No. 660,293. Patented Oct. 23, 1900.

T. A. EDISON.

ELECTRIC METER.

(Application filed Sept. 16, 1899.)

(No Model.)

Fig. 1

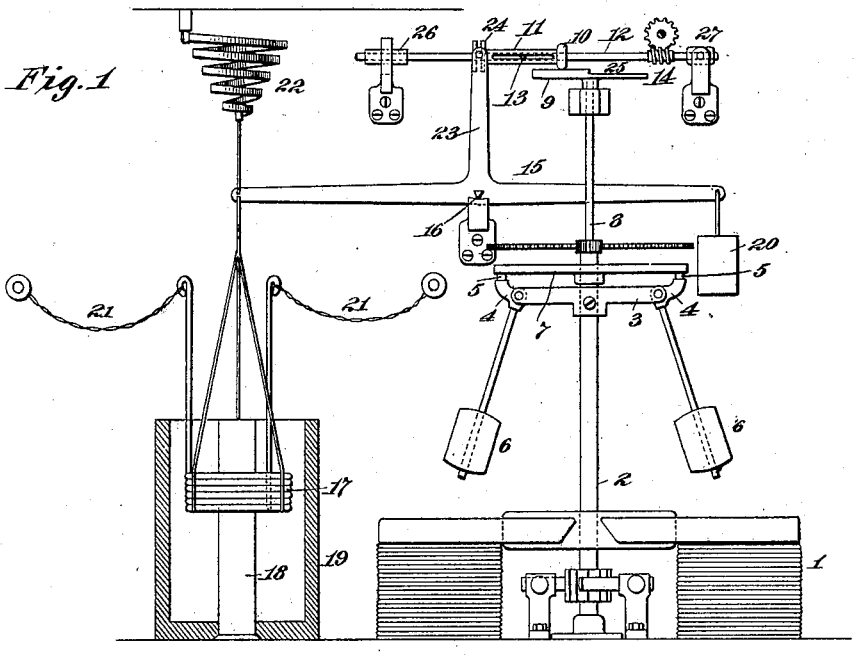


Fig. 3

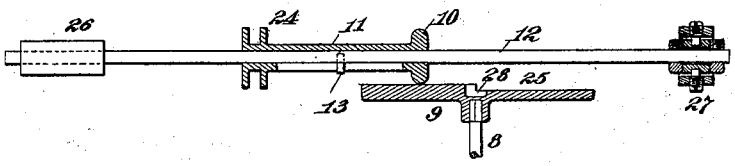


Fig. 2

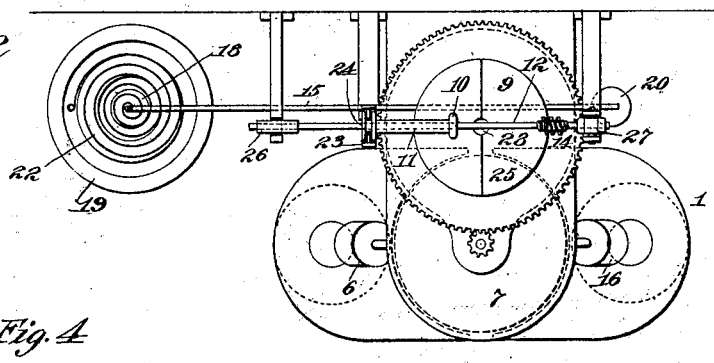
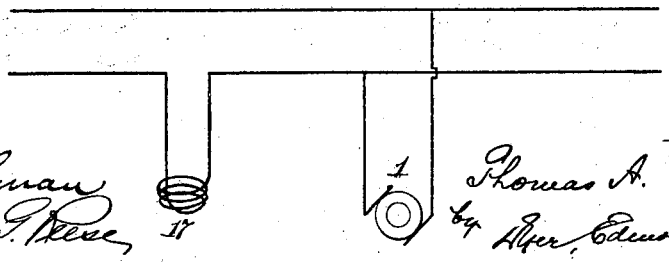


Fig. 4



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UNITED STATES PATENT OFFICE.

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ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 660,293, dated October 23, 1900.

Application filed September 16, 1899. Serial No. 730,657. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Electric Meters, (Case No. 1,006,) of which the following is a specification.

My invention relates to improvements in electric meters; and my objects are to simplify the construction of electric meters, to improve their efficiency and accuracy, and to make them susceptible of being operated with a minimum expenditure of energy.

In carrying out my invention I employ a motor operating at a constant speed, a register by which a direct reading can be secured, mechanism connecting the motor and register capable of converting the constant speed of the motor into a variable speed of the register-train from zero to maximum, and means controlled by the consumption of the energy for placing the intermediate mechanism in condition to permit the operation of the register at a rate proportional to the energy consumed. I am aware that meters of this general type have been before suggested, but such prior meters have for reasons which appear on their face been either impracticable or inoperative.

I prefer to use as a device for operating the register-train an electric motor connected across the circuit to be metered and to secure constancy of speed of rotation of the motor-armature by the employment of a centrifugal governor possessing great accuracy. The mechanism intermediate the motor and register-train, having capacity to convert the constant speed of rotation into a variable speed, may be of any suitable ordinary mechanical construction, of which many instances exist in the art. A convenient form of variable-speed connection which I will describe comprises a driving-disk with which coöperates a driven roller engaging the working face of the disk and movable diametrically toward and away from the geometrical center thereof. When the roller occupies a position coincident with the center, obviously rotation of the disk will not move the roller; but if the roller is moved diametrically toward the periphery of the disk its rate of rotation will be gradually increased. In order that when no current is influencing the meter wear will be prevented between the roller and disk, I provide the latter with a depression coincident with the center, into which the roller will be normally received. The means employed for changing the condition of the intermediate mechanism comprise an ampere-indicator of great delicacy and accuracy. I employ a scale-beam mounted on a knife-edge bearing, carrying at one end an armature, core, coil, or electromagnet coöperating with a stationary companion element and subjected either directly to the current to be measured or to attraction due to that current, the elements so carried by the scale-beam being exactly counterbalanced, whereby the beam will normally occupy a position of equilibrium, and a resisting device being employed to resist the movement of the beam due to the action of the current to be measured and of such a character that the proper proportionality of speed of the register-train to the energy consumed will be maintained throughout the necessary limits of registration. Preferably the scale-beam carries a relatively-light coil connected in the main line of the circuit to be metered, whereby the coil will be subjected to the current to be measured. A relatively-light counterbalancing-weight can thus be employed, thereby reducing the mass of the elements comprising the ampere-indicator. The coil may coöperate with another coil, both being subjected to the current or to a part of the current to be measured; but it preferably coöperates with a stationary armor-clad core of relatively-great mass. I prefer to use an ordinary convolute steel spring, connected at one end of the scale-beam to oppose the stress due to the current to be measured, as I find it possible in this way to secure an ampere-indicator wherein the amplitude of movement of the scale-beam is in constant ratio to the energy. Finally, in order that the operation of the ampere-indicator may effect the change in the condition of the intermediate mechanism between the motor and register without excessive friction provision is made whereby at rapidly-recurring intervals the ampere-indicator will be practically disconnected from both the motor and register, whereby during such periods its po-

sition may be changed to correspond with any variations in the consumption of the current. This result may be accomplished in a variety of ways—as, for example, by providing the driving-disk with a cut-away portion coincident with a section of its area, whereby the driven roller will during a part of each rotation of the disk be maintained out of contact therewith. By thus producing a meter wherein a motor is employed rotating at a constant speed, with a variable-speed connection between the motor and the register and wherein is used an ampere-indicator of great accuracy and delicacy, arranged to change the condition of the speed connection without friction, I am enabled to obtain a meter wherein certainty of registration is effected throughout its full capacity.

In order that my invention may be better understood, attention is directed to the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is an elevation of the working parts of the meter with the case removed; Fig. 2, a plan of the same; Fig. 3, a longitudinal section, on an enlarged scale, through the roller-shaft and sleeve; and Fig. 4, a diagram of the circuit connections.

In all of the above views corresponding parts are represented by the same numerals of reference.

1 represents an electric motor of any suitable type, the armature-shaft 2 of which drives an arm 3, at the ends of which are pivoted bell-cranks 4. The short arm of each bell-crank carries a brake-shoe 5, and the long arm carries a centrifugal weight 6. The brake-shoes 5 coöperate with and bear against the under surface of a stationary friction-disk 7. The rotation of the shaft 2 causes the weights 6 to be thrown outward by the centrifugal effect, whereby any tendency toward increase in speed will result in an increase in the pressure between the brake-shoes 5 and the surface 7, while any tendency to decrease in speed will result in a diminution of that pressure. By carrying the centrifugal weights 6 at the end of the relatively-long arms of the bell-cranks the centrifugal effect is made very sensitive, and a motor can be produced in this way which will operate with great accuracy. The armature-shaft 2 drives either directly or through an intermediate gearing, as shown, a shaft 8, on which is carried a disk 9. Coöperating with this disk is a roller 10, carried by a sleeve 11, which surrounds and is movable longitudinally with respect to a shaft 12. The shaft is provided with a pin 13, which works in a longitudinal slot formed in the sleeve, thus permitting the sleeve to move longitudinally, but communicating its rotative movement to the shaft. The shaft drives a worm 14 of a register of any suitable type.

15 represents a scale-beam mounted on knife-edge bearings 16, so as to be as frictionless as possible. This scale-beam carries at one end one of the elements of the ampere-indicator, preferably a light coil 17, coöperating with a stationary core 18, having an armored section or sheath 19. The coil 17 or other element carried by the scale-beam is accurately balanced by a weight 20, whereby the scale-beam will normally maintain a position of equilibrium. When the element which the scale-beam carries is a coil, as is preferable, electrical connections thereto are made through strips 21 of thin metal foil or a series of such strips wound in the form of a light cable. The elasticity of strips of metal foil for this purpose is so slight as to be negligible. In order to resist the attraction of the coil 17 toward its core 18, I prefer to employ an ordinary convolute steel spring 22, fixed at one end and connected at the other to the scale-beam. I find that by using a spring of this character it is possible to permit an amplitude of movement of the scale-beam under the effect of the current to be measured which will be absolutely proportional to that current throughout the entire capacity of the meter.

Connection between the scale-beam and the mechanism intermediate the motor and register is made in any suitable way—as, for instance, by connecting the forked arm 23 on the scale-beam with the grooved collar 24 on the sleeve 11. In order that the ampere-indicator may respond accurately to variations in the consumption of the energy, provision should be made, as stated, to practically disconnect it during frequently-recurring intervals from the other parts of the meter. In the specific instance shown the disk 9 is provided with a cut-away portion 25, occupying a section of its area, the mounting of the roller 10 being so effected that the cut-away portion of the disk will not engage said roller. The roller 10 is maintained in sufficient frictional engagement with the elevated portion of the disk 9, preferably by a weight 26, carried at one end of the shaft 12 and turning with it. The other end of the shaft is mounted in gimbals 27, whereby the shaft and sleeve will be permitted to partake of a slight vertical play, not sufficient, however, in its downward extent to engage the roller 10 with the cut-away section of the disk 9. The disk 9 is provided at its geometrical center with an opening or concavity 28, in which the roller 10 normally rests out of contact with the surface of the disk, thus obviating wear and friction between the disk and roller when no current is influencing the coil 17.

As shown in Fig. 4, the motor 1 is connected across the circuit to be measured, while the coil 17 is connected in line with the current to be metered, whereby the said coil will be subjected to that current.

The operation will be readily understood. Normally—that is to say, when no current is influencing the coil 17—the roller 10 is coincident with the opening 28 in the disk 9 and that disk is being turned at a constant speed by the motor 1. As current affects the coil

17 the latter will be drawn downward against the tension of the spring 22 to an extent proportional to the influencing current. This movement of the scale-beam shifts the sleeve 11 relatively to the shaft 12 and moves the roller 10 toward the periphery of the disk 9. The parts are so proportioned that the rotative movement communicated to the roller 10 by the elevated section of the disk 9 will operate the register at a speed proportional to the current influencing the coil. At each rotation the engaging contact between the roller 10 and disk 9 is released by the cut-away section 25, and at these points the ampere-indicator is free to adjust itself without resistance to any changes in the load.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows:

1. In an electric meter, the combination with a register, of a motor, a centrifugal device carried by the motor and arranged to produce a retardation to the rotative effect varying with the speed of rotation, a variable-speed connection between the motor and the register, and a device influenced by the current to be measured for varying the speed of the intermediate mechanism, substantially as set forth.

2. In an electric meter, the combination with a register, of an electric motor, a centrifugal device carried by the motor and arranged to produce a retardation to the rotative effect varying with the speed of rotation, a variable-speed connection between the motor and the register, and a device influenced by the current to be measured for varying the speed of the intermediate mechanism, substantially as set forth.

3. In an electric meter, the combination with a motor, of an arm carried by the motor-shaft, a plurality of bell-crank levers suspended from said arm, brake-shoes carried by the short arms of said levers, centrifugal weights carried by the long arms thereof, a friction-surface with which said brake-shoes coöperate, and a register operated by said motor, substantially as set forth.

4. In an electric meter, the combination with an electric motor, of an arm carried by the motor-shaft, a plurality of bell-crank levers suspended from said arm, brake-shoes carried by the short arms of said levers, centrifugal weights carried by the long arms thereof, a friction-surface with which said brake-shoes coöperate, and a register operated by said motor, substantially as set forth.

5. In an electric meter, the combination with a motor and a register, of an ampere-indicator the position of which controls the speed of registration, said indicator comprising a balanced scale-beam, an element moved by the current to be metered, and a resisting device connected to said scale-beam for opposing its entire movement under the effect of that element, substantially as set forth.

6. In an electric meter, the combination with a motor and a register, of an ampere-indicator the position of which controls the speed of registration, said indicator comprising a balanced scale-beam, an element moved by the current to be metered, and a convolute spring connected to said scale-beam for opposing its movement under the effect of that element, substantially as set forth.

7. In an electric meter, the combination with a motor and a register, of an ampere-indicator the position of which controls the speed of registration, said indicator comprising a scale-beam, a coil connected to said scale-beam, means for balancing said coil, a stationary element with which said coil cooperates, and a resisting device connected to the scale-beam for opposing the attraction of said coil, substantially as set forth.

8. In an electric meter, the combination with a motor and a register, of an ampere-indicator the position of which controls the speed of registration, said indicator comprising a scale-beam, a coil connected to said scale-beam, means for balancing said coil, a stationary element with which said coil coöperates, and a convolute spring connected to the scale-beam for opposing the attraction of said coil, substantially as set forth.

9. In an electric meter, the combination with a motor and a register, of an ampere-indicator the position of which controls the speed of registration, said indicator comprising a scale-beam, a coil connected to said scale-beam, means for balancing said coil, a stationary core with which said coil coöperates, and a resisting device connected to the scale-beam for opposing the attraction of said coil, substantially as set forth.

10. In an electric meter, the combination with a motor and a register, of an ampere-indicator the position of which controls the speed of registration, said indicator comprising a scale-beam, a coil connected to said scale-beam, means for balancing said coil, a stationary core with which said coil coöperates, a magnetic sheath for said core, and a resisting device connected to the scale-beam for opposing the attraction of said coil, substantially as set forth.

11. In an electric meter, the combination with a motor and a register, of an ampere-indicator the position of which controls the speed of registration, said indicator comprising a scale-beam, a coil connected to said scale-beam, a device with which said coil cooperates, means for opposing the attraction of said coil, and a non-elastic metallic connection to said coil, substantially as set forth.

12. In an electric meter, the combination with an electric motor having a centrifugal friction-governor, a register and a variable-speed mechanism between the motor and register, of a balanced scale-beam the position of which is altered by the current to be measured, a resisting device for opposing the said movement, and means for periodically connecting and disconnecting the scale-beam

with the variable-speed mechanism, substantially as set forth.

13. In an electric meter, the combination with a constant-speed motor, of a disk rotated by said motor and having a cut-away section, a roller coöperating with said disk, a weight for engaging the roller frictionally with the uncut-away section of the disk, a register, an ampere-indicator, connections between the roller and register, and connections between the roller and ampere-indicator, substantially as set forth.

14. In an electric meter, the combination with a constant-speed motor, of a disk rotated by said motor, a roller coöperating with said disk, a recess coincident with the geometrical center of the disk normally receiving said roller, a register, an ampere-indicator, connections between the roller and register, and connections between the roller and ampere-indicator, substantially as set forth.

This specification signed and witnessed this 23d day of March, 1899.

THOMAS A. EDISON.

Witnesses:
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