No. 848,083. PATENTED MAR. 26, 1907.

J. T. ARMSTRONG & A. ORLING.

ELECTROCAPILLARY DETECTOR AND RECORDING APPARATUS.

APPLICATION FILED AUG. 31, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

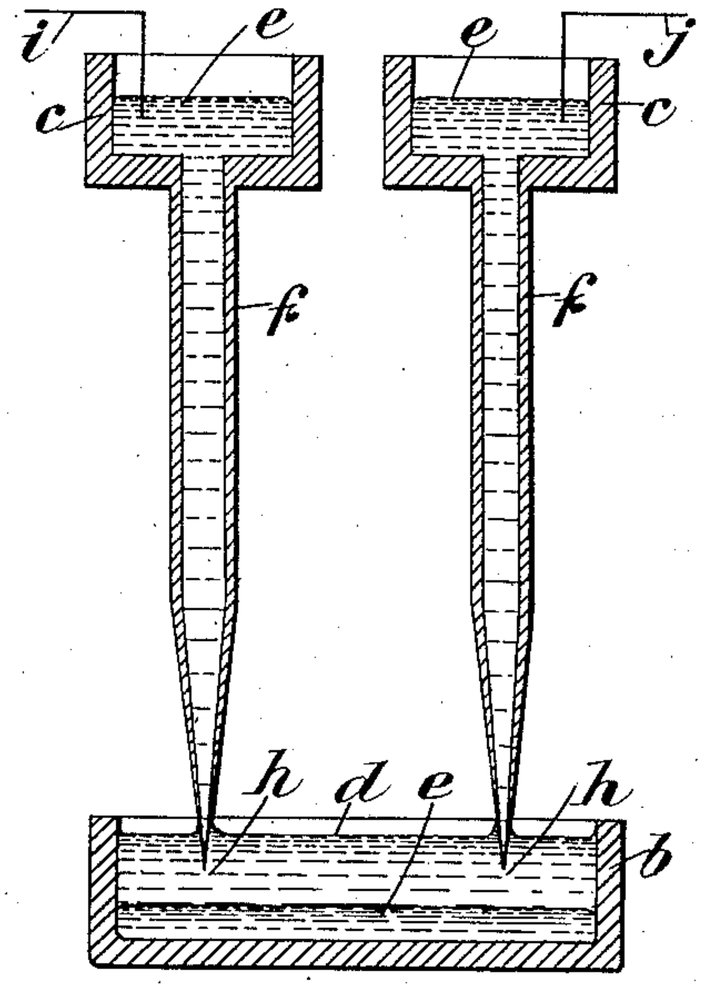


Fig. 2.

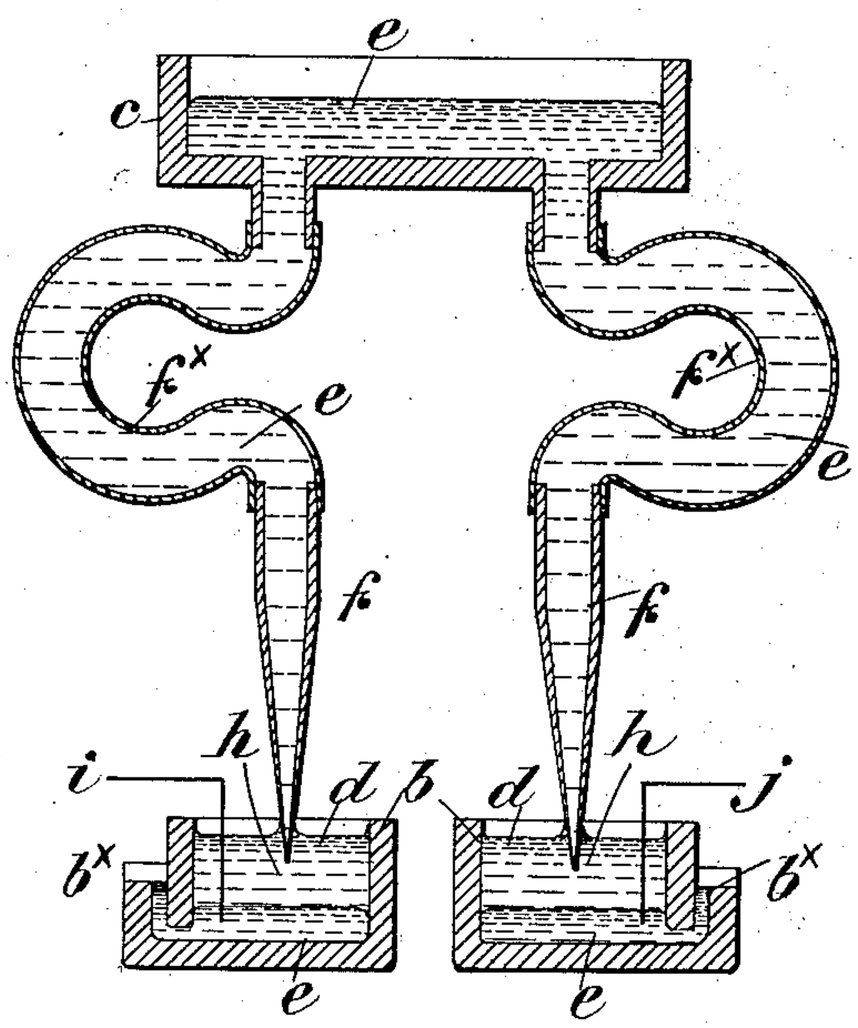
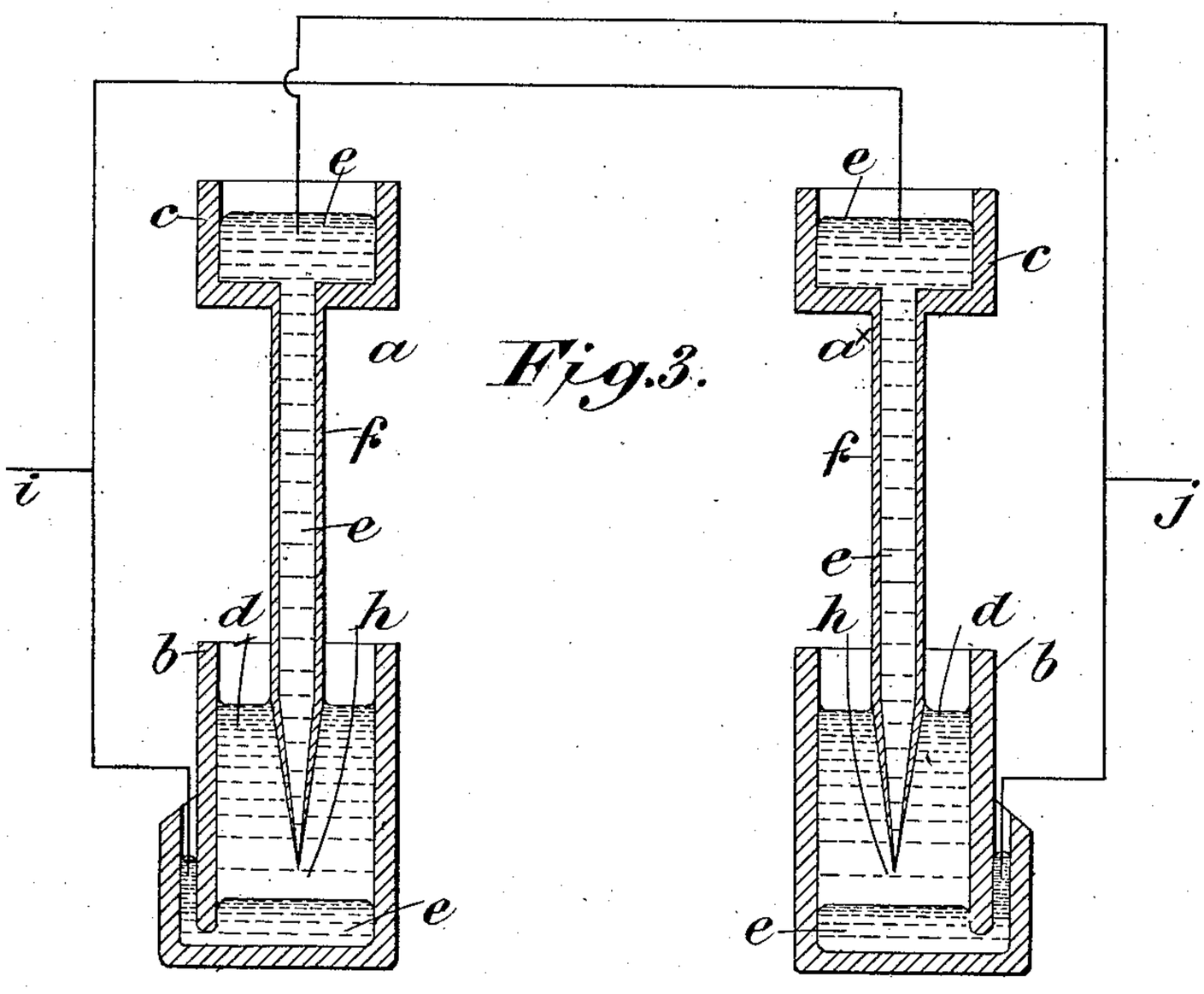


Fig. 3.



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2 SHEETS—SHEET 2.

Fig. 3.

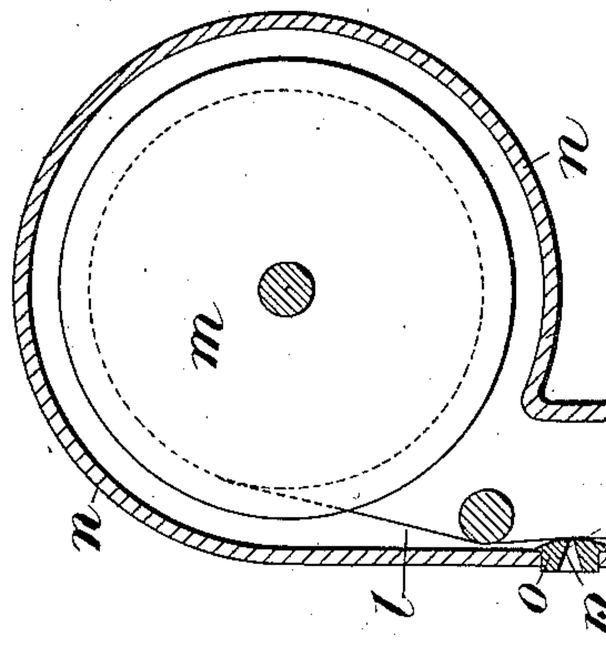

Fig. 6.

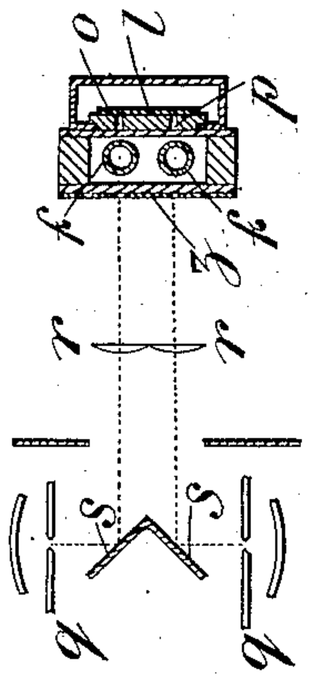

Fig. 4.

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UNITED STATES PATENT OFFICE.

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

ELECTROCAPILLARY DETECTOR AND RECORDING APPARATUS.

No. 848,083. Specification of Letters Patent. Patented March 26, 1907.

Application filed August 31, 1904. Serial No. 222,909.

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, both residing at London, England, have invented new and useful Improvements in and Relating to Electrocapillary Detectors and Recording Apparatus, of which the following is a specification.

Our invention relates to electrocapillary apparatus of the kind described in the specifications to British Patent No. 21,981, dated October 31, 1901, and Nos. 2,053 and 2,053[A], both dated January 28, 1903, and has for its object improvements whereby the direction of the current or difference of potential is shown and may be recorded.

In carrying out the first part of our invention we employ two electrocapillary elements constructed substantially as described in the specifications hereinbefore referred to, which are connected up reversely in one circuit. These electrocapillary elements may be arranged in parallel circuit or in series.

In carrying out the second part of our invention we employ one or more beams of light whose direction is such as to be interrupted by the mercury displaced by electrocapillary action, but which are normally allowed to fall upon a traveling sensitized surface whereon one or more lines are printed photographically, the continuity of which lines is interrupted when signals are received.

In order that our invention may be clearly understood, we will now proceed to particularly describe it with reference to the accompanying drawings, in which—

Figures 1, 2, and 3 are diagrams showing different arrangements of our improved electrocapillary apparatus. Fig. 4 is a diagram illustrating the recording apparatus. Fig. 5 is a sectional elevation of a detail thereof, and Fig. 6 is a diagrammatic plan showing the general arrangement of the apparatus.

According to the construction shown in Fig. 1 we employ two mercury-chambers *c*, each of which is provided with a tubular part *f*, terminating in a constricted or capillary end *h*, through which the mercury *e* is under normal conditions prevented from flowing, owing to the capillary force due to its surface tension being greater than the hydrostatic pressure of the superincumbent column of mercury. The capillary ends of these tubular parts are immersed in a dissimilar conducting fluid *d*, such as a solution of sulfuric acid and water, contained by a chamber *b*, by means of which the mercury in the tubular parts is electrically connected.

The terminals *i j* of the apparatus are connected to the two mercury-chambers *c c* to which the current or difference of potential to be detected is applied, with the result that the tension of the surface of the positively-charged mercury in contact with the dilute acid is, as is well known, reduced and the mercury permitted to flow through the capillary end *h* of the tubular part *f* into the chamber *b* containing the dilute acid. At the same time the tension of the surface of the negatively-charged mercury in contact with the dilute acid is, as is also well known, increased, causing the mercury to recede from the capillary end of the tubular part that contains it.

According to the construction shown in Fig. 2 we employ one mercury-chamber *c*, having two tubular parts *f f*, each terminating in a capillary end *h*, which we immerse in different chambers *b b*, containing dilute acid or other suitable dissimilar fluid conductor *d*. In this case the dilute acid *d* in each of the chambers *b* respectively constitutes the terminals *i j* of the apparatus and are electrically connected through the mercury *e* in the tubular part *f f*[×] and in the chamber *c*.

According to the construction shown in Fig. 3 we employ two mercury-chambers *c c*, each having a tubular part *f*, provided with a capillary end *h*, and two chambers *b b* containing dilute sulfuric acid *d*, (or another suitable dissimilar fluid conductor,) into which the tubular parts are respectively immersed, thus forming two distinct electrocapillary elements *a a*[×]. These are connected in parallel circuit, the dilute acid *d* of the element *a* and the mercury *e* of the other element *a*[×] being connected to one of the terminals *i* of the apparatus, while the other mercury and dilute-acid chambers are connected to the other terminal *j*. Thus when one terminal of any of these apparatus is positive mercury will flow from one of the tubular parts, whereas if the potentials be reversed the mercury will flow from the other.

Preferably the capillary ends of the tubular parts *f* are connected with their respective mercury-chambers *e* by means of an india-rubber or other suitable flexible connection $f^{\times}$ (shown in Fig. 2) that will admit of the adjustment of the height of the said chamber in any well-known or suitable manner independently of its respective capillary end *h*. The chambers *b b* that contain the dissimilar fluid conductor *d* are also preferably provided with a mercury-overflow $b^{\times}$ (see Fig. 2) to permit the excess of mercury delivered into it to run away. This outlet is sealed by the mercury *e* at the bottom of the said chambers *b b*, which prevents the escape of the lighter fluid conductor.

In order to make a record of signals received when our detector is employed for telegraphic and analogous purposes, we employ a sensitized tape *l*. In practice a roll *m* of this tape *l* is journaled in a light-proof box *n*, from which it is drawn at a suitable speed by a clockwork or other suitable motor (not shown) past a screen *o*, formed by one of the walls of the box *n*. This screen is provided with two pin-holes *p p*, located side by side and in such a position as to allow the light of a lamp or other convenient source *q* to fall upon the traveling sensitized tape *l*. We may in some cases employ one or more lenses *r* or reflectors *s* (see Fig. 6) in conjunction with one or more lamps or the like *q* to concentrate or focus the light at one or more points for this purpose.

Between the lamp and the screen we locate our electrocapillary detector, which we so arrange that the mercury delivered by one of the tubular parts *f* will close one of the holes *p* in the screen *o* to the beam of light, while the mercury from the other tubular part will similarly close the other hole. For this purpose the chamber *b* is made of a suitable translucent material, such as glass, and the capillary ends *h* of the tubular parts *f* are brought as near to the screen *o* as is possible and are in some cases bent toward it, as is shown by dotted lines in Fig. 4. By these means a photographic record is produced upon the traveling tape consisting of two lines, the continuity of which is broken by the received signals. After passing the screen the tape may be led around a rod or roller *t*, immersed in a bath *u*, of developing solution, from which it is drawn and thereafter similarly led around another rod or roller *v*, immersed in a washing-bath *w*, whereafter it is similarly drawn through a bath *x*, of fixing solution, and afterward washed in a bath *y*. We do not, however, restrict ourselves to the means of developing, fixing, and washing described and shown.

According to the arrangement shown in Fig. 6 two sources of light *q* (full lines) may be employed in conjunction with reflectors *s s*, which may be plane or lenticular. We may also use one or more lenses, such as are shown at *r*, to focus or concentrate the beams of light on the apertures *p p*.

Instead of the reflectors *s* we may employ suitable prisms.

In some cases we employ a second screen *z*, having apertures opposite those in the screen *o*.

We may also in some cases employ only one source of light $q^{\times}$, (see dotted lines in Fig. 6,) in which case the apertures in the screen or screens and the capillary end of the tubular parts *f* are so located as to be in the path of a ray emanating from that source.

It is obvious that we may employ our improved photographic recording device in conjunction with a single electrocapillary element—such, for instance, as is described in the specifications hereinbefore referred to—and in some cases we may dispense with the sensitized surface and cause the beam of light to fall upon a flat surface or screen, from which it may be observed.

It is also obvious that any desired number of detectors may be actuated by the received signals, and so caused to operate a corresponding number of relays or recorders.

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

1. In electrocapillary apparatus, the combination of an electrocapillary element with a second electrocapillary element and electric conductors constituting means of conducting a positive electric charge to the mercury-column of one of the said elements when the mercury-column of the other is negatively charged substantially as set forth.

2. In electrocapillary apparatus the combination of an electrocapillary element with a second electrocapillary element, an electric conductor connected with the mercury-column of one of the said electrocapillary elements and the electrolyte of the other and a second electric conductor connected to the opposite terminals of the said electrocapillary elements substantially as set forth.

3. In electrocapillary apparatus, the combination of an electrocapillary element with a second electrocapillary element and electric conductors connected thereto constituting means of conducting an electric charge to the said elements to cause an electrocapillary flow of mercury from one or the other of them substantially as set forth

4. In electrocapillary apparatus, a mercury-chamber a tubular part depending therefrom, a capillary end, a flexible tube to connect such capillary end to the mercury-chamber a body of electrolyte with which the mercury in the capillary end makes contact, substantially as and for the purpose set forth.

5. In electrocapillary recording apparatus, the combination with a traveling sensitized surface and one or more beams of light which normally fall thereon with one or more elec-

trocapillary elements adapted to intercept such beams of light when a displacement of the mercury takes place substantially as and for the purpose set forth.

6. In electrocapillary recording apparatus the combination of a light-proof chamber, one or more apertures therein, one or more beams of light adapted to pass through such apertures and a sensitized surface located within said light-proof chamber and fed past the apertures therein with one or more electrocapillary elements adapted to intercept such beams of light when a displacement of the mercury takes place to produce a record substantially as set forth.

7. In electrocapillary recording apparatus, the combination of a light-proof chamber, one or more apertures therein, a screen provided with corresponding apertures, one or more beams of light adapted to pass through such apertures and a sensitized surface located within said light-proof chamber and fed past the apertures therein with one or more electrocapillary elements adapted to intercept such beams of light when a displacement of the mercury takes place to produce a record substantially as set forth.

8. In electrocapillary recording apparatus, the combination of a light-proof chamber, one or more apertures therein, a screen provided with corresponding apertures, one or more beams of light adapted to pass through such apertures and a sensitized surface located within said light-proof chamber and fed past the apertures therein with one or more electrocapillary elements adapted to intercept such beams of light when a displacement of the mercury takes place to produce a record, baths containing developing and fixing solutions and water respectively and means of drawing the sensitized tape therethrough, substantially as set forth.

9. In electrocapillary recording apparatus, the combination of a light-proof chamber, one or more apertures therein, a screen provided with corresponding apertures, one or more beams of light adapted to pass through such apertures, one or more reflectors lenses or prisms to direct and concentrate said beams of light, and a sensitized surface located within said light-proof chamber and fed past the apertures therein with one or more electrocapillary elements adapted to intercept such beams of light when a displacement of the mercury takes place to produce a record, baths containing developing and fixing solutions and water respectively and means of drawing the sensitized tape therethrough, substantially as set forth.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

JAMES TARBOTTON ARMSTRONG.
AXEL ORLING.

Witnesses:
A. M. BIRD,
EDGAR A. GODDIN.