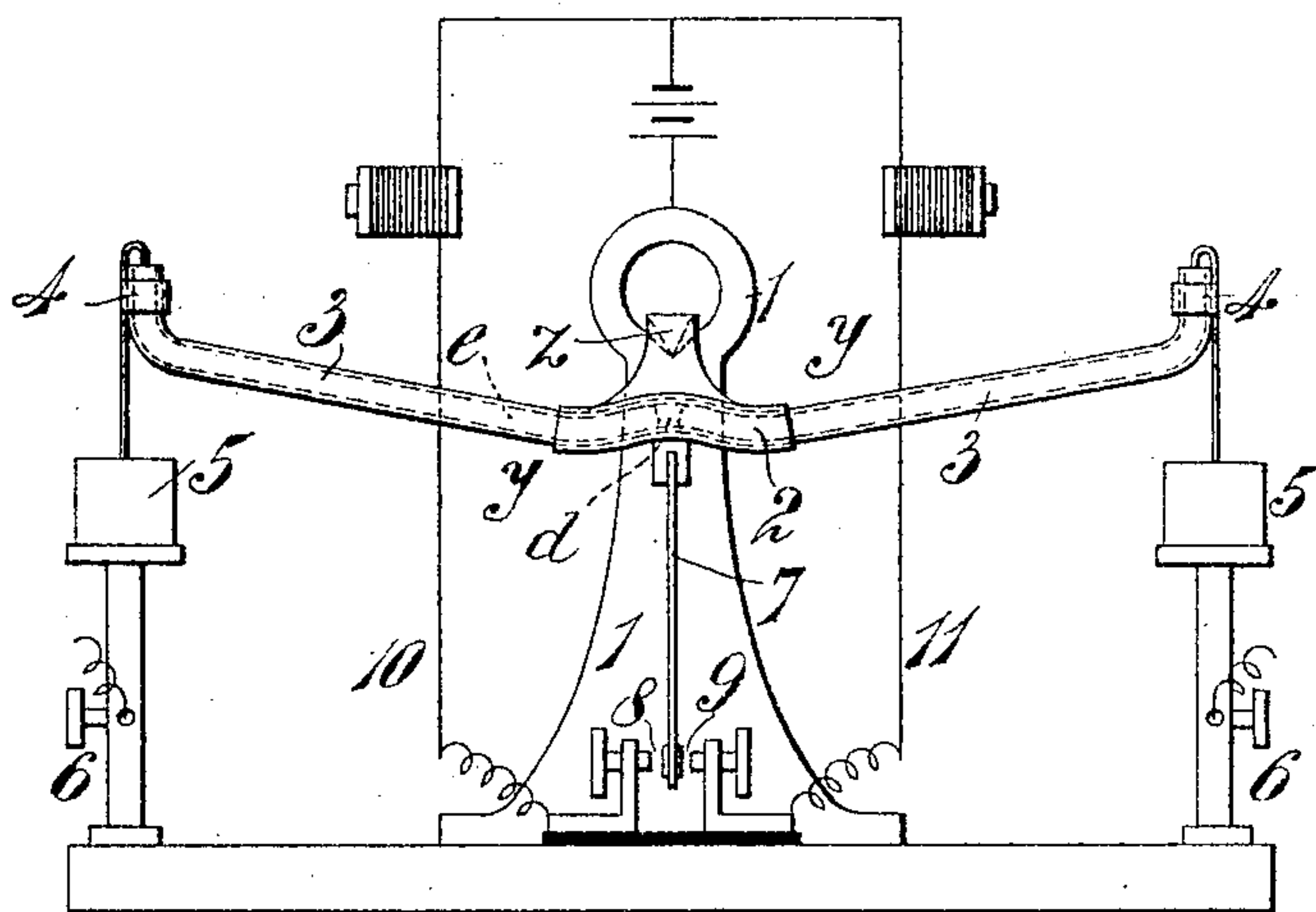
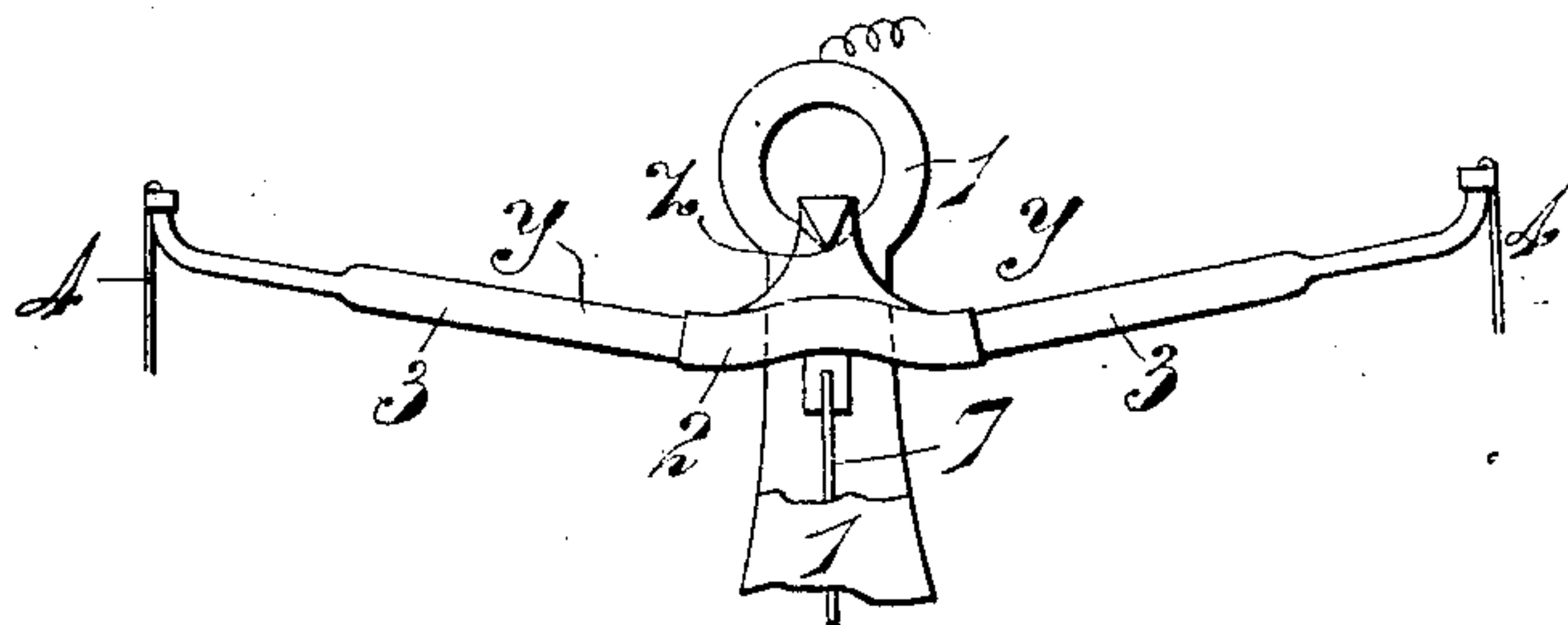


Fig. 2.



WITNESSES:

James C. Babcock
F. B. Williams

INVENTORS:

James T. Armstrong
A. Orling
by W. H. Babcock
Attorney

UNITED STATES PATENT OFFICE.

JAMES TARBOTTON ARMSTRONG AND AXEL ORLING, OF LONDON,
ENGLAND.

ELECTROCAPILLARY APPARATUS.

No. 798,483.

Specification of Letters Patent.

Patented Aug. 29, 1905.

Original application filed May 19, 1902, Serial No. 108,139. Divided and this application filed February 2, 1904. Serial No. 191,676.

To all whom it may concern:

Be it known that we, JAMES TARBOTTON ARMSTRONG, a subject of the King of England, and AXEL ORLING, a subject of the King of Sweden and Norway, both residing at London, England, have invented new and useful Improvements in Electrocapillary-Apparatus, of which the following is a specification.

Our invention relates to apparatus employed to detect the presence of electrical currents, and has for its object improvements whereby extremely weak currents may be detected and caused to actuate other apparatus or mechanisms directly or through one or more relays.

In carrying out our invention we make use of the electrocapillary force exerted at the surfaces in contact of certain dissimilar fluid conductors (such as mercury and dilute acid or a solution of spirits of wine and potassium iodid) when an electric current flows through one to the other. This force brings about a displacement of the said fluids, which effect we employ to disturb the balance of a delicately-poised part of the apparatus by means of which a relay-circuit may be closed.

The normal condition of the apparatus is one of equipoise, and the effect of the electrocapillary force is to disturb the equilibrium. It is therefore manifest that the displacement (which always accompanies the passage of even the weakest currents) must vary the distribution of weight and cause a preponderance on one side that will effectually operate the apparatus.

According to our invention the fluid conductors are in some cases contained by separate receptacles, which communicate with each other through a tube or other suitable channel, or, alternatively, we employ a tube or an equivalent part of suitable form alone, as is hereinafter particularly described with reference to the accompanying drawings, in which—

Figure 1 is a front elevation of one form of our invention, a part of the frame being shown broken away; and Fig. 2 is a similar view illustrating a modification.

According to the construction shown in Fig. 1 a scale-beam y is delicately poised on a knife-edge z in suitable standards I, one of which is shown broken off on the drawings in order to show more clearly what is behind.

The scale-beam y consists of a tube or receptacle of non-conducting material, which rests in a suitable cradle 2 and is provided with two upwardly-inclined limbs 3, arranged symmetrically on either side of the knife-edge z . These limbs 3 may be reduced in diameter toward their ends, (see Fig. 2,) where they are left open and are upturned. This tube or receptacle, which is of the shape shown in the drawings, contains a small quantity of dilute acid d at its center, while equal quantities of mercury e are provided on each side of that point, which are kept separate by the said drop of dilute acid d .

To the ends of the scale-beam are secured conductors 4, which maintain electrical connection between the mercury e in the limbs 3 and the mercury in the cups 5, into which the said conductors 4 dip. These mercury-cups are provided with suitable terminal connections 6, by way of which an electric current may enter the apparatus and after traversing the fluid conductors in the tube of the scale-beam y leave it.

When a current is passed through the apparatus, the electrocapillary force exerted at the surfaces in contact of the dissimilar fluid conductors causes them to be displaced in the direction from positive to negative, thereby disturbing the balance and causing the beam to turn in a direction controlled by that of the current. By reducing the diameter of the limbs 3 of the scale-beam tube toward their ends, as shown in Fig. 2, a slight displacement of the fluids at the center is magnified at the end, resulting in a more decided movement, owing to the increased leverage. The beam y is provided with a conducting-finger 7, depending from the conducting-cradle 2 and located between the contacts 8 and 9 of two relay-circuits 10 11, one or other of which is closed by the said finger and one of the contacts when the balance is turned.

It is obvious that we may employ two or more tubular scale-beams or the equivalent capillary element in order that a larger quantity of mercury may be displaced when a current passes through the apparatus.

What we claim as our invention, and desire to secure by Letters Patent, is—

1. In electrocapillary apparatus, the combination of a balanced tube or receptacle, con-

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taining two fluids with means for sending a current of electricity through the same, to disturb the equilibrium by changing the capillary condition of the said fluids substantially as set forth.

2. In electrocapillary apparatus, the combination of a balanced tube or receptacle containing mercury and a lighter liquid with means for sending a current of electricity through the same to disturb the equilibrium by changing the capillary condition of the said liquids substantially as set forth.

3. In electrocapillary apparatus, the combination of a balanced tube or elongated receptacle, containing two liquids, one of which is normally at its center of gravity, and means for sending a current of electricity through the said tube to disturb the equilibrium by changing the capillary condition of the said liquids and causing an endwise shifting of their position in the tube substantially as set forth.

4. In electrocapillary apparatus, the combination of a balanced tube or elongated receptacle containing mercury and also a small quantity of dilute acid or equivalent material at the normal center of gravity, with means for sending a current of electricity through the same and changing the capillary condition of the two fluids with consequent shifting of the mercury and the center of gravity substantially as set forth.

5. In electrocapillary apparatus, the combination of a balanced tube, having its ends upturned and containing two liquids with means for sending an electric current through the same to disturb the equilibrium substantially as set forth.

6. In electrocapillary apparatus, the combination of a balanced tube or elongated receptacle containing two fluids and having its ends diminished in diameter with means for sending an electric current through the same to disturb the equilibrium substantially as set forth.

7. In electrocapillary apparatus, the combination of a balanced tube containing two fluids and having its open ends turned upward and reduced in diameter with means for sending an electric current through it to disturb the equilibrium substantially as set forth.

8. In electrocapillary apparatus, the combination of a balanced tube containing two fluids and having its open ends turned upward with mercury-cups, bent conductors which dip into the ends of said tube and also into said cups, and electric conductors connecting said cups to an electric circuit substantially as set forth.

9. In electrocapillary apparatus, the combination of a balanced tube or receptacle containing two fluids with a circuit-closing device attached thereto, a relay-circuit opened and closed by the said device and means for

sending an electric current through the said tube, to change the capillary conditions and disturb the equilibrium substantially as set forth.

10. In electrocapillary apparatus, the combination of a balanced tube or receptacle containing two fluids with means for sending an electric current through the same to change the capillary conditions and disturb the equilibrium, a conducting-finger depending from the said tube and two contacts arranged on opposite sides of the said finger, each closing a relay-circuit when the said arm is in contact with one or the other of said contacts substantially as set forth.

11. In electrocapillary apparatus, the combination of a balanced tube or receptacle containing two liquids with means for sending an electric current through the same to change the capillary conditions and disturb the equilibrium, a finger vibrating with the said tube and a pair of relay-circuits having contacts on the opposite sides of the said finger, in order that its movement in either direction may close one or the other of the said circuits substantially as set forth.

12. In electrocapillary apparatus, the combination of a balanced tube or receptacle of non-conducting material containing two fluids, in combination with a cradle of conducting material in which the said tube rests, a suitably-supported knife-edge on which the said cradle is balanced, means for sending a current of electricity through the contents of the said tube to change the capillary conditions and disturb the equilibrium, a conducting-finger attached to said cradle, two contacts arranged on opposite sides of the said finger and the two conductors of two relay-circuits each connected at one pole with the support of said knife-edge, in order that the relay-circuit may be completed through the said support, knife-edge, cradle and finger, whichever relay-circuit be closed by the movement of the said finger in one direction or the other substantially as set forth.

13. A relay-operating device comprising a delicately-poised scale-beam consisting of a tube of suitable non-conducting material having upwardly-inclined limbs arranged symmetrically on either side of its support, the said tube containing a drop of dilute acid at the point where its limbs join and a suitable quantity of mercury on either side of it, electrical connection with the said fluid conductors being maintained with the terminals of the apparatus by wires or equivalent parts which extend through the open upturned ends of the tube and thereafter dip into stationary mercury-cups, so that the electrocapillary force generated by the passage of an electric current will displace the fluid conductors in a direction controlled by that of the said currents thereby altering the distribution of

weight and causing the scale-beam which is provided with an insulating-finger to turn and close one or other of two relay-circuits, according to the direction of the actuating-current, through suitable contacts, substantially as described.

In testimony whereof we have signed our

names to this specification in the presence of two subscribing witnesses.

JAMES TARBOTTON ARMSTRONG.

AXEL ORLING.

Witnesses:

W. H. WOOD,

E. A. GODDIN.