(No Model.) 2 Sheets—Sheet 1.

E. WESTON.

RECORDING VOLTMETER.

No. 494,829. Patented Apr. 4, 1893.

Fig. 3.

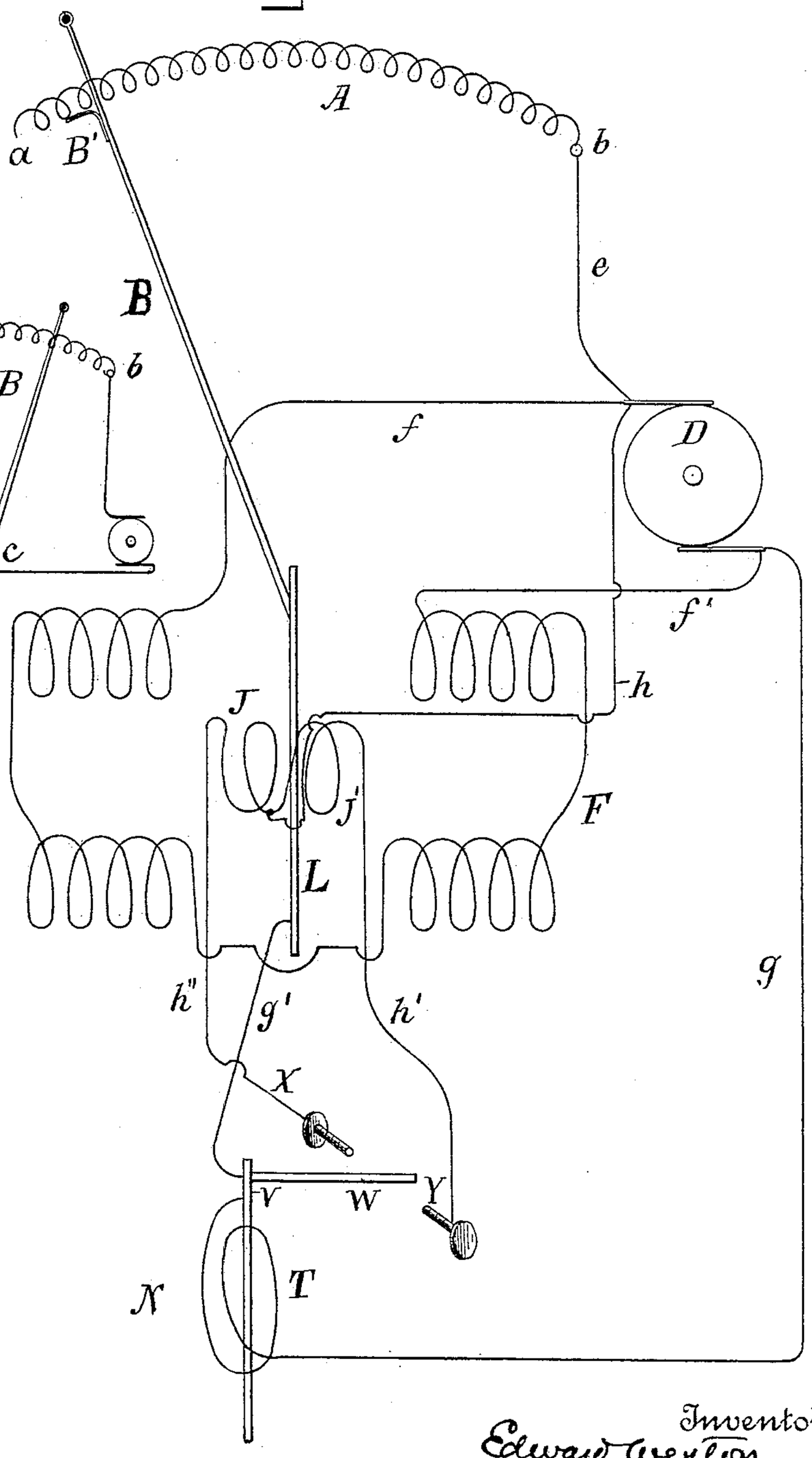
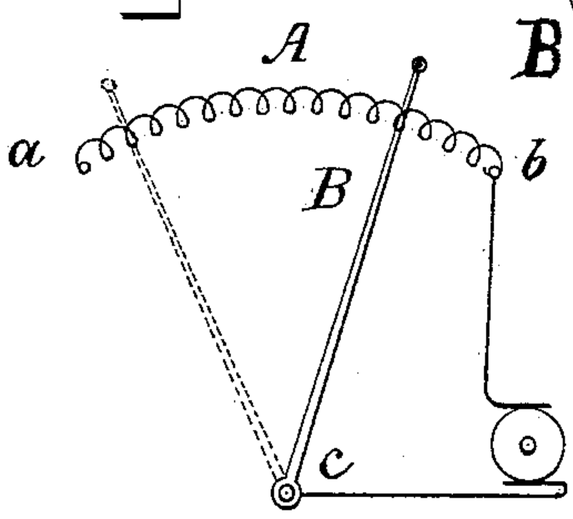


Fig. 1



Witnesses

Chas. Hanimann

A. R. Moller

Inventor

Edward Weston

By his Attorney Laub Benjamin

(No Model.) 2 Sheets—Sheet 2.

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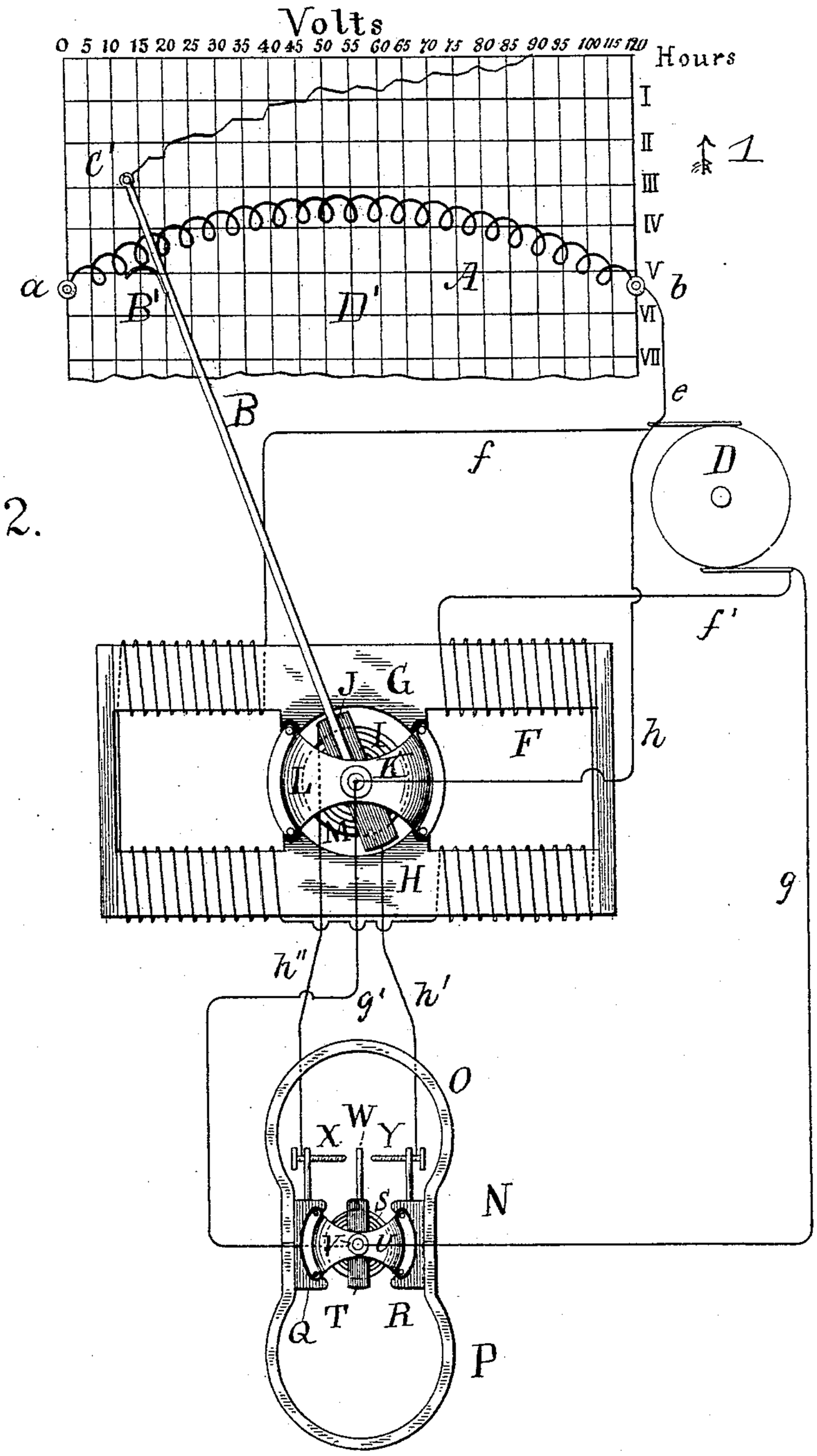
Fig. 2.



Witnesses
Chas. Hanimann
H. R. Moller

Inventor
Edward Weston
By his Attorney
Louis Benjamin

UNITED STATES PATENT OFFICE.

EDWARD WESTON, OF NEWARK, NEW JERSEY.

RECORDING-VOLTMETER.

SPECIFICATION forming part of Letters Patent No. 494,829, dated April 4, 1893.

Application filed March 18, 1892. Serial No. 425,430. (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-Voltmeters, of which the following is a specification.

My invention is an apparatus for producing a continuous record of the variations in electrical pressure occurring in a circuit.

The principle of my invention consists in causing a contact arm moving over an elongated body in traversing which the current undergoes a definite fall in potential, automatically to cut out or introduce in circuit such fraction of the length of said body as will compensate for the change in pressure occurring in the circuit. So long as the pressure remains at a normal or fixed point, no movement of said arm occurs; and, as a consequence, a marking point on said arm produces a substantially straight line upon a record surface moving in front of it. When, however, a variation in pressure occurs, then the arm automatically moves in one direction or the other with consequent diversion in direction of the trace made. If the advancing movement of the record surface be timed, and scale indications be added so that the extent of deviation of the trace in one direction or the other can be measured in units of electrical pressure, it follows that the instrument is one which will afford a continuous record showing the pressure and changes thereof at all times.

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 circuits.

Referring to Fig. 1, let A be a high resisting body extending between the points *a* and *b*. Let B be an arm pivoted at the point *c*, and having its ends moving along and making contact with the successive turns of the body A. The body A, for example, may be an insulated wire wound in spiral form and having a portion of the insulation removed on each turn along a line extending from one end of the wire to the other as it is coiled. The arm B is supposed to move over the non-insulated points. Let the point *b* of the body A and the pivot point *c* of the arm B be connected in circuit with any source of electricity. There will then be a definite fall of potential over the length of the body A, and depending upon the resistance thereof. This will be maximum when the arm B is placed at the point *a* and decreasing as the arm B is moved toward the point *b*. If the body A is of definite known resistance, it will be plain that any falling off in pressure in the circuit can be compensated for by changing the position of the arm B so as to cut out more or less of the length, and hence of the resistance, of the body A; and clearly, it follows that the extent of movement of the arm B will bear a relation to change in pressure in the circuit, and hence may be used to indicate pressure variation, provided means be supplied to move the arm B automatically whenever a change in pressure occurs; and if a suitable scale be arranged in proximity to the arm B, the indications of said arm may be noted on said scale, and the electrical pressure in the circuit be therefore read therefrom. If, furthermore, the scale be a surface which is moved continuously in front of the arm B, and if the arm B be provided with a suitable marking point, I may thus construct an apparatus which will, at all times, record by an actual trace, variations in the pressure of the current. My device, as a whole, is, therefore, a recording voltmeter which will show at all times, and which will produce a continuous record of the current pressure traversing the instrument.

I will now describe the mechanism which is shown in Fig. 2. D is a dynamo or any other source of electricity represented, as usual, symbolically. Electrically connected thereto at one end, *b*, is a coil A of platinum silver wire or any other high resisting material, the total resistance of which is known. 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, and 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, coil J, cap K, the pivot L and springs M, are substantially the same as has already been fully described by me in various Letters Patent hitherto granted to me; such, for example, as 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 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, 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 and Y.

Returning now to the instrument F, the coil J, instead of being a single coil, is composed of two coils J J′, Fig. 3, which are wound in opposite directions. The pivot shaft L carries an arm B, which extends beyond the resistance coil A, but makes contact therewith by means of the wiping springs 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 volts, and horizontally 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 point C′. The resistance of the coil A may be marked in any suitable manner in divisions to indicate volts, and the vertical lines on the moving scale D′ are to be laid off in manner corresponding to those on the body A. As the divisions on the moving scale showing volts are made along a right line, while those of the coil A are made along a curved line, it follows that the divisions of the paper which correspond to the divisions of 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* through the resistance coil A to spring B′ and arm B to pivot shaft L, by wire *g′* to pivot shaft V, to coil T in instrument N, and thence by wire *g* back to the other brush of the dynamo. Circuit No. 2 proceeds by the wire *f* to the field coils of instrument F, and thence by wire *f′* to the other brush of the dynamo. Circuit No. 3 proceeds from the dynamo by the wire *h* through the coil J or J′ by wire *h′* or *h″* to stop X or Y, and thence by arm W to coil T and so by wire *g* back to the dynamo. The wire *h* is connected midway between the two coils J and J′.

I will now describe the operation of the apparatus:—Let it be supposed that when no current is passing, the arm B is at the point *a* on the coil A, and the lever arm W is in contact with the stop X. When the current is established, it will pass through the wire *g* to coil T, to wire *h″*, coil J, and thence by wire *h* back to the dynamo. The coil J is located in the intense magnetic field produced in the instrument F, through the fixed coils of which the dynamo current passes. Inasmuch as both coils J J′ are arranged in this magnetic field, and, in conformity with well-known laws, whichever coil J or J′ is energized will tend to place itself in a new position in that field and thus to rotate the shaft L. As the coils J and J′ are wound in opposite directions, it will be obvious that a current circulating through the coil J will turn pivot L one way, while the current circulating through the coil J′ will turn it the other way. The springs acting on the shaft V in instrument N are to be so proportioned that they will offer a definite resistance to the movement of shaft V. When the current is established as already stated, coil will tend to move so as to carry the arm W out of contact with the stop X, and into contact with the stop Y. When this happens, the current will be diverted through the wire *h′* and coil J′, the effect of which will be to cause the index B to move over the fixed coil A until it reaches a point where the decrease of resistance offers compensation for the change in potential, and then the arm W will move away from the stop Y. So long as the pressure remains constant, the arm will stand between the stops X and Y, making contact with neither, and the arm B will remain at rest, the pencil point producing a straight line on the record surface. The instant, however, there is a variation in the current pressure, the arm W moves into contact with one or the other stop, X or Y, and the current is diverted into one or the other coil, J or J′, and the arm B is moved in one or the other direction to modify the length of the coil A in circuit (and

hence the resistance) to compensate for the change. In so moving, as already explained, the pencil point on arm B makes its record on the continuously traveling scale.

I claim—

1. Two oppositely-wound coils in electrical circuit supported on a common pivot shaft and vibrating in a field of force, an arm actuated by said shaft, a tracing device controlled by said arm, a moving record surface upon which said tracing device marks, and means for directing a current into one or the other of said coils as the electrical pressure rises above or falls below a given point in a circuit including said means.

2. A body of conducting material having a definite resistance per unit length, an arm moving in contact with said body and connected in circuit therewith, and an indicating device showing the period and extent of movement of said arm, in combination with motor mechanism included in said circuit and actuated by the current traversing the same, whereby said arm is caused automatically to move in one direction or the other according as the electrical pressure on the circuit rises or falls above or below a predetermined point.

3. A body of conducting material having a definite resistance per unit of length, an arm moving in contact with said body and connected in circuit therewith, a tracing device actuated by said arm, and a moving record surface on which said tracing device marks, in combination with motor mechanism included in said circuit and actuated by the current traversing the same, whereby said arm is caused automatically to move in one direction or the other according as the electrical pressure on the circuit rises or falls above or below a predetermined point.

4. A coil in electrical circuit and supported and vibrating in a field of force, a circuit closing arm actuated by said coil, two contact stops at opposite sides of and in the path of movement of said arm, two oppositely-wound coils supported and vibrating in a second field of force upon a pivot shaft common to both, each of said coils having a corresponding terminal connected to said contact stops, and an index actuated by said pivot shaft; the aforesaid parts being constructed and arranged so that when said first coil moves under a variation of pressure in its circuit into contact with one or the other of said stops, circuit shall be established through one or the other of said oppositely-wound coils and the index thereby be caused to move in one or the other direction.

5. In an electrical measuring instrument the combination of the fixed body A of definite resistance per unit length, the arm B moving in contact with said body and supported on a pivot L, coils J and J′ also supported on said pivot L and disposed in the field of force of the fixed coils F, a pivoted coil T supported and vibrating in a field of force and provided with a contact arm W moving between fixed stops X and Y, and circuit connections, substantially as described.

6. In an electrical measuring instrument the combination of the fixed body A of definite resistance per unit length, the arm B moving in contact with said body and supported on a pivot L, coils J and J′ also supported on said pivot L and disposed in the field of force of the fixed coils F, a pivoted coil T supported and vibrating in a field of force and provided with a contact arm W moving between fixed stops X and Y, and circuit connections, in combination with a moving record surface arranged in proximity to said arm B and a marking device, C′, on said arm B arranged to produce a trace on said moving surface.

7. In an electrical measuring instrument the combination of the fixed body A of definite resistance per unit length, the arm B moving in contact with said body and supported on a pivot L, coils J and J′ also supported on said pivot L and disposed in the field of force of the fixed coils F, a pivoted coil T supported and vibrating in a field of force and provided with a contact arm W moving between fixed stops X and Y, and circuit connections, in combination with a record surface in proximity to said arm B, and actuated at a definite rate of speed, and a marking device, C′, on said arm B arranged to produce a trace on said moving surface.

EDWARD WESTON.

Witnesses:
H. R. MOLLER,
JAMES T. LAW.