(No Model.) 2 Sheets—Sheet 1.

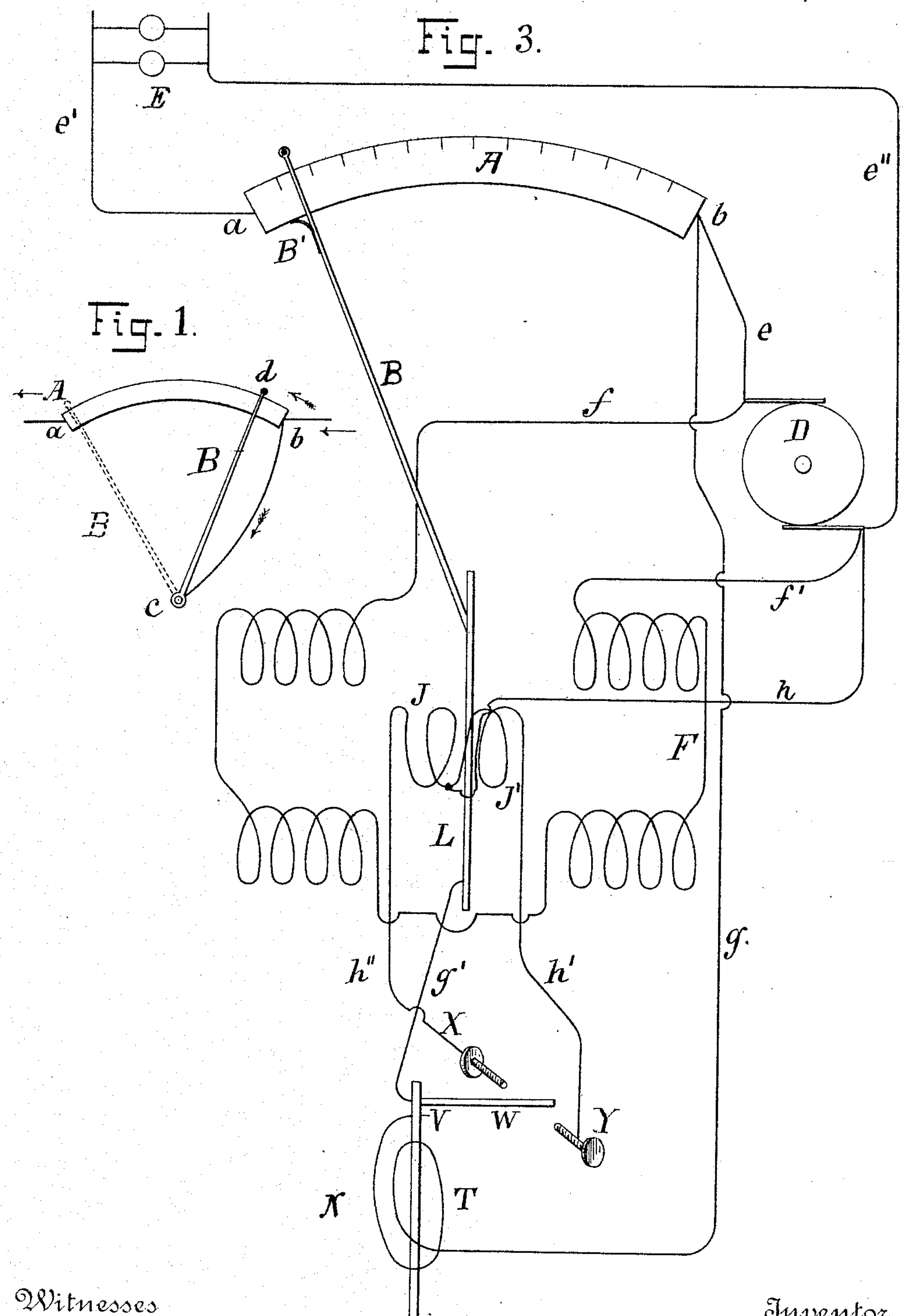
E. WESTON.

RECORDING AMMETER.

No. 490,699. Patented Jan. 31, 1893.

Fig. 3.

Fig. 1.



Witnesses
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(No Model.)

2 Sheets—Sheet 2.

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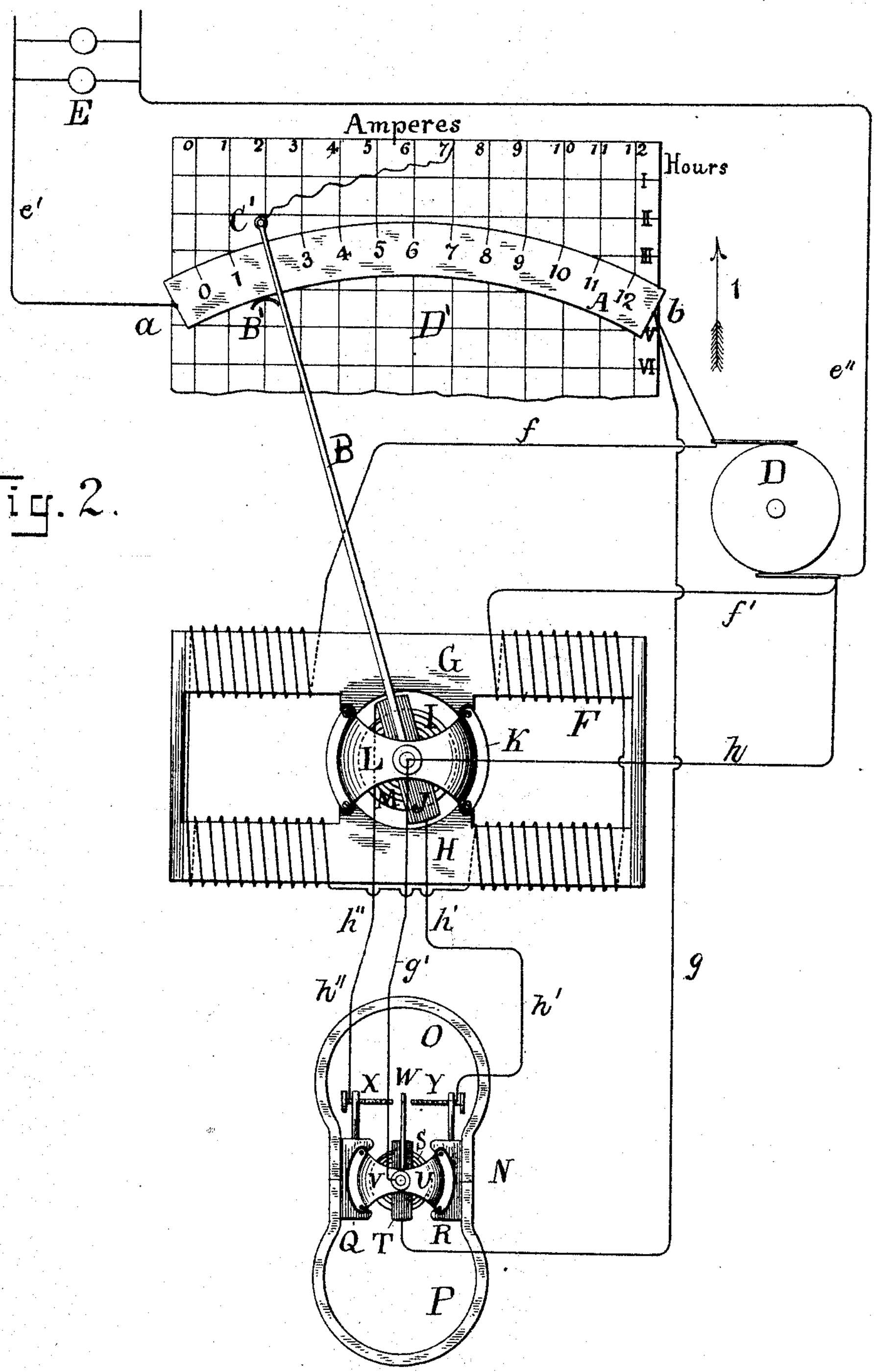
Fig. 2.



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UNITED STATES PATENT OFFICE.

EDWARD WESTON, OF NEWARK, NEW JERSEY.

RECORDING-AMMETER.

SPECIFICATION forming part of Letters Patent No. 490,699, dated January 31, 1893.

Application filed March 18, 1892. Serial No. 425,431. (No model.)

To all whom it may concern:

Be it known that I, EDWARD WESTON, of Newark, Essex county, New Jersey, have invented a new and useful Improvement in Recording-Ammeters, of which the following is a specification.

My invention is a recording ammeter which will show at all times, and which will produce a continuous record of the strength of the current traversing the instrument.

In the accompanying drawings, Figure 1 is a simple diagram illustrative of the principle of my invention. Fig. 2 is an electrical diagram of my said invention showing the general construction and arrangement of the parts. Fig. 3 is a skeleton diagram of the circuit.

Referring first to Fig. 1, let A be a body of conducting material extending between the points a, b. Let B be an arm pivoted at the point c, and having its end moving along and making contact with the body A. Assume that a current enters at b and passes through the body A, and that a part of that current is diverted through the wire b, c and arm B, which parts are obviously in shunt. Assume that the resistance of the bar A is ten ohms, merely for convenience of illustration, and that the resistance of the shunt is one ohm. Assume further that a current of ten ampères is in circuit. Then there will obviously be a fall of potential between the points b and a of one hundred volts. Let this be the normal condition of affairs when the arm B is in the position indicated by dotted lines, that is, touching the extremity a of the arm A. Now suppose the current in the circuit goes up to a hundred ampères, and that we wish to maintain in the shunt circuit B c b the same potential difference as before. Clearly, all that we should have to do would be to move the arm B to the point d, or over nine-tenths the distance between a and b; or in other words, we shall have, when the arm B is placed at the point d the same fall of potential between the points b and d as we had between the points b and a when the arm B was placed in the position shown in dotted lines, or before it was moved; although in one case we have a current of ten ampères, and in the other a current of a hundred ampères. Now, if some means existed whereby the arm B would be moved by reason of this change in strength of current to the point d, then it is clear that when we saw the arm B come to the point d, we should know when a current of one hundred ampères was passing. And if the arm B should move to another point on the body A, we should, if we put a suitable scale adjacent to said body, be able to recognize the strength of the current in the circuit.

Now my present invention is a means for causing the arm B to be moved automatically by reason of a change in the strength of the current to such a point on the body A as will maintain the same potential difference in the shunt of which said arm B is a part; and it also includes apparatus whereby the strength of current corresponding to the position of said arm B is indicated and also continuously registered or recorded upon a suitable moving surface.

My device, as a whole, is, therefore, a recording ammeter which will show at all times, and which will produce a continuous record of the strength of current traversing the instrument.

I will now describe the mechanism which is shown in Fig. 2. D is a dynamo represented, as usual, symbolically, which is supposed to supply current for the lamps at E. Interposed in the main circuit is a bar A of German silver, or other conducting material of known resistance, so that a definite fall of potential occurs between the extremities a, b of said bar. This bar is to be of suitably large cross section to convey the whole current on the main circuit, and its connections with the dynamo are also to be of suitably large area. At F is an instrument composed of two electro-magnets having their poles at G and H. Supported between the poles G and H, which are concave, as shown, is a cylinder of magnetic material I. Surrounding this cylinder is a coil of fine insulated wire, J, which is supported on a pivot L received in suitable caps fastened to the pole pieces, one of which caps is shown at K. Connected to the pivot L of this coil are volute springs. One end of each spring is fastened to the pivot L; the other end to a fixed abutment. One of these springs is shown at M. The construction and arrangement of the pole pieces G, H, the inner cylinder I, the coil J, the cap K, the pivot L and springs M is substantially the same as has already been fully described by me in various Letters Patent hitherto granted to me; such, for example, as United States Patent No. 392,387, granted to me November 6, 1888, and others.

The coils of the instrument F are in circuit with the dynamo D, and in this way I may produce a very powerful field in the instrument. This field, it will be observed, as in the case of my prior apparatus, is substantially annular in form, and the coil J passes through and turns in it.

At N is another instrument which contains two permanent magnets O and P placed with like poles facing and having pole pieces, Q and R, connected to said poles. These pole pieces are concave, like the pole pieces G, H. A cylinder of magnetic material, S, like the cylinder I, is supported between them, and surrounding this cylinder S is a coil of fine wire, T, which is supported and vibrates on a pivot V supported in caps, one of which is shown at U, which caps are supported on the pole pieces. The pivot shaft V of the coil T is provided with volute springs substantially similar to the springs M and arranged in like manner; so that the entire combination of pole pieces Q, R, cylinder S, coil T, caps U, pivot shaft V and its springs are like those already described in connection with instrument F, and are also substantially similar to the arrangement shown in my above-named prior patent. Upon the pivot shaft V is supported an arm W, which vibrates between adjustable stops X, Y.

Returning now to the instrument F, the coil J instead of being a single coil is composed of two coils, J and J′, Fig. 3, which are wound in opposite directions. The pivot shaft L carries an arm B, which extends beyond the body A, but makes contact with said body by means of the wiping spring B′. At the extremity of the arm B there is supported a pencil C′, the extremity of which touches a roll of paper, D′, which is laid off vertically in divisions to indicate hours. This roll of paper is to be combined with any suitable mechanism whereby it may be moved continuously in the direction of the arrow 1, Fig. 2, under the pencil or pen point, or other tracing device, at C′. The body A may also be divided into suitable divisions to indicate ampères, and the vertical lines on the moving scale are to be laid off in manner corresponding to those on the body A. As the divisions on the moving scale showing ampères are made along a right line, while those on the body A are made along a curved line, it follows that the divisions on the paper which correspond to the divisions on the body A nearer to the extremities will necessarily be narrower in width than those which correspond to the divisions approaching the middle of the body. This is clearly indicated in Fig. 2.

The arrangement of the circuits in the instrument will best be understood by reference to Fig. 3. Circuit No. 1 proceeds from one brush of the dynamo by the conductor *e* to the body A, thence by conductor *e′* to the lamps, and thence by conductor *e″* back to the other brush of the dynamo. This is the main lamp circuit. Circuit No. 2 proceeds by the wire *f* to the field coils of instrument F, and thence back by wire *f′* to the other brush of the dynamo. Circuit No. 3 begins at the point *b* at one end of the body A and proceeds by the wire *g* to and through the coil T of instrument N, thence to the pivot shaft V of said instrument, thence by wire *g′* to pivot shaft L of instrument F, thence to the arm B through the contact spring B′, through the body A to the main lamp circuit and thence to the dynamo and point of beginning, *b*. Circuit No. 4 proceeds to one brush of the dynamo through the wire *h* from the middle point between the coils J J′. This circuit may then be supposed to divide, one branch being through the coil J′ wire *h′* and stop Y in instrument N, and the other through the reversely-wound coil J, the wire *h″*, and adjustable stop X in instrument N.

I will now describe the operation of the apparatus:—Assume the condition of affairs in the beginning to be such that with a difference of potential between the points *a*, *b* of the body A in circuit, and the arm B being at the point *a* or at the end of the body A, the circuit-closing arm W in instrument M stands between the stops X and Y and has no tendency to move in either direction to make contact with either stop. Suppose further, that the springs M in the instrument F are so organized and constructed that they exercise no apparent effect upon the shaft; or in other words, that they are made so weak that if the finger B be moved to any position over the bar A by hand, it will remain indifferently in such position. Now assume that the current strength on the circuit increases. I have pointed out in connection with Fig. 1 that I could produce a balance, so to speak, of this increased current strength by moving the finger B along until it found a new place on the bar A where the potential difference will be the same as before; in other words, I made the finger feel for and find its new place. Now, I propose to cause the finger B to do this feeling operation for itself, automatically. When the increased current proceeds through the wire *g* to the coil T, it causes that coil, in accordance with well-known laws, to move in the field of the permanent magnets in which it is situated, and to take a new position which will depend in extent upon the increased strength of the current. This movement of the coil T brings the arm W into contact with, say the stop Y. Circuit is then completed through the wire h' to the coil J', and so back by the wire h to the dynamo. The current then circulating in the coil J' causes that coil to rotate in the powerful field of the instrument F, in accordance with the same laws as govern the coil in the instrument N; but, of course, the direction of movement of the shaft L which carries the coil J' will depend upon the direction of turns in said coil J', and this direction of turns is supposed to be such that the shaft L will move in such a way as to carry the finger B over the body A from the point a toward the point b; but the effect of this movement will be to shorten the fractional part of the body A which is included in circuit No. 3; and the effect of shortening the fractional part of the body A is to reduce the potential difference in that circuit in the manner explained in connection with Fig. 1; but as the potential difference in that circuit falls, the coil T of instrument M tends to go back to its normal position. And finally, when this potential difference is reduced to the point of potential difference at which the instrument, as already described, is originally set, the arm W will leave its stop Y and return to its position out of contact with either stop. It will be seen, therefore, that I have automatically moved the finger B until it has felt a place on the bar A, between which point and the end b of said bar, there is the same fall of potential as originally existed in the circuit before the current was increased in strength. Now, as I have already said, it simply remains to mark the bar A in suitable manner to show the current strength in ampères corresponding to those of the new position of the finger B; but as I have devised the instrument for recording, as well as for indicating, it will be plain that the trace of the pencil across the moving scale will show the variation in ampères, and the trace of the pencil vertically or in the direction of movement of the scale, will show the times when these variations in current strength occur. This, as will be easily understood, furnishes a complete record of the varying strength of the current. If now, the current falls in strength, then the effect of the current passing through the wire g in circuit No. 3 is to cause the arm W of the instrument N to move into contact with the stop X, whereby circuit is completed through the coil J of instrument F, and thence by wire h'' back to the dynamo. In such case, the shaft L of instrument F moves in the opposite direction from that in which it moved when the coil J' was traversed by the current; and therefore, the arm B is carried back toward the end a of the bar A until a new place is found, when the arm W of instrument N once more leaves its stop.

I claim:—

1. A coil in electrical circuit supported and vibrating in a field of force, an arm actuated by said coil, a tracing device controlled by said arm, a moving record surface upon which said tracing device marks, a means for controlling the direction of the current in and consequent direction of vibration of said coil in accordance with the rise and fall of current strength in said circuit.

2. A body of conducting material of known resistance per unit length connected in direct circuit and in shunt circuit, an arm moving in contact therewith, and a motor mechanism actuated by the current on said circuit and actuating said arm; the said parts being constructed and arranged that upon a change in current strength on the direct circuit the corresponding change in electrical pressure on the shunt circuit shall determine the operation of said motor mechanism and the movement thereby of said arm along said body to a position whereat a definite potential difference on the shunt circuit is re-established.

3. A body of conducting material of known resistance per unit length connected in direct circuit and in shunt circuit, an arm moving in contact therewith, and a motor mechanism actuated by the current on said circuit and actuating said arm; (the said parts being constructed and arranged that upon a change in current strength on the direct circuit the corresponding change in electrical pressure on the shunt circuit shall determine the operation of said motor mechanism and the movement thereby of said arm along said body to a position whereat a definite potential difference on the shunt circuit is re-established), in combination with a tracing device controlled by said arm, and a moving record surface whereon said device marks.

4. A body of conducting material of definite resistance per unit length in direct circuit and in shunt circuit, a coil supported and vibrating in a field of force, an arm actuated by said coil to move in contact with said body, and means for controlling the direction of the current in and consequent direction of the vibration of said coil in accordance with variation in electric pressure on said circuits; the said parts being constructed and arranged that upon a change in current strength on the direct circuit the corresponding change in electrical pressure on the shunt circuit shall determine the operation of said motor mechanism and the movement thereby of said arm along said body to a position whereat a definite potential difference on the shunt circuit is re-established.

5. The combination in an electrical measuring instrument of the elongated conducting body A in direct circuit, and in shunt circuit said body A, an arm B, moving in contact with said body, a pivot shaft supporting said arm, two coils J and J' wound in reverse directions and supported on said shaft and arranged in a field of force, a coil, T, carrying a contact arm, W, and supporting and vibrating in a second field of force, contact stops, X and Y, arranged on opposite sides and in the path of said arm W, and circuit connections, substantially as described; the afore-

said parts being constructed and arranged that upon a change of current strength on the direct circuit, the corresponding change in pressure on the shunt circuit shall determine the vibration of the coil T and the movement of the arm W into contact with one or the other stop, X or Y, whereby current is diverted to one or the other coil, J or J′, and the arm B thereby moved along said body A to a position whereat a given potential difference in the shunt circuit is re-established.

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Witnesses:
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