Feb. 18, 1930. G. BABCOCK 1,747,210

TELECHRONOMETER

Filed Oct. 15, 1921 5 Sheets-Sheet 1

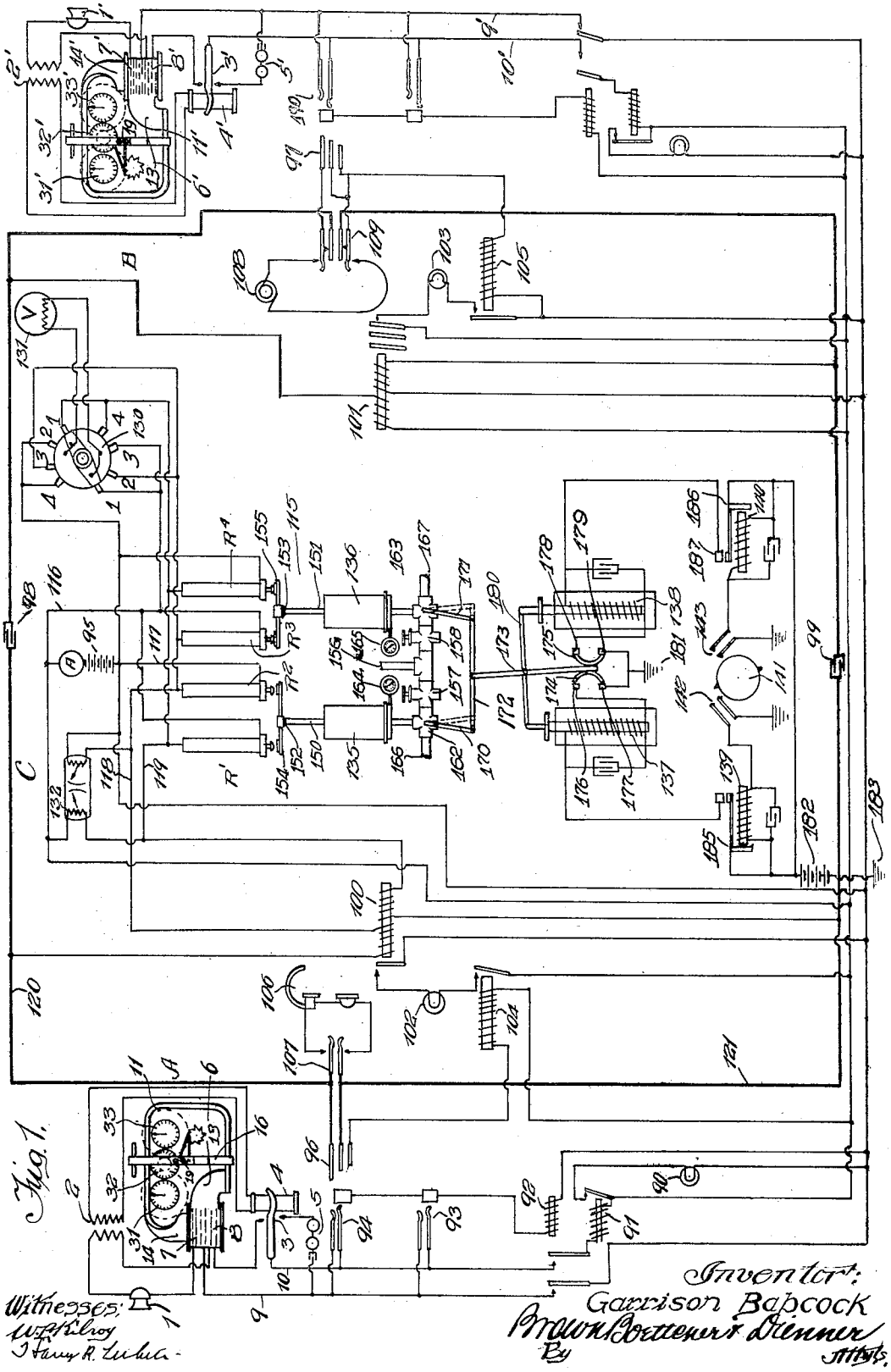


Fig. 1.

Witnesses:
W. F. Kelley
Harry R. Lubcke

Inventor:
Garrison Babcock
By Brown, Critchlow & Flannery
Attys.

Feb. 18, 1930. G. BABCOCK 1,747,210

TELECHRONOMETER

Filed Oct. 15, 1921 5 Sheets-Sheet 2

Fig. 2.

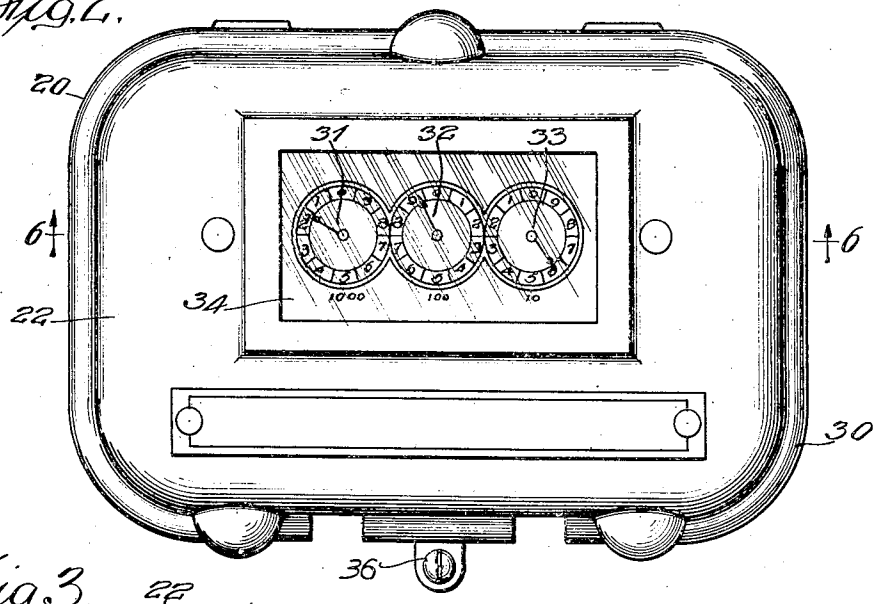


Fig. 3.

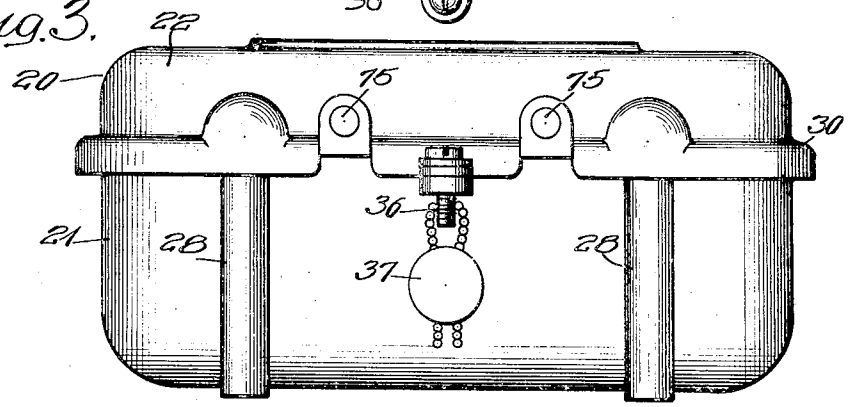
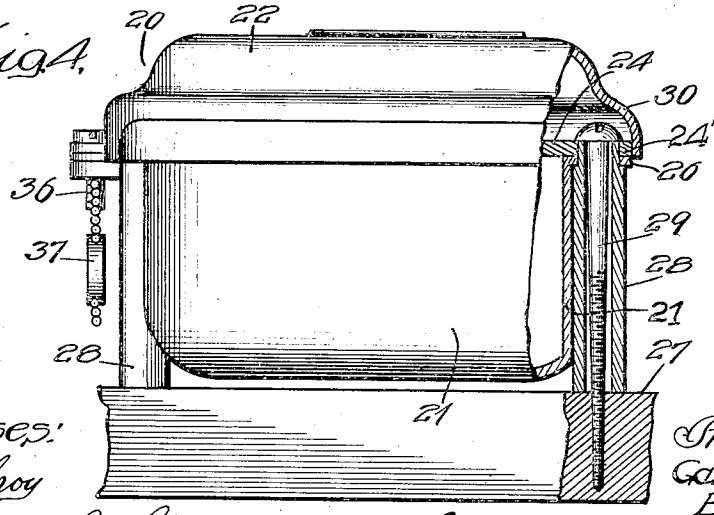


Fig. 4.



Witnesses:
W. P. Kilroy
Harry R. LaMotte

Inventor:
Garrison Babcock
By Brown Boardman Dinner
Attys.

Feb. 18, 1930. G. BABCOCK 1,747,210

TELECHRONOMETER

Filed Oct. 15, 1921 5 Sheets-Sheet 3

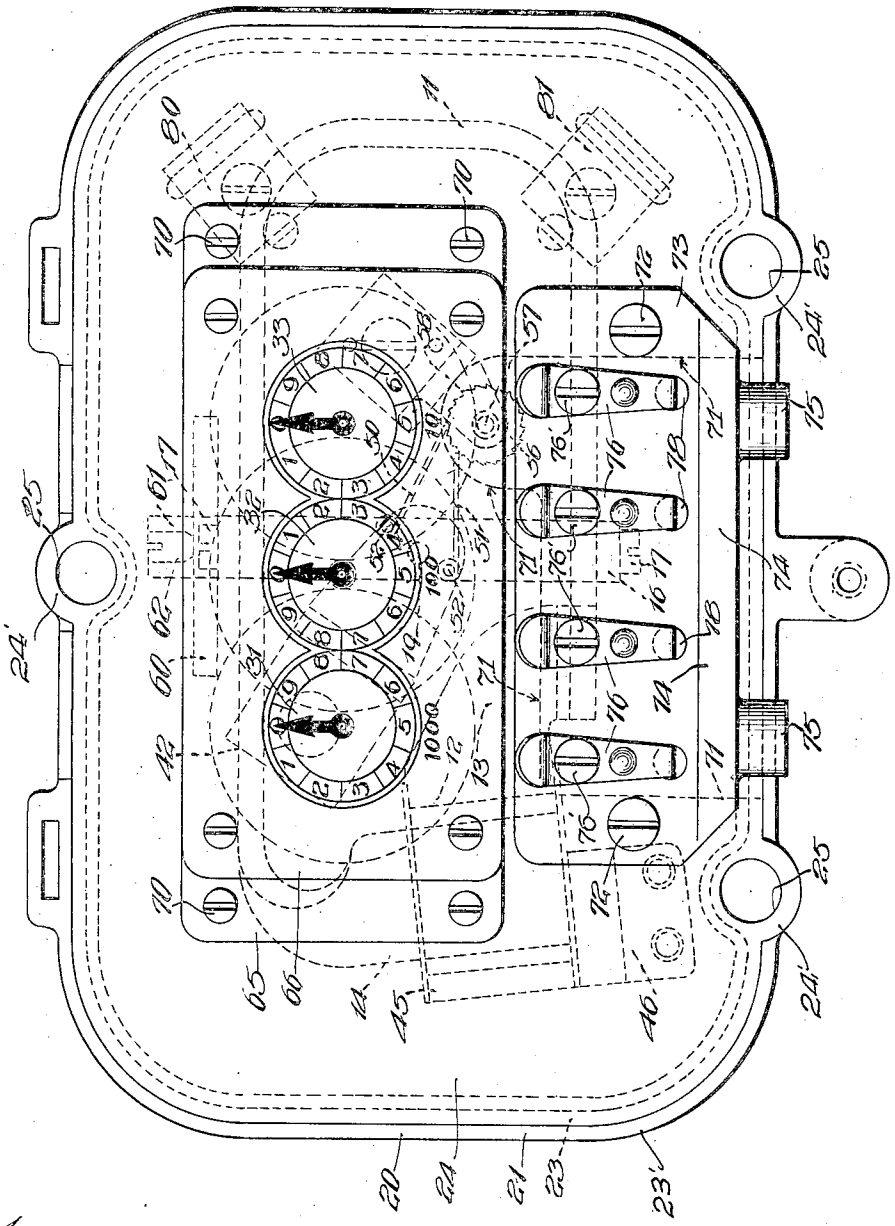


Fig. 5.

Witnesses:
W. L. Kilroy
Harry P. Lewis

Inventor:
Garrison Babcock
By Brown, Bottcher and Dienner
Attys.

Feb. 18, 1930. G. BABCOCK 1,747,210

TELECHRONOMETER

Filed Oct. 15, 1921 5 Sheets-Sheet 4

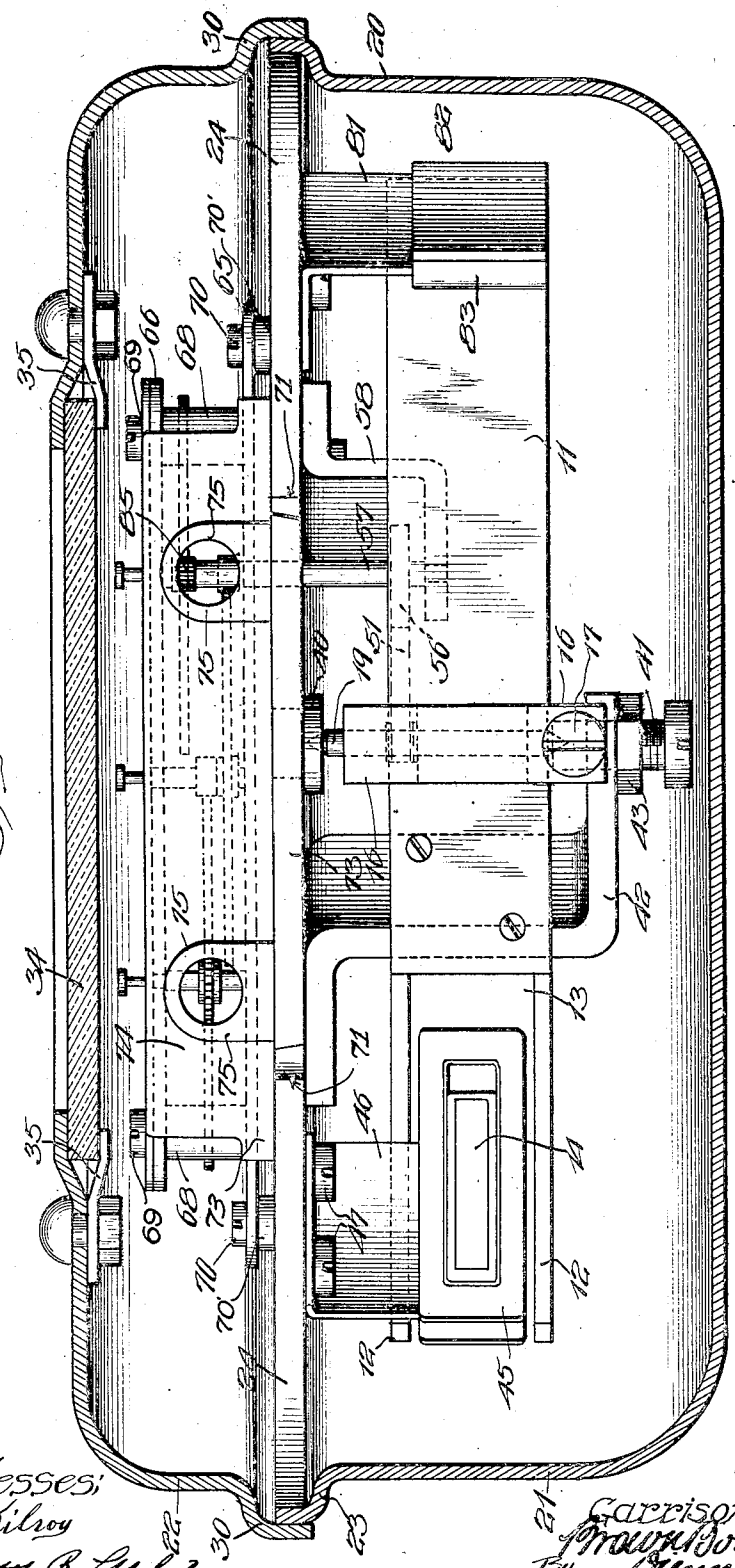


Fig. 6

Witnesses:
W. F. Kilroy
Fanny R. Lubitz

Inventor:
Garrison Babcock
By Mowry, Bottcher and Klenner
Attys

Feb. 18, 1930. G. BABCOCK 1,747,210

TELECHRONOMETER

Filed Oct. 15, 1921 5 Sheets-Sheet 5

Fig. 8

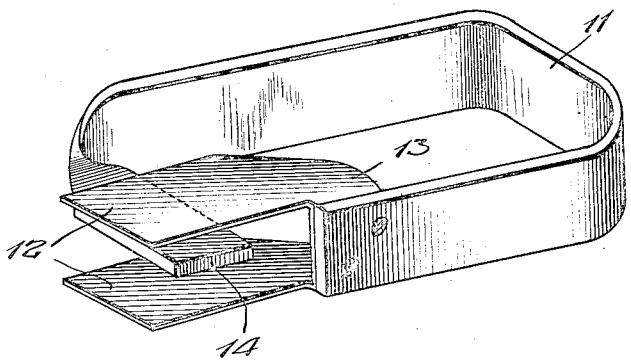


Fig. 7.

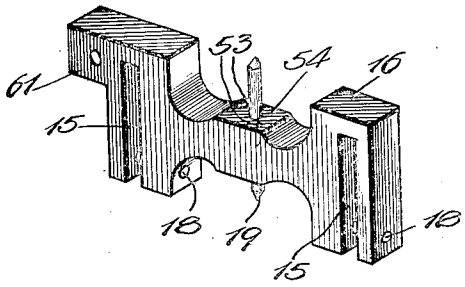


Fig. 10

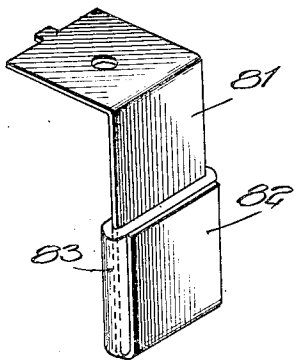
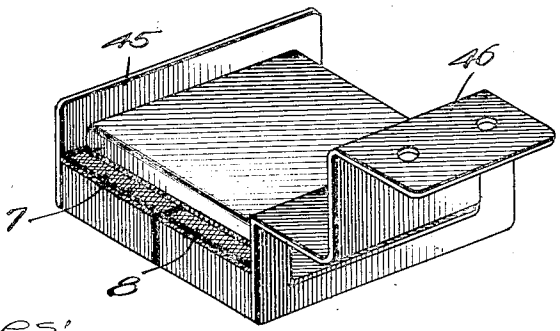


Fig. 9.



Witnesses:
W. P. Kilroy
Harry R. Lubcke

Inventor:
Garrison Babcock
By Brown, Gottscher and Dienner
Attys.

Patented Feb. 18, 1930

1,747,210

UNITED STATES PATENT OFFICE

GARRISON BABCOCK, OF EVERETT, WASHINGTON, ASSIGNOR TO AMERICAN TELECHRONOMETER COMPANY

TELECHRONOMETER

Application filed October 15, 1921. Serial No. 508,037.

My invention relates to means for metering and registering the number of time units consumed by a flow of current in an electrical circuit, and is concerned particularly with a novel and improved form of reversal responsive metering device of the type known under the trade name of "Telechronometer" for measuring and registering the time units consumed by a message in a telephone system employing means for converting or securing reversals of current flow and for applying them to the meter.

While my present invention is particularly directed to a novel and improved form of meter, especially adapted for use in telephone systems and the manner in which it is employed in a system having periodic reversals of current flow over the calling line, it is not limited to employment in telephone systems, or if employed in a telephone system, it is not limited to employment in the specific telephone system, nor to the particular manner of employment i. e., method of connection and application, which I have elected to describe in the following specification.

My present invention which is along the line of the invention set out in my co-pending application, Serial No. 476,712, filed June 11, 1921 provides primarily an improved operating element which, while compact is powerful and of a simple and rugged character. The meter of my present invention employs two stationary operating coils of a novel form and arrangement, which, as in my above co-pending application, are connected serially, one in each side of the line, whereby the circuit is balanced and the transmission thereby improved. The metering arrangement of my present invention, as in my co-pending application, makes surreptitious or accidental shunting of the meter practically impossible. My present invention provides in addition to a novel and improved form of operating element a novel and improved arrangement of simple, compact, rugged and reliable character for registering the number of time units consumed by a conversation or connection.

Certain constructional features and arrangements of my present invention, which aims to standardize a meter of the "telechronometer" type, are novel and important, and these together with such other provisions as have not been already set forth will appear from the following detailed description, taken with an inspection of the accompanying drawings, in which I have disclosed a particular embodiment of my invention in order to explain more fully to those skilled in the art how to construct and practice the same.

In the drawings:

Figure 1 is a diagrammatic illustration of a telephone system, embodying my invention;

Figure 2 is a face view (front elevation) of a meter embodying my invention;

Figure 3 is a bottom side elevational view of the same;

Figure 4 is an end elevational view, partially broken away, to show the manner of mounting the meter;

Figure 5 is an enlarged face view with the cover or lid removed;

Figure 6 is an enlarged horizontal sectional view through the housing or casing of the meter substantially on the line 6—6 of Figure 2 showing the metering mechanism therewithin in elevation;

Figure 7 is an isometric view of the magnet holder employed;

Figure 8 is an isometric view of the magnet;

Figure 9 is an isometric view of the coil spool showing the arrangement and insulation of the coils thereon in section; and

Figure 10 is an isometric view of one of the magnet bumpers.

As illustrated in Figure 1, the system in which my invention is embodied comprises a calling sub-station A, called sub-station B, and connecting cord circuit C, located preferably at a central switchboard.

The calling sub-station A comprises a transmitter 1, induction coil 2, automatic switch hook 3, receiver 4 and a suitable call bell 5. In addition, I provide a meter 6, having its coils 7 and 8 connected serially in the two limbs of the subscriber's line. The sub-station A is connected by suitable line wires 9 and 10 to line signaling and switching apparatus in a manner, which will be

described more in detail as this description proceeds.

The meter 6, per se, which is shown in detail in Figures 2 to 10, inclusive, comprises a permanent magnet 11 of general rectangular form having its opposite ends brought relatively near each other. The parallel arms 12 of a channel shaped pole piece 13 secured to one end of the magnet 11 as by means of suitable screws as shown in Figure 8 project out in parallel planes at substantially right angles to the plane of the adjacent end of the magnet 11. The opposite end or pole 14 of the magnet 11 is twisted, as shown in Figure 8 to lie in a plane parallel to the arms 12 of the pole piece 13 and projects between the arms 12 as shown. The longitudinal side portions of the permanent magnet 11 are mounted in openings 15 in a magnet holder 16, and securely clamped therein as by means of suitable screws 17 or the like (Figures 5 and 6) for the reception of which screws 17 suitable openings 18 are provided. A pivot post or spindle 19 forms the pivot about which the magnet holder 16 is adapted for rocking movement, back and forth in accordance with the prevailing polarity in the coils 7 and 8. The coils 7 and 8 surround the end or pole 14 of the magnet 11, and are embraced by the arms 12 projecting from the opposite end or pole thereof. These coils 7 and 8 are so connected and mounted in the line wires 9 and 10, that they tend to produce the proper polarity cumulatively to swing the magnet 11 about the pivot 19 to the position corresponding to the polarity impressed upon the lines 9 and 10.

The metering mechanism is enclosed in a housing or casing 20 comprising a bottom casing portion 21, and an upper casing or lid portion 22. The upper edge of the bottom casing portion 21 is flared out as shown at 23 to provide a peripheral seat for a frame, or meter mechanism carrying plate 24, which is mounted in this upper flared portion 23 of the casing portion 21. Apertures 25 at the projecting ear portions 24′ of the plate 24 register with similar apertures in flanges or ledge portions 26 formed integral with the lower casing portion 21. The peripheral flange or lip 23′ is cut away to provide room for the apertured ears 25. The meter is mounted upon a mounting board 27 or other suitable support by means of mounting posts 28 and suitable screws 29, the posts 28 having upper reduced ends extending into the registering apertures in the plate 24 and flanges or ledge portions 26 substantially as shown in Figure 4. The upper casing portion or lid 22, is provided with a skirt 30 which covers the upper flared edge 23 of the bottom 21. The lid 22 is provided with an opening through which the indicating devices 31, 32 and 33 may be viewed. A glass or other suitable covering 34 for this opening is clamped in place by means of suitable clamping arms 35 bolted or otherwise suitably secured to the lid 22. The lid 22 is held against opening by a screw 36 and a suitable seal 37, breaking of which seal is necessary before opening the lid.

The opposite ends of the pivot post 19 bear in pivot bearings 40 and 41 respectively. The bearing 40 is mounted in the plate 24 as shown in Figure 6. The bearing screw 41 is threaded through an arm of a bracket member 42 which is mounted upon and depends from the underside of the plate 24. A lock nut 43 locks pivot bearing 41 in place. The coils 7 and 8 are wound upon a common spool 45 mounted on a bracket 46 which is fastened by screws 47 upon the underside of the mounting plate 24. The coils 7 and 8 are preferably wound and insulated as shown in Figure 9. They may, however, be wound and insulated in any other desired manner.

The magnet holder 16 is provided with a pair of ratchet pawls 50 and 51 (Figures 5 and 6) mounted upon pins 52 which pins 52 are in turn secured in openings 53 in the face 54 of the holder 16. The pawls 50 and 51 cooperate with a ratchet 56 fixed upon a shaft 57 journaled at its lower end in a bracket member 58 secured to the frame plate 24, and at its opposite end in the frame of the indicating devices. The shaft 57 carries a pinion 85 at its upper end through which pinion 85 movement of the shaft 57 is transmitted to the unit wheel 33. A suitable driving mechanism such as Geneva gears, or the like, transmits the motion to the indicating devices 31, 32 to register multiples of the counts registered upon the unit wheel 33. The pawls 50 and 51 and ratchet 56 provide an actuating device or escapement which requires two movements for a complete registration of a unit, namely, pivotal movement of the magnet holder 15, about its pivot 19, to one position and thereafter, pivotal movement of the magnet holder 15, about its pivot 19, to the reverse position, to register a count upon the unit wheel 33. In other words, the ratchet 56 is advanced part way by the pawl 50 upon movement of the holder 16 in a clockwise direction (Figure 5) about its pivot 19 and the advance is completed by motion of the pawl 51 upon movement of the holder in a counter-clockwise direction about its pivot 19. The magnet 11 is properly balanced by a balance rod or bar 60 extending through and secured as by means of a suitable set screw 62 (Figure 5) in a lug 61 extending from one end of the holder 16. This rod is adjustable to bring two ends of the magnet on opposite sides of the pivot into balance. As the meter is mounted in the position shown in Fig. 2 the adjustment of rod 60 is able to bring the movable system to a balance. The driving mechanism between the shaft 57 and the indi-

cating devices 31, 32 and 33 is mounted between a bottom plate 65 and a top plate 66 secured together in the form of a frame by means of suitable posts 68, which posts in the particular arrangement illustrated are riveted in the bottom plate 65 and carry the top plate 66 at their upper ends as through suitable screws 69. The bottom plate 65 is mounted upon the upper surface of the frame plate 24 as by means of suitable screws 70, being spaced from the plate 24 by means of suitable collars 70'.

The front edge of the frame plate 24 is recessed or cut away along the dotted line 71, shown in Figure 5 and a terminal block 73 of bakelite or other suitable insulating material extends across and into the opening provided, and is secured at its opposite ends, as by means of screws 72 to the frame plate 24. The terminal block 73 is provided with a portion depending into the cut away portion of the plate 24, a vertical flange 74 along its forward edge and a pair of conductor receiving lugs 75 extending forwardly therefrom. Terminal strips 76 mounted upon the terminal block 73 provide for connecting the coils 7 and 8 serially in the two limbs of the subscriber's line as shown in Figure 1. The forward reduced ends of the terminals 76 extend or are bent down through openings 78 in the block 73 to facilitate connection with the terminals of the coils 7 and 8. The line wires 9 and 10, or terminals thereof, are led in and out through the lugs 75 and connected to the terminal strips 76, as by securing them beneath the screws or bolts 76'.

A pair of bumpers 80 and 81 secured to and depending from the frame plate 24 are provided for the magnet 11. The lower ends of these bumpers are bent back as shown at 82 in Figure 10, to securely grasp and hold a piece of felt, billiard cloth or other suitable padding 83 wrapped thereabout.

The shaft 57 carries a pinion 85 at its upper end through which pinion 85 motion is transmitted to the units wheel 33 and then to the wheels 32 and 31 through the registering mechanism already described.

The calling subscriber's line is provided with the usual line signal 90, controlled by a line relay 91, and also governed by a cut-off relay 92 as is well known in the art. Suitable terminals, such as the multiple jacks 93, and the answering jacks 94, are connected to the line wires 9 and 10, for the purpose of making a connection with central, or with another subscriber as may be desired. The sub-station B of the called subscriber in the particular system shown is provided with similar apparatus, the parts of which are designated by primed reference numerals corresponding to those of the calling line. The subscriber's lines are supplied with current from a central battery 95 which also supplies current for the central apparatus.

The apparatus at the central station comprises a cord circuit having an answering plug 96 and a ringing plug 97. The two ends of the cord circuit are separated by condensers 98 and 99, and the separate ends are supplied with battery through the supervisory relays 100 and 101. The respective ends of the cord circuit are provided with supervisory signals 102 and 103 respectively, these signals being also controlled by the sleeve relays, 104 and 105 respectively.

The answering end of the cord circuit C is provided with connections to the operator's talking set 106, through a suitable listening key 107, and the ringing end of the cord circuit is provided with connections to a ringing generator 108 through a suitable ringing key 109.

Current is supplied to the talking strands of the cord circuit upon the ringing end, through a supervisory relay 101 directly, so as to provide uni-directional flow of current over the called line, and current is supplied to the answering end of the cord circuit through a time controlled current flow reversing device indicated generally by the reference character 115 for securing periodic reversals of current flow over the calling line for operating the "register or meter" 6 at the sub-station of the calling party. The answering end of the cord circuit may be provided with uni-directional current until such time as the called party answers if desired.

The particular pole changer device or current converter 115 illustrated is described and claimed in my co-pending application, Serial No. 508,038, filed Oct. 15, 1921. Any other suitable pole changing device may be employed.

The pole changing device illustrated comprises two pairs of compression rheostats R^1, R^2 and R^3, R^4 between which battery 95 is connected over conductors 116 and 117. The terminals 118 and 119 of the pole changer lead to the talking strands 120 and 121 respectively, through the supervisory relay 100. The rheostats shown are of the carbon pile type well known in the art. The resistance of these piles is lowered or decreased upon compressing the same, and is increased when the pressure thereupon is released.

One terminal of the battery 95 is connected with the lower ends of the rheostats R^1, R^3. The upper end of the rheostats R^1 is connected with the terminal 119 of the pole changer. The upper end of the rheostat R^3 is connected with the terminal 118. The lower ends of the rheostats R^2 and R^4 are connected to the opposite terminal of the battery 95. It will now be apparent that if the resistance of rheostats R^1, R^2 and R^3, R^4 are all equal, there will be no difference of potential at the terminals 118 and 119. If the rheostats R^1, R^2 are simultaneously compressed to reduce the value of the same, the terminal 118 will ex-

hibit a strong positive potential while the terminal 119 will exhibit a strong negative potential. If now the pressure on rheostats R^1 and R^2 is relaxed or released and simultaneously the pressure on rheostats R^3 and R^4 is increased, the terminal 118 will exhibit a strong negative potential while the terminal 119 will exhibit a strong positive potential. The change from one potential to the other is performed without any interruption or abrupt change in the current flow.

A balance indicator 130 between the line and the battery enables the attendant to observe any out of balance condition in the rheostats, so that the same may be readily adjusted to a balance as more fully explained in my last referred to copending application. To further assist in the adjustment of the rheostats, I provide a voltmeter 131 for indicating to the attendant the performance or operation of any of the individual rheostats. A suitable switch 132 is adapted for connecting either of the rheostats R^1, R^2, R^3 or R^4 individually across the voltmeter 131.

The arrangement for actuating or compressing the pairs of resistances, comprises a pressure cylinder 135 for the rheostat R^1, R^2 and pressure cylinder 136 for the rheostats R^3, R^4. Piston rods 150 and 151 connected at their inner ends to suitable pistons within the cylinders 135 and 136, respectively, are adjustably connected at 152 and 153 with rheostat actuating shoes 154 and 155. Actuation of the respective rheostats is had by engagement of these actuating shoes with insulated buttons projecting from the lower ends of the rheostats. The supply of compressed air or other suitable motive fluid from a common supply conduit 156 to the cylinders 135 and 136 is regulated by suitable adjustable pressure regulators 157 and 158. Conduits 166 and 167 provide exhaust outlets for discharging or exhausting the pressure from the chambers 135 and 136 while suitable valve members 162 and 163 control the flow to and exhaust from the respective cylinders. The cylinders 135 and 136 are provided with suitable pressure gauges 164 and 165 respectively.

The adjustable connections 152 and 153 between the outer ends of the piston rods and the actuating shoes 154 and 155 as well as the manner whereby the actuation of one pair of rheostats relative the other may be varied by means of the regulators 157 and 158 and the degree of actuation of any resistance relative the other of the same set adjusted is more fully expained in said companion application No. 508,038.

The actuating arms 170 and 171 for controlling the valves 162 and 163 respectively, are connected at their free ends to the opposite ends of a link 172, which link 172 is connected by a pin joint at its center to the upper end of an actuating lever 173. A pair of bridging contact fingers 174 and 175 carried by the opposite end of the bar 173 are adapted for bridging terminals 176, 177 and 178, 179 of a valve actuating circuit. The lever 173 is pivotally mounted centrally and is rigidly joined to a rocker arm 180. The rocker arm 180 is connected at its opposite ends through suitable links with the plungers or cores of a pair of solenoids 137, 138. The terminals 177 and 179 are grounded as shown at 181 (Fig. 1). The circuits through the solenoid windings 137 and 138 are controlled by a pair of time controlled relays 139 and 140. The windings of the relays 139 and 140 are connected at one end of a battery 182 or other suitable source of current, which source is grounded as shown at 183. The circuits through the relays 139 and 140 are governed by a time controlled circuit controller, which includes a cam wheel 141 mounted, for example, on the second shaft of a standard clock and contacts 142 and 143 which are alternately closed by engagement of the cam portions of the wheel 141 therewith. The cam wheel 141 has two dwells substantially 180 degrees apart so that the polarity is shifted every 15 seconds. Energization of the relay 139 actuates armature 186 to close the contacts 187 and thereby complete the circuit from battery 182 to solenoid winding 138 to ground 181 assuming the contact finger 175 is in engagement with the terminals 178 and 179 as shown.

The operation of the system shown is as follows:

Assuming that the calling subscriber A raises his receiver from the switch hook 3 and desires to call through central the subscriber B, closing of the hook switch places current of normal potential upon the line wires 9 and 10 energizing line relay 91 and line signal 90 whereupon the operator makes a connection with the answering plug 96 with the line of the calling subscriber through the answering jack 94, thereby effacing the calling signal 90, disconnecting the line conductors 9 and 10 from the battery 95 by means of the line relay 92 and applying the potential prevailing in the strands 120 and 121 of the cord circuit employed.

The normal current in the line wires 9 and 10 moves the magnet 11 of the telechronometer 6 about its pivot 19 in one direction. A reversal of current in the lines 9, 10 causes the magnet 11 to move about its pivot 19 in the opposite direction, thereby completing the cycle of operation necessary to make the registration on the telechronometer 6.

The operator at central, connects her talking sets 106 and receives the order for connection from the subscriber A whereupon she selects the multiple jack 190 of the called subscriber B and makes connection thereto with the ringing plug 97, applying ringing current by means of the key 109 and gen-

erator 108. As soon as the called subscriber B answers, the supervisor signal 103 is effaced and the parties carry on their conversation. Meanwhile, periodical reversals of current are occurring on the calling line, these cycles of reversals being registered as counts upon the meter 6.

Movement of the permanent magnet 11 about its pivot 19 to register the cycles of reversals as counts upon the meter is effected as follows:

The arrangement of the pole 14 of the magnet 11 between the arms 12—12 of the pole piece 13 at the opposite end of the magnet sets up, or creates a magnetic field the lines of force of which travel in a horizontal plane, Figures 1 and 5, between the arms 12—12 of the pole piece 13 and the pole 14 arranged therebetween. Then, according to the "Right-hand rule" well known in the art when a flow of current is set up through the coils 7, 8 in a counterclockwise direction, looking down from the top upon the meter as shown in Figures 1 and 5, the poles of the magnet will be moved upwardly, moving the magnet 11 in a clockwise direction about its pivot 19. When the direction of flow of current through the coils 7, 8 is reversed, i. e. set up in a clockwise direction looking down upon the meter from the top as before, the poles of the magnet will be moved downwardly, moving the magnet in a counterclockwise direction about its pivot 19. The periodical reversals of current flow occuring on the calling line thereby cause successive pivotal movements of the magnet 11 about its pivot 19 first to one extreme position, and then to the other extreme position. Upon pivotal movement of the magnet in a clockwise direction, looking from the front in Figures 1 and 5, the ratchet 56 is advanced part way by the pawl 50 and the advance is completed by the pawl 51 upon movement of the magnet 11 in a counterclockwise direction, as has already been set out.

In the particular system illustrated, the calling party is charged for all of the time consumed in making a connection and consummating the conversation. It is to be understood, however, that the charge may be for only the time during which the connection between the parties is established. This may be accomplished by cutting the terminals of the pole changer into the talking circuit of the calling line through the contacts of the supervisory answering relay so that normal polarity of current prevails on the calling line until the called party responds. This is well known in the art and is, therefore, not illustrated here.

The operation of the pole changer is as follows:

The time controlled wheel 141 rotates continuously, successively closing the contacts 142 and 143 and thereby the circuits through the solenoid windings 137 and 138. The closing of these circuits is only momentary, sufficient to operate the valves 162 and 163 and set the connecting piece or bridge carreid by the arm 173 for closing the other circuit. The operation of the valves 162 and 163 in turn controls release of one set of rheostats and compression of the other set. A complete cycle of change of polarity occurring in the calling line from positive to negative and back to positive or vice versa causes an actuation or registration upon the meter 6 at the calling station.

It will now be apparent that as in my copending application the placing of the two coils of the telechronometer in the two sides of the telephone line balances the circuit and secures better transmission and more positive operation. Surreptitious shunting of the meter is made difficult by the double coil arrangement. The arrangement of these coils has been standardized as have the other parts and the close spacing of the poles of the magnet maintained. The pivotal mounting of the magnet has eliminated the additional armature used before. In addition, an improved counter actuating arrangement has been provided. The magnet needs very little flow to move from one extreme position to the other and the entire meter is compact, powerful and of a simple and rugged character.

No springs for the pawls are employed since the placing of the meter in proper position permits the pawls to function properly by their own weight.

I do not intend that the invention shall be limited to telephone systems nor to use in connection with the particular current reversing arrangement described. Neither do I intend to be limited to the precise details of construction in the meter itself which I have shown and described.

I claim:

1. In combination, a mechanism, a housing enclosing said mechanism, a frame plate within said housing, mounting means for the housing, said mounting means including a post projecting through a portion of the housing and into an opening in said mounting plate, a cover for the housing, and a screw cooperating with said post and inaccessible when said cover is closed.

2. In combination, an enclosing housing, a frame plate within said housing, mounting means for the housing, said mounting means including a post having a reduced end portion projecting into the housing and into an opening in the frame plate, said reduced end portion providing a shoulder for cooperation with the housing, a cover for the housing and a screw threaded into the reduced end of the mounting post, said screw cooperating with the frame plate and being inaccessible when the cover is closed.

3. In combination, a magnet holder having

a pair of openings for the reception of the legs of a magnet, said magnet holder carrying a pivot post and a pair of actuating pawls mounted upon said holder.

4. In a device of the class described, a magnet holder, a magnet of generally rectangular form having opposite legs carried by said holder, a pivot for said holder, a coil at one corner of the magnet for swinging same about said pivot, and actuating means on said holder.

In witness whereof, I hereunto subscribe my name this 6th day of October, 1921.

GARRISON BABCOCK.