June 10, 1930. J. R. FRY 1,762,774

ELECTROMAGNETIC DEVICE

Filed June 15, 1928

FIG. 1

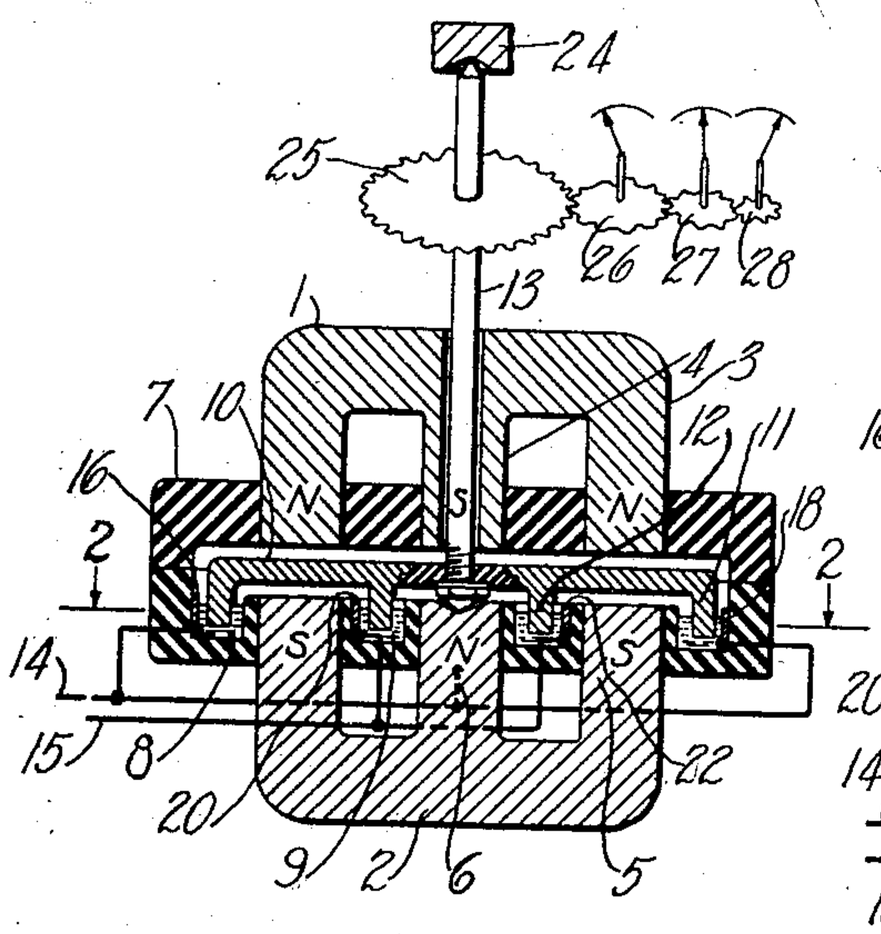


FIG. 2

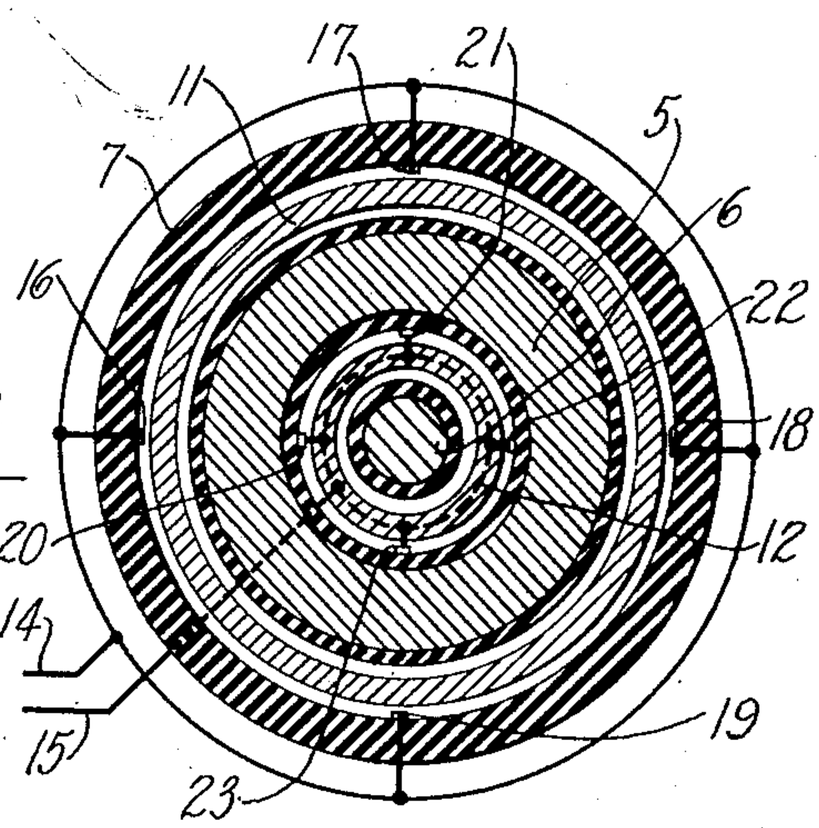


FIG. 3

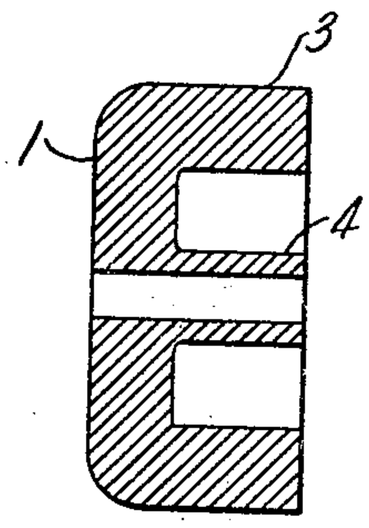
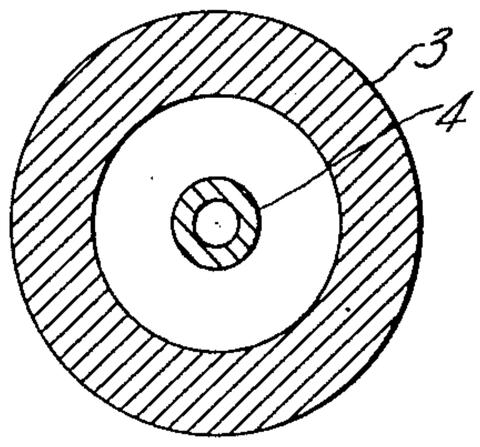


FIG. 4



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UNITED STATES PATENT OFFICE

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ELECTROMAGNETIC DEVICE

Application filed June 15, 1928. Serial No. 285,519.

This invention relates to electromagnetic devices and particularly to devices employed for measuring purposes.

The object of the invention is to increase the sensitivity of these devices.

Suggestions have been made heretofore to measure the service rendered a telephone subscriber by means of a substation meter comprising a disc immersed in a mercury bath and rotating continuously, during conversation on the line, due to magnetic action on the disc resulting from the flow of the talking current therethrough. In these prior devices only a portion of the disc is in operative relation to the pole pieces of the magnets at any given time. Moreover, only a portion of the current reaches the disc due to the shunting effect of the mercury and of this portion only a part passes beneath the pole pieces of the magnets with the result that a fractional part of the total current is effective in producing torque.

According to the present invention the sensitivity of these devices is increased by providing a construction in which the operating current is so directed that all of it flows through the rotating disc at points in proximity to the poles of the magnets. In this way the torque necessary to drive the meter gear train is produced with smaller values of operating current.

In the drawing Fig. 1 is a sectional view taken vertically through the center of the device and illustrating the internal construction. Fig. 2 is a section taken along the horizontal plane indicated at 2—2 in Fig. 1. Fig. 3 is a side view of one of the permanent magnets. Fig. 4 is another view of the permanent magnet taken at right angles to the one shown in Fig. 3.

The device herein described is particularly suitable for use at the substations of telephone lines for measuring the length of conversation. In principle, it comprises a movable element which rotates continuously in response to the flow of current in the telephone line during the conversational period. Since the intensity of the current in a subscriber's line is of a low order, the problem of designing a device which will produce sufficient mechanical energy to operate a recording instrument is a difficult one. To meet this difficulty the device herein described is so constructed that the entire amount of current available in the subscriber's line is conducted through the rotatable element or disc in such a way that the current flowing through the disc passes in close proximity to the pole pieces of the stationary permanent magnets, whereby the maximum amount of turning effort is produced.

Referring to the drawing, the measuring device comprises two stationary cup-shaped permanent magnets 1 and 2 as illustrated in Fig. 1. The magnet, which is further illustrated in Figs. 3 and 4, is a circular shaped member having an outer annular wall 3 and an integral cylindrically shaped portion 4. The portion 4 has a cylindrical orifice passing therethrough for the purpose of admitting a spindle. Except for the orifice in the portion 4, the other permanent magnet 2 is a counterpart of the first, having its outer annular wall 5 and its inner cylindrical portion 6. The permanent magnet 1 is so magnetized that the annular wall 3 constitutes one pole piece and the cylindrical portion 4 the opposite pole piece, the return path being by way of the solid or base portion of the member. Similarly the magnet 2 is magnetized such that the wall 5 is one pole piece and the inner element 6 the opposite pole piece.

When the device is assembled as illustrated in Fig. 1, the magnets 1 and 2 are placed in opposing relation. The poles are so related to each other that a field of force exists in the continuous circular air gap formed by the opposing faces of the walls 3 and 5.

Surrounding the magnets 1 and 2 near their pole tips is an insulating member 7 so shaped as to provide a closed chamber within. The lower portion of the insulating member 7 is provided with an annular channel 8, passing around the outer portion of the insulating member 7. The lower part is also provided with a second annular channel 9 of smaller diameter and concentric with the first. The channels 8 and 9 contain some conducting fluid such as mercury.

A rotatable disc 10, which may be of some

conducting material such as copper, is secured to the spindle 13 and supported within the chamber formed by the insulating member 7. The disc 10 has two concentric continuous flanges 11 and 12 so positioned on the underside of the disc that when the instrument is assembled these flanges are immersed in the mercury filling the channels 8 and 9 respectively.

The spindle 13 passes through the orifice in the magnet 1 and is delicately pivoted as seen in Fig. 1. The external part of the spindle 13 is pivoted in the stationary member 24 and carries a driving wheel or sprocket 25. The sprocket 25 engages other wheels 26, 27 and 28 which constitute the well-known measuring train.

In order that the operating current may be conducted through the instrument, the conductors 14 and 15 are connected to the mercury channels as illustrated. The conductor 14, for example, appears in terminals 16, 17, 18 and 19, which are secured in the edge of the channel 8 in physical contact with the mercury therein. Likewise the conductor 15 is multiplied to the terminals 20, 21, 22 and 23 located in the edge of the channel 9.

Considering the conductors 14 and 15 connected in series with a telephone line, as an instance of the utility of this device, a brief description will now be given of the operation. Current flowing into the instrument over conductor 14 passes to the terminals 16, 17, 18 and 19 at equally spaced points around the circumference of the device. From these points it enters the mercury in the channel 8 and passes directly to the disc by way of the flange 11. After reaching the flange 11 the current passes radially through the disc 10 under the pole pieces of the permanent magnet and thence through the flange 12 into the mercury in the channel 9 and thence to the terminals 20, 21, 22 and 23 to the return conductor 15. The current flowing directly through the field of the permanent magnet produces, in the well known manner, a turning effort which causes the disc 10 to rotate. Thus the rotation of the disc is a measure of the length of time during which current flows in the circuit and may be taken as a measure of the length of a telephone conversation.

While only one embodiment of the invention has been illustrated it will be understood that numerous modifications may be made and also that the instrument is not limited to use in telephone systems, but may be employed for a variety of purposes.

What is claimed is:

1. In combination, a magnet having an annular pole piece, a rotatable disc arranged in continuous magnetic relation with said pole piece, and means for directing a flow of current across said disc at different points about its circumference.

2. In combination, a cup-shaped permanent magnet having a central pole piece and a continuous peripheral pole piece, a rotatable disc arranged in continuous magnetic relation with said peripheral pole piece, and means for directing a flow of current through said disc at predetermined points in proximity to said peripheral pole piece.

3. In combination, two cup-shaped permanent magnets with continuous pole pieces, a rotatable current conducting member supported for rotation between said pole pieces, and an electric circuit for directing a flow of current through said member at definite points under said pole pieces.

4. The combination in a metering device of a magnet having a continuous circular pole piece, a disc supported for rotation in proximity to said pole piece, a member containing a current conducting liquid through which said disc rotates, and an electric circuit including said liquid for directing a flow of current through said disc at predetermined points.

5. The combination in a metering device of a magnet having a continuous circular pole piece, a disc supported for rotation in proximity to said pole piece, a member having annular channels filled with mercury, said disc having portions immersed in said mercury during its rotation, and an electric circuit including the mercury in said channels for directing a flow of current through the disc at different radial points.

6. In combination, a magnet having a continuous circular pole piece, a disc supported on a spindle for rotation in proximity to said pole piece, means for directing a flow of current through the disc at predetermined radial points, and a registering device driven by said spindle.

In witness whereof, I hereunto subscribe my name this 12th day of June, 1928.

JACOB R. FRY.