

(No Model.)

2 Sheets—Sheet 1.

C. COLEMAN.
GALVANOMETER.

No. 570,454.

Patented Nov. 3, 1896.

Fig. 4.

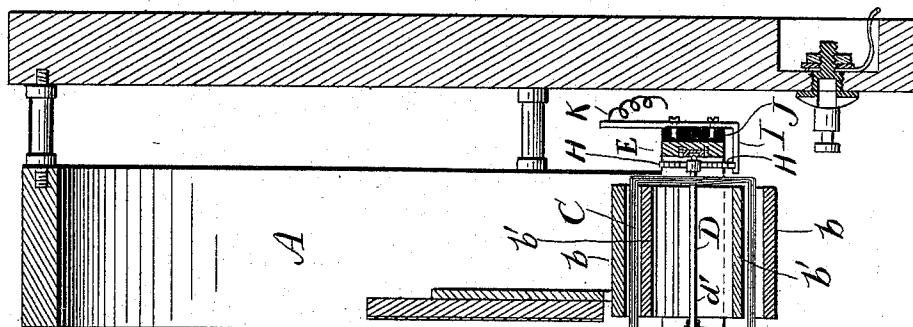


Fig. 2.

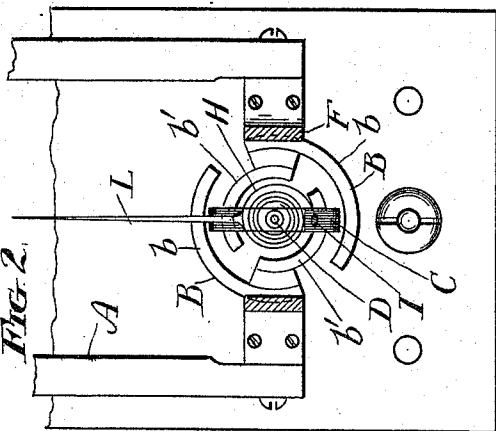


Fig. 3.

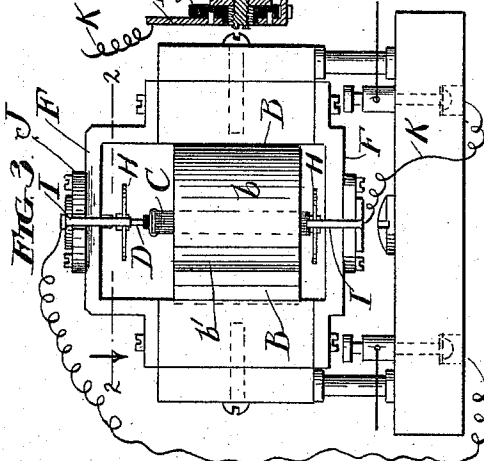
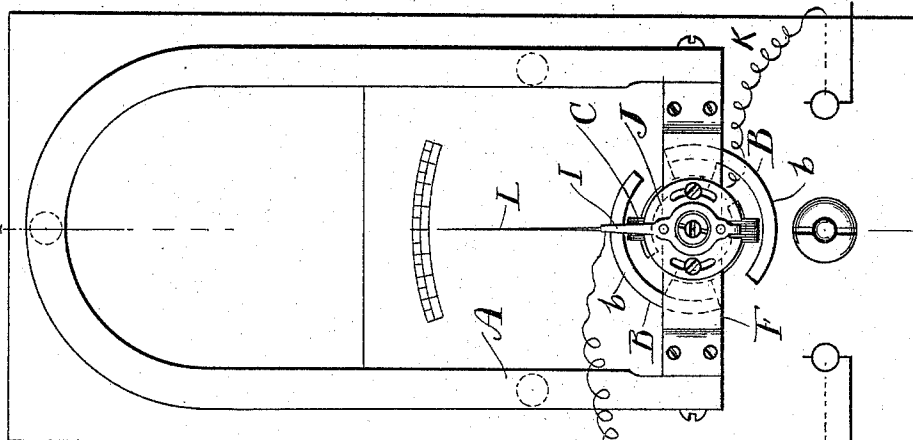


Fig. 1.



Witnesses.
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d. Cross

Inventor.
C. Coleman
By his attorneys
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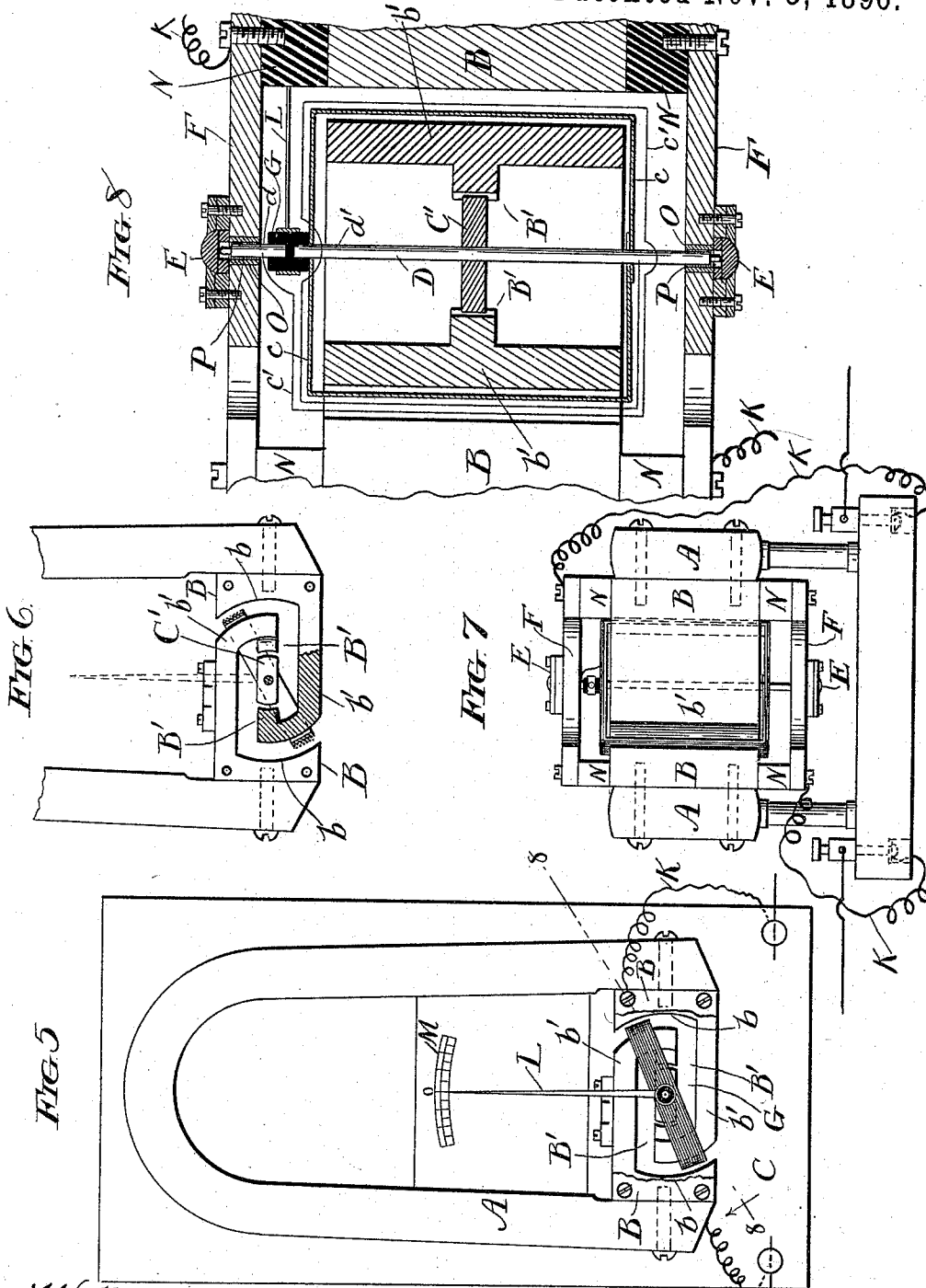
(No Model.)

2 Sheets—Sheet 2.

C. COLEMAN.
GALVANOMETER.

No. 570,454.

Patented Nov. 3, 1896.



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UNITED STATES PATENT OFFICE.

CLYDE COLEMAN, OF CHICAGO, ILLINOIS, ASSIGNOR OF TWO-THIRDS TO
ALBERT L. DEANE AND JAMES W. DONNELL, OF SAME PLACE.

GALVANOMETER.

SPECIFICATION forming part of Letters Patent No. 570,454, dated November 3, 1896.

Application filed June 9, 1896. Serial No. 594,839. (No model.)

To all whom it may concern:

Be it known that I, CLYDE COLEMAN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Galvanometers and other Electrical Appliances, of which the following is a specification.

The invention relates in part to a galvanometer, or, to be more explicit, an instrument for indicating the presence of an electric current, its direction, its voltage, and its amperage; in part to the construction of the magnet which is adapted for use therein and in other electrical appliances; in part to the means for resisting the movement of the armature of an electrical appliance from its initial or normal position and returning it thereto upon the removal of the force that moved it therefrom, and in part to a journal-bearing that is especially adapted for the shafts of delicate electrical appliances, but which may be used for the shafts of other instruments or machines. In the drawings I have illustrated all of these features of my invention as being embodied in a galvanometer, and the following description will be confined thereto; but in its broadest aspect the invention is not limited thereto, and I therefore reserve to myself the exclusive right to embody any of its features in any machine or instrument for whatever purpose, and in construing the claims this statement is to be considered. Subject to this qualification the invention consists in the features of novelty that are particularly pointed out in the claims hereinafter, and in order that it may be fully understood I will describe it with reference to the accompanying drawings, which are made a part hereof, and in which—

Figure 1 is a plan view of a galvanometer embodying some of the features of the invention. Fig. 2 is a section thereof on the line 2 2, Fig. 3, a portion of the magnet and base being broken away. Fig. 3 is an end elevation thereof. Fig. 4 is a vertical longitudinal section thereof on the line 4 4, Fig. 1. Fig. 5 is a plan view of a galvanometer embodying all of the several features of my invention in their preferred forms, a portion of the bracket for sustaining the upper end of the armature-

shaft being broken away. Fig. 6 is a plan view thereof with still other portions broken away. Fig. 7 is an end elevation thereof. Fig. 8 is an enlarged section thereof on the line 8 8, Fig. 5, looking in the direction of the arrow.

A represents the magnet. In the drawings I have shown a permanent horseshoe-magnet, but the invention is not limited thereto.

B represents the pole-pieces, and C the armature, which is carried by a shaft D, journaled at its opposite ends in jewel-bearings E, that are supported by brackets F. The shaft is made in two parts *d d'*, that are mechanically connected together, but electrically insulated from each other by means of a coupling G, of some non-conducting material, such as rubber or vulcanite.

The armature is in the form of an open ring and is made up of a frame *c* and a coil *c'*, disposed around it, the character of the wire used for the coil depending upon the use for which the instrument is intended. The current is led to and from the armature through the shaft, and it is this that necessitates making the shaft of two insulated parts, with which the opposite ends of the coil are respectively connected.

In the form of the invention shown in Figs. 1 to 4, inclusive, the current is led to and from the two parts of the shaft through hair-springs H, each of which is secured at one end to one section of the shaft and at the other end to a regulating-lever I, which is pivoted to one of the brackets F, but insulated therefrom by an insulator J. With this arrangement the current passes from one branch of the conductor K into and through one of the levers I, thence into and through one of the hair-springs, thence into and through one section of the shaft, thence into and through the coil, thence into and through the other section of the shaft or a portion thereof, thence into and through the other hair-spring, thence into and through the other regulating-lever, and thence to the other branch of the wire K. The purpose of the hair-springs is to resist the movement of the armature from its initial or normal position and to restore it thereto when the current ceases to flow through the coil, and the pur-

pose of the levers J is to regulate the tension of the hair-springs. The shaft of the armature carries an index L, which sweeps over a scale M, preferably graduated in both directions, the normal or initial position of the index being at the center of the scale.

As ordinarily constructed the pole-pieces of magnets have inner surfaces that are curved concentrically with the axis of motion of the armature, and the shortest distance between these curved inner surfaces represents the axis of the magnet. Since the attraction of the magnet is inversely as the square of the distance, it follows that the efficiency and reliability of the apparatus materially decrease as the strength of the current to be indicated or measured decreases. It is also true that with pole-pieces of this construction variations in the current to be measured will not produce uniformly corresponding variations in the position of the armature. This is because, by reason of the described shape of the inner surfaces of the pole-pieces, the lines of magnet force composing the field through which the armature moves are not equal in length and consequently are not equal in strength. Consequently to the extent of this variation in the field the indications of the instrument will be inaccurate unless compensation therefor is made in the graduations of the scale.

So far as the invention relates to the construction of the magnet, one of its objects is to provide a magnet in which the magnetic axis is reduced to a minimum, to the end that the instrument in which it is incorporated shall be more sensitive to weak currents, and another of its objects is to provide a magnet of such construction that within the sweep of the armature the field shall be uniform and constant. In order to accomplish both of these objects, I provide pole-pieces whose opposing surfaces are parallel and concentric with the axis of motion of the armature, and in order to accomplish this each of the pole-pieces is provided with a portion *b*, whose inner surface is concentric with the axis of motion of the armature, and with an extension *b'*, whose outer surface is opposite to and parallel with the inner surface of the part *b* of the opposite pole-piece. Thus the distance between opposing surfaces of the two pole-pieces is equal at all points within the sweep of the armature and may be reduced to a minimum. In constructing pole-pieces upon this principle care should be taken to have the space between the concentric opposing surfaces of the two pole-pieces greater than the space between the extremity of the extension *b'* of each pole-piece and the opposite pole-piece. These pole-pieces may each be built up of several pieces, as shown in Figs. 1 to 4, inclusive, or each may be made of a single piece, as shown in Figs. 5 to 8, inclusive, and they may be of circular shape throughout, as shown in Figs. 1 to 4, inclusive, or they may be of circular shape throughout

only a portion of their length, as shown in Figs. 5 to 8, inclusive. In the drawings I have shown an extension on each of the pole-pieces, thereby dividing the field into two parts, in each of which one side of the armature is located; but one of the extensions may be dispensed with and still the advantages resulting from pole-pieces having parallel opposing surfaces that are concentric with the axis of motion of the armature would be attained; but the double arrangement possesses advantages which the single arrangement does not, and is therefore preferred.

Where the force for resisting the movement of the armature from its normal or initial position is derived from a spring, it varies with variations in the temperature, and variations in temperature also produce variations in the strength of the magnet, and these variations in the spring and magnet are of such a character that each aggravates the effect of the other. Either would result in an inaccuracy in the indications of the instrument and each aggravates the inaccuracy produced by the other. I prefer, therefore, to dispense with the use of a spring and to make use of force derived from the magnet itself for resisting the movement of the armature. By doing so as the strength of the magnet varies the force (derived from the magnet) which resists the movement of the armature varies correspondingly, and thus variations in temperature are completely and perfectly compensated for automatically, and their influence is not manifested in the indications of the instrument. In order to accomplish this, I provide the shaft of the armature with an auxiliary armature C', and I prefer to provide the magnet with auxiliary pole-pieces B', the auxiliary pole-pieces and auxiliary armature being so related that the lines of magnetic force passing from one of the auxiliary pole-pieces to the other, acting through the auxiliary armature, will resist the movement of the main armature from normal or initial position and will restore it thereto when the main armature becomes inert.

In the form of the invention shown in Figs. 5 to 8, inclusive, the brackets F are insulated by means of blocks or plates N, and the two branches of the wire K are connected to them, respectively. Each of them is provided with an opening through which the shaft D passes, and in each of these openings is secured a sleeve or bushing O, the internal diameter of which is slightly greater than the external diameter of the shaft, and the annular space between them is filled with a film P, of mercury, the space being so slight that the mercury is held therein by capillary attraction. This film of mercury serves the double purpose of electrically connecting the bracket and the shaft and of providing for the shaft a bearing that is as near frictionless as it is possible to attain. For the bushing I prefer to use platinum, but any other material with

which the mercury will not amalgamate may be used, and where the part corresponding to the part F is made of such material the bushing may be dispensed with.

5 Having thus described my invention, the following is what I claim as new therein and desire to secure by Letters Patent:

10 1. The combination of a pivoted armature and a magnet having pole-pieces provided with overlapping portions whose opposing surfaces are parallel and concentric with the axis of motion of the armature, substantially as set forth.

15 2. The combination of a pivoted armature and a magnet having pole-pieces each of which has an extension overlapping the other, the opposing surfaces of the pole-pieces being parallel and concentric with the axis of motion of the armature, substantially as set forth.

20 3. The combination with a pivoted armature in the form of a ring, of a magnet having pole-pieces each of which is provided with an extension which overlaps the other and is surrounded by the armature, the opposing surfaces of the pole-pieces being parallel and concentric with the axis of motion of the armature, substantially as set forth.

25 4. The combination with a pivoted armature and a magnet, of an auxiliary armature connected to the main armature and so re-

lated thereto that the magnetic force acting upon the auxiliary armature will resist its movement and consequently the movement of the main armature from normal position, substantially as set forth.

5. The combination with a pivoted armature, and a magnet, of an auxiliary armature connected to the main armature, the magnet being provided with auxiliary pole-pieces between which the auxiliary armature is located so as to be held normally parallel with the lines of magnetic force and returned thereto when the main armature is deenergized, substantially as set forth.

6. The combination with a shaft, of a part having a socket occupied by the shaft, the diameter of the socket being slightly greater than the diameter of the shaft, and a film of mercury filling the space between them, substantially as set forth.

7. In an electrical appliance the combination with a shaft, of a part having a socket occupied by the shaft, the diameter of the socket being slightly greater than the diameter of the shaft, and a film of mercury filling the space between them and electrically connecting them, substantially as set forth.

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Witnesses:

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