(No Model.) 2 Sheets—Sheet 1.

E. R. KNOWLES & L. T. ROBINSON.

ELECTRICAL MEASURING INSTRUMENT.

No. 516,823. Patented Mar. 20, 1894.

FIG. 1.

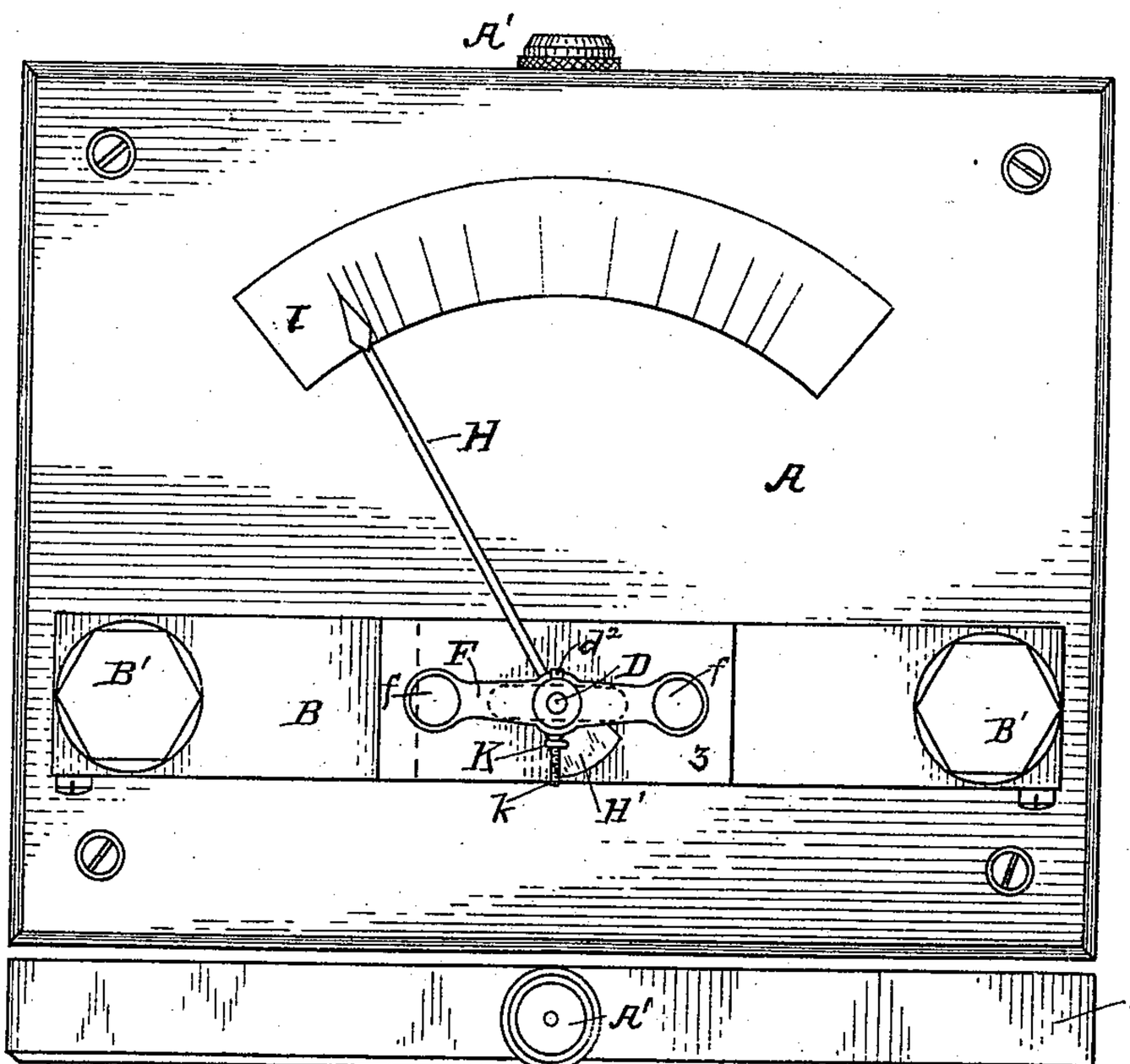


FIG. 2.

FIG. 3.

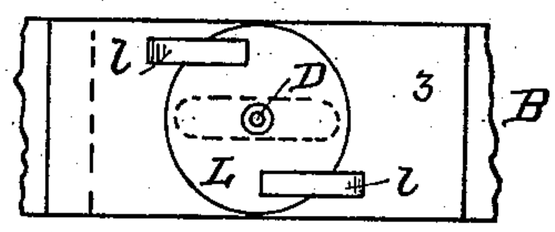
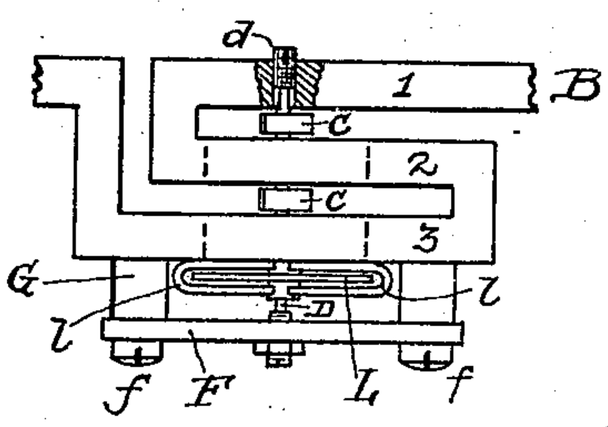


FIG. 4.



WITNESSES.

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(No Model.) 2 Sheets—Sheet 2.

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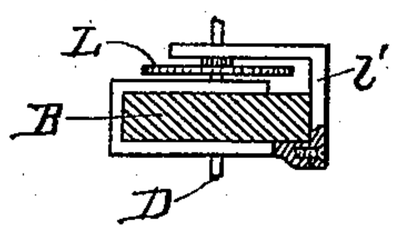
FIG. 5



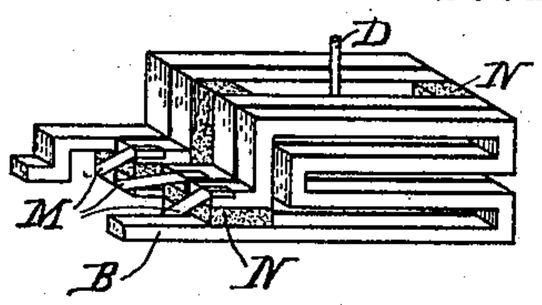


FIG. 6

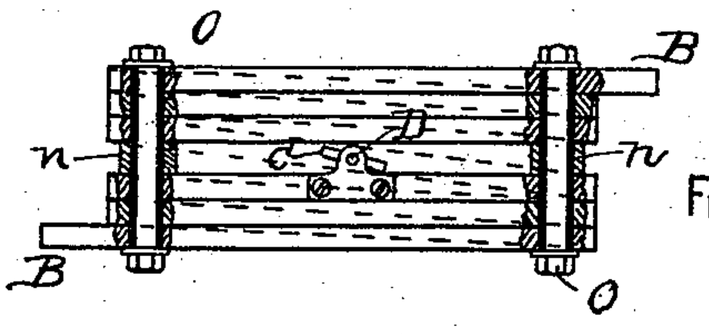


FIG. 7

FIG. 8.

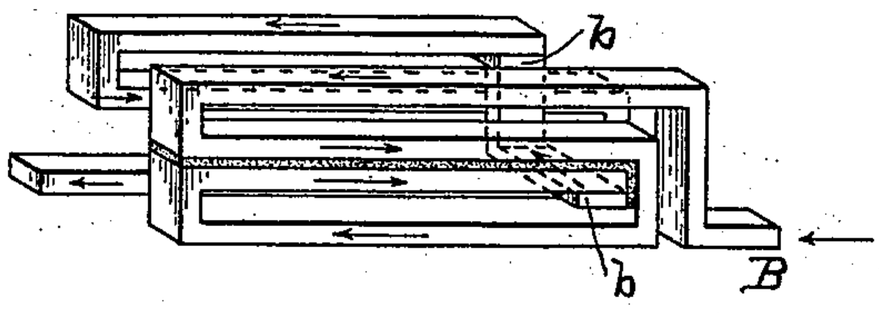
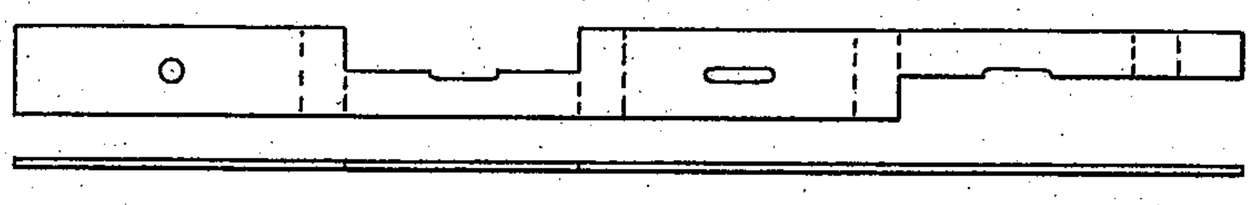


FIG. 9



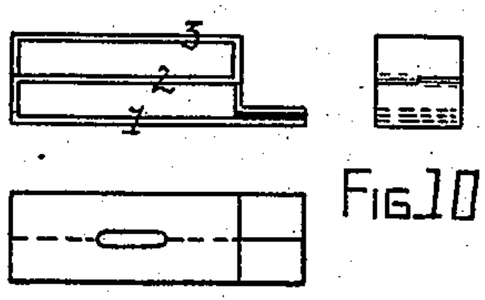


FIG. 10

FIG. 11

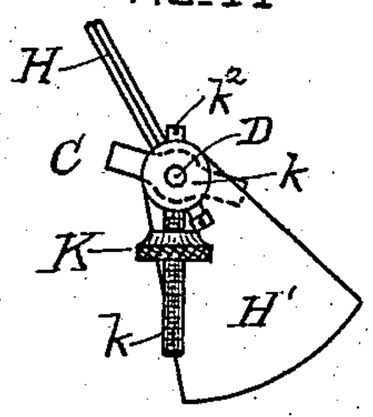


FIG. 12

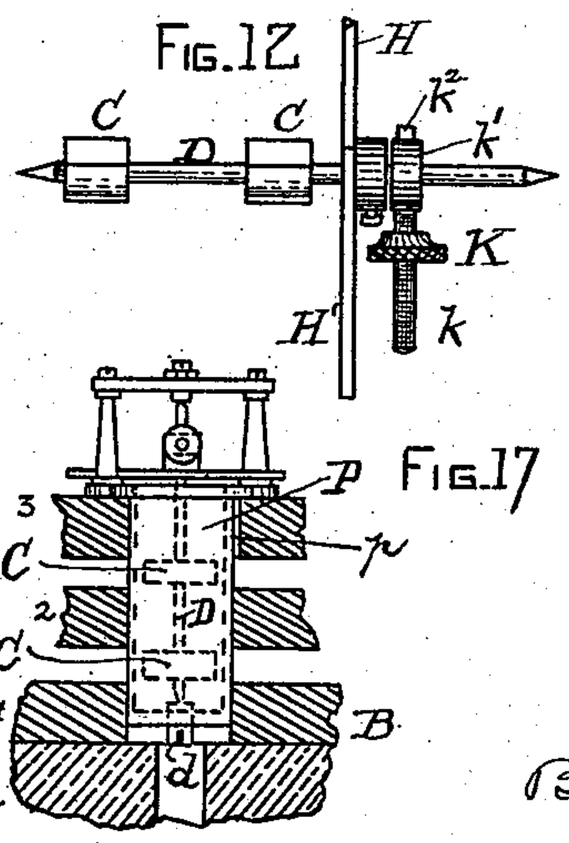


FIG. 13

FIG. 14

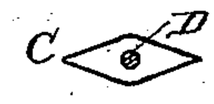


FIG. 15

FIG. 16

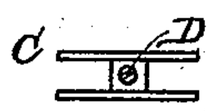


FIG. 17

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UNITED STATES PATENT OFFICE.

EDWARD R. KNOWLES AND LEWIS T. ROBINSON, OF MIDDLETOWN, CONNECTICUT, ASSIGNORS TO THE SCHUYLER ELECTRIC COMPANY, OF CONNECTICUT.

ELECTRICAL MEASURING-INSTRUMENT.

SPECIFICATION forming part of Letters Patent No. 516,823, dated March 20, 1894.

Application filed February 25, 1893. Serial No. 463,753. (No model.)

To all whom it may concern:

Be it known that we, EDWARD R. KNOWLES and LEWIS T. ROBINSON, citizens of the United States, residing at Middletown, in the county of Middlesex and State of Connecticut, have invented certain new and useful Improvements in Electrical Measuring-Instruments; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

Our invention relates to instruments that are placed in electric circuits for the purpose of indicating the amount of current flowing therein; commonly called ammeters.

The object of the invention is to simplify the construction and improve the efficiency of the instrument, and the invention consists in certain features hereinafter described and particularly pointed out in the claims.

In the drawings, Figure 1 is a front elevation of an ammeter embodying our invention. Fig. 2 is a plan view. Figs. 3, 4 and 5 are details of dampening or retarding devices. Figs. 6, 7 and 8 are details of loops. Fig. 9 is a blank for another form of loop. Fig. 10 shows edge, end and plan views of the blank bent into a loop. Figs. 11 and 12 are detail views of the needle. Figs. 13, 14, 15 and 16 are modifications of the needle; and Fig. 17 shows a modification in which the needles are inclosed in a removable frame.

In all the modifications shown the principle is the same, to wit: passing the electric current through a metallic bar so formed as to carry the current on each side of the magnetic needle, or each of them. Any number of needles may be mounted on the spindle, which is weighted or otherwise adjusted to cause the needles to stand normally in line with the bar, or preferably at a slight angle thereto, so that upon the passage of the current the needles are deflected toward or to a position at right angles with the bar, the angle of deflection depending upon the strength of the current.

The parts are mounted upon a base A, of insulating material, such as slate, provided on its upper edge with a spirit level A′. The conducting bar B is preferably horizontal, and at each end is a binding post B′ for connecting the line wires. The middle portion of the bar is folded upon itself two or more times, as clearly shown in the drawings, forming a loop composed of two or more parallel folds, 1, 2, 3, between which is room for the needle or needles C, rigidly mounted on the spindle D, which is stepped in jewel bearings. The inner bearing is adjustable, being set in the end of a screw *d*, tapped into a hole in the inner fold 1. The outer bearing may be similarly mounted, as in Fig. 4; or it may be held in the end of a rod *d′*, adjustable by means of a set screw d^2 in a socket E, secured to a cross-bar F fastened by screws *f* to studs G projecting from the outer fold 3 of the loop. Suitable registering holes are formed in the middle and outer folds 2, 3, to receive the spindle, these holes being preferably lengthened into slots, as indicated in dotted lines, to allow the needles to pass through them when the spindle is put into place or removed. By unscrewing the screws *f* and taking off the cross-bar F, the spindle with the needles, index H and counterweight H′, can be removed from the bar. The index is light, so that its inertia offers practically no resistance to the movement of the needles. It swings over a scale I, properly graduated in accordance with the ascertained angles of deflection under known variations of current. In practice it is found that sixty degrees is the best range for the index; though we do not limit ourselves to any particular range. The counterweight is made to just balance the index. In order to bring the index back to zero when the circuit is broken, a separate weight K is attached to the spindle, being adjustable toward and away from the spindle, preferably by making it in the form of a nut traversing a radial screw *k*. The end of the screw has a collar *k′*, fitting the spindle and

provided with a set screw k^2, whereby the screw can be angularly adjusted on the spindle so as to bring the index exactly to zero when no current is passing. The weight K is so adjusted on the screw that it is barely enough to return the index without shock. The meter can be set perfectly horizontal by means of the spirit level A'.

In order to lessen or eliminate the oscillation of the index, a brake or damper is provided, consisting preferably of a copper disk L, mounted on the spindle and rotating therewith. A magnet is arranged with its poles adjacent to opposite sides of the disk, so that the induced currents tend to retard the movement of the disk. Permanent horseshoe magnets *l l* may be used, as shown in Figs. 3 and 4, the disk passing between their poles. Or, a strip of soft iron *l'* may be placed around the bar B, with its ends overlapping and far enough apart to permit the disk to rotate between them. The current passing through the bar B induces magnetism in the soft iron, and the lines of force passing across between its overlapping ends act to retard the disk.

The needles best suited for instruments of this kind are made rather deep in the direction of the axis of the spindle and rather thin transversely thereto. They need not be very long. The reason for making the needle deep in the direction of the axis of the spindle, and thin in a direction transverse thereto, is to get sufficient mass for the lines of force to act on, and to confine them in such a narrow path that the needle is compelled to place itself exactly in line with them. If the needle was thicker, there would be a tendency to what is called cross-magnetization, and the needle would not place itself exactly in line.

Fig. 11 shows a simple needle, rectangular in cross section. Fig. 13 shows two such needles, one being given a slight lead over the other to insure their starting promptly, and in the right direction. It has been found that it is essential to give one or both of the needles a lead of (say) fifteen degrees, since otherwise if they stood parallel with the bar they would be on a "dead center," and might start in the wrong direction. The particular amount of lead is, however, immaterial, and we do not limit ourselves to any specific number of degrees.

Fig. 14 shows a needle diamond-shaped in plan. Fig. 15 shows a hollow diamond. Fig. 16 shows a needle composed of two parallel plates. Or it may represent a longitudinal section of a tubular needle.

When it is desired to have the current flow more than twice by each needle, a series of loops is used, as shown in Figs. 6, 7 and 8. The loops are placed side by side, and connected in series by means of cross-pieces M, or a flexible coupling. Where the ends of the loops approach each other, they are separated by means of insulation N. Fig. 7 shows in plan view a battery of six loops arranged in two groups of three each, placed side by side and insulated from each other. Insulating washers *n* are placed between the groups, and insulated bolts O hold all the loops together. The spindle D passes through the opening between the two groups. The loops are connected in series by means of metal strips, placed preferably on the back of the base A, and insulated from each other. These strips are indicated by the dotted lines in Fig. 7. In the loops shown in Fig. 8, the current flows twice by each needle, but in opposite directions to Fig. 6; that is to say, in Fig. 6 the current flows to the right under each needle and to the left above them; while in Fig. 8 it flows to the right under one and to the left under the other, and vice versa over them. These loops in Fig. 8 can be readily cut out with dies, or may be cast. The inside end of one loop is connected with the outside end of the next, by the bent strip of metal *b*.

Fig. 9 shows a blank of sheet metal, which when properly folded on the dotted lines makes the loop shown in Fig. 10.

In case it is desired to have one size of needles serve for a number of instruments of largely varying capacity, the spindle carrying the needles and index is mounted in jewel bearings in a frame or tube P, which is inserted into registering holes cut in the folds of the loop. To keep the tube in proper alignment, it is provided with an external rib or key *p*, which engages a slot in one or more folds of the loop. By making all the instruments with holes of a standard size, one size of needles can be used for all, and readily inserted or removed.

Having thus described our invention, what we claim as new is—

1. An ammeter consisting of the combination with a conducting bar folded into three or more folds with spaces between them, the outer folds containing registering holes, of a spindle, two or more magnetic needles mounted thereon and adapted to pass through said holes with the spindle, and turn freely in the spaces aforesaid, and suitable bearings for the ends of the spindle, substantially as described.

2. In an ammeter, the combination with the conducting bar, of a strip of soft iron inclosing it, and a spindle carrying a copper disk turning freely between the separated overlapping ends of said strip, substantially as described.

3. An ammeter comprising two or more magnetic needles, one of which is given a lead over the other or others, substantially as described.

4. An ammeter comprising a magnetic needle made deep in the direction of the axis of the spindle and thin in a direction transverse thereto, substantially as described.

5. An ammeter having its spindle mounted in a frame removable bodily from the conducting bar without disturbing the mounting of the spindle, substantially as described.

6. An ammeter comprising a spindle mounted in a tube fitting into registering holes in the folds of a folded conducting bar, substantially as described.

In testimony whereof we affix our signatures in presence of two witnesses.

EDWARD R. KNOWLES.
LEWIS T. ROBINSON

Witnesses:
JOS. A. LYNCH,
WM. E. BANTA.