

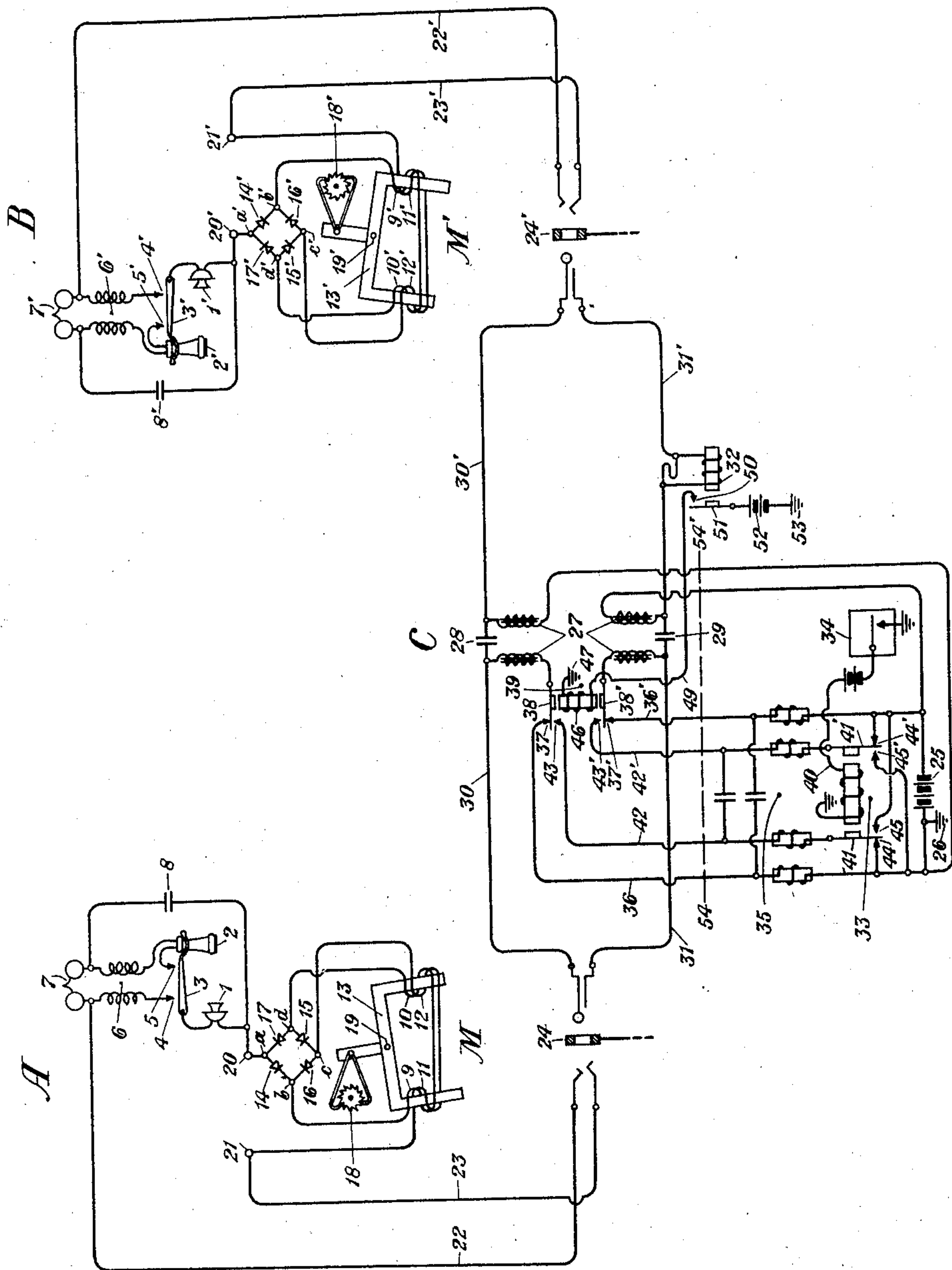
Dec. 31, 1929.

H. M. BASCOM

1,741,272

TELEPHONE SYSTEM

Filed Nov. 30, 1928



INVENTOR
H. M. Bascom
BY *g r t o r k*
ATTORNEY

UNITED STATES PATENT OFFICE

HENRY M. BASCOM, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

TELEPHONE SYSTEM

Application filed November 30, 1928. Serial No. 322,729.

This invention relates to telephone metering systems, and more particularly to meters by means of which the subscribers are charged for the length of time their telephones are in use.

In such systems it has been proposed to operate a meter located either at the substation or at the central office by periodically reversing the direction of current flow in the telephone circuit. It is an object of this invention to provide a simple, efficient and inexpensive meter adapted to be used in connection with such systems.

The invention comprises in combination with a telephone metering system, a meter which includes a plurality of windings in the form of solenoids, means for controlling the direction of current flow through said windings, said windings being so related to one another that when the current flow through the terminals of the meter is in one direction, one set of said windings is series aiding while the remaining set is series opposing, and when the current flow is in the opposite direction, said first mentioned set is series opposing while the remaining set is series aiding, and means for registering the number of times each of said sets becomes series aiding.

A better understanding of the invention may be had from the detailed description hereinafter following.

The drawing represents diagrammatically a telephone circuit illustrating one embodiment of the invention.

In the drawing two subscribers' stations A and B are shown with subscribers' loops extending to the central office and terminating in the jacks 24 and 24'. As shown, A represents the station of the calling subscriber and B that of the called subscriber. Substation A comprises the usual transmitter 1, receiver 2, receiver hook 3, contacts 4 and 5, induction coil 6, ringer 7 and capacity 8. In addition, there is located at the substation a meter M having terminals 20 and 21 and including unidirectional elements 14, 15, 16 and 17, a plurality of windings 9, 10, 11 and 12, the armature 13 and counter mechanism 18. The unidirectional elements 14, 15, 16 and 17,

which are preferably copper oxide rectifiers, are arranged in the form of a bridge, for example in the form of a Wheatstone bridge, or of a full wave rectifier bridge—that is, the elements 14 and 15, which are located respectively in the opposite arms $a-b$ and $c-d$, permit the passage of current therethrough in one direction only and the elements 16 and 17, which are located respectively in the opposite arms $b-c$ and $a-d$, permit the passage of current therethrough in the opposite direction only. This bridge has two diagonals $b-d$ and $a-c$. The diagonal $b-d$ includes the windings 9 and 10; the diagonal $a-c$ includes the windings 11 and 12, the subscribers' lines 22 and 23 and the telephone circuit. As shown, the windings are in the form of solenoids, the winding 9 being a right-hand spiral and the windings 10, 11 and 12 being left-hand spirals. The windings 9 and 11 and 10 and 12, respectively, are grouped together, the windings in each group being inductively related to each other. Due to the arrangement of the unidirectional elements and to the connection of the diagonals as described above, the same direction of current flow is maintained at all times through the diagonal $b-d$, which includes the windings 9 and 10, even when the direction of current flow in the lines 22 and 23 is varied, but the direction of current flow through the diagonal $a-c$, which includes the windings 11 and 12, is varied in accordance with the change in the direction of current flow in said lines. When the current flow through the windings 11 and 12 is in one direction the magnetic fluxes of the pair of windings 9—11 becomes series aiding while those of the pair 10—12 are series opposing, and when the current flow through the windings 11 and 12 is in the opposite direction the magnetic fluxes of the pair 9—11 becomes series opposing while those of the pair 10—12 are series aiding. In short, as the direction of current flow in the lines 22 and 23 is periodically reversed, the windings 9—11 become successively series aiding and series opposing and the windings 10—12 become successively series opposing and series aiding.

A U-shaped armature 13, made of a mate-

rial of high permeability such as soft iron, is pivoted at 19 and so placed with respect to the windings that its legs may move or vibrate freely within the pairs of solenoids 9—11 and 10—12. During the period when the windings 9—11 are series aiding and the windings 10—12 are series opposing, the armature 13 will be attracted toward the windings 9—11, due to the strong magnetic force exerted thereby. At the same time, the windings 10—12, being series opposing or neutral, will exert no magnetic force thereon. During the period when the windings 9—11 are series opposing and the windings 10—12 are series aiding, said armature will be attracted toward the windings 10—12, for the same reasons, while the windings 9—11 will exert no magnetic force thereon. The counter mechanism 18, including two pawls attached to an extension of the armature and a ratchet-wheel, is provided to register the number of times the armature is attracted toward each pair of windings when it is series aiding. The moment of inertia of the armature 13, which is balanced on pivotal elements at 19, is sufficiently high to render it sluggish in operation in order to prevent false registration. Also, the armature is so designed that it will remain in either extreme position at all times except during the moment when the current is being reversed. Although the armature has been shown and described as a balanced U-shaped armature, it is obvious that it may be of any convenient shape or may be biased.

In the particular embodiment shown in the drawing there is disclosed a meter having four windings of which one is a right-hand spiral and the remaining three left-hand spirals. However, it should be understood that four windings may be used of which one is a left-hand spiral and the remaining three right-hand spirals, or any number of windings may be used, provided that where more than four windings are used, the ratio of three left-hand spirals to one right-hand spiral, or of three right-hand spirals to one left-hand spiral, is maintained. Likewise, it should be understood that this invention is not limited to a meter having unidirectional elements in the form of a bridge. Other analogous means may be employed to maintain the same direction of current flow through the windings 9 and 10 and to vary the direction of current flow through the windings 11 and 12 when the direction of current flow through the lines 22 and 23 is varied.

The arrangement at substation B is the same as that shown at substation A and described above.

The cord circuit C of the central office is here illustrated as the impedance coil feed type. Obviously, a cord circuit of the repeating coil feed type may be used, if de-

sired. The cord circuit shown comprises the usual current source 25 grounded at 26, a current supply bridge comprising the impedance coils 27, the capacities 28 and 29, the cord conductors 30, 30', 31 and 31' and the supervisory relay 32. In addition, there is located at the central office a current reversing means 33 under the control of the clock mechanism 34. This reversing means comprises the contacts 44, 44', 45 and 45', the relay circuit 40, the armatures 41 and 41', the leads 42 and 42' and the contacts 43 and 43'. Normally, the impedance coils of the current supply bridge of the calling subscriber's line are connected directly to the source 25 through the leads 36 and 36', the contacts 37 and 37' and the armatures 38 and 38'. A switching means 39 under the control of relay 32 is provided to associate the current supply bridge of the calling subscriber's line with the source 25 through the reversing means 33. This switch comprises the relay 46 grounded at 47, the armatures 38 and 38', the conductor 49, the contact 50, the armature 51 and the source 52 grounded at 53. A filter element 35 comprising a plurality of choke coils and high capacity condensers is associated with the leads 36, 36', 42 and 42' to prevent any objectionable disturbances in the talking circuit.

The operation of the system is as follows. When the calling subscriber at station A removes his receiver from the hook to initiate a call the operator, in response to the signal, establishes a connection to the central office in the well known manner. At this time the current flows from the positive terminal of the source 25 through the lead 36, the contact 37, the armature 38, the upper left impedance coil 27, cord conductor 30, the jack 24, the line 22, the left winding of the induction coil 6, the contact 4, the receiver hook 3, the transmitter 1, the terminal 20, the unidirectional element 14, the windings 9 and 10, the unidirectional element 15, the windings 12 and 11, the terminal 21, the line 23, the jack 24, the cord conductor 31, the lower left impedance coil 27, the armature 38', the contact 37' and the lead 36' to the negative terminal of the source 25. The windings 9—11 become series aiding while the windings 10—12 become series opposing and the armature 13 is attracted toward the windings 9—11, if at the termination of the previous conversation said armature was at its other extreme position. This movement of the armature causes the counter mechanism to be advanced one step. If at the termination of the previous conversation the armature was in the position to which it is attracted when the windings 9—11 are series aiding, it will, of course, remain in said position when the windings 9—11 again are series aiding and no registration will be made on the counter mechanism. The ringing current transmitted

over the line of the called subscriber does not operate the meter located at his substation because the meter is made sufficiently sluggish in operation to prevent its response to the rapid variation of the ringing current. After the connection has been completed through the cord circuit C to the station B of the called subscriber, and when the called subscriber removes his receiver from the hook, the circuit including the relay 32 will be closed in the well known manner. The closure of this circuit and the resulting energization of the relay 32 causes the latter to attract its armature 51, which establishes a connection with the contact 50. The establishment of this connection closes the circuit of the relay 46 and causes its energization. When energized this relay attracts its armatures 38 and 38' to break their connection with the contacts 37 and 37', respectively, and to establish their connection with the contacts 43 and 43', respectively. This breaks the direct connection of the impedance coils of the current supply bridge of the calling subscriber with the source 25 and reconnects it to said source through the reversing means 33. At this time, if the relay circuit 40 is open, the current flows from the positive terminal of the source 25 through the contact 44, the armature 41, the lead 42, the contact 43, the armature 38, the upper left impedance coil 27, the cord conductor 30, the jack 24, out over the subscriber's loop in the same direction as before, back through the jack 24, the cord conductor 31, the lower left impedance coil 27, the armature 38', the contact 43', the lead 42', the armature 41' and the contact 44' to the negative terminal of the source 25. Obviously, no further registration of the meter of the calling subscriber is produced. At predetermined intervals of time, for example every fifteen seconds, the clock mechanism 34 closes the relay circuit 40, which causes the armatures 41 and 41' to break their connection with the contacts 44 and 44', respectively, and establish their connection with the contacts 45 and 45', respectively. This causes the reversal of the current flowing through the lines 22 and 23. The current now flows from the positive terminal of the source 25 through the contact 45', the armature 41', the lead 42', the contact 43', the armature 38', the lower left impedance coil 27, the cord conductor 31, the jack 24, the line 23, the terminal 21, the windings 11 and 12, the unidirectional element 16, the windings 9 and 10, the unidirectional element 17, the terminal 20, the transmitter 1, the receiver hook 3, the contact 4, the left winding of the induction coil 6, the line 22, the jack 24, the cord conductor 30, the upper left impedance coil 27, the armature 38, the contact 43, the lead 42, the armature 41 and the contact 45 to the negative terminal of the source 25. It will be noted that upon the reversal of the line

current the direction of current flow through the windings 11 and 12 is reversed, but the direction of current flow through the windings 9 and 10 remains the same. With this direction of current flow in the lines, the windings 9—11 become series opposing and the windings 10—12 become series aiding. The armature 13 is now attracted toward the windings 10—12 due to the strong magnetic force exerted thereby, while the windings 9—11, being series opposing or neutral, have no effect thereon. This movement of the armature through its arc of vibration to its other extreme position causes the counter mechanism to be advanced one step. It is obvious that each time the current is reversed the counter mechanism will be advanced one step, and that the meter of the calling subscriber will record the actual time during which his instrument is used for conversational purposes in calls which he initiates. When the receivers are returned to the hooks the meter and the reversing means are removed from the circuit.

As shown and described, the current reversing means is connected on one side of the cord circuit only since, in general, it is desirable to charge the call to the calling subscriber only. It is obvious, however, that the same mechanism could be applied on the other side of the cord circuit or on both sides of the cord circuit, if desired. The current reversing means 33 indicated in the drawing below the dotted line 54—54' may be common to all the cords of a given exchange or to a group of cords or, if desired, may be supplied for each cord separately. Likewise, the association of said current reversing means with the cord circuit may be under the control of other means than the relay 32 in such a manner that the operation of the meter will begin at any desired time during the connection.

While this invention has been illustrated in connection with a typical cord circuit using manual operation, it is apparent that it is equally applicable to machine switching apparatus.

What is claimed is:

1. In a measuring device having terminals, a plurality of windings connected between said terminals and adapted to be energized, a plurality of unidirectional elements arranged in Wheatstone bridge fashion between said terminals and said windings and adapted to control the direction of current flow through said windings, certain of said windings being inductively related to one another and adapted to be successively series aiding and series opposing, and the remainder of said windings being inductively related to one another and adapted to be successively series opposing and series aiding when the direction of current flow through said terminals is varied, and means under the influ-

ence of said windings for determining the number of times said windings become series aiding.

2. In a measuring device having terminals, a plurality of windings connected between said terminals and adapted to be energized, means for controlling the direction of current flow through said windings, certain of said windings being inductively related to one another and adapted to be successively series aiding and series opposing and the remainder of said windings being inductively related to one another and adapted to be successively series opposing and series aiding when the direction of current flow through said terminals is varied, and means under the influence of said windings for determining the number of times said windings become series aiding.

3. In a measuring device having terminals, a plurality of windings connected between said terminals and adapted to be energized, means for controlling the direction of current flow through said windings, said windings being inductively related and adapted to be alternately series aiding and series opposing when the direction of current flow through said terminals is varied, and means under the control of said windings for determining the number of times said windings become series aiding.

4. A measuring device including a pair of terminals, a plurality of windings connected between said terminals and adapted to be alternately series aiding and series opposing when the direction of current flow through said terminals is varied, and means under the influence of said windings for determining the number of times said windings become series aiding.

5. A meter including a pair of terminals, a plurality of pairs of windings connected between said terminals, the windings of each of said pairs being inductively related to each other and so arranged with respect to each other that when the same direction of current flow is maintained through a first winding of each of said pairs and the direction of current flow through the other winding of each of said pairs is varied, the windings of certain of said pairs are successively series aiding and series opposing and the windings of the remainder of said pairs are successively series opposing and series aiding, means for maintaining the same direction of current flow through said first winding of each of said pairs and for varying the direction of current flow through said other winding of each of said pairs when the direction of current flow through said terminals is varied, and means under the influence of said pairs of windings which are series aiding for determining the number of times the direction of current flow through said terminals is varied.

6. In a meter having two terminals, the combination of two pairs of solenoids connected between said terminals and adapted to be energized, the solenoids of each of said pairs being inductively related to each other, a plurality of copper oxide rectifiers arranged between said terminals and said solenoids in the manner of a full wave rectifier and adapted to control the direction of current flow through said solenoids, one of said pairs of solenoids being adapted to be successively series aiding and series opposing and the other of said pairs being adapted to be successively series opposing and series aiding when the direction of current flow through said terminals is varied, a U-shaped armature of high magnetic permeability pivoted at its midpoint and adapted to be attracted toward the pair of solenoids which is series aiding, and counter mechanism for registering the number of times said armature is attracted toward the pair of solenoids which is series aiding.

7. An electrical bridge comprising four arms, a unidirectional element located in each of said arms, the unidirectional elements in one pair of opposite arms being adapted to permit the passage of current therethrough in one direction and the unidirectional elements in the other pair of opposite arms being adapted to permit the passage of current therethrough in the opposite direction, a first diagonal including a pair of windings, a second diagonal including a pair of windings and a source of current, each of said windings in said first diagonal being inductively related to a corresponding winding in said second diagonal, and the fluxes of one of said inductively related pairs of windings being adapted to be successively series aiding and series opposing and the fluxes of the other of said inductively related pairs of windings being adapted to be successively series opposing and series aiding when the polarity of said source of current is reversed, and means for determining the number of times the fluxes of each of said inductively related pairs of windings are series aiding.

8. In combination, an electrical bridge comprising four arms, a rectifying means located in each of said arms, the rectifying means in one pair of opposite arms being adapted to permit the passage of current therethrough in one direction and the rectifying means in the other pair of opposite arms being adapted to permit the passage of current therethrough in the opposite direction, a first diagonal including a first winding and a second winding, and a second diagonal including a third winding, a fourth winding and a source of current adapted to be periodically reversed, said first and said second windings being inductively related to said third and fourth windings, respectively, and when the polarity of said source of current

is reversed the magnetic fluxes of said first and third windings being adapted to be alternately series aiding and series opposing at the same time that the magnetic fluxes of
5 said second and fourth windings are alternately series opposing and series aiding, a pivoted armature adapted to be attracted alternately toward said first and third windings and toward said second and fourth
10 windings when their respective magnetic fluxes are series aiding, and counter mechanism for registering the number of times said armature moves through its arc of vibration.

9. In combination, an electrical bridge
15 comprising four arms, rectifying means located in each of said arms, the rectifying means in one pair of opposite arms being adapted to permit the passage of current therethrough in one direction and the rectify-
20 ing means in the other pair of opposite arms being adapted to permit the passage of current therethrough in the opposite direction, and a pair of opposite diagonals each including a winding, said windings being in
25 proximity to and in coaxial alignment with each other, a source of current, the polarity of which is periodically reversed, adapted to be connected in one of said diagonals, the magnetic fluxes of said windings being
30 adapted to be alternately series aiding and series opposing when the polarity of said source of current is reversed, an armature adapted to be attracted toward said windings when the magnetic fluxes thereof are series
35 aiding, and counter mechanism for determining the number of times said armature is attracted toward said windings.

In testimony whereof, I have signed my name to this specification this 28th day of No-
40 vember 1928.

HENRY M. BASCOM.

45

50

55

60

65