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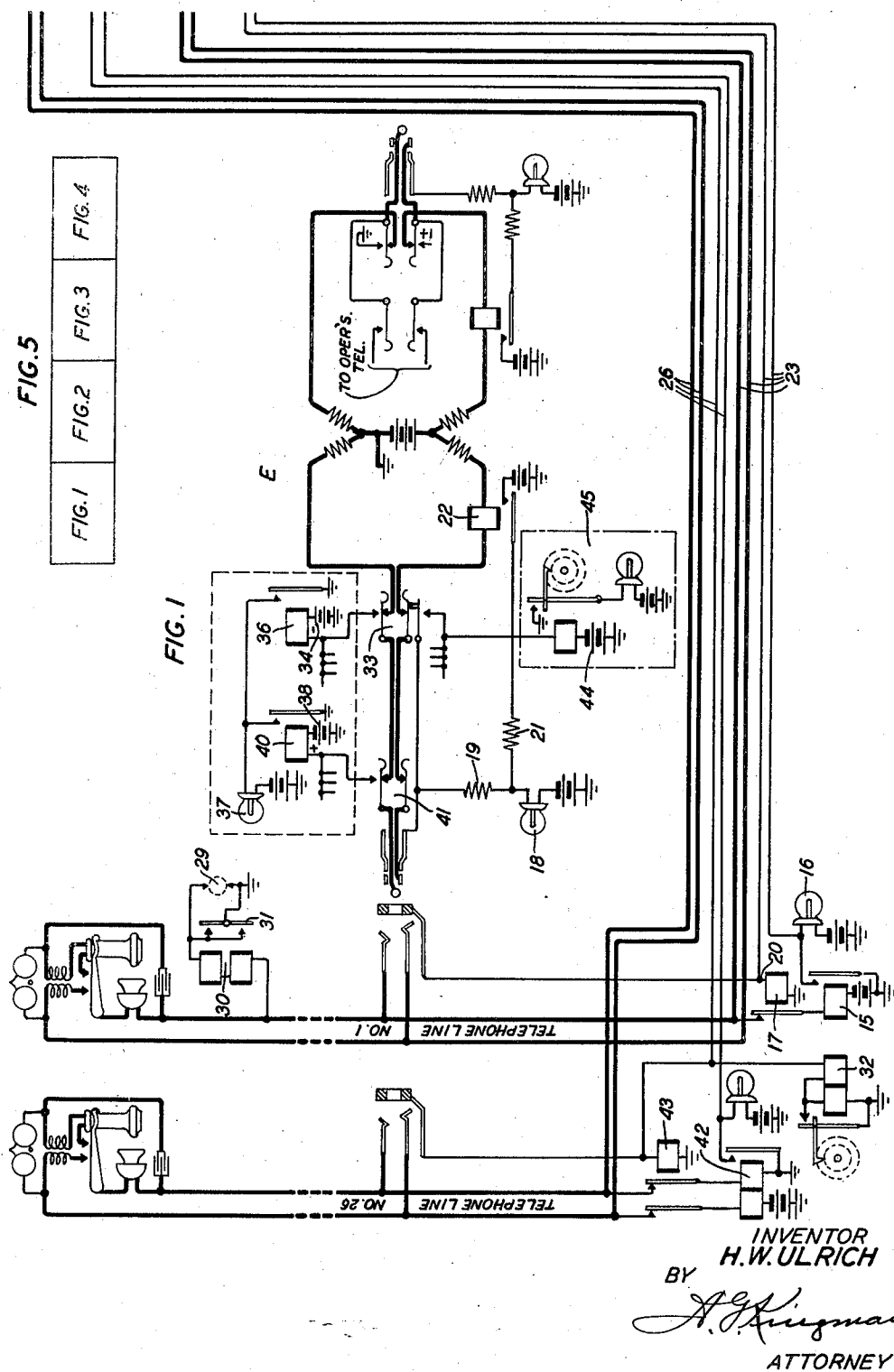
H. W. ULRICH

2,102,769

SERVICE OBSERVING SYSTEM

Filed July 29, 1936

4 Sheets-Sheet 1



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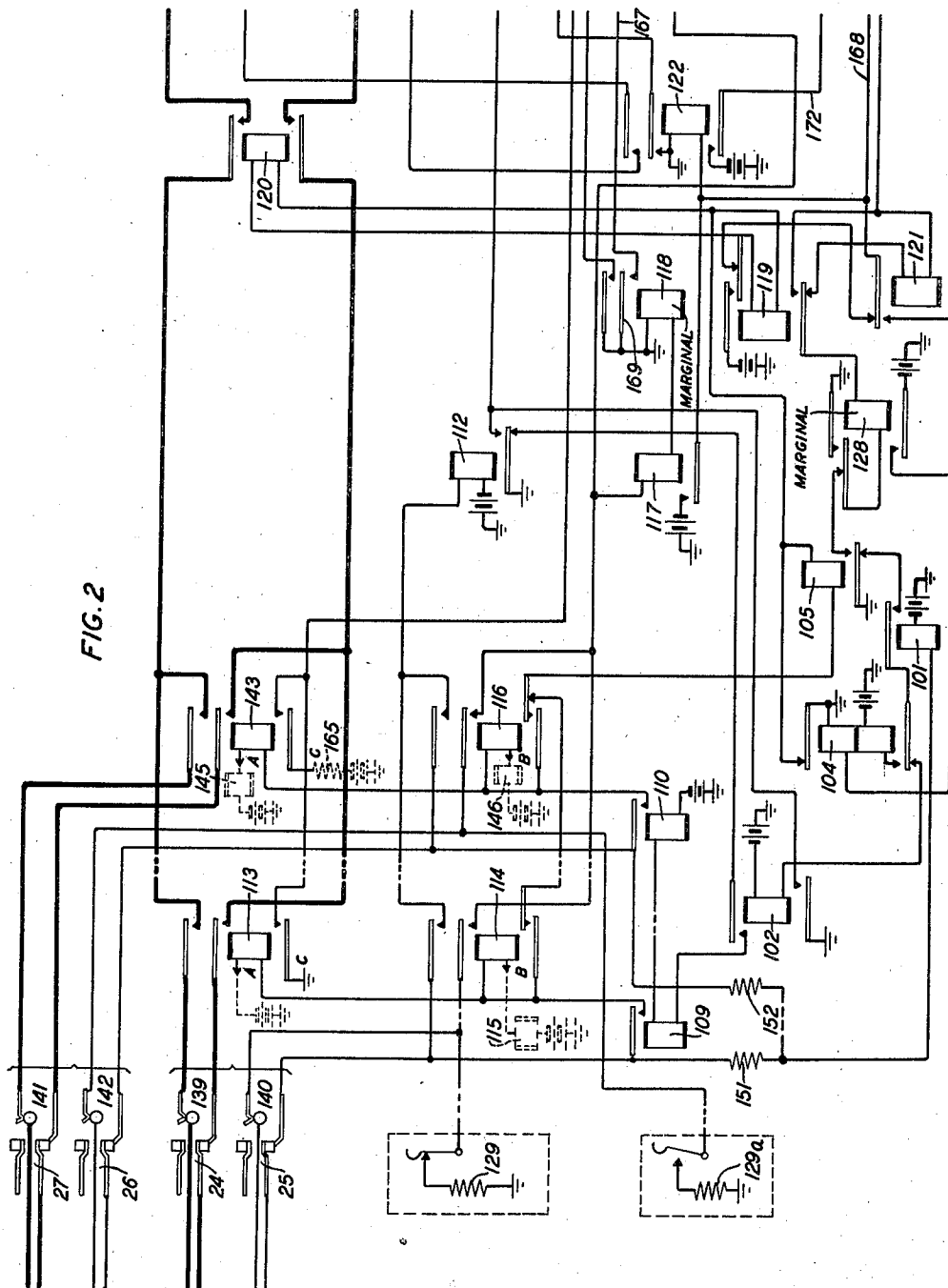
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2,102,769

SERVICE OBSERVING SYSTEM

Filed July 29, 1936

4 Sheets-Sheet 2



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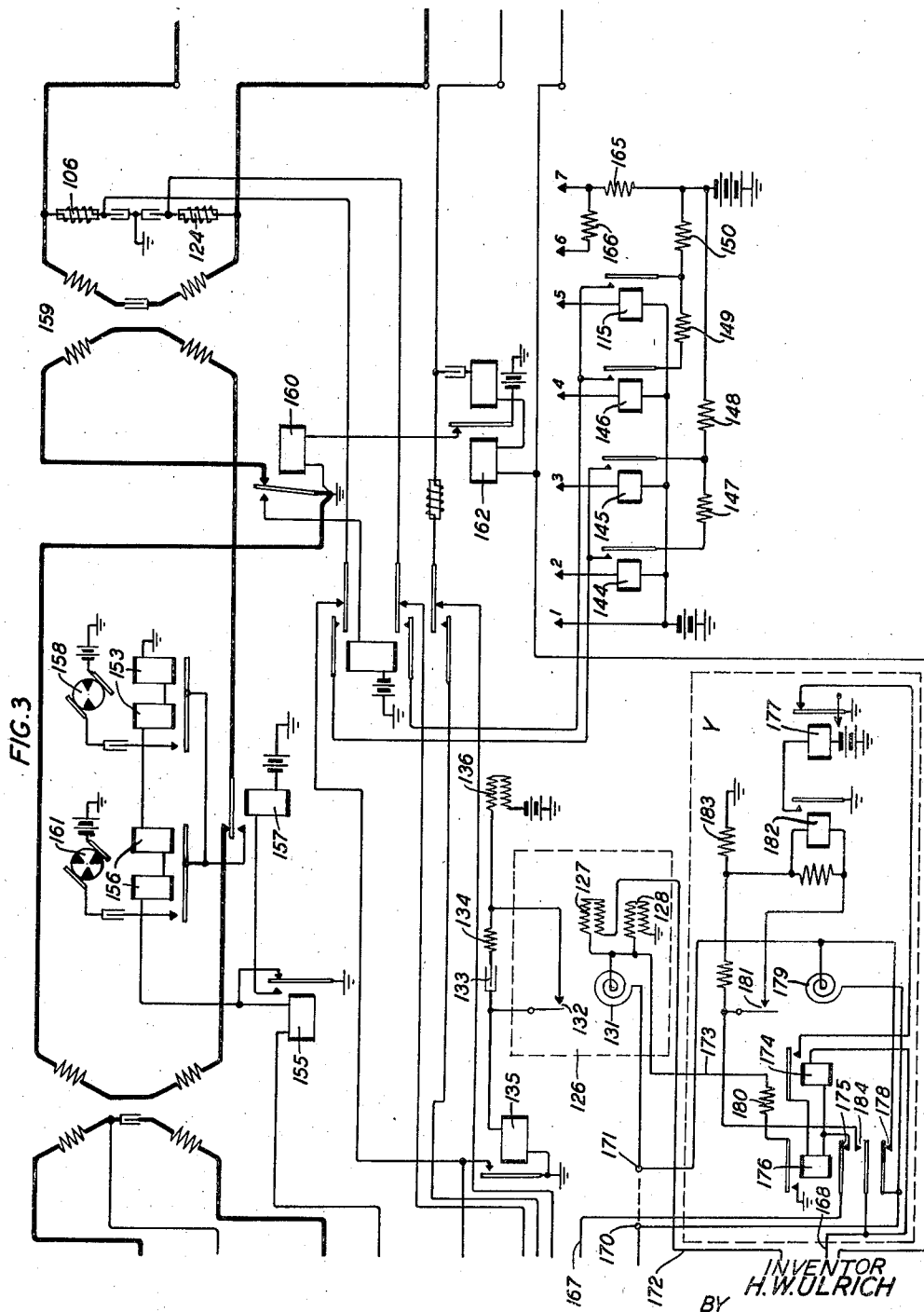
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Dec. 21, 1937.

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2,102,769

SERVICE OBSERVING SYSTEM

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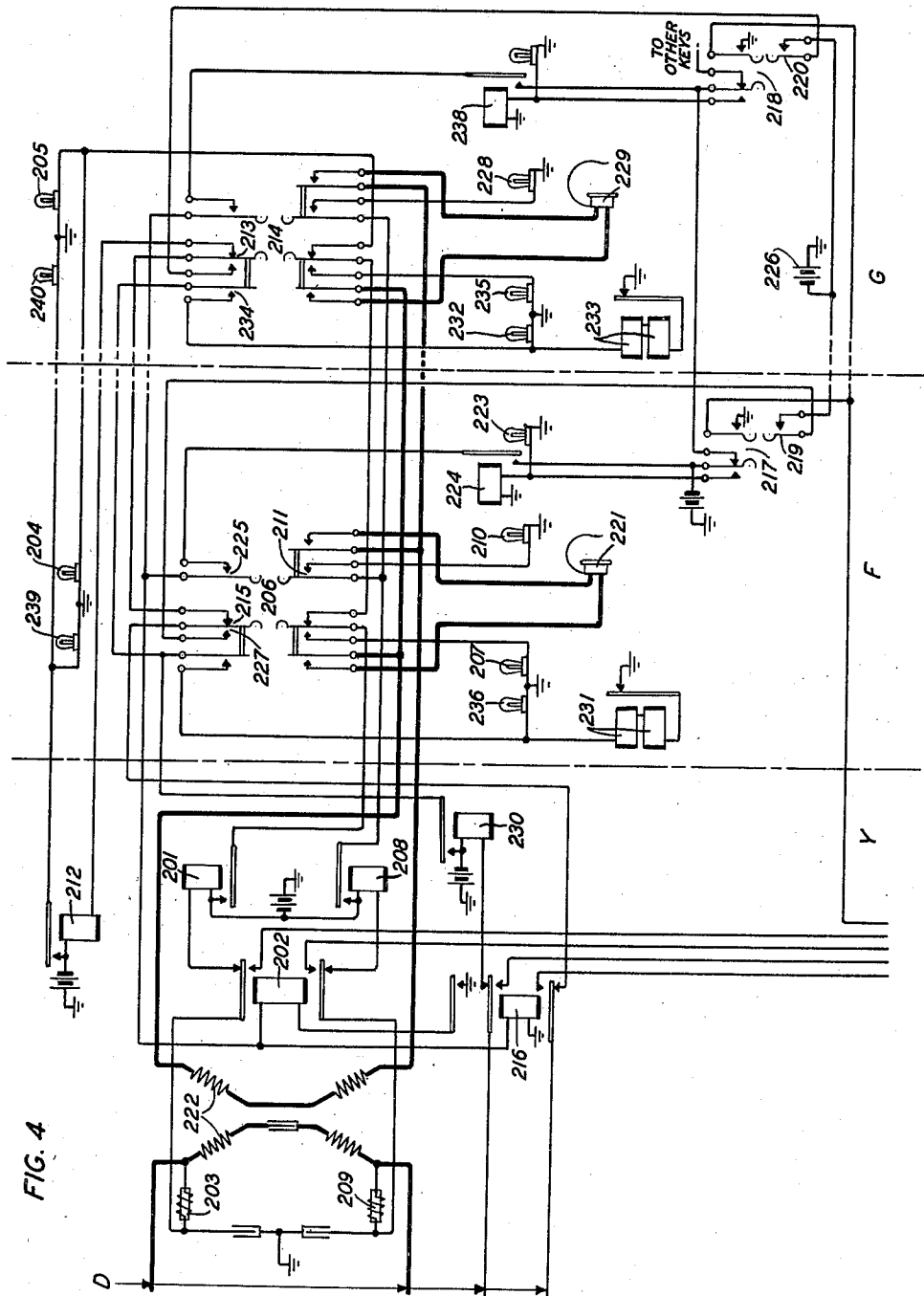


FIG. 4

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2,102,769

SERVICE OBSERVING SYSTEM

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Application July 29, 1936, Serial No. 93,188

4 Claims. (Cl. 179—175.2)

This invention relates to service observing systems and more particularly to such systems in which the service upon any one of a plurality of telephone lines may be observed from a central point.

Systems of this character are well known and an arrangement on which the present invention is based is disclosed in U. S. Patent 1,194,721 dated August 15, 1916 which arrangement has been used extensively for the past twenty years, with the exception that the regular operator's cord circuit shown in Fig. 1 of the patent, eliminates, in practice, the message register key 35 shown, the control of the contact 46 being transferred to the coin collect key 33; in other words, key 33 is used both as a message register key and as a coin collect key, that is to say, when the cord circuit is connected to a coin box line, such as line No. 1 shown, the operation of key 33 connects the high voltage negative battery 34 to the tip conductor of the line to dispose of coin 29 in the coin box at the subscriber's station. At the same time 36-volt battery 44 is connected to the sleeve circuit of the line but as no message register is associated with this line it performs no useful function at this time. Conversely, if the cord circuit is connected to the message rate line 26 which is provided with a message register 32 connected to its sleeve circuit but has no coin box, operation of key 33 will connect the high voltage negative battery 34 to the line as before which, however, performs no function as there is no coin box present on the line but battery 44 connected to the sleeve will cause the message register to operate.

The foregoing describes the standard arrangement of coin box and message rate lines and an operator's cord circuit adapted to be used with either type of line.

While in many exchanges it is not customary to terminate both such types of lines at the same operator's position it is occasionally desirable to do so and by the foregoing arrangement of the cord circuit either coin disposal or message registration is effected by the simple operation of a single key.

In order to avoid annoying subscribers with a click when either a coin is collected or when the message register is operated it has heretofore been the practice to collect coins and register calls at the end of the conversation, i. e., after the calling subscriber has hung up. It is at exchanges in which this operating practice is followed that the service observing circuit arrange-

ment in accordance with the foregoing Patent 1,194,721 is adapted for use.

Conditions under which collection of coins at the start of conversation is desirable are described in a copending application filed August 8, 1935 of Anderson, Bascom et al. Serial No. 35,226, and in the copending application filed May 19, 1936 for H. W. Ulrich Serial No. 80,522 (Case 24) a similar but somewhat improved circuit arrangement is disclosed which is also arranged for coin collection at the start of conversation, the cord circuit of which is shown having a single key which when operated connects both high voltage coin battery to the tip of the line and message register battery to the sleeve of the line.

Now considering the operation of the service observing system as described in the before-mentioned Patent 1,194,721 it will be noted, see page 3, lines 67 to 107, that when the operator answers the call with her cord circuit, relay 122 operates which completes a Wheatstone bridge circuit which is at that time sufficiently unbalanced to energize coil 131 of the voltmeter relay 126 in a direction to close contact 132 thereby operating relay 135 which, in turn, reenergizes relay 201 to hold lamp 207 lighted as long as the subscriber has his receiver off the hook.

When the receiver is restored the resistance of the third arm of the bridge is changed sufficiently to balance the bridge thereby deenergizing coil 131 of the voltmeter relay which opens contact 132 thereby releasing relays 135 and 201 in turn and extinguishing lamp 207 as an indication to the observer that the subscriber has hung up. The fundamentals of such a Wheatstone bridge arrangement for controlling a lamp signal in service observing systems are disclosed and claimed in the U. S. patent to Bascom 1,232,183 dated July 3, 1917.

On page 7, lines 40 to 45 the specification states the voltmeter relay operates in the same manner as before described when the operator answers a call on line 26 which is equipped with a message register in its sleeve circuit.

As pointed out in the specification after the operator has answered a call on line 26 the voltmeter relay is operated to hold lamp 207 or 235 (depending on whether key 206 or 214 is operated) lighted. On page 6, lines 117 et seq. it is stated that the operator registers the call on line 26 by connecting the 36-volt battery 44 to the sleeve of the line which operates the meter magnet 32. Magnet 32 in operating short circuits its right-hand winding thereby lowering its effective resistance.

Although not specifically pointed out in the specification it will be observed that when relays 143 and 116 operate resistance 129 is not connected to the sleeve wire as was the case when relays 113 and 114 operated. The reason for this is that the meter magnet 32, which has the same resistance, when both windings are connected in series, as resistance 129 is substituted therefor in the fourth arm of the Wheatstone bridge which now comprises a parallel arrangement of the sleeve cut-off relay 43, meter magnet 32 and relays 117 and 118. It will be obvious, therefore, that if the operator should register a call on line 26 while this line is under observation and the calling subscriber's receiver is off the hook as indicated by the lighted lamp 207 (or 235) when the meter magnet operates its right-hand winding is short-circuited thereby lowering the resistance of the fourth arm of the bridge which unbalances the bridge in the opposite direction and causes the voltmeter relay to open its contact 132 thereby extinguishing lamp 207 or 235 and giving a false indication to the observer. Due to the fact that magnet 32 is locked in an operated condition during the remainder of the connection the bridge remains in this unbalanced state and the lamp 207 (or 235) cannot be relighted. Hence, further observation on the line is interfered with.

As hereinbefore mentioned, however, this difficulty has not arisen in the past as it has been the standard operating practice to collect coins and register calls at the end of conversation and not at the start of conversation and consequently lamp 207 (or 235) has already been extinguished by the replacing of the calling subscriber's receiver. However, in case it is desired to use this service observing arrangement in exchanges where the operating practice is to collect coins and register calls at the start of conversation, as described in the application referred to, the foregoing defect is serious and some steps appear necessary to prevent falsely extinguishing lamp 207 (or 235) before the calling subscriber hangs up.

An object of this invention, therefore, is to prevent falsely extinguishing the "receiver off the hook lamp" in service observing systems of the type disclosed in Patent 1,194,721.

A feature of the invention whereby the foregoing object is attained resides in means responsive, when message register potential is connected to the sleeve of a message register line connected to the service observing equipment and subsequently disconnected, to hold the voltmeter relay operated under control of the subscriber's switch-hook, thereby maintaining the "receiver off the hook" lamp lighted.

More specifically the foregoing feature resides in connecting a predetermined resistance element in parallel with the resistance in the second arm of the Wheatstone bridge circuit when the message register in the fourth arm of the bridge is operated and the message register potential is disconnected from the sleeve, thereby compensating the bridge, for the change in resistance of the fourth arm by the operation of the register, sufficiently to maintain a difference in potential between the terminals of the voltmeter relay winding to hold this relay operated.

Another feature related to the foregoing resides in additional means comprising a second voltmeter relay which is connected in series with the first relay, when message register potential is applied to the sleeve of either a message regis-

ter or coin box line and subsequently removed, and operated if the connected line is not equipped with a message register, to disconnect the parallel resistance from the second arm of the bridge, which was connected when the message register potential was removed from the sleeve, and to restore all of said means and said bridge to the condition prior to application of message register current to the line sleeve.

The invention will be understood by referring to the accompanying drawings, Figs. 1, 2, 3 and 4 of which when placed end to end as shown in Fig. 5 illustrate the essential parts of the observing system as originally described in Patent 1,194,721, together with the modifications thereof (shown on Figs. 2 and 3) in accordance with the present invention. Referring specifically to the various features of the drawings, Fig. 1 is identical, in all essentials, with Fig. 1 of Patent 1,194,721, including reference characters, with the exception that key 35 of the patent has been eliminated, the function of this key, which is to connect battery 44 to the sleeve of the plug, having been combined with key 33 by the addition of an extra pair of contact springs on key 33.

Fig. 2 is identical with Fig. 2 of the patent, including reference characters, except for the following:

- a. Addition of resistance 129—A and its associated key which connects to the tip of jack 142 in the same manner as resistance 129 is connected to the tip of jack 140.
- b. Addition of a second grounded armature (169) to relay 118.
- c. Addition of two conductors 167 and 168.
- d. Elimination of grounded resistance 130, which was shown in error in the patent.

In this figure (Fig. 2) also, certain current sources, relays and resistances such as relays 115, 145, and 146 and resistance 165 have been shown by dotted lines which were merely indicated by the table of Fig. 4 of the patent but not shown in original Fig. 2. For example, by referring to relay 113 of the patent, it will be noted that one terminal of its winding appears as a lead "A" and by referring to the table shown in Fig. 4 we note that lead "A" of relay 113 when used with line 1, should be connected to terminal 1 of the group of relays, resistances and current sources shown at the bottom of the figure which, in the present case, is direct battery.

Fig. 3 is identical with Fig. 3 of the patent, including reference characters, except for the addition of a circuit arrangement whereby the present invention is achieved, which is shown within the dotted rectangle Y at the lower left of the figure and by the further addition of leads with which this arrangement is connected to the rest of the system. In this connection it will be noted that conductors 167 and 168, added to Fig. 2, are extended to and terminate in this new circuit arrangement, that the conductor originally extending from Fig. 2 to the moving coil 131 of voltmeter relay 126 of Fig. 3 of the patent has been opened at points 170 and 171 and serially extended through the new circuit arrangement and that an additional lead 173 has been extended from the new circuit arrangement to ground through resistance 128. Further, it will be noted that the table identified as Fig. 4 of the patent has been omitted.

The present Fig. 4 is an abbreviation of Fig. 5 of the patent which shows enough of the circuit to illustrate the operation of the invention. No changes, however, have been made, certain 75

apparatus and connections having merely been omitted.

The invention will now be described in detail.

In Patent 1,194,721 beginning with line 58 on page 2, there will be found a description of the operation of the observing circuit when the subscriber on coin box line 1 removes his receiver from the switchhook and deposits a coin in the coin box associated with his station. Briefly, this circuit operation may be summarized as follows:

Removal of the receiver and deposit of a coin operates line relay 15 which lights line lamp 16 and operates relay 101.

Relay 101 operates relay 102 which in turn operates relay 201. Relay 201 lights lamps 204 and 205 at the service observing desk which indicates to the observers that a call is being made on one of the lines which are connected to the observing equipment. Operation of relay 102 also operates relays 109 and 110. Relay 109 operates relays 113 and 114. Relay 113 extends the calling line toward the service observing desk and relay 114 operates relay 112 which releases relays 109 and 110. Relay 114 operating, locks itself and relay 113 operated over a circuit which includes relay 105 which relay operates and causes relay 102 to release. As long as relay 105 is operated all other lines are prevented from being connected to the observing trunk because relay 102 can not operate due to the removal of ground at the back contact of relay 105. Release of relay 102 does not extinguish lamps 204 and 205 as relay 112, now operated, furnishes ground to hold relay 201 operated.

It will be assumed that the lighted lamp 204 is noted by the observer sitting at position F of the observing desk who immediately operates key 206, which extinguishes lamps 204 and 205, lights lamp 207 and connects the observer's telephone set to the observing trunk D.

It is further assumed that key 206 is operated before the regular operator answers the calling line by inserting the answering plug of the cord circuit E into the jack of line 1.

Now, when the call is answered by the regular operator by inserting the answering plug in the jack of line 1, cut-off relay 17 and relay 117 operate from the sleeve battery of the cord. Relay 118 is in series with relay 117 but does not operate due to its resistance. Operation of cut-off relay 17 releases line relay 15 which in turn extinguishes the line lamp 16 and releases relay 112. Operation of relay 117 operates relays 119, 120 and 122. Relay 120 extends the trunk through to the observing desk and relay 122 operates relay 208 which in turn lights lamp 210 to indicate to the observer that the operator has answered the call. The operation of relay 122 also connects, at its lower contact, battery to lead 172 which extends to the voltmeter 126 of Fig. 3 thereby completing a Wheatstone bridge circuit in which resistance 127 forms the first arm, resistance 128 the second arm, resistance 21 and lamp 18 in parallel and in series with resistance 19 forms the third arm, and three parallel paths form the fourth arm which consists of the following: First path, winding of cut-off relay 17; second path, winding of relays 117 and 118 in series; third path, resistance 129. Ground is connected at the junction of the second and fourth arms and the exchange battery is connected to the junction of the first and third arms.

In this connection it should be pointed out that when the coin subscriber's line 1 is connected to

the observing circuit by connecting plugs 24 and 25 with jacks 139 and 140, respectively, resistance 129 is connected to the tip of jack 140 by operating the associated key, this being done to make the combined resistance of the fourth arm of the bridge, the same as it would be if the message rate line 26 were connected to the observing circuit which line (26) includes the message register magnet 32 in parallel with the cut-off relay 43 to ground. In other words, resistance 129 compensates the bridge for the absence of meter magnet 32 when a coin line is connected.

It will, of course, be understood that when the message rate line 26 is connected to the observing circuit, resistance 129—A, for example, associated with jack 142 will not be required and hence the associated key will be opened.

The moving coil 131 of the voltmeter relay 126 is connected across the foregoing described bridge from the junction of the first and second arm to the junction of the third and fourth arm. In the condition described the bridge is unbalanced sufficiently and in such a direction that sufficient current flows through the coil 131 from the junction of the third and fourth arms to the junction of the first and second arms to cause the voltmeter contacts 132 to close.

Closure of contacts 132 short-circuits condenser 133 and resistance 134 and operates relay 135 which in turn supplies ground to hold relay 201 operated which otherwise would release due to the release of relay 112. This maintains lamp 207 lighted at the observing desk to indicate to the observer that the subscriber has his receiver off the hook. Relay 201 will release for an instant due to the release of relay 112, but it will immediately reoperate as soon as relay 135 operates. This may cause lamp 207 to flicker momentarily.

Restoration of the subscriber's receiver will release cord supervisory relay 22 which removes resistance 21 from parallel relation to lamp 18 thereby changing the resistance of the third arm of the bridge to such an extent that the bridge becomes balanced and coil 131 of the voltmeter relay assumes its normal position which opens contact 132 thereby releasing relay 135 and relay 201 in sequence and extinguishes lamp 207.

Functions 1, 2, and 3 described in line 108 on page 3 through line 74 on page 4 of Patent 1,194,721 will not be redescribed herein as they are not directly related to the invention of the present application.

In case a subscriber on message rate line 26 calls, line relay 42 operates which operates relays 101 and 102 as before, which latter relay operates relays 201, 109 and 110. Relay 201 lights lamps 204 and 205 as usual and relay 110 operates relays 143 and 116. Relay 116 operates relays 112 and 105. Relay 112 in operating removes ground from relays 109 and 110 which release and relay 105 in operating opens the circuit of relay 102 which releases and which also breaks the operating circuit of relays 109 and 110.

It will be assumed the same observer (position F) observes the lighted lamp 204 and operates relay 206 as before thereby extinguishing lamps 204 and 205, and lighting lamp 207 in their stead.

When the regular operator answers the call by inserting the answering plug of cord circuit E in the jack of line 26, line cut-off relay 43 and relay 117 operate. Cut-off relay 43 releases line

relay 42 which in turn extinguishes the line lamp and releases relay 112 which momentarily releases relay 201. Lamp 207, however, is only momentarily extinguished as relay 201 is immediately reoperated by the operation of relay 135 when the voltmeter relay 126 operates and closes its contacts 132 which follows the operation of relay 122, which relays together with relays 119 and 120 operate in response to operation of relay 117. Operation of relay 122 also operates relay 208 as before which lights lamp 210 as an indication to the observer that the operator has answered the call.

In accordance with the new operating practice before referred to, the operator will inquire the wanted number and establish the desired connection, but either simultaneously with plugging up the called line or prior thereto, will register the call on the calling subscriber's meter 32 by operating key 33 of the cord circuit which opens the talking conductors of the cord, connects negative 110-volt battery 34 through relay 36 to the tip of the cord and line and 39-volt battery 44 through the magnet of the position register 45 to the sleeve circuit of the cord and line.

There being no coin box associated with line 26, connection of battery 34 to the tip of the line has no effect, but as this line is equipped with a message register 32 connected to the sleeve, operation of key 33 causes the message register to operate which short-circuits its high resistance left-hand winding thereby materially reducing the jack sleeve resistance to ground. The call is now registered on line meter 32 and also recorded on position register 45, which also operates.

Marginal relay 118, in series with relay 117, now operates due to the higher voltage of battery 44 connected to the jack sleeve and at its inner contacts connects ground to lead 167 to operate relay 174, the circuit for which can be traced from ground, inner contact of relay 118, lead 167, contacts 175 of relay 176, winding of relay 174, lead 168 and contacts of relay 117 to battery.

Relay 118 also closes its upper contact to operate relay 230 which relay in operating lights lamp 236 and operates buzzer 231, as an indication to the observer that the operator has registered the call on the line under observation.

When key 33 is released the 39-volt battery 44 is disconnected from the sleeve of the cord whereupon relay 118 releases as it is so designed as to require more current to hold it operated than is supplied by the normal 24-volt exchange battery. Magnet 32, however, holds up on the exchange battery during the remainder of the connection.

When relay 118 releases it disconnects ground from lead 167 whereupon relay 176 operates in series with relay 174 in the following circuit: Ground, contacts of relay 177, contacts of relay 174 (now operated), windings of relays 176 and 174 and lead 168 to battery at the operated contacts of relay 117.

Relay 176 in operating opens its contacts 178 thereby removing the short circuit that has heretofore existed across coil 179 of a second voltmeter relay similar to 126.

Relay 176 also closes its upper contact thereby connecting a high resistance 180 in parallel with resistance 128 thereby maintaining a sufficient unbalance in the bridge circuit, and in the proper direction, to hold coil 131 energized

and contacts 132 closed which, otherwise, would be open due to the unbalance caused by short-circuiting the high resistance winding of magnet 32 of the message register.

The coil 179 of the second voltmeter relay is now in series with coil 131 across the bridge, but being of slightly lower resistance the current therein is not sufficient to cause its contacts 181 to close.

As relay 135 is held operated by voltmeter relay 126 lamp 207 remains lighted as an indication that the subscriber's receiver is still off the hook.

Returning now to the case where the coin line number 1 was under observation, it will be recalled that when the operator answered the call a bridge circuit was established the fourth arm of which was made up of a parallel arrangement of cut-off relay 17, resistance 129 and relays 117 and 118 in series, resistance 129 being substituted at this time to compensate for the resistance of message register 32 which is present in the circuit when a message register line is observed.

In accordance with the operating practice previously referred to, the operator upon receiving the wanted subscriber's number, before plugging up and ringing on the called line, operates the combined coin collect and message register key 33 in the cord circuit which, as before described, connects negative 110-volt coin battery 34 to the tip of the line and 39-volt message register battery 44 to the sleeve circuit.

Connection of 110-volt battery to the tip of the line causes coin magnet 30 to deposit the coin 29 in the proper receptacle as is well known.

Connection of the 39-volt battery 44 to the sleeve causes marginal relay 118 to operate, as before described in connection with message register line 26, which in turn operates relay 174.

When key 33 is released, following the disposal of the coin, relay 176 operates in series with relay 174, as previously described. Relay 176 in operating connects the high resistance 180 in parallel with resistance 128 in the second arm of the bridge, as before described, and removes the short circuit from coil 179 thereby connecting it in series with coil 131 of the voltmeter relay 126. Under this condition, however, as no change occurs in the resistance of the line sleeve due to the absence of the message register and the substitution therefor of the resistance 129, the bridge is unbalanced to such an extent that a larger current flows from the junction of the third and fourth arms of the bridge through coils 179 and 131 in series to the junction of the first and second arms which current is sufficient to cause coil 179 to close its contact 181 which completes a circuit to operate relay 182 which can be traced from ground, resistance 183, winding of relay 182, contact 181, contact 184 of relays 176 and 168, and contact of relay 117 to battery. Relay 182 operates and closes an obvious circuit to energize slow-operate relay 177 which soon opens its contact and releases relays 174 and 176. Relay 176 in releasing, disconnects the high resistance 180 from the second arm of the bridge and again short-circuits voltmeter coil 179 which opens its contact 181. The original bridge unbalance again exists which is sufficient to hold contact 132 closed, relays 135 and 201 operated and lamp 207 lighted.

It will be obvious that it was necessary to remove the high resistance 180 from the second arm of the bridge as soon as it was connected, on a coin line, as otherwise the unbalance of the

bridge would have been such that the voltmeter relay coil 131 would have received such an increase in current that disconnection of resistance 21 from the third arm of the bridge when the calling subscriber hung up would not have reduced the current through coil 131 sufficiently to allow contact 132 to open. Therefore, lamp 207 would have remained lighted as a false indication to the observer.

10 The remainder of the system functions in the same manner as described in Patent 1,194,721 and therefore a repetition of its description appears unnecessary.

What is claimed is:

15 1. In a service observing system, a subscriber's line having a message register, adapted to reduce its effective resistance when operated, associated with the line, an operator's cord circuit adapted to be connected thereto having means therein
20 for operating the message register, a service observing circuit connected to said line, a signal lamp associated with said observing circuit, means comprising a voltmeter relay in a Wheatstone bridge arrangement established when the
25 cord is connected to the line, said voltmeter relay being adapted to operate to light said lamp when the subscriber's receiver is off the hook, one arm of said Wheatstone bridge arrangement including said message register, and means effective
30 when said message register is operated to compensate said bridge for the change in resistance of its message register arm to maintain said voltmeter relay operated.

35 2. In a service observing system, a subscriber's line having a cut-off relay in its sleeve circuit and a double-wound message register magnet in shunt thereto, an operator's cord circuit adapted to be connected to said line having a source of current, a supervisory signal and a resistance serially connected in its sleeve conductor, a second
40 resistance, a supervisory relay in said cord adapted when operated to connect said second resistance in shunt to said signal, a second source of current of a higher voltage than the cord sleeve source for operating said message register, means
45 in said cord for connecting said second source to the sleeve thereof, said register being adapted when operated to lower its resistance in shunt to the cut-off relay, a service observing desk, a trunk line, having a sleeve conductor, for extending
50 said subscriber's line to said desk, means responsive to a call on said subscriber's line for connecting said trunk sleeve conductor to the subscriber's line sleeve, a pair of relays in series in the trunk line sleeve conductor and in shunt to the
55 line cut-off relay when the cord is connected to the line, one of said relays being marginal and adapted to operate only on the higher potential of said second source, a voltmeter relay, a pair of high resistance elements, means responsive to the connection of said cord circuit to said subscriber's line to establish a Wheatstone balance circuit, the first and second arms including
60 respective ones of said high resistance elements, the third arm said supervisory signal and its series resistance and said second resistance in shunt to the supervisory signal when the cord supervisory relay is operated, the fourth arm including a parallel arrangement of said line cut-off relay, message register magnet and pair of trunk
65 line sleeve relays, and the bridge arm of the balance including the winding of said voltmeter relay, said resistances being so proportioned that when the cord circuit is connected to the subscriber's line and the cord supervisory relay is operated a difference in potential will exist between

the ends of the bridge arm sufficient to cause the voltmeter relay therein to operate in one direction to close one of its contacts and, when the supervisory relay is released, the potential difference between the ends of the bridge arm will be insufficient to hold the voltmeter relay operated, a lamp
5 signal at said desk adapted to be lighted, when the voltmeter relay contact is closed, as an indication that the subscriber's receiver is off the hook, and means jointly controlled by said trunk
10 sleeve relays so arranged that the change in resistance of said message register magnet caused by its operation, thereby causing a change in resistance of the fourth arm of the balance, will simultaneously effect a change in the opposing
15 arm of the balance to maintain a sufficient difference of potential between the ends of the bridge arm to hold the voltmeter relay operated as long as the message register is operated and the subscriber's receiver is off the hook.

20 3. In a service observing system, a subscriber's line having a cut-off relay in its sleeve circuit and a double-wound message register magnet in shunt thereto, a second subscriber's line having a cut-off relay in its sleeve circuit, a resistance, equivalent to that of said first line message register, connected in shunt thereto, an operator's cord circuit adapted to be connected to either of
25 said lines and having a source of current, a supervisory signal and another resistance serially connected in its sleeve conductor, a third resistance, a supervisory relay in said cord adapted when operated to connect said third resistance in shunt to said supervisory signal, a second source
30 of current of a higher voltage than the cord sleeve source for operating the message register in the first line, means in said cord for connecting said second source to the sleeve thereof, said register on the first line being adapted when operated to lower its resistance in shunt to its associated cut-off relay, a service observing desk, a trunk line, having a sleeve conductor for extending either
35 of said subscribers' lines to said desk, means responsive to a call on either of said subscribers' lines for connecting said trunk sleeve conductor to the calling line sleeve, a pair of relays in series in the trunk line sleeve conductor and in shunt to the cut-off relay of the connected line, one of
40 said relays being marginal and adapted to operate only while said second source is connected to the sleeve, a voltmeter relay, a pair of high resistance elements, means responsive to the connection of said cord circuit to either of said subscribers' lines to establish a Wheatstone balance circuit, the first and second arms of which include
45 respective ones of said resistance elements, the third arm including said supervisory signal and its series resistance and said third resistance in shunt to the signal when the cord supervisory relay is operated, the fourth arm including a parallel arrangement of the line cut-off relay, the pair of trunk line sleeve relays in series and the message register or its equivalent resistance, depending on which line is calling and connected to
50 by said cord, the bridge arm of the balance including the winding of said voltmeter relay, and said first cord sleeve current source connected across the remaining point of the balance, said plurality of resistance being so proportioned that when the cord circuit is connected to the subscriber's line and the supervisory relay is operated a difference in potential will exist between the ends of the bridge arm sufficient to cause the voltmeter relay therein to operate in one direction to close one of its contacts and, when the supervisory relay is released, the potential difference
55 60 65 70 75

across the voltmeter relay will be insufficient to hold it operated, a lamp signal at said desk adapted to be lighted when the voltmeter contact is closed as an indication that the subscriber's receiver is off the hook, means jointly controlled by said trunk sleeve relays when the current source is connected to the sleeve of the message register line and subsequently disconnected to maintain a sufficient difference in potential across said voltmeter relay to hold it operated as long as the message register is operated, and the receiver is off the hook, and further means including a second voltmeter relay connected in series with the first voltmeter relay in response to the joint operation of said trunk sleeve relay and the subsequent release of one of them and operated, if the non-message register line is connected, to immediately restore the Wheatstone balance to the condition existing before the second source was connected to the subscriber's line sleeve.

4. In a service observing system, a subscriber's line having a cut-off relay in its sleeve circuit and double-wound message register magnet in shunt thereto, an operator's cord circuit adapted to be connected to said line having a source of current, a supervisory signal and a resistance serially connected in its sleeve conductor, a second resistance, a supervisory relay in said cord adapted when operated to connect said second resistance in shunt to said signal, a second source of current of a higher voltage than the cord sleeve source for operating said message register, means in said cord for connecting said second source to the sleeve thereof, said register being adapted when operated to lower its resistance in shunt to the cutoff relay, a service observing desk, a trunk-line, having a sleeve conductor, for extending said subscriber's line to said desk, means responsive to a call on said subscriber's line for connecting said

trunk sleeve conductor to the subscriber's line sleeve, a pair of relays in series in the trunk line sleeve conductor and in shunt to the line cut-off relay when the cord is connected to the line, one of said relays being marginal and adapted to operate only on the higher potential of said second source, a voltmeter relay, a pair of high resistance elements, means responsive to the connection of said cord circuit to said subscriber's line to establish a Wheatstone balance circuit, the first and second arms including respective ones of said high resistance elements, the third arm said supervisory signal and its series resistance and said second resistance in shunt to the supervisory signal when the cord supervisory relay is operated, the fourth arm including a parallel arrangement of said line cut-off relay, message register magnet and pair of trunk line sleeve relays, and the bridge arm of the balance including the winding of said voltmeter relay, said resistance being so proportioned that when the cord circuit is connected to the subscriber's line and the cord supervisory relay is operated a difference in potential will exist between the ends of the bridge arm sufficient to cause the voltmeter relay therein to operate in one direction to close one of its contacts and, when the supervisory relay is released, the potential difference between the ends of the bridge arm will be insufficient to hold the voltmeter relay operated, a lamp signal at said desk adapted to be lighted when the voltmeter relay contact is closed as an indication that the subscriber's receiver is off the hook, and means jointly controlled by said trunk sleeve relays to maintain a sufficient difference of potential across said voltmeter relay to hold it operated when the message register magnet is operated before the receiver is replaced on the hook.

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