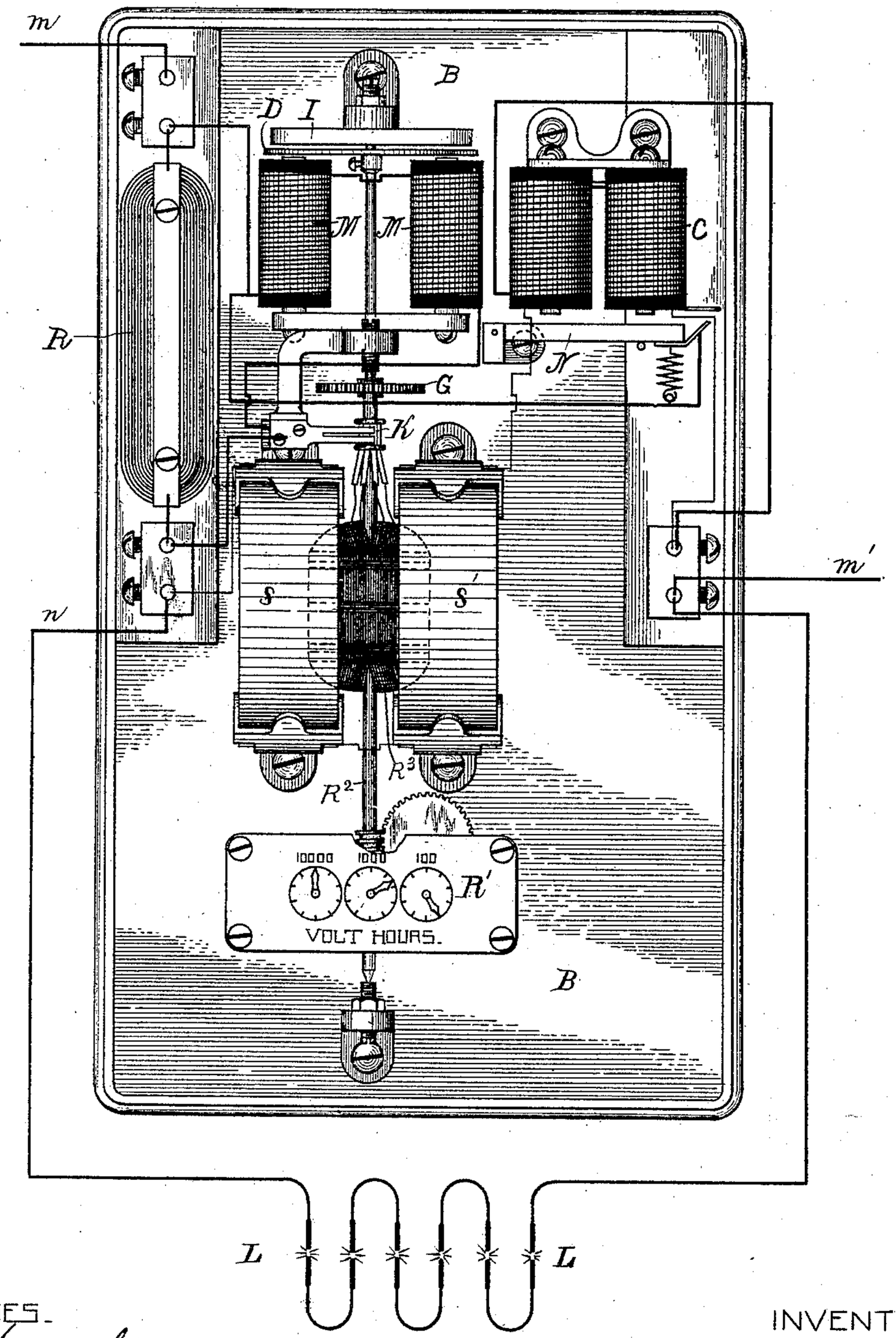
(No Model.) 3 Sheets—Sheet 1.

# E. THOMSON.

## ELECTRIC METER.

No. 444,931. Patented Jan. 20, 1891.

FIG. 1.




WITNESSES.

A. F. Macdonald.

Chas. D. Cooper

INVENTOR.

Elihu Thomson

By H. B. Townsend

Atty.

(No Model.) 3 Sheets—Sheet 2.

# E. THOMSON.

## ELECTRIC METER.

No. 444,931. Patented Jan. 20, 1891.

FIG. 2.

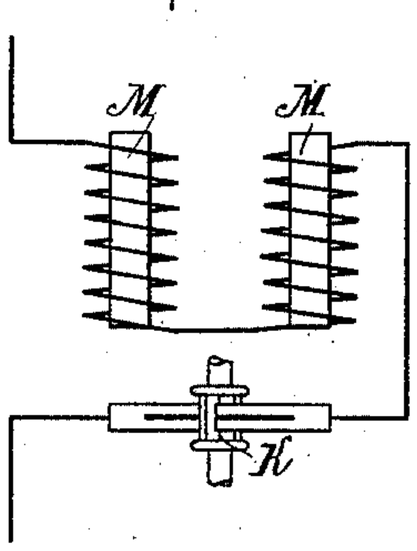



FIG. 3.

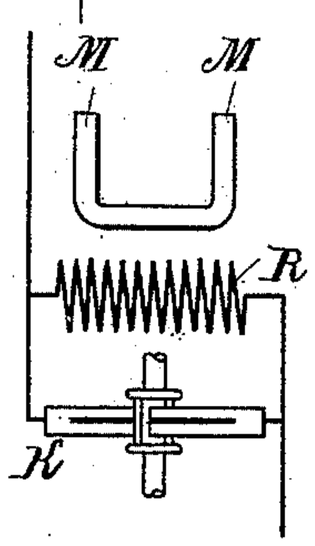



FIG. 4.

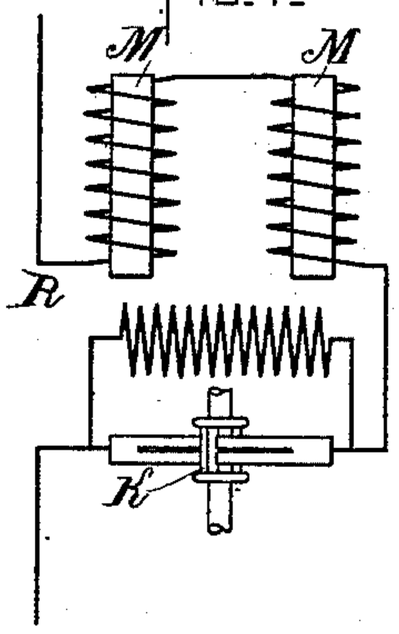



FIG. 5.

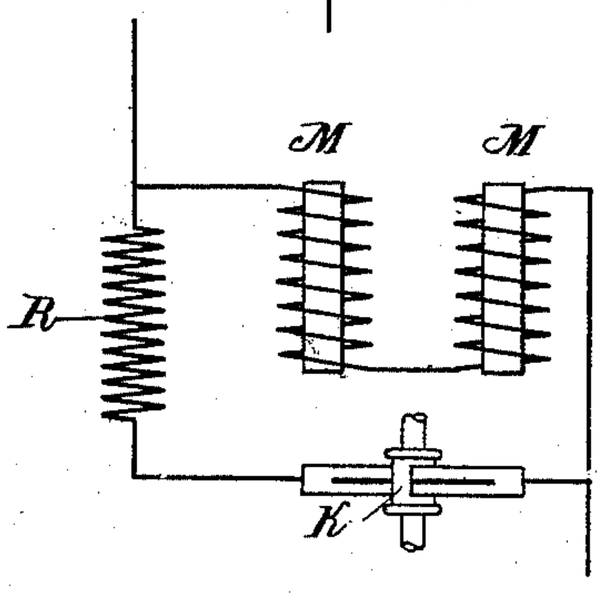



FIG. 6.

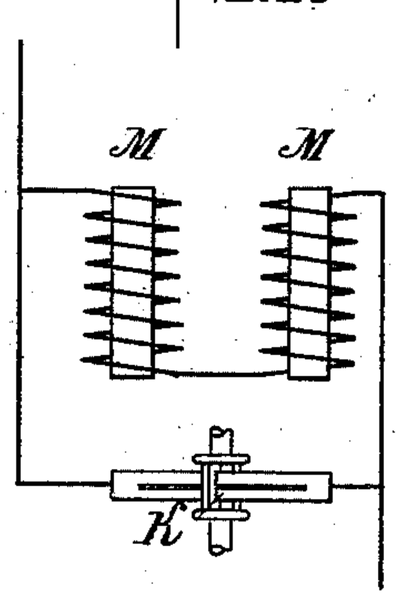



FIG. 7.

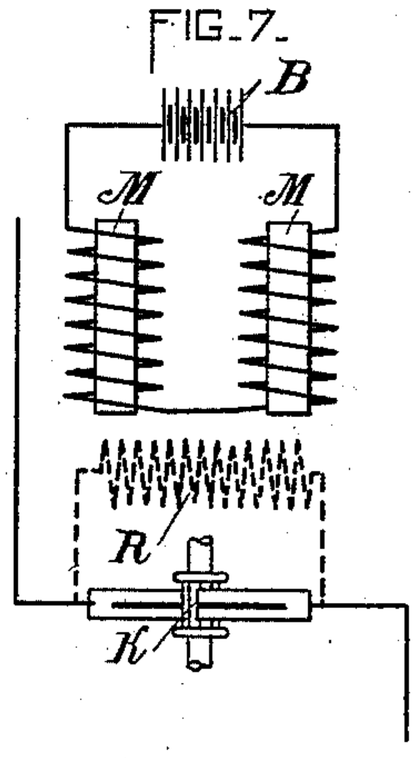
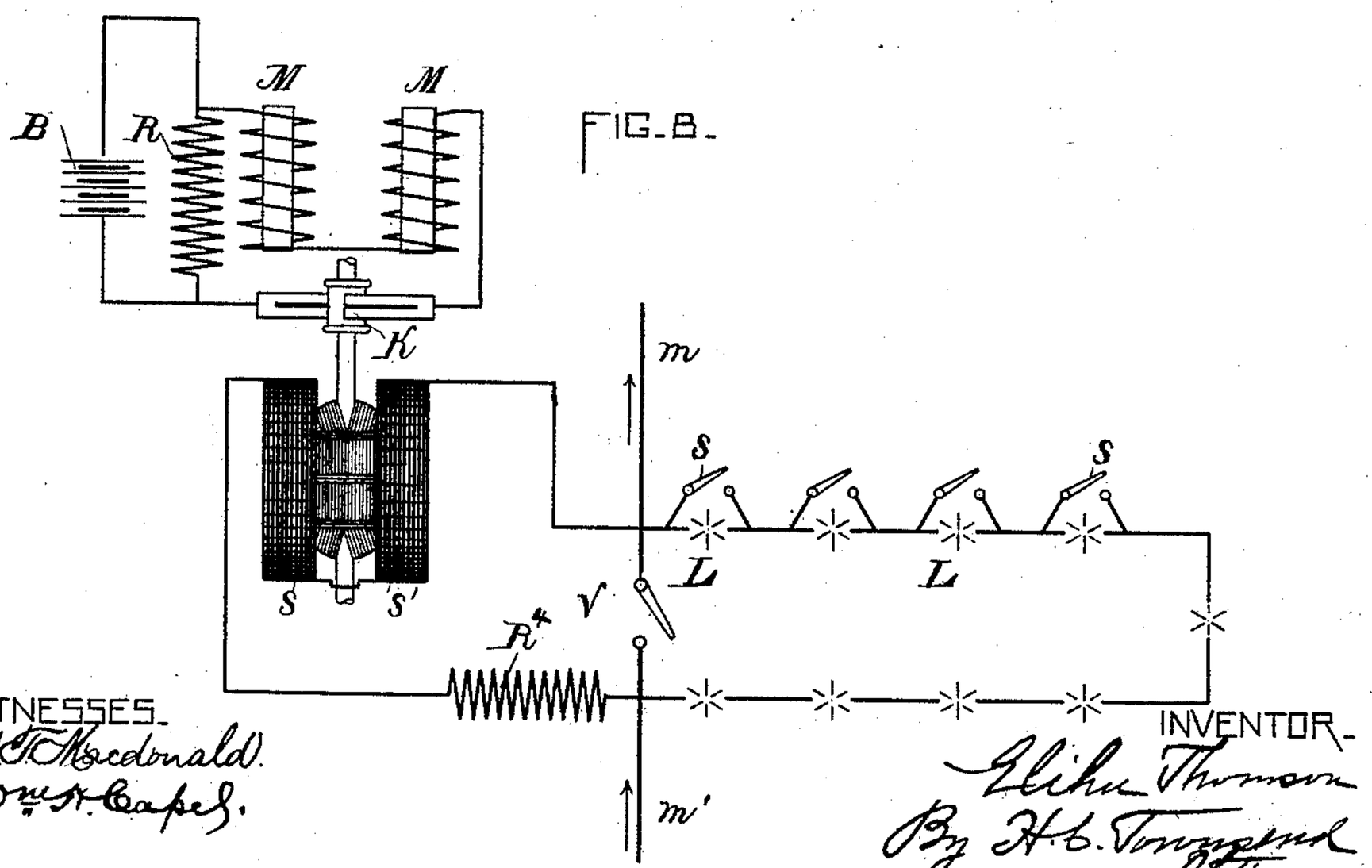



FIG. 8.




WITNESSES.
A. T. Macdonald.
Wm. A. Capes.

INVENTOR.
Elihu Thomson
By H. B. Townsend
Atty.

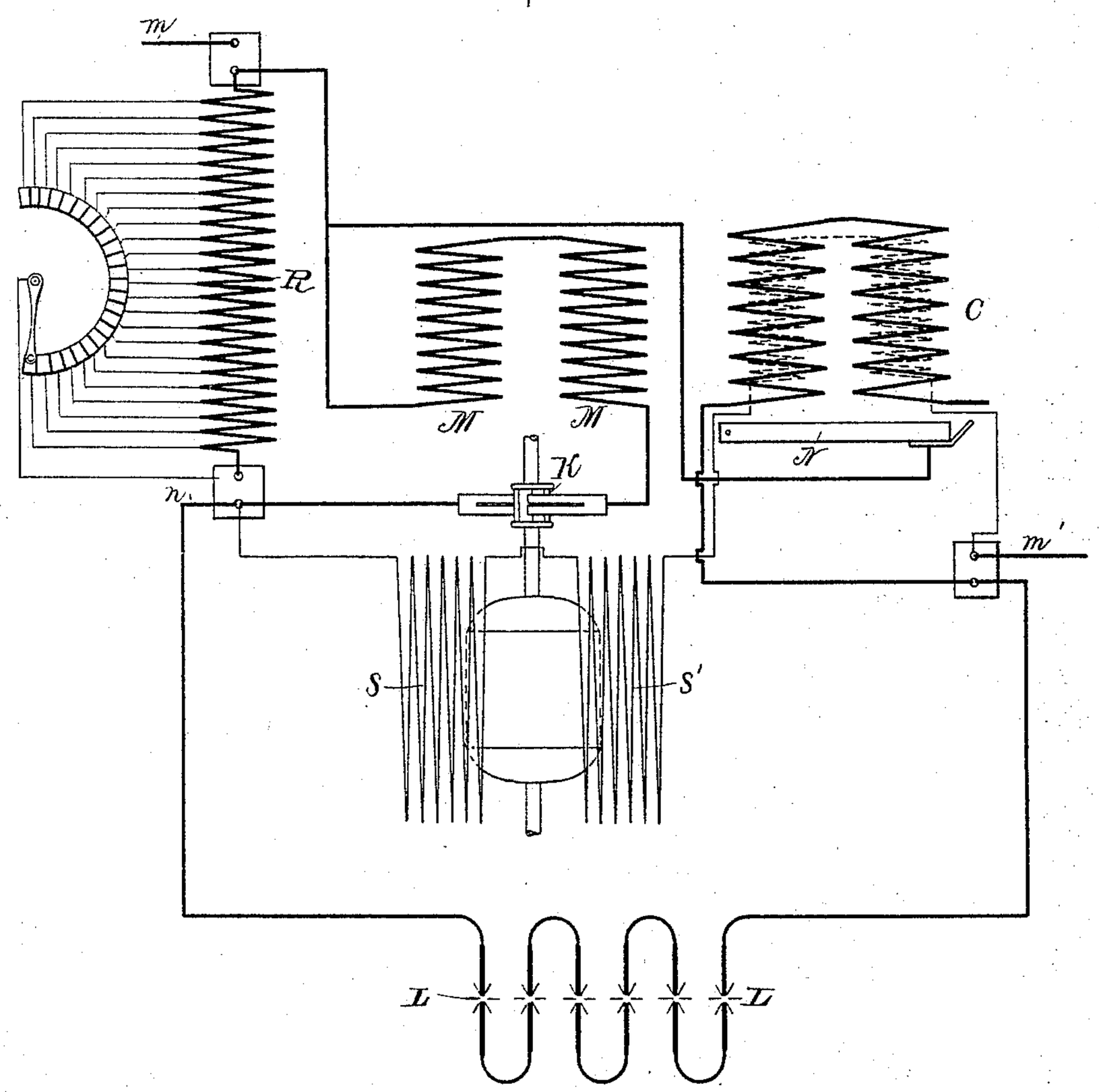
(No Model.) 3 Sheets—Sheet 3.

# E. THOMSON.

## ELECTRIC METER.

No. 444,931. Patented Jan. 20, 1891.

FIG. 9.




WITNESSES.
A. D. Macdonald
W. W. Capes.

INVENTOR.
Elihu Thomson
By H. B. Townsend
Atty

# UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF CONNECTICUT.

## ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 444,931, dated January 20, 1891.

Application filed September 22, 1890. Serial No. 365,760. (No model.)

*To all whom it may concern:*

Be it known that I, ELIHU THOMSON, a citizen of the United States, and a resident of Swampscott, in the State of Massachusetts, have invented a certain new and useful Electric Meter, of which the following is a specification.

My invention relates to means for measuring the consumption of energy in translating devices operated upon constant-current or series circuits—such, for instance, as arc-light circuits.

The invention consists in the combination, with the translating device or devices in which the current to be measured circulates and which are placed on a constant-current or series circuit, of an electric motor of any suitable description having the usual field-magnet and armature, one element of said motor being traversed by a current which is variable according to the differences of potential at the terminals of the loop containing the translating devices, while the other element has an excitation which is preferably constant in amount, and a register for registering the movements of the movable element of said motor.

My invention consists, further, in the combination, with translating devices placed in a loop of a series or constant-current circuit, of an electric motor whose field excitation is produced by the current in a shunt of high resistance around the loop, so as to be traversed by a current due to the varying potential at the terminals of the loop, a suitable register for registering the movements of the armature of said motor, and a retarding device furnishing a load for the motor, which increases in a ratio substantially proportional to the speed of movement of the motor.

My invention consists, also, in the special combinations of apparatus and arrangements of circuits, hereinafter more particularly described, and then specified in the claims.

In carrying out my invention I prefer to employ an electric motor in which the armature is a rotating armature.

I prefer also in carrying out my invention to employ the field-magnet coils as that element of the motor which shall be traversed by a current variable according to the differences of potential at the terminals of a loop on the series circuit.

The retarding device employed in the combinations of apparatus hereinafter described and claimed is preferably one described and claimed in an application for patent filed by me August 26, 1889, Serial No. 321,986, and consisting, essentially, of a magnetic damper acting by development of Foucault or induced currents produced in an electric conductor movable in a magnetic field.

In the accompanying drawings, Figure 1 shows in side elevation an electric meter constructed and connected to circuits in accordance with my invention. Figs. 2, 3, 4, 5, and 6 show modifications in the manner of connecting parts of the apparatus. Figs. 7 and 8 illustrate further modifications in the manner of exciting the parts of the apparatus. Fig. 9 is a diagram of the apparatus illustrated in Fig. 1.

The parts of the apparatus are supported on a suitable back plate B B, preferably of insulating material, and the points of connection of the circuit $m$ $m'$ are insulated from one another, insulation being also provided at other suitable points, as will be well understood by electricians.

S S′ are the field-coils of an electric motor, the rotating armature of which is indicated at $R^3$. This motor may be of any desired description, and may have its armature wound in any proper manner and connected with a suitable commutator K, the brushes of which bear on the commutator disk or cylinder on a line at right angles to the direct magnetic fields established around the armature by the coils S S′. While the form of motor shown is a desirable and effective one, I do not limit myself to such special form. The armature-shaft $R^2$ of the motor has its rotations registered or counted by means of a registering or counting device R′, here shown as a train of wheels like the counting-wheels of a gas-meter. The coils S S′, by connections of their terminals to the blocks connecting to the terminals of the loop containing the lights L L or other translating devices, are placed in shunt to such lights on the series circuit $m$ $m'$.

This shunt is made of very high resistance, for which purpose the coils S S′ are preferably made themselves of high resistance, or the necessary resistance may be obtained in part by the placing of an artificial resistance at another point in the connection with said coil. Such high resistance might be obtained, also, in part by introducing the coils of other parts of the apparatus in the circuit with the coils S S′. By so connecting the coils S S′ it is obvious that the current in them will vary with the variations in the difference of potential between the terminals of the loop containing the lights L L, and therefore that the field in which the armature $R^3$ moves will be strengthened or weakened in accordance with variations in the number of lights in use. The armature is traversed by a current, preferably of constant amount, from any suitable source. This current is in the diagram, Fig. 1, shown as taken from the main circuit by placing the armature in a branch of such circuit around an artificial resistance R. As will be presently shown, the current for excitation of the armature might be derived from any other suitable source, or the branch containing such armature might be a branch in multiple with a coil used for exciting some part of the apparatus and placed in circuit in the same manner as the resistance R.

The resistance to the rotation of the armature is provided by a disk D, of copper or other conducting material, which rotates over the poles of an electro-magnet M and between the poles and an armature I, fixed in position above it, such armature being of magnetic material and spanning the poles of the magnet. Connection of such disk with the armature, so that the disk will be rotated by such armature, is made by means of a gear-wheel G, meshing with a pinion on the shaft carrying the disk D. By this device a check on the rotation of the armature is produced, which is comparatively constant, or which is at least constant when the current flowing is constant.

The magnet M, which produces a field in which the disk D revolves, might be a permanent magnet; but is preferably an electro-magnet, and may be excited by current taken from the main circuit or any suitable source. In the arrangement shown in Fig. 1 the coils of the electro-magnet M are in the branch containing the armature of the motor.

C indicates an electro-magnet, which is employed as a cut-out magnet and provided with connections, whereby in case of damage to the loop containing the translating devices the loop or portion of the circuit containing the meter may be cut out of circuit or short-circuited. For this purpose the magnet C is placed in a branch of high resistance around the loop containing the lamps L, and may be, as herein shown, in the same branch which contains the coils S S′. The armature of the magnet C when excited will close the circuit, which is a branch of low resistance around both the meter and the loop containing the lights L L. The magnet C may be also provided with a coarse-wire coil, which will be included in such cut-out circuit, and will thereby hold the armature in position to keep the cut-out circuit closed. The resistance R is preferably made as a variable resistance, as indicated in the diagram, Fig. 9, so that its amount may be varied for adjusting the rotation of the motor by adjusting the strength of the current passing through the armature, and also through the coils of the retarding-magnet M M.

The circuit arrangements thus briefly described may be traced in detail in the drawings as follows, but may obviously be varied to place the apparatus in the same relative circuit arrangement: From pole *m* of the main circuit circuit is formed through the artificial resistance R, and by wire *n* through the series of translating devices L to the other pole *m′* of the main circuit. From the pole *m* a branch passes around the resistance R through the coils M M in series with one another or in multiple, and thence through the commutator K and the armature to the opposite terminal of the resistance R. Coils M M and the armature are thus in a branch of the main circuit with one another. From the connecting-block to which the wire *n* is connected the circuit is formed through the coils S S′, and thence through the fine-wire coils of C to the terminal block to which *m′* is connected, thereby putting the coils S S′ in a shunt around the translating devices. A low-resistance connection is formed also from the pole *m* directly to a contact carried by the armature N of electro-magnet C, which low-resistance connection is continued when the armature is drawn up by way of a contact engaged by the first and connected to a coarse-wire coil of the magnet C, and thence from said coarse-wire coil to the terminal to which *m′* is connected.

In brief, the operation of the meter is as follows: When a number of lights L L or other translating devices are in use, there is a difference of potential between the terminals of the loop containing them, and this potential is felt by the coils S S′, which produce the magnetic field more or less strong, in which the armature $R^3$ revolves. This armature is traversed by a current in the branch around the resistance R, and consequently a rotation is set up, which results in a registry on the dial R′ and in a rotation of the copper disk D in the field produced by the magnet M M. The resistance R is adjusted so as to give the requisite rate for registering a number of units on the dial R′ equal to volt-hours, or any other proper unit adopted. When the voltage is increased between the terminals of the loop by increasing the number of translating devices L in circuit in series with one another, the rotation is proportionately more rapid and the indications increase proportionately, while if the loop containing the translating devices L be shunted, or if the lights be

extinguished by shunting, the meter would cease to register and no rotation of the armature and disk would take place. The addition successively of light after light increases the speed in such a way as to register the proportional volt-hours. In case an extremely great or abnormal increase of current, such as might injure the integrity of the coils S S′, should occur, the magnet C will overcome the retractor of its armature, which is properly adjusted to such condition and will close the branch circuit described, thus producing a dead-shunt or short circuit of the meter, which will be held closed by the current circulating in it through the coarse-wire coils of the magnet C.

Among other variations in the connections which may be employed are the following: Instead of causing a portion only of the main current to traverse the armature-coils and the magnets M M, the whole line-current might be passed through them, as indicated in Fig. 2, the resistance R in such event being simply omitted. This, however, is not desirable unless the current is very small, and obviously would require coarser winding in the armature and in the coils of the magnet M. The armature might be in a branch by itself, as indicated in Fig. 3, and the magnetic field for the disk D produced by means of a permanent magnet, (marked M.) A definite shunt R might at the same time be used, so that the armature will not have to carry the full line-current, and in case of trouble at the commutator a by-path will be afforded by the resistance or branch around the armature.

Fig. 4 illustrates the application to the arrangement shown in Fig. 2 of the branch or shunt containing the definite resistance R. The branch around the armature need not be an artificial resistance R, but may contain a coil forming an exciting-coil of the meter apparatus, as indicated in Fig. 5, where the branch around the armature contains the coils of the electro-magnet M. In case of damage to the armature a by-path will be afforded, as before, and under no circumstances will the full current traverse the armature. The resistance R might be placed in the armature branch, as indicated, and by adjustment afford a means for fixing the definite amount of current which shall flow through the armature. If desired, however, such resistance R might be omitted in the relation shown in Fig. 5 and the flow of current determined by the resistance of the armature in shunt as compared with that containing the coils M. This variation is indicated in Fig. 6.

The excitation of the magnets M, which afford the field for the damping-disk, might be obtained from the current derived from a separate source B, as indicated in Fig. 7. Such source should be one which will supply current that will be comparatively constant. The armature might be arranged, as indicated, in a branch around the resistance R, as shown, or be otherwise arranged or fed with exciting-current. When the armature is placed in a circuit where a current of substantially constant amount flows, such current may be derived from any source, but is preferably, for the sake of simplicity, taken from the main circuit.

Fig. 8 illustrates a modification wherein both the armature and the magnet M are supplied from a separate source B of substantially constant current. Here the resistance R may be placed in circuit in a branch around the magnet M, the latter being in series with the armature.

It is quite obvious that in any of the cases illustrated in Figs. 2, 3, 4, 5, and 6 the connection might be made with a separate source of current, as B, instead of with the main circuit. In cases, however, where it is desired to have variations in the excitation of the armature or of the damping-magnet take place in accordance with variations of the line-current, it is obviously desirable that the line-current be permitted to act directly on such portion of the apparatus; but such special arrangement forms no essential feature of my invention.

In Fig. 8 the lights or other translating devices in series with one another, as shown, are provided each with the usual shunting-switch, and the whole loop is provided with a shunting-switch V. The coils S S′ are of high resistance and are placed in a circuit connected to the terminals of the loop. For the purpose of adjustment a resistance $R^4$ may be inserted into the connection containing the coils S S′. This resistance might be the coils on the circuit of the cut-out magnet C, as before described.

Other variations in the arrangements without departing from the invention, as hereinafter claimed, will readily occur to electricians.

While I have shown that element of the motor which comprises the field of the motor as traversed directly by a current forming a branch of the main current and variable according to the differences of potential at the terminals of the loop, I do not limit myself to such arrangement, although it is preferred on account of its simplicity, since the same operation will be produced if the current were derived from any other source, provided it were made variable according to the differences of potential at the terminals of the loop containing the translating devices.

While I prefer to employ the magnetic damping or retarding device on account of simplicity, I do not limit myself to the same, but may use any other which will furnish a retardation or resistance to the rotation proportionate or substantially proportionate to the speed of rotation.

I do not claim herein the system of distribution herein shown and comprising a constant-current or series circuit adapted to operate translating devices in series with means

for keeping a registry of the voltage-difference at the terminals of loops containing such translating devices, as this forms the subject of broad claims in another application for patent filed by me of even date herewith, Serial No. 365,759.

What I claim as my invention is—

1. The combination, with translating devices on a constant-current or series circuit, of an electric motor, one element of which is traversed by a current variable according to the differences of potential at the terminals of a series of translating devices in said circuit, while the other element has a substantially constant excitation and a register of the movements of the armature of said motor.

2. The combination, with a loop on a series line and one or more translating devices in series in the loop, of a high-resistance shunt to the loop using an extremely small fraction of the current for furnishing the field for the rotation of an armature traversed by current, the rotations of which armature are measured by a suitable register, and a retarding device applied to said armature, substantially as described.

3. The combination, with a loop on a series line and one or more translating devices in series in the loop, of a high-resistance shunt to the loop using an extremely small fraction of the current for furnishing the field for an electric-motor armature in the series circuit, a register for counting the movements of said armature, and a retarding device connected to said armature, as and for the purpose described.

4. The combination, with a loop on a series line and translating devices in series on the loop, of an electric-motor field-coil in a branch of high resistance connected to the terminals of the loop, an armature for said motor in the series circuit, a register for counting the movements thereof, and a damping or retarding device connected to the armature, as and for the purpose described.

5. The combination, with a translating device or devices on a series or constant-current circuit, of an electric meter having a motor, one element of which (armature or field) is traversed by a constant current taken from a branch of the main, while the other is traversed by current varying with the potential difference at the terminals of a loop containing a translating device or devices.

6. The combination, with a series electric line, of an electric motor having a field-coil in a high-resistance shunt around translating devices on said line, and an armature in a constant-current branch of said line, and a register of the rotation of said armature, as and for the purpose described.

7. The combination, with a series electric line, of an energizing-coil in a high-resistance shunt around translating devices on said line, an armature in a field produced by said coil and traversed by a constant current taken from said line, and a work or load for said motor which is directly proportional to the speed of rotation.

8. The combination, with a number of translating devices in a constant-current circuit, of an electric motor having a field-coil in a high-resistance branch around the translating devices, an armature traversed by a constant current from any source, and suitable retarding and registering devices connected to said armature.

9. The combination, with a series line supplied with a current which is constant despite variations in the number of translating devices in circuit, of a shunt around any number of such devices, a high-resistance stationary coil in said shunt, a motor-armature acted upon by said coil, a magnetic retarding device, substantially such as described, and a register for indicating the movement of the armature connected to such retarding device.

10. The combination, with the electric meter having motor-coils in a branch of high resistance around the translating devices, of a cut-off magnet in series with said coils, as and for the purpose described.

11. The combination, substantially as described, with translating devices on a series or constant-current circuit, of an electric motor, one element of which is in a branch of high resistance around translating devices arranged in series, while the other element is in the main or principal circuit, a branch of said circuit around the latter element and containing an adjustable resistance whose amount may be varied for adjusting the rotation of the motor, and a counter for registering the number of rotations of the armature of said motor.

12. The combination, substantially as described, with a series of translating devices on a constant-current line, of an electric motor having a field-magnet in a branch of high resistance connected to the terminals of the loop containing such translating devices, an armature for the motor in the main circuit, an adjustable resistance in the branch around said armature for adjusting the rotation of the motor, and a register for counting the rotations of the armature.

13. The combination, substantially as described, with the electric motor having coils in a branch of high resistance around the translating devices in series, of an armature for said motor in a branch of the main circuit, a retarding device having exciting-coils also in the branch of the main circuit, and a variable resistance for determining the flow of current in the armature and retarding device, as and for the purpose described.

14. The combination, with an electric motor having field-coils in a circuit of high resistance connected to the terminals of a loop in a series circuit, of an armature for said motor and a retarding-magnet, both in one branch of the series circuit, and a variable

resistance in a branch of the main circuit in multiple with the first for adjusting the strength of the current passing through the armature and retarding-magnet.

15. The combination, with translating devices arranged in series on a series or constant-current circuit, of an electric motor excited by current in a high-resistance derived circuit around the series of translating devices, an armature for said motor in the main circuit, a branch around said armature, and a counter for registering the movements of said armature.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 18th day of September, A. D. 1890.

ELIHU THOMSON.

Witnesses:
JOHN W. GIBBONEY,
JOHN P. BRODERICK.