

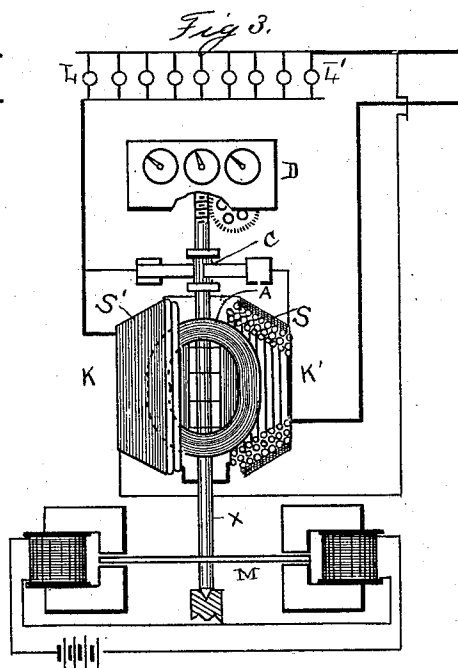
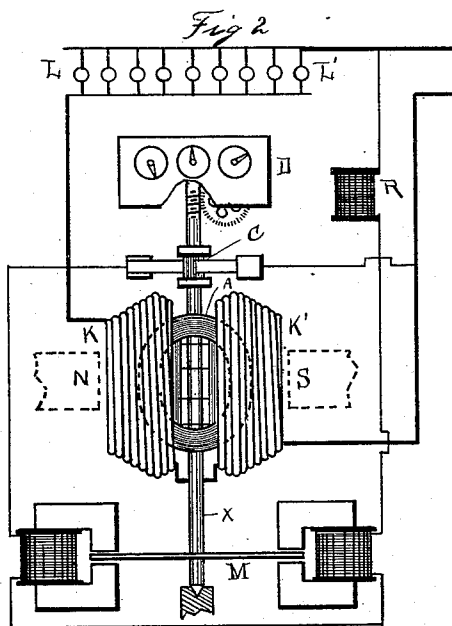
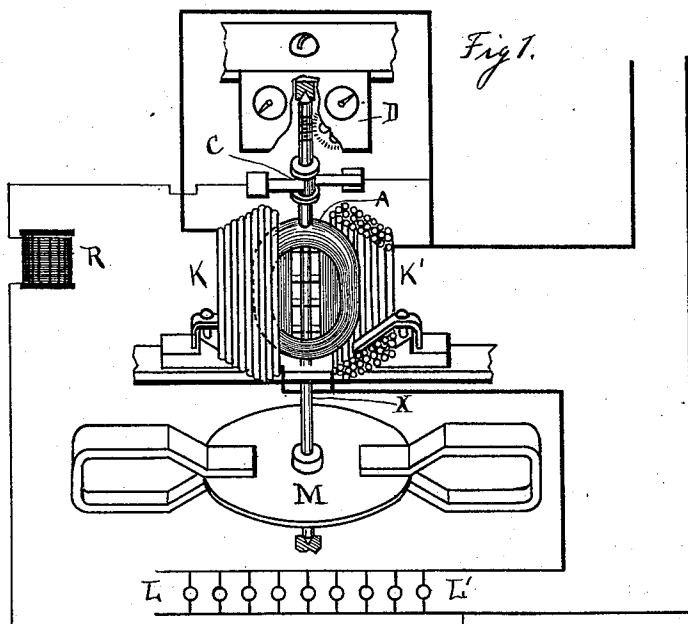
(No Model.)

2 Sheets—Sheet 1.

E. THOMSON.
ELECTRIC METER.

No. 578,430.

Patented Mar. 9, 1897.



Witnesses:

John W. Gibbonney
Joseph H. Jenkins

Inventor:

Elihu Thomson

(No Model.)

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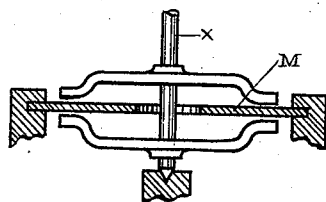
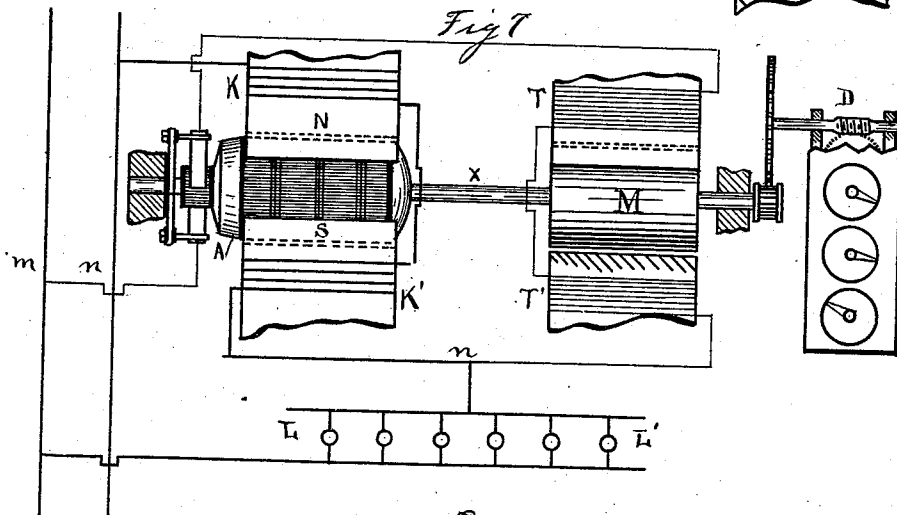
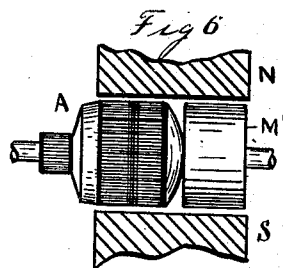
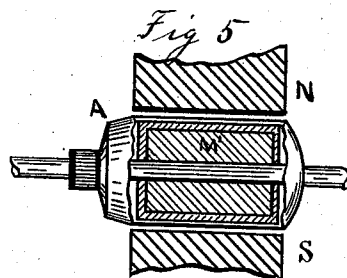
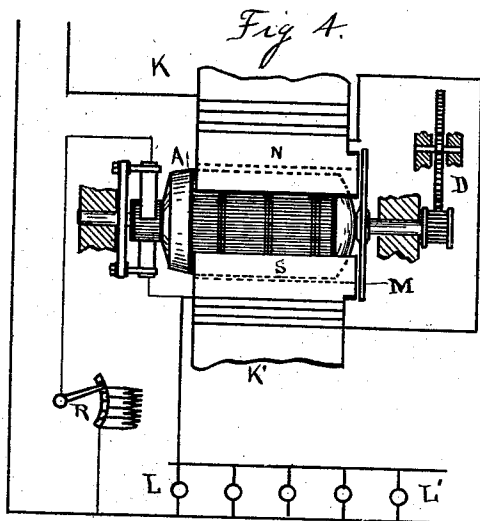


Fig 8.

Witnesses:

John W. Gibboney
Joseph R. Jenkins

Inventor:

Elihu Thomson

UNITED STATES PATENT OFFICE.

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

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 578,430, dated March 9, 1897.

Application filed August-26, 1889. Serial No. 321,986. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, of the city of Lynn, county of Essex, and State of Massachusetts, have invented certain new and useful Improvements in Electric Meters, of which the following is a specification.

My invention relates to that class of electric apparatus which is adapted to measure the consumption of energy in a circuit upon which lamps, motors, or other translating devices are employed; and my invention therefore applies to the class of devices called "electric meters."

The object of my invention is to provide a means for simply and easily keeping a record of the product of the current flowing and potential on an electric circuit feeding groups of lamps or other devices from alternating-current mains, from transformers, or from direct-current-supply mains.

Another object of my invention is to secure freedom from too great delicacy of parts, simplicity of construction, and practical accuracy in an electric meter.

I employ, in carrying my invention into practice, a coil which responds to the amount of current flowing through the consumption devices, and I employ an armature of considerable resistance which is in circuit between the terminals of the supply-mains or in a separate circuit of constant current, and therefore responds to the potential of the mains, such movable armature being directly affected by the magnetic field set up by the current in the said coil, which is in circuit and conveys current to the consumption devices. I also employ a magnetic damper or retarder of the speed of motion of the armature, which magnetic damper acts by the development in it of Foucault currents or induction-currents in a magnetic field. Various modifications and different embodiments of my invention may be made without departing from the essence of the invention. These matters will be more particularly referred to in describing the accompanying drawings.

Figure 1 shows a general view of the essential parts embodying my invention. Figs. 2 and 3 show modifications. Fig. 4 shows a still further modification adapting the meter to a special kind of registry. Figs. 5 and 6 are further modifications in the disposition of the

parts somewhat similar to Fig. 4. Fig. 7 is a view embodying similar principles to those shown in Fig. 2, but of different construction. Fig. 8 illustrates a modification in the retarder or damping device.

In Fig. 1, X is an upright shaft mounted on delicate pivots, upon which is carried a screw-gearing for moving a registry or counter system or train D. On this shaft is mounted at some other convenient point an armature A, composed, preferably, when the instrument is to be used on alternating currents or direct currents *ad libitum* or for alternating currents alone, of a hollow series of coils without iron, or with very little iron, in the interior. These coils are preferably wound in as large a hollow figure as the dimensions of the instrument will admit. They are also wound in a similar manner to a Siemens armature or other form of armature which gives a continuously-rotative effect when used with a commutator C.

The commutator C is made of as small diameter as practicable, and the brushes bearing on it are delicate springs carrying small blocks of metal, or, preferably, carbon, resting on diametrically opposite points on the commutator, on a line at right angles, or nearly so, to the common axis of the large coils K K', which surround the armature closely and as closely as possible envelop it. These coils are made of coarse enough wire to carry the full load of current to be measured without much drop in electromotive force and without heating. The structure as thus constituted is a motor without iron cores, or with very little iron in its structure, so as not to give induction or reactive effects when alternating currents flow through it. It is connected so that the coils K K', either in series or multiple are with each other in the circuit direct to the lights or other consumption devices, are traversed by the current feeding the lights or consumption devices or by another current corresponding to its amount. They could be traversed by a fraction thereof if adjusted properly.

The armature A is wound with fine wire, there being a considerable number of turns traversed by a very small current in derivation around the lights or other devices, and to limit this current, as well as to adjust its strength, a resistance R is interposed, which

is of greater or less amount, as needed, or the resistance of the armature itself might be made sufficient for this purpose.

We thus have constituted a motor of simple construction which is responsive to the energy supplied to the lights, and its rotative torque will be in proportion to that energy. The current in the fine wire on the armature A is so excessively small as not to give trouble at the commutator C, and the commutator itself may therefore be made so insignificant in size as not to involve friction, which would interfere with the readings.

In order to give the motor so constituted a work which will be proportional likewise to the speed of rotation, I place upon the shaft X a device in which Foucault or induced currents may be generated by revolution, such as a copper disk M, affixed to the shaft X and held at right angles thereto. The edges of the copper disk M run between the poles of permanent or electric magnets of constant power, which are shaped to embrace or closely envelop the disk M, and of which there may be one or more according to the damping action required. A small wound armature on short circuit might replace the disk M. The action is quite simple. As the load is thrown on or off the speed of rotation of the motor is maintained in almost direct proportion to the load, and the dial registry at D is therefore accelerated or retarded in exact, or nearly exact, proportion with the changes of load. An integrated reading therefore gives the actual energy supplied in working the lamps or consumption devices.

The instrument when properly constructed has a range of one to fifty or more.

In Fig. 2 the same instrument is shown of substantially the same construction, the armature A being wound on a suitable carrier, preferably with little magnetic material in it or with no magnetic material, although when continuous currents are alone used the armature A may contain considerable magnetic material. In addition to the coils K K' there is in Fig. 3 a parallel winding of finer wire S S', which assists in furnishing the magnetic field in which the armature A revolves. This winding is supplied with initial energy in shunt around the consumption devices or supplied in any other way or from any source with a small current of initial energy, so as to give an initial field. In fact a winding even traversed by a battery-current would suffice where continuous currents alone are to be measured, or a slight-power permanent magnet might obviously be employed to replace this initial field-winding.

Where alternating currents are used, it is preferable to supply this initial field directly, though it will of course be understood that it may be supplied indirectly through induction, such as a small induction-coil, and, in fact, the currents delivered to the whole meter may, in the case of alternating currents, be derived inductively from those which are

to be measured, the only requirement being that the induced currents be related proportionally with those which are to be measured. Fig. 2 also shows the replacement of the permanent magnets whose poles are presented to the copper disk M by electromagnets which may be energized in shunt to the mains when continuous currents are to be measured or which may be energized by a separate battery-current when, as in Fig. 3, alternating currents are to be measured in the other coils of the instrument. The connections to the coils which are to be in shunt or derivation to the work may be all in series or they may be in separate derivation from the mains, independent from one another, any connection being sufficient which supplies the energy to the circuit.

Fig. 2 shows the arrangement with the initial energy or initial field devices absent, the dotted lines indicating the application of the permanent magnet-poles in place thereof. This is only applicable, however, to the measurement of continuous or direct currents.

Fig. 4 shows the structure so modified as to resemble more closely a form of motor in which iron is used. The magnetic poles N S have wound upon them in the ordinary way the coils K K', while the armature A is, as before, in circuit through the commutator in derivation to the lights L L' through an adjustable resistance R, the armature being wound with a fine conductor and either containing no iron or being composed of an iron armature with laminated plates in the usual way. The retarding-disk M is mounted on the armature-shaft and near the poles N S, and the registry-gearing is shown symbolized at D. This construction is only applicable to cases in which the registry is desired to be less in proportion with a large load or number of lights L than with a small number, the disk M being run near to the poles N S, which, instead of being constant, as in the previous figures, is subject to variation directly in proportion to the amount of current flowing to the lights L. The retarding effect will therefore be an increasing effect, and the registry will be a decreasing registry per unit of consumption the larger the load. This is useful in some cases where it is desired to discount for heavy loads and make an extra charge for small loads. In Fig. 5 the arrangement has about the same effect, the armature A being shown as having an inner closed circuited shell M' under the winding and between the winding and the core in the interior.

In Fig. 6 the armature A and retarder M are alongside under the same field-pole, the retarder M being in this case a copper cylinder with or without an iron core.

Fig. 7 shows a construction which is in effect similar to that given by the construction Fig. 2. The armature A revolves between field-poles energized by the coils K K' in series with each other and with the lights L L'.

The magnetic poles cause rotation of the armature A, which is in derivation from the main *m* through the winding T T' on another set of poles to the other main *n*, or rather to a connection from such main through the coils K K' to the group of lights. This puts the armature A and the coils T T' in series, while they are in shunt to the lights together. A revolving mass of metal, such as a copper cylinder or even a solid block of brass, iron, or any other structure in which Foucault or induced currents may be developed by rotation in a magnetic field, is carried by the shaft X in front of the poles created by the coils T T'. The registry mechanism D is actuated by the rotation of the shaft, as before. The windings A T T' are, of course, rather fine and calculated to limit the current which flows to a small amount, while the windings K K' are coarse and will carry the full current readily or a determined fraction thereof which is required to supply all the lights L L' in multiple. Any increase in the load at L L' increases the strength of the poles N S, while the armature A is supplied with a constant current, due to its being in a high-resistance circuit, between the mains *m n*, assuming, of course, that constant potential is maintained at the terminals or between the mains *m n*. The torque developed by the armature under these conditions will be proportional to the strength of the field N S, which is proportional below saturation with the current in the coils K K'. The retardation of the disk M will increase as the speed rises, and proportionally thereto as the field in which it moves is substantially constant with constant potential between the mains *m n*. The action, then, will be very similar to that of the arrangement, Fig. 1, under changed potentials. In Fig. 1 a change of potential between the mains increases the armature-current and thereby increases the torque and speed of turning. In Fig. 7 the same action of increase of armature-current takes place on increase of potential between the mains; but this effect is counteracted by the increased retardation given by the coils T T', acting on the disk M, which coils T T' are also responsive to the increased potential and increase of field in which the disk M moves, so that the device, Fig. 1, is an energy-meter and responds not only to increase or decrease of current, but also to increase or decrease of potential, while the arrangement of Fig. 7 is more strictly a current-meter, as the effect of increase or decrease of potential is compensated for. The device, Fig. 1, will approximately measure the energy supplied, while that of Fig. 7 will measure simply the current supplied without responding proportionally to the potential.

It will be understood that other forms and dispositions involving other shapes and arrangements of meter devices and other shapes or arrangements of retarding devices acting on the principle of Foucault or induced cur-

rents or magnetic effects may be substituted for the elements shown in my present invention, and I therefore by no means limit myself to the constructions shown, as they can be widely varied and apparently departed from without affecting the actual principles involved and their relation one to the other. It will also be understood that in every case in which the retarding disk or conductor M has been shown as revolving it could be replaced by the magnets themselves revolving while the disk M remains stationary, as indicated in Fig. 8, and this structure may be adopted in some cases. In addition it will be seen that where the current due to the existence of constant potential is of constant strength in the armature portion A of the apparatus such current might be supplied from a separate constant-current source, such as a battery, in the case of direct currents instead of being taken in derivation from the mains themselves, though I prefer a connection to the mains as more practicable and simpler.

I am aware that what are called "motor-meters" have been constructed in a number of different ways and with various arrangements of circuits. I am aware also that they have been provided with retarding devices depending on fan-wheels moving either in air, gas, or liquid, whereby a definite loading of the motor is at all times obtained. I find, however, that such loading is entirely unsuitable for the purpose, as it does not vary in proportion to the torque exhibited by the motor except in such cases in which both armature and field of the motor vary together. My invention is distinguished by having its rotative power depending on a practically constant armature-current when constant potentials exist therein in a field variable with the work on the circuit, the rotative effort of which is expended in giving revolution to a current-generating system, such as a copper disk (which may be taken as representing a dynamo-armature on closed circuit) turning in a constant field, whereby the magnetic actions become balanced and the load on the motor varies in direct relation to its torque, so that with a double current passing through the field-coils of the motor a double speed of rotation is obtained. For accuracy of registry, therefore, it is not sufficient that the motor be given a definite resistance or loading, but it is requisite that the loading shall vary in direct relation with the torque or turning power of the motor itself, and this I secure in my present invention.

What I claim is—

1. The combination in an electric meter, of a rotating armature in a circuit of high resistance in derivation to the work and traversed by a current which is practically constant for all speeds of rotation while connected to a source of practically constant potential, a set of coils traversed by, or responding to, the variable current fed to the consumption devices, said coils furnishing a whole or a

part of the field in which said armature revolves, a retarding device moved by said armature consisting of a conductor movable in a magnetic field and consuming energy of rotation therein, and a registry device for counting the turns of the revolving armature.

2. In an electric meter, the combination with the armature-coils carrying a practically constant current, of the main field producing or energizing coils in which a rotating armature moves, and an accessory or initial field-circuit supplied with current from any suitable source such as a derived circuit around the consumption devices, a constant battery-current, or the like.

3. The combination of the following elements in an electric meter, a rotating shaft connected with a registry system for recording its revolutions, an armature-coil system mounted upon said shaft and provided with a suitable commutator, connections to said commutator from a circuit in derivation to the consumption devices and having a difference of potential at its terminals substantially constant in amount irrespective of the changes of resistance in the part of the circuit containing the consumption devices, said armature-circuit being constructed as described to be traversed by a very small current practically constant in amount although the speed of the motor may change under variations in the strength of its other element, a field for rotating said armature produced by coils in series with or responding to the current fed to the consumption devices, and a retarding device carried by said armature-shaft consisting of magnets and closed conductors in relative movement, whereby Foucault or induced currents or magnetic losses are generated, substantially as described.

4. The method of measuring electric energy or current which consists in establishing a field by the current flowing to the devices, causing said field to envelop or act upon a rotating-armature-coil system traversed by a current which is substantially constant in amount under all conditions of working of

the meter with variable work, retarding the revolutions of said armature-coil system by a magnetic field acting on a closed conductor, and counting the revolutions of the rotating-armature-coil system, substantially as described.

5. The combination with an electric circuit containing translating devices, of an electric motor whose field-energizing coils are in the main circuit to the translating devices, and whose armature is traversed by current maintained substantially constant irrespective of variations in the work and consequent change of speed of the motor, said motor having a loading or retardation which is substantially *nil* under very low rotations and which increases directly as the speed of rotation increases.

6. An electric meter for constant-potential circuits having a motor whose rotative energy depends upon the action of a field variable with the consumption of current, or number of translating devices in use, said motor having a constant armature, irrespective of the variations in the working, in combination with a retarding device consisting of an electric generator of induced currents of variable amount in proportion to the speed of rotation and with a constant or nearly constant field.

7. A meter for alternating electric currents, consisting of a motor having field-magnet coils connected in series with the work-circuit, armature-coils connected across the work-circuit and carrying a current which is substantially constant in amount under all conditions of working, a counting, registering or indicating device operated by the movements of the armature, and a retarding device applied to the armature.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 22d day of August, A. D. 1889.

ELIHU THOMSON.

Witnesses:

JOHN W. GIBBONEY,
JOSEPH H. JENKINS.