No. 648,805. Patented May 1, 1900.

H. E. SHREEVE.

SERVICE METER APPARATUS AND CIRCUIT FOR TELEPHONE SUBSTATIONS.

(Application filed Jan. 22, 1900.)

(No Model.)

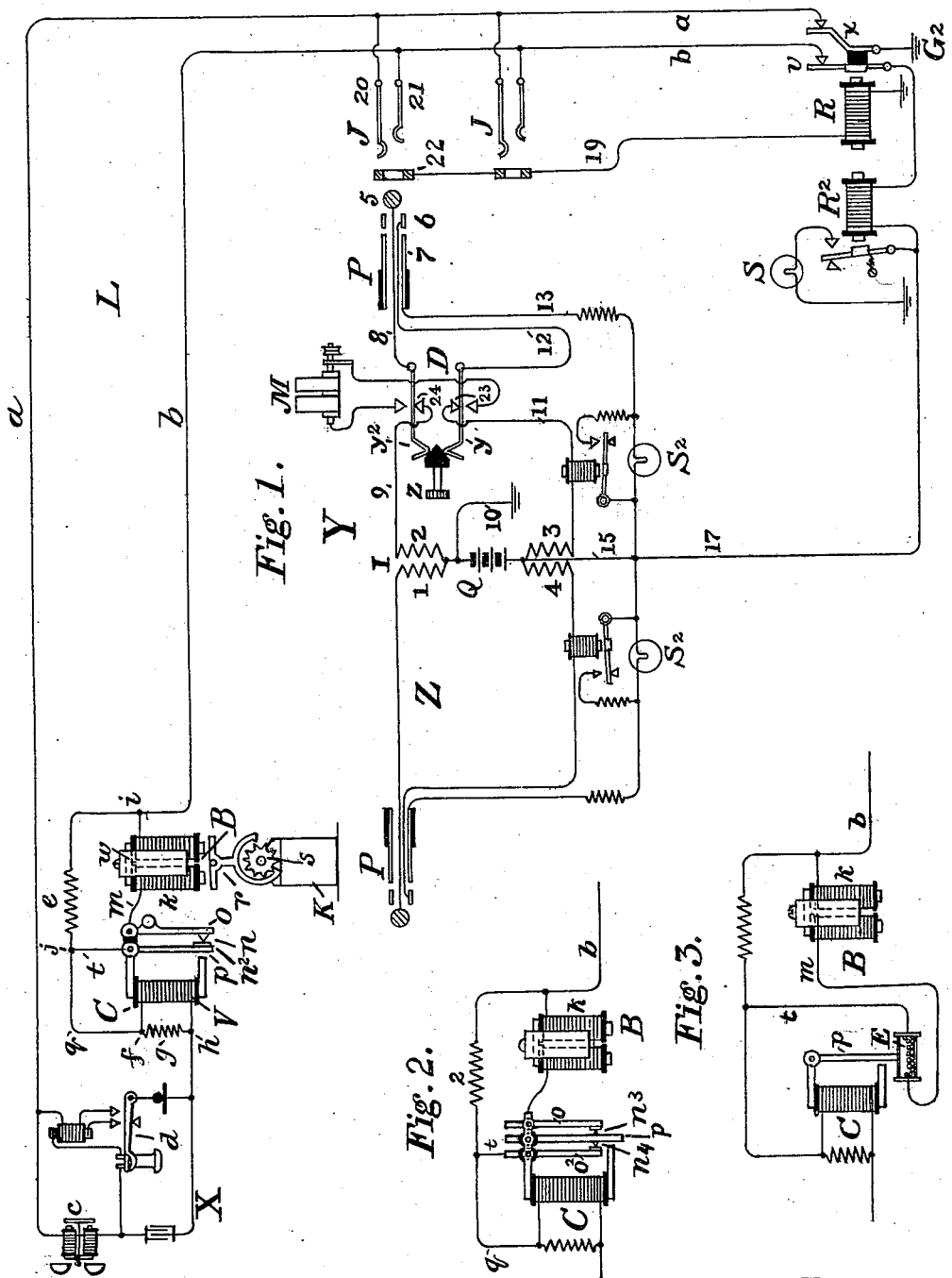

Fig. 1.

Fig. 2.

Fig. 3.

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SERVICE-METER APPARATUS AND CIRCUIT FOR TELEPHONE-SUBSTATIONS.

SPECIFICATION forming part of Letters Patent No. 648,805, dated May 1, 1900.

Application filed January 22, 1900. Serial No. 2,374. (No model.

To all whom it may concern:

Be it known that I, HERBERT E. SHREEVE, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Service-Meter Apparatus and Circuits for Telephone Substations, of which the following is a specification.

In order to relieve the operators at central stations of the necessity of recording calls originating on measured-service telephone-lines, automatic recording apparatus, known as "service-meters" or "call-registers," have been devised and applied, these meters being in some cases located at the central station, while in other cases they are placed at the substation.

The service-meter concerned in my invention is intended for use at telephone-system substations and is adapted for application to telephone systems of the so-called "common-battery" relay class. It is designed that the registration of a call on the dial of such a substation service-meter shall require the successive performance of two steps, one produced by the act of a connection initiating subscriber at such station in sending a call and the other by the act of the central-station operator in answering such call. The call-register or service-meter is actuated by a polarized electromagnet, the armature of which oscillates from one magnet-pole to the other, according to the direction of current circulating through the magnet-coils. When the telephone at a calling-substation is removed from the hook-switch, the circuit is closed by the action of the said switch and current of proper direction to produce a swing of the meter-armature flows through the circuit from the central-station battery, giving the call by causing a display at said central station of the regular line-signal and producing such a single movement of the meter-armature as is required for the first step toward the registration of the call by said meter. In response to the call-signal the operator inserts one switch-plug of a regular pair into an answering-jack or switch-socket of the calling-line, an action which operates to reverse the direction of the battery-current through the circuit. The armature of the substation-meter, responding to the reversal of current, now oscillates back to its original position, and the second step requisite to the operation of the meter having thus been made the mechanism thereof moves the indicating-pointer or like device in such manner as to complete the registration of the call. Being informed of the number of the desired connection the operator after testing the line of the substation wanted sends a ringing-current over such line and then connects the two for conversation.

It is of course required that the charge for service shall be made against that station only which in each connection initiates the call, and that no charge shall be registered upon the meter of the substation which is called for communication with such initiating party. Experience, however, has shown that the operation of the meter at the called substation, though undesired, is liable to occur if the telephone at such station is taken from its hook before the bell there ceases to ring, and this comes about because the resistance in the circuit is thereby greatly decreased, causing a correspondingly-great increase in the current through the magnet-coils of the said meter.

The object of my invention is to provide that substation call-registering apparatus while fully responsive to the steady battery-current traversing the circuit when a call is answered and during the pendency of a connection shall be irresponsive to the alternating or pulsatory currents of the regular central-station-ringing generator which traverse the circuit when a call is transmitted by the operator over the line of the wanted substation.

The invention consists in combining with the substation-register an associate controlling device or appliance which while the alternating ringing-current is being transmitted shall act to produce in the circuit containing the register-magnet a series of rapidly-recurring interruptions whereby such alternating current is prevented from exercising an operative magnetizing effect upon the said register or meter-magnet, but which during the passage of the steady current employed for inward signaling or transmitter supply will maintain the continuity of the

meter-magnet circuit unimpaired. A shunt-circuit containing a suitable resistance surrounds the service-meter magnet and the means for producing the current interruptions therethrough. The said interruptions in this way are restricted to the service-meter magnet and do not affect the circuit at large, so that the apparatus producing them, which is itself in the main circuit, also remains unaffected by them and continues to operate as long as the alternating call-current continues to traverse the circuit. The controlling device may preferably be formed as an electromagnetic vibrator having a following contact-piece of considerable inertia, whereby interruptions of distinct appreciability may be produced; and the invention further consists in combining the register and its controlling device in an electric circuit, together with means for alternatively transmitting in such circuit alternating currents and currents of either direction, the said controlling device being adapted to permit the operation of the said register by means of currents of the latter class and to prevent its operation by currents of the former class.

In the drawings which accompany and illustrate this specification, Figure 1 is a diagram of a substation telephone-circuit containing a preferred form of the invention; and Figs. 2 and 3 show modifications of the service-meter-controlling device.

L represents a telephone-circuit extending between a substation X and the central station Y, and *a b* are its constituent conductors. The circuit is provided at the substation with the standard or usual common battery outfit of telephonic apparatus and at the central-station switchboard has switch sockets or jacks J, a cut-off relay R, a line or call signal relay R^2, and the lamp-signal S, controlled thereby.

Z is a switch cord-circuit, (a number of such being of course assigned to each operator,) the same being provided with the connecting-plugs P, the repeating-coil I, the battery Q, the disconnecting or supervisory signals S^2, the calling-generator M, and the ringing or calling key D, these instrumentalities being all arranged in the usual manner.

The circuit-conductor *b* after passing the contact *v* of the cut-off relay R continues through the line-relay R^2 and connects by conductors 17 and 15 with one pole of the common battery Q and terminates in the earth connection 10, thus furnishing a circuit for the incoming-call signal, which circuit is closed to produce the said signal when the subscriber removes his telephone from the switch. Under these conditions the direction of the current is outward over conductor *b* and inward by way of conductor *a*. To answer such an incoming-call signal, the answering-plug P is inserted in one of the jacks J. The ring-conductor 6 of said plug will then engage with the longer jack-spring 20 of conductor *a*, and the tip-conductor 5 thereof will engage with the shorter jack-spring 21 of conductor *b*. At the same time the rear sleeve-conductor 7 of the answering-plug registers with the test-ring 22 and closes a circuit of the battery through the cut-off relay R by way of wire 15, lamp S^2, wire 13, plug-sleeve 7, ring 22, wire 19, and relay R, and the said relay operating severs the normal-battery connection; but the battery has also a connection with the switch-plug main-line contacts 5 and 6. Contact 6 connects with that pole of said battery to which the normal battery connection 17 is attached by way of winding 3 of the repeating coil, conductor 11, ringing-key contact 23, key-spring *y*, and conductor 12, while the plug-tip 5 connects with the opposite pole of said battery by way of winding 2 of the repeating-coil, conductor 9, ringing-key contact-point 24, spring y^2, and conductor 8. Thus by the insertion of the switch-plug, though the original battery connection is taken off, a new one for the substation-transmitter is supplied, the current in this case, however, being of reversed direction.

B indicates the service-meter apparatus at the substation X. The registering mechanism K thereof is operated by an electromagnet *k*, made sluggish by having iron cores small in diameter and incased in copper sheaths in a manner well understood and having a centrally-pivoted armature *r*, carrying an escapement adapted to engage the teeth of the escape-wheel *s*, and controlling thereby the operation of the clock mechanism K of the service-meter. The electromagnet and its armature are polarized by the permanent magnet *w*.

It is not deemed necessary to show or describe any specific form of meter mechanism, and such a one as is disclosed by Letters Patent of the United States granted to Hammond V. Hayes and Thomas C. Wales, Jr., September 7, 1897, No. 589,431, or, in fact, any form possessing similar characteristics, may conveniently be employed.

V indicates the controlling device or vibrator, which by my invention is associated with the service-meter to protect the same from undesired operative influences. It comprises an electromagnet C, with a pendulous armature *p*, hung upon and free to swing about a pivot, which may be arranged in any suitable bracket or in an extension of the upper magnet-pole, as shown, an insulated suspended arm *o*, a contact-point *n*, carried thereby, and a similar contact point or piece n^2, mounted on the free end of the armature, the said points *n* and n^2 being normally in contact with one another.

The electrical connections of the service-meter and the controlling device, both in relation to themselves and to the main circuit, are as follows: The electromagnet C of the controlling device is shunted by a resistance *g*, and a second resistance-coil *e* shunts the electromagnet *k* of the meter and also the

separable contacts $n\,n^2$ of the controlling device, the latter shunt-circuit being completed by a conductor t, which connects the conductor q at the point j with the armature p. The apparatus as a whole, including the electromagnets of both appliances and their respective shunts, may be placed in the circuit l either in series with the entire substation outfit or with the transmitter and induction-coil only. The former arrangement is the one shown, and the said apparatus is introduced into the main circuit between the points h and i. To a certain extent the presence in the talking-circuit of the said electromagnet C offers impedance to the passage of the voice-currents; but this difficulty is minimized by providing it with the said resistance-coil g in shunt relation therewith, the said coil, as well as resistance e, being preferably in a well-known manner wound double to avoid self-induction. Thus when the system is at rest, and also when a steady current is passing through the circuit, there are two distinct paths for the current between the said points h and i. Beginning at i one of these is through the coils of the meter-magnet k and thence by wire m to the pendent arm o and by way of the contacts $n\,n^2$, the armature p, conductor t, point j, conductor q, point f, and the shunted controlling-device magnet C, while the other leads through shunt-resistance coil e, conductor q, and electromagnet C. The latter, being permanently shunted by the resistance-coil g, is connected around magnet C between the points f and h. It will be seen that the electromagnet C of the controlling device V, though shunted, is at all times in the circuit, while the meter-magnet is out of the circuit whenever the contact-points n and n^2 are separated. The suspended arm o tends to follow the forward movements of the armature, but by reason of its inertia exercises this tendency but slowly, so that when sudden and recurring vibrations of the armature are produced, as is the case while magneto call-currents are being transmitted, the arm o does not follow the armature immediately, and under such conditions the circuit, through the contacts $n\,n^2$, is for the instant necessarily broken. The resistance of the coil e may be about fifty ohms, that of the coil g about one hundred ohms, while the resistances of the electromagnets k and C may be seventeen and twenty-two ohms, respectively.

In the operation of the invention, when the subscriber removes his telephone to call, the closing of the circuit by the hook-switch d causes current to flow from the battery Q via conductors 15 and 17, line-signal relay R^2, armature v of cut-off relay R, main conductor b, to the point i, thence through the meter and meter-controlling appliances and the station instruments to main conductor a, and by way of the cut-out relay-armature lever x to ground 4^2 and the other pole of the battery. Owing to the lesser resistance of the electromagnets k and C the main portion of the current flows that way instead of through the shunt-resistances e and g. The current thus established in the circuit vitalizes call-relay R^2, which lights up the signal-lamp S. It also excites the electromagnet k of the meter, which, attracting the armature r, causes the same to rock on its pivot and to make the first of the two steps required for the registration of the call. When the operator in response to display of signal S inserts plug P into the switch socket or jack J of the line, its tip 5 makes contact with the lower spring 21, its front sleeve 6 contacts with the upper spring 20, and its rear sleeve contacts with the test-ring, as already described, and current from battery Q operates the cut-off relay R and opens the main circuit, cutting off the normal battery connection. At the same time the transmitter supply-current flows from the battery over the line in a direction opposite to that resulting from the normal connection, and in this instance also the electromagnet k of the meter influenced thereby attracts its armature back to its original position, thus completing the registration of the call. It will be observed that in both of these instances of current transmission—the first brought about by the act of sending the initial call from the substation and the second by inserting the switch-plug to answer the said call—the current is steady for the whole period of its application. The arm o, following up the armature, speedily reëstablishes contact between the points n and n^2, which, indeed, is disestablished but for a moment and under conditions which do not impair the perfect operation of the apparatus. Thus far the substation-circuit L has been regarded as the "call-initiating" circuit and its operation has been considered from that point of view. It will now be regarded as the circuit of the substation with which communication is desired. To connect the calling-circuit with the called circuit after the usual busy test, the operator inserts the calling or companion plug P of the pair into the jack J of the latter, its tip 5 contacting with the lower spring 21 and its front sleeve 6 with the upper spring 20. The battery-current passing to the called circuit is of such direction as to retain the armature of the service-meter at the wanted station in its normal position, and therefore exercises no effect thereon. She then depresses the button of the ringing-key D, forcing the springs $y\,y^2$ thereof away from their normal contacts into connection with the terminals of the central-station call-current generator M, and an alternating or pulsating current is transmitted by way of conductor 8, plug-tip 5, jack-spring 21, conductor b, meter apparatus B, controller V, call-bell c, conductor a, jack-spring 20, ring-contact 6 of the plug, and wire 12 to the other pole of the generator. Under the first impulse of this current the armature p of the controlling device is drawn up so quickly that the arm o, on account of its inertia, does not

immediately follow, and it therefore separates from the arm and the circuit through the meter-magnet is momentarily broken. When the impulse or wave subsides, the armature p is released and drops back into contact with the arm, which has meanwhile swung toward the electromagnet C, and upon the continuation or recurrence of the impulse the operation is repeated. The electromagnet C, armature p, and following arm o are so proportioned that for currents of the periodicity, furnished by an ordinary central-office-ringing generator, contact at the points n and n^2 does not recur until after the impulse has reached its zero value, and therefore the period of contact is very brief; but while it lasts current may flow through the coils of the meter-magnet k. The said magnet, however, by reason of the combined effect of its sluggishness and the brevity of the contact, does not become appreciably excited, such impulses as reach it while the ringing-current is being transmitted over the line being too transient to reach their full value in the coils of such a slow-working magnet, and all undesirable, undesigned, and accidental operation of the service-meter of the called line under the influence of the ringing-current is thus forestalled and prevented.

In Fig. 2 a modification of the vibrating device is illustrated. It has two following arms o and o^2, one on each side of the armature p. They are insulated from one another, and the branch conductor t unites the conductor q to the arm o^2. There are two sets of separable contacts, one, n^3, between the armature p and arm o and the other, n^4, between the armature and arm o^2, and in this arrangement both sets of contacts are in serial circuit with the magnet of the service-meter. Only when the circuit through both sets of contacts is closed can an operative current pass through the coils of the said magnets. When the armature is attracted, it opens the contacts n^3, and when it recedes from the magnet-poles it separates the contacts of n^4, so that when the magnet C is under the influence of such a vibratory current as that of the call-generator the circuit is practically opened continuously; but since the tendency of both arms is to follow the armature and to continually reëstablish the contacts of both sets it is manifest that when the apparatus is subjected to the influence of a steady or unvarying current contact is substantially maintained, and this fact insures the operation of the meter-magnet under appropriate conditions.

A third construction of my controlling device is shown in Fig. 3. It consists of an electromagnet C and armature p, as before; but the armature carries at its lower extremity a small glass tube E, sealed at the ends by conducting-plates and containing a number of metal particles or a globule of mercury, the end contacts of the tube being connected in circuit, as shown. When the armature vibrates under the influence of an alternating or pulsating current, the particles of metal are thrown violently from one end of the tube to the other, thus keeping the circuit of the recording-magnet open. When the tube is quiet, the particles of metal distribute themselves therealong, establishing a continuous contact from plate to plate. In the case of the mercury-globule it spreads out until it makes contact with both plates.

All of the several described forms of vibrator are obviously based upon the same principle—viz., that of introducing a series of rapidly-recurring interruptions into the circuit of the service-meter magnet, while alternating or pulsatory currents liable to produce undesired operation of that magnet are flowing in the said circuit, the apparatus producing such interruptions being at the same time maintained free from their influence by its position in the said circuit in series with a shunt-conductor arranged around the said service-meter magnet and the separable contacts at which the said interruptions are produced.

I claim—

1. The combination at a telephone-station, with a telephone-circuit, and an electromagnetic service-meter connected therein, and adapted to count the communications initiated at such station; of means responsive to the passage through said circuit, of alternating or vibratory electric currents, for producing interruptions in the circuit through the actuating-electromagnet of said service-meter; whereby the said alternating currents are prevented from affecting the said meter, substantially as and for the purpose set forth.

2. The combination in a telephone system, of a telephone-circuit extending between a central station and a substation; an electromagnetic call-counter or service-meter connected with said circuit, and placed at the substation to register the calls thereof; and an electromagnetic device therefor, controlling the continuity of the circuit through the electromagnet of said service-meter, and adapted to interrupt the same, on the passage through the circuit of alternating call-currents, but to maintain the same during the passage of steady currents; substantially as specified.

3. In a telephone-station apparatus, the combination of a main circuit; a service-meter or call-counter having an actuating-electromagnet included in a branch thereof; a controlling device for preventing said meter from responding to alternating call-currents, comprising an electromagnet in said main circuit, and a vibratory circuit-interrupter actuated by said magnet, but included in the service-meter branch of said circuit and adapted to produce rapidly-recurring interruptions in the said branch while the said alternating call-currents are flowing in the main circuit, and to maintain substantial continuity there-

of during the passage of steady currents; and a second branch circuit or shunt around the said meter-magnet and interrupter, containing a resistance and maintaining the continuity of the main circuit for the operation of said controlling-device magnet, independent of the said interrupter; as set forth.

4. In a telephone system, the combination in an electric circuit of the telephone-call register, and its controlling device, both at a substation; with means as indicated for transmitting in such circuit alternating currents, and direct currents of either direction; the said controlling device being adapted to permit the operation of the said register by means of currents of the latter class, and to prevent its operation by currents of the former class.

5. The combination in an exchange-telephone circuit between a central station and a substation; of means at the former station for sending alternating or pulsating currents to the latter station; a call-bell at the substation responsive to said currents; and a permanently-shunted service-meter in the circuit at the substation, the said meter being provided with an electromagnetic protective device operated by the said currents to intermittently open the circuit through said meter, leaving it closed through the shunt only; as set forth.

6. The combination in a telephone-circuit extending between a central station and a substation, of a generator at the former station adapted to send alternating call-currents to the latter station; a call-bell at the substation responsive to said currents; a service-meter having a sluggish actuating-electromagnet in the circuit at the substation; and an electromagnetic protective device operated by the said currents to open the circuit through the meter, at each alternation or pulsation of said currents, and to thereby prevent the normal operation thereof, as set forth.

7. In a telephone system, the combination of a telephone-circuit extending between a central station and a substation; an alternating-current call-generator associated therewith at said central station for sending outgoing calls; a battery or steady-current generator also associated therewith at said central station to furnish a current-supply for incoming calls and telephone-transmitters; and a service-meter at the substation having an actuating-electromagnet in a branch of the main circuit, with means for preventing the said meter-magnet from responding to the currents of said alternating-current call-generator, while leaving it free to respond to the currents of said battery; the said means comprising a vibratory circuit-interrupter included in the service-meter circuit branch and adapted to produce rapidly-recurring interruptions therein on the passage of alternating currents, but to maintain substantial continuity thereof on the passage of steady currents, an actuating-electromagnet for the said interrupter in the main portion of the telephone-circuit; and a branch circuit containing a resistance-coil connected around the service-meter magnet and interrupter, to maintain an uninterrupted circuit for the main-line interrupter-magnet; substantially as specified.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 4th day of January, 1900.

HERBERT E. SHREEVE.

Witnesses:
GEO. WILLIS PIERCE,
JOSEPH A. GATELY.