March 4, 1930. E. W. NILES 1,749,044

METER

Filed Dec. 14, 1927

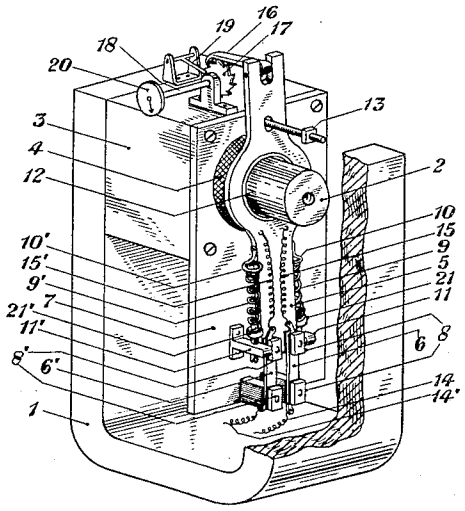


Fig. 1

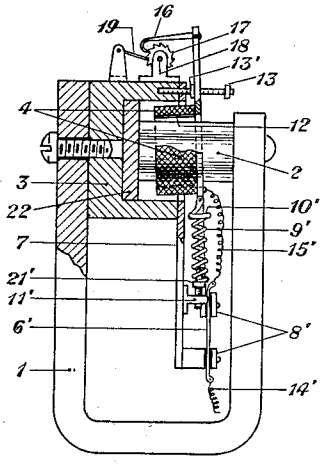


Fig. 2

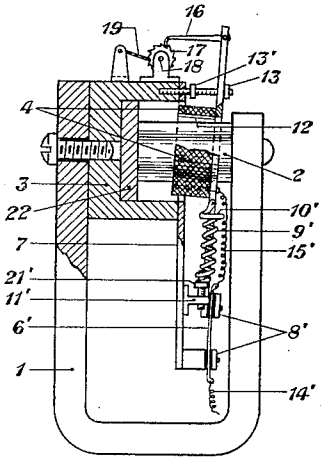


Fig. 3

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UNITED STATES PATENT OFFICE

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METER

Application filed December 14, 1927. Serial No. 239,934.

This invention relates to measuring devices, and more particularly to telephone meters by means of which a subscriber is charged for the length of time his telephone is in actual use.

In telephone metering systems, it has been proposed to operate the meter periodically by varying the current or reversing the direction of the flow of the current in the telephone circuit. The present invention is adapted to be used in connection with such systems.

In the moving coil armature type of meter, a device has been suggested in which the armature is mounted in a vertical position and vibrates in a manner similar to that of an inverted pendulum. The armature, due to its mass, is acted upon by the force of gravity and tends to remain in or restore to either extreme position in its arc of vibration when the coil is deenergized.

The present invention consists of a stationary permanent magnet having concentric pole pieces, a movable coil surrounding the inner pole piece of said magnet and fastened to one end of an armature, spring reeds supporting said armature at the other end thereof, and compression toggle springs positioned along two opposite sides of said armature between suitable supports. The force exerted by the compression springs tends to cause the armature to remain in or restore to either extreme position. The moving parts may be made so light that the effect of the force of gravity acting thereon is relatively negligible when the device is mounted in any position.

It is essential in the moving coil type of meter that when the telephone is in actual use, the meter be as sensitive as possible to the small line current, and that when the telephone conversation ceases, the armature remain in or restore to either extreme position rather than the mid-position of its arc of vibration. If the armature does not restore to either extreme position, false registration will result when the subscriber attempts to recall the operator by flashing, or during dialing. Therefore, it is essential that the force tending to restore the armature to either extreme position be as great as possible at any given point on its arc of vibration between its mid-position and either extreme position without, at the same time, rendering the device inoperative to the small line current. It is also essential that this restoring force be as constant as possible during the travel of the armature from either extreme position to its mid-position, or vice versa.

The resultant restoring force exerted on the armature of the meter hitherto employed was dependent primarily upon the force of gravity. As the armature moved along its path of travel from either extreme position to its mid-position, the force tending to restore the armature to its extreme position decreased very rapidly.

The resultant restoring force exerted on the armature of the meter constituting the present invention is dependent primarily upon the force exerted by the toggle springs. These springs are under greatest compression when the armature is at its mid-position, and under least compression when the armature is at either extreme position. However, at the same time the leverage force exerted by these springs is least when the armature is at its mid-position and greatest when the armature is at either extreme position. The result is that as the armature moves along its path of travel from either extreme position to its mid-position, the resultant restoring force decreases very slowly because of the building up of the spring compression force which tends to counteract the reduction of the leverage force. Therefore, with equal restoring force exerted on the armature at their extreme positions, the restoring force exerted on the armature of the present invention at any given point on its arc of vibration between its mid-position and either extreme position, is greater than that exerted on the armature of the meter hitherto employed at the corresponding point on its arc of vibration.

It is the object of this invention to provide a meter which is positive in its operation, which reduces the danger of false registration to a minimum, which may be mounted in any position with equally efficient results, and which is inexpensive in initial cost and subsequent maintenance.

Figure 1 of the drawing is a perspective

view of the meter; Fig. 2 is a side view broken away when the moving coil armature is in one of its extreme positions, the indicator not being shown; and Fig. 3 is the same view when the moving coil armature is in the other of its extreme positions. Corresponding elements are indicated by the same numerals.

In the drawing, specifically Fig. 1, the stationary permanent magnet 1 has adjacent or concentric pole pieces, 2 being the inner pole piece and 3 being the outer. A number 22, preferably made of brass or other similar material, separates the outer pole piece from one end of the inner pole piece. The movable armature coil 4 is secured to a coil-arm 5 which is supported by spring reeds 6 and 6'. The spring reeds are fastened to the coil-arm and the plate support 7, which is preferably made of brass or other similar material, by the clamps 8 and 8'. The compression toggle springs 9 and 9' are positioned along two sides of the armature arm 5 and are held in place at one end by the supports 10 and 10', which are fastened to the armature arm. At the other end the toggle springs are held in place by the threaded members 21 and 21', which are screwed through the correspondingly threaded supports 11 and 11', which in turn are fastened to the plate support 7. The supports 11 and 11' are positioned above the pivotal center of the spring reeds 6 and 6'. It is obvious that supports 11 and 11' may be positioned below the pivotal center of the spring reeds and suitable means provided for fastening the springs 9 and 9' to the members 21 and 21', in which case the springs would be extended rather than compressed as the armature moves along its path of travel from either extreme position to its mid-position. However, by using compression springs supported above the pivotal center of the spring reeds or other pivotal elements, none of the components of the force exerted on the armature is exerted in a direction toward the pivotal elements. Thus, the pressure on the delicate pivotal elements with consequent high friction loss and damage thereto is reduced to a minimum. The force exerted on the armature by the compression springs constitutes a restoring force tending to cause the armature to remain in or restore to either extreme position of its arc of vibration. When the coil is energized by the line current, the force causing the coil to move in the magnetic field between the concentric pole pieces is greater than the force exerted on the armature by the compression springs. When the coil is deenergized, the force causing the coil to move in the magnetic field between the concentric pole pieces is removed, and the force exerted on the armature by the compression springs immediately becomes sufficiently positive to cause the armature to remain in or restore to either extreme position. The compression on the toggle springs and hence the force tending to cause the armature to remain in or restore to either extreme position may be increased or decreased by adjusting the threaded members 21 and 21'. The fact that when the coil is deenergized, the armature always remains in or restores to either extreme position, prevents false operation of the meter when the current is interrupted, as when the subscriber attempts to recall the operator by flashing, during dialing, or at the termination of the call, which would occur if the armature restored to its mid-position when the current is interrupted. The use of spring reeds avoids the necessity of employing delicate bearings which are subject to damage due to handling and which may become unreliable in operation due to corrosion and dirt. Also, the force exerted on the armature by the compression toggle springs in conjunction with the force due to the large radius of gyration provides sufficient sluggishness of action with light moving parts to prevent response to large forces of short duration, for example, mechanical vibration of the meter or the current used for ringing signals. Additional sluggishness of action with light moving parts is obtained by the use of eddy current damping by means of a copper slug 12 inside the coil which is acted upon by the field of the permanent magnet. A bolt and nuts 13 and 13' are provided to serve as stops when the armature reaches its extreme positions. These stops are made adjustable in order that the arc of vibration of the armature may be regulated.

In the particular embodiment shown, there are two spring reeds which are insulated from the armature support and the armature, and serve as conductors, for example, from the terminal wire 14 to the wire 15 and the winding of the coil 4, and thence back through the wire 15' to the other terminal wire 14'. The use of the supporting reeds as electrical conductors avoids the necessity of employing additional current conducting means with consequent maintenance difficulties and drag on the armature.

There is connected to the armature a pawl 16 which operates a ratchet-wheel 17. The rotation of the ratchet-wheel in turn operates, by means of the connecting rod 18, an indicator 20. A holding pawl 19 is provided to hold the ratchet-wheel in its rotated position. This invention is not limited to the specific arrangement of the registering means disclosed. Different arrangements may be employed when the meter is mounted in other positions.

During manufacture, the strength of the magnet, the resilience of the toggle springs and the compression thereon may be selected so that the device will be sensitive to the small line current when the coil is energized, and so that the force exerted on the armature by the toggle springs will be sufficiently

positive to insure the armature's remaining in or restoring to either extreme position when the coil is deenergized. Also, the moving parts may be made so light that the force of gravity acting thereon will be relatively negligible and the meter may be mounted in any position with equal efficiency of operation. The fact that the device may be mounted in any position eliminates the danger of false registration due to the creeping of the meter on its supports out of position, which is caused by vibration of the supporting structure.

The meter is designed so that the armature will be in either one of its extreme positions at all times when the subscriber's telephone is not in use. The operation of the device is as follows: At the beginning of the conversation the direction of the flow of current is, for example, through the terminal wire 14, the spring reed 6, the wire 15, the winding of the coil 4, the wire 15′, the spring reed 6′ and the other terminal wire 14′. The coil is energized in such a way, for example, that the coil is moved away from the position shown in Fig. 2 through the field created between the pole pieces. This movement of the coil through the field created between the pole pieces moves the coil arm 5 to its other extreme position, as shown in Fig. 3. This movement, by means of the pawl 16, rotates the ratchet-wheel 17, which in turn, by means of the shaft 18, operates the indicator 20. When the direction of the flow of the current is reversed, the current flows through the terminal wire 14′, the spring reed 6′, the wire 15′, the winding of the coil 4, and thence back through the wire 15, the spring reed 6, and the other terminal wire 14. With this direction of the current the coil moves away from the position shown in Fig. 3 through the magnetic field between the two pole pieces. This movement of the coil through the field between the two pole pieces moves the armature arm 5 back into the other extreme position, as shown in Fig. 2. This movement again places the pawl 17 in position to rotate the ratchet-wheel when the current is reversed again. During the first half of the movement of the armature through its arc, the force exerted by the compression springs 9 and 9′ is opposing the movement, but this is counteracted by the fact that the force causing the coil to move in the magnetic field between the concentric pole pieces and that exerted by the spring reeds 6 and 6′ is greater than the force exerted by the compression springs. During the latter half of the travel the force exerted by the compression springs is assisting the movement, while that exerted by the spring reeds is opposing it. When the coil is deenergized, the force causing the coil to move in the field between the concentric pole pieces is removed, and the force exerted by the compression springs immediately becomes sufficiently positive to cause the armature to remain in or restore to either extreme position.

This invention may be used in connection with systems in which the current is suddenly reversed or in which the current is gradually reversed. Also, by providing a spring, or by suitable adjustment of the meter so that the coil arm will be restored after operation to the position illustrated in Fig. 2, this invention may be used in connection with systems using pulsating currents to operate the meter. Under certain conditions it may be desirable to bias the meter by a spring so that the armature will tend to restore to or remain in the position to which it is operated by the normal line battery polarity. Furthermore, the use of the meter described is not limited to systems in which the subscriber is charged for the length of time his telephone is in use, but may be employed in systems where the charge is made on a message basis.

It is to be understood that this invention, although disclosed in a particular embodiment herein set forth, is capable of being embodied in other forms without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. In combination, a magnet having adjacent pole pieces, an armature supported by pivotal means, a coil fastened to said armature and adapted to move between said pole pieces, and means under stress fastened to said armature and adapted to influence its movement through its arc of vibration.

2. In combination, a magnet having adjacent pole pieces, an armature supported by pivotal means, a coil fastened to said armature and adapted to move between said pole pieces, and means under stress causing said armature to remain only in either extreme position of its path of vibration when said coil is deenergized.

3. In combination, a magnet having concentric pole pieces, a coil adapted to move between said pole pieces, an armature fastened to said coil and adapted to be moved thereby, resilient means supporting said armature, and means under stress tending to counteract the force exerted on said armature by said resilient means and by said coil during part of its movement through its arc of vibration when said coil is energized.

4. In combination, a permanent magnet one pole piece of which surrounds the other, a coil adapted to move between said pole pieces, an armature fastened to said coil and adapted to be moved thereby, resilient means fastened to and supporting said armature, and compression springs secured at one end to said armature and at the other end to supporting means, said compression springs being adapted to cause said armature to remain

only in either extreme position of its arc of vibration when said coil is deenergized.

5. In combination a permanent magnet one pole piece of which surrounds the other, a coil adapted to move between said pole pieces, an armature fastened to said coil and adapted to be moved thereby, spring reeds fastened to and supporting said armature, said spring reeds being insulated from one another and electrically connecting terminal wires with said coil, and compression springs secured at one end to said armature and at the other end to supporting means, said compression springs being adapted to cause said armature to remain only in either extreme position of its arc of vibration when said coil is deenergized.

In testimony whereof, I have signed my name to this specification this 12th day of December, 1927.

ELIOT W. NILES.