Nov. 17, 1942. C. W. HALLIGAN 2,302,544

SIGNALING SYSTEM

Filed May 10, 1939 2 Sheets-Sheet 1

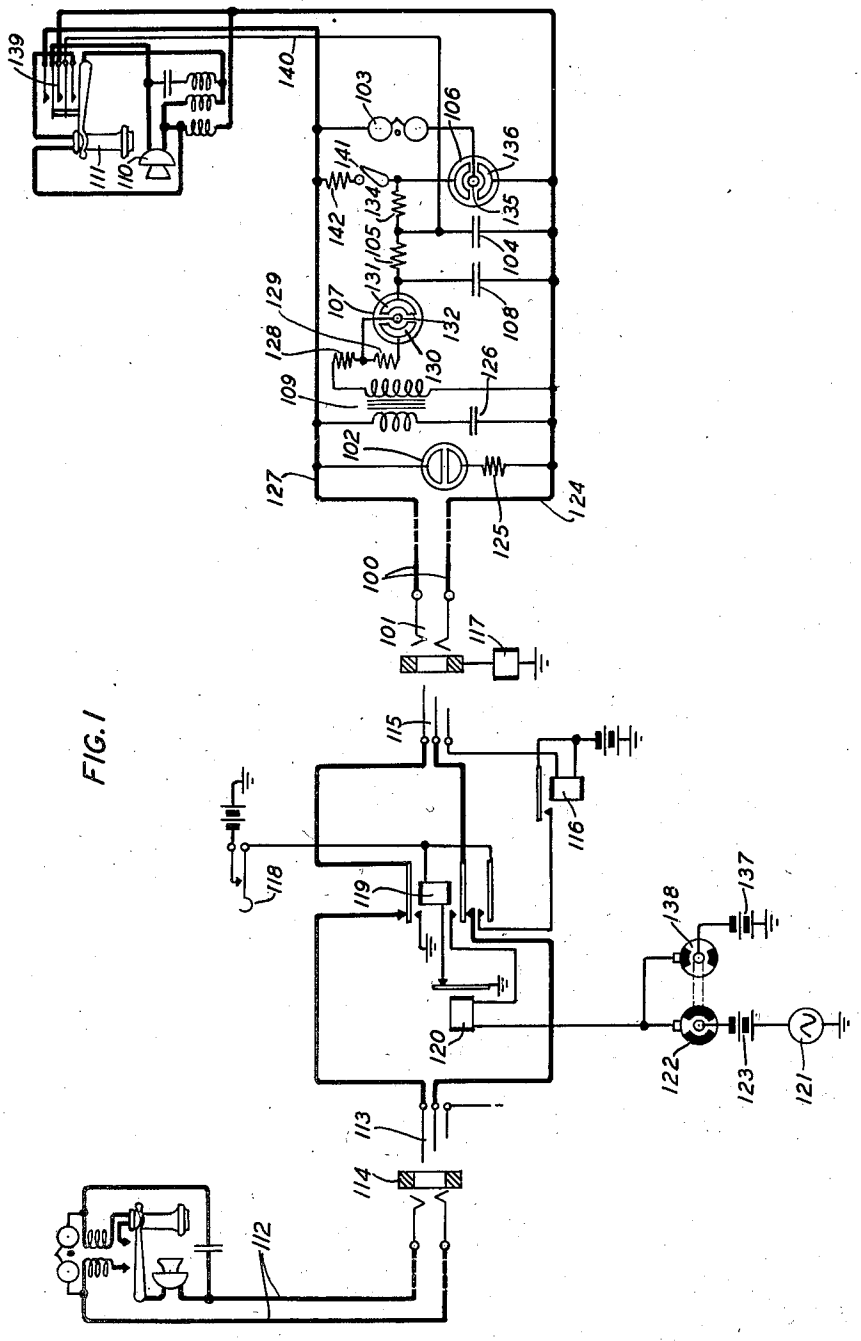

FIG. 1

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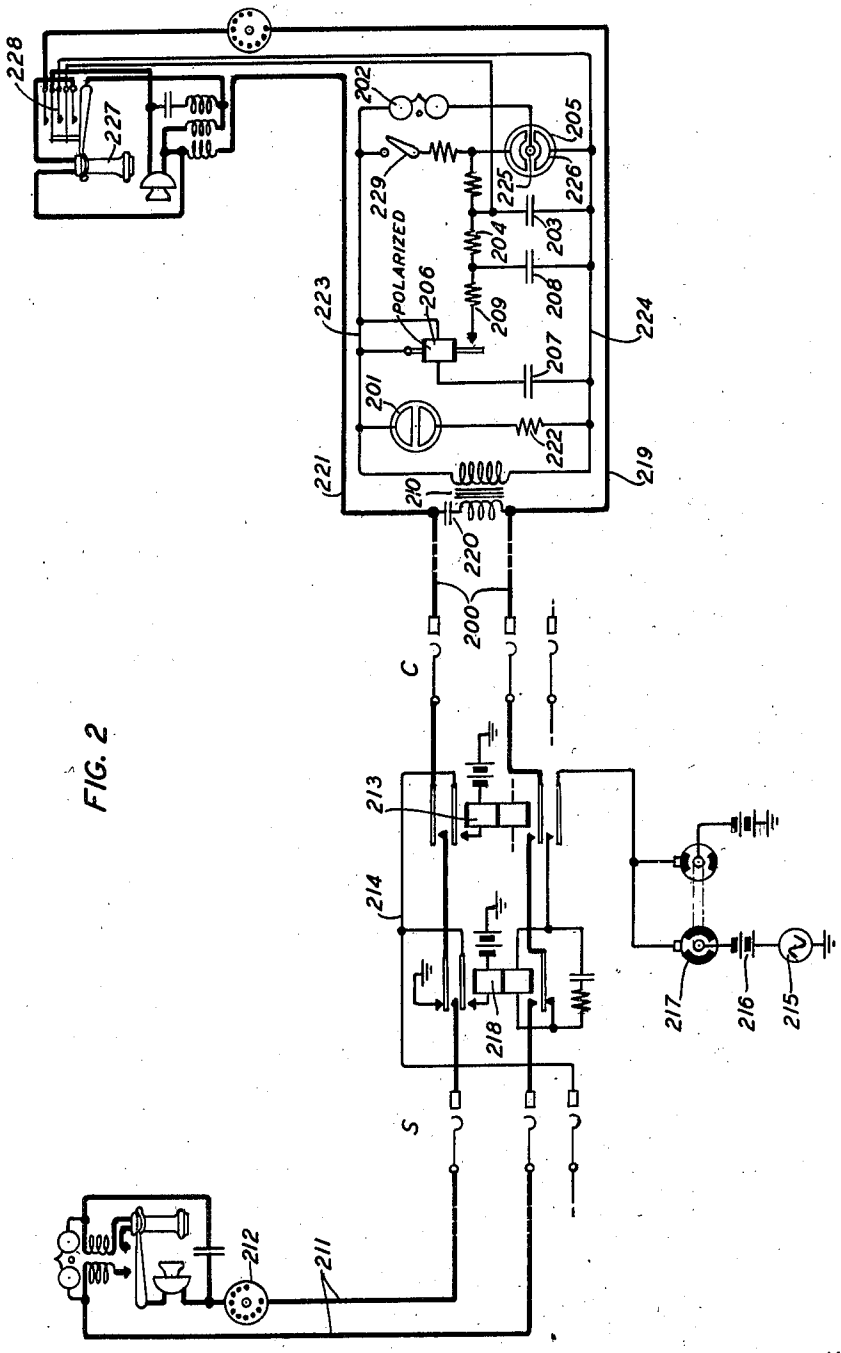

FIG. 2

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SIGNALING SYSTEM

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Application May 10, 1939, Serial No. 272,738

11 Claims. (Cl. 179—84)

This invention relates to electric signaling and particularly to signaling devices for use in telephone systems.

The objects of the invention are to increase the effectiveness of signaling over telephone lines; to utilize the signaling current for operating both visual and audible signal devices at a subscriber's station; to postpone the actuation of one of the signals under the control of a delay mechanism operated by the signaling current flowing in the line; and in other respects to secure improvements in signaling systems and devices.

These objects are realized by means of a signaling system in which a communication line, such as a telephone subscriber's line, is provided at the substation with a visual signal, an audible signal, and a time measuring mechanism; in which the presence of signaling current in the line energizes the visual signal to attract the subscriber's attention; in which the signaling current flowing in the line is also utilized by the timing mechanism to measure a predetermined interval following the commencement of the signaling operation; and in which the timing mechanism, having measured said interval, renders the audible signal effective to respond thereafter to the signaling current to attract the subscriber's attention more positively in case he fails to recognize the visual signal.

A feature of the invention is a system of this character in which the delay interval preceding the operation of the audible signal is effected by charging a condenser through a resistance by the signaling current flowing in the line and by utilizing the charge on the condenser to ionize a tube at the expiration of the interval, and in which the tube, when ionized, serves to close the operating circuit for the audible signal.

Another feature is a signaling system in which alternating signaling current is applied to the line to operate first the visual signal and then, after the delay interval, the audible signal, and in which a gas-filled discharge tube serves to rectify the signaling current and supply it to the timing mechanism for measuring the delay interval.

According to a further feature the gas-filled tube, which supplies the rectified signaling current to operate the time measuring mechanism, glows during the delay interval as a visual signal to the subscriber that his line is being called.

The foregoing and other features of the invention will be described in the detailed specification.

In the drawings accompanying the specification:

Fig. 1 shows one form of the signaling system applied to subscribers' lines in a manual telephone exchange; and

Fig. 2 shows another form of the signaling system applied to subscribers' lines in an automatic telephone exchange.

In the system illustrated in Fig. 1 the subscriber's line, which appears in a jack 101 at an operator's position in the central office, is provided at the substation with a visual signal 102 for attracting the called subscriber's attention, in case he is near his telephone, when his line is first called by the operator at the central office. The signal 102 may be of any suitable type, such as a gas-filled lamp which ionizes and glows in response to the application of ringing current to the line.

The line 100 is also equipped at the substation with the usual audible ringer 103 which, however, is so arranged that it does not respond until the ringing current has persisted in the subscriber's line for a predetermined interval of time. This interval of time is measured by a delay mechanism which includes a time measuring condenser 104, a charging resistance 105 over which said condenser is charged, and a three-electrode gas-filled tube 106. The current for charging the time measuring condenser 104 is derived by means of a tube 107 which rectifies the incoming alternating ringing current. The rectified current is applied to the condenser 104 through resistance 105 and also is stored in a condenser 108 from whence it is drawn to charge and to maintain charged the time measuring condenser 104. In order to charge condenser 108 to a voltage high enough to operate tube 106, a transformer 109 is employed.

The subscriber's station is further equipped with the usual telephone transmitter 110, receiver 111, and the associated induction coil and switchhook contacts.

In the modification shown in Fig. 2 the subscriber's line 200 appears in the terminals of automatic switches in the central office. At the substation this line is also equipped with the visual signal lamp 201, the audible ringer 202 and with the time delay mechanism comprising the time measuring condenser 203, charging resistance 204 and the gas-filled tube 205. The means for obtaining the charging current for the condenser 203, is, however, somewhat different. This means comprises a polarized relay 206 connected across the subscriber's line in series with a condenser 207. For each operation of the relay 206 on alternating half-cycles of the ringing current a circuit is closed for condenser 203 through resistances 209 and 204 and for the storage condenser 208 through the resistance 209.

To insure sufficient voltage for operating the lamp 201 and the time delay mechanism a transformer 210 may be inserted in the line as illustrated. If, however, the ringing current is of sufficient voltage, this transformer may be omitted.

A detailed description of the signaling system

will now be given, first discussing Fig. 1 and then Fig. 2.

Assume that the subscriber of a line 112 wishes to converse with the subscriber of line 100, which is equipped with the visual and audible signals. The operator in the central office answers the calling subscriber in the usual manner by inserting her answering plug 113 in the jack 114 of the calling line and learns that a called line 100 is desired. Thereupon she seizes the calling plug 115 of her cord circuit and inserts it in the jack 101 of the called line. This results in the operation of sleeve relay 116 in a circuit from battery through the winding of said relay, over the sleeve of the plug and jack, to ground through the winding of cut-off relay 117. Next the operator closes her ringing key 118 to initiate the ringing operation. The closed ringing key 118 completes a circuit from battery through its contacts and the winding of relay 119 to ground at the normal contacts of relay 120. Relay 119 locks in a circuit from battery through the contacts of relay 116, contacts and winding of relay 119 to ground at the normal contacts of relay 120. Relay 119 also closes the ringing circuit for supplying ringing current from alternating current source 121 to the called line 100.

The ringing circuit is opened and closed periodically by the interrupter 122 and may be traced from generator 121, battery 123, through conducting segments of interrupter 122, winding of relay 120, inner lower front contacts of relay 119, ring of the plug 115 and jack 101, thence over the ring conductor 124 of the line to the substation, where it flows through the resistance 125 and the glow tube 102 and in parallel therewith through the condenser 126 and the primary winding of transformer 109, to the tip conductor 127 of the line, returning through the tip of the jack and plug to ground at the upper front contact of relay 119. Current flowing in these circuits lights the glow lamp 102 and energizes the transformer 109. Relay 120, however, is marginal and does not respond at this time to the current flowing over the circuits traced.

The lamp 102 serves as a visual signal to give the subscriber immediate notice that his line is being called. If he is near his telephone and sees the lighted lamp, he responds by removing his receiver, and ringing current at the central office is tripped in the usual manner, which will be described hereinafter. If, however, the subscriber is not in the immediate vicinity of his telephone or does not notice the glowing lamp, the central office mechanism will continue to apply ringing current to the line, energizing the primary winding of the transformer 109 and inducing a corresponding voltage across the secondary winding of the transformer. The voltage across the secondary winding of the transformer is applied, through resistances 128 and 129 and condenser 108, across the control electrodes 130 and 131 of the tube 107. This voltage ionizes the control gap, whereupon the main gap is also ionized. Since the main gap of the tube conducts in only one direction, current flows, during alternate half cycles of the incoming alternating current, into the time measuring condenser 104 and also into the storage condenser 108. The charging circuits for these condensers may be traced from the upper terminal of the secondary winding of transformer 109 (when said upper terminal is postive) through the resistance 128, anode 132 of the tube, cathode 131 thence in parallel through the storage condenser 108 and through the resistance 105 and condenser 104 to conductor 124 and returning to the lower terminal of the secondary winding of the transformer 109. The time measuring condenser 104 accumulates a charge at a rate depending upon the value of the resistance 105, and the storage condenser 108 accumulates a charge for purposes to be explained hereinafter.

Assuming, as above suggested, that the subscriber does not observe the glow lamp 102 and that he fails to answer the call within a predetermined interval of time, the condenser 104 will accumulate a charge sufficient to ionize the control gap of the gas-filled tube 106, the condenser being connected across this gap through the resistance 134. Ionization of the control gap of tube 106 causes a discharge across the main gap. Since the main gap is in series with the ringer 103, the ringer now responds to ringing current incoming over the line. The circuit for the application of ringing current to the bell 103 may be traced from conductor 127, during each half cycle that the positive pole of the generator 121 is connected to this conductor, through the ringer 103, anode 135 and cathode 136 of tube 106, conductor 124 and thence through the trip relay 120, interrupter 122, battery 123 to the opposite pole of generator 121, which is negative' Since no current flows across the main discharge gap of the tube 106 on the alternate half cycles of the ringing current, namely, when the conductor 124 is positive and the conductor 121 negative, it is necessary to maintain the control gap of the tube ionized throughout the ringing interval of the interrupter 122. This is accomplished by making the resistance 134 sufficiently high to limit the amount of current drawn from the condenser 104 and by providing the storage condenser 108. By limiting the amount of current taken from the condenser 104 it is possible for the condenser 108, which may be of relatively large capacity if desirable, to replenish the condenser 104 at a rate sufficient to prevent the charge on condenser 104 from falling below the sustaining voltage of the control gap of the tube 106. The charge on the storage condenser 108 is also replenished during each ringing interval by current supplied from the rectifier 107. When the interrupter 122 reaches the silent interval segment, the generator 121 is disconnected from the line, and the bell 103 ceases to ring. Upon the reclosure of the ringing circuit by the interrupter 122, the bell begins to ring immediately, without waiting for any delay interval, since the condenser 108 may be made sufficiently large in capacity to maintain the condenser 104 charged throughout the silent interval of the interrupter 122.

This procedure continues until the called party removes his receiver or until the call is abandoned. The removal of receiver 111 from the switchhook closes the usual low resistance bridge across the line conductors 124 and 127, and the marginal tripping relay 120 now operates to disconnect the ringing machine automatically. If the called party answers during a ringing interval, the relay 120 is operated by current from the generator 121 and battery 123; if he answers during the silent interval current for operating the relay 120 is supplied from the battery 137 over interrupter 138, which is driven in synchronism with interrupter 122. Relay 120 in operating releases relay 119, and the latter relay disconnects the ringing machine from the line and

closes the tip and ring conductors of the cord circuit for conversation. The lamp 102 is now extinguished, and the bell 103 ceases to ring. Furthermore, the removal of the receiver 111 by the called party serves to discharge the condensers 104 and 108 in order that the time measuring mechanism may be restored to its normal condition ready for the next use. The discharge circuit for these condensers may be traced from conductor 124, which is connected to one terminal of each of the condensers, through contacts 139 of the switchhook, conductor 140, to the other terminal of condenser 104 and through resistance 105 to the other terminal of condenser 108.

When the subscribers have finished conversing the operator removes the cord circuit, and the equipment is restored to its normal condition.

Since the rectifier tube 107 glows during the time that signalling current is applied to the subscriber's line, this tube, in addition to its rectifying function for charging the condensers, may serve as a visual signal to notify the subscriber that his line is being signaled. In such a case it would not be necessary to provide the separate signal tube 102.

Referring now to the modification disclosed in Fig. 2, assume that the subscriber of line 211 in a dial office wishes to converse with the subscriber of line 200, the latter being equipped with both visible and audible signals. The calling subscriber initiates the call in the usual manner and operates his dial 212 to extend his line by way of automatic switches, including the selector switch S and connector switch C, to the called line 200.

When the connector C has been set on the terminals of the called line 200 and has found the line to be idle, relay 213 operates in the well-known manner and locks over its upper winding and contact to the sleeve conductor 214, which is grounded at this time. Relay 213 closes the ringing circuit, which may be traced from the generator 215 through battery 216, interrupter 217, lower contacts of relay 213 through the lower winding and lowermost back contact of the tripping relay 218, inner lower front contact of relay 213 over a brush of connector switch C to conductor 219, thence through the primary winding of transformer 210 and condenser 220 and returning over the line conductor 221 through the connector C, uppermost contact of relay 213 to ground at the uppermost back contact of relay 218. During the ringing interval of interrupter 217 alternating ringing current from the source 215 flows through the primary winding of the transformer 210 and induces a corresponding voltage across the secondary winding thereof. This voltage across the secondary winding causes current to flow through the lamp 201 and resistance 222, and the lamp glows as a visual signal to the subscriber.

The alternating voltage induced across the secondary winding of the transformer also causes an alternating current to flow in the circuit including the polarized relay 206 and condenser 207. Since relay 206 is polarized, it responds only to the alternate half cycles of the current, serving as a rectifier for charging the time measuring condenser 203 and the storage condenser 208. The charging circuit may be traced from conductor 223, through the contact of relay 206, closed only on half cycles of like polarity, through resistance 209 and storage condenser 208 to conductor 224 and in parallel therewith through the resistance 204 and the time measuring condenser 203. Condenser 203 charges at a rate depending on the value of resistance 204 to measure a predetermined interval of time, and condenser 208 assumes a storage charge. At the end of the measured interval, when condenser 203 reaches the ionizing voltage of tube 205, the tube discharges, and a circuit is closed for applying the alternating ringing current to the bell 202. The circuit for operating the bell may be traced from conductor 223, ringer 202, anode 225, cathode 226 to conductor 224. During each half cycle that conductor 223 is positive, current flows over this circuit, and the ringer 202 operates as an audible signal to the called party. During the non-conducting half cycles of the tube 205 and during the silent intervals of the interrupter 217 the condenser 203 is assisted by the storage condenser 208 in maintaining its charge up to the ionizing potential of the control gap of the tube.

When the called party answers by removing his receiver 227 from the switchhook, increased current flowing through the relay 213 causes the relay to operate and lock over its upper winding and contact to the grounded conductor 214. Relay 218 also removes the ringing current and closes the tip and ring conductors through for conversation. At the called station the closure of contacts 228 completes a discharge circuit for condensers 203 and 208 to restore the time measuring device to its normal condition.

When the subscribers finish conversation and replace their receivers, the automatic switches are released, and all equipment is restored to normal.

Should the subscriber wish to have his bell operate immediately that ringing current is applied to his line he may disable the time measuring mechanism by operating a key or suitable manual switch. In Fig. 1, for example, closure of the switch 141 places the control gap of the tube 106 across the conductors 124 and 127 in series with a resistance 142. With this circuit closed the application of ringing current to the line causes the immediate inonization of the tube and the immediate ringing of the bell 103. Similarly in Fig. 2 the subscriber may disable the time delay mechanism by closing the switch 229.

Numerous variations and modifications of these systems will also be apparent to those skilled in the art. For example, the transformers may be omitted, provided the voltages applied at the central office are sufficiently high to operate the equipment at the substation. Also it may be desirable to connect the ringers to ground, instead of bridging them across the line, at substations equipped with impulse dials.

What is claimed is:

1. The combination in a telephone system of a line having a station thereon, a source of signaling current, means for connecting said source to the line, a lamp at said station energized by the signaling current flowing in said line, a ringer at said station, a time measuring condenser at said station, a charging circuit including a resistor for charging said condenser at a definite rate with the signaling current received over said line, and means responsive to the charge accumulated on said condenser at the end of a predetermined interval for rendering said ringer responsive to the signaling current flowing in said line.

2. The combination in a telephone system of a subscriber's line having a station thereon, a source of alternating current, means for connecting said source to the line, a lamp at said station

energized by the current flowing in said line to give a visual signal, a bell at said station, means at said station for rectifying the alternating current flowing in said line, timing means operated by said rectified current for measuring an interval of time, and means controlled by said timing means for rendering said bell responsive after the expiration of said interval to the alternating current flowing in said line.

3. The combination in a telephone system of a subscriber's line having a station thereon, a source of alternating current, means for connecting said source to the line, a lamp at said station energized by the current flowing in said line to give a visual signal, an audible device at said station, means at said station for rectifying the alternating current in said line, a timing condenser charged at a definite rate by said rectified current to measure a desired interval of time, and means controlled by the charge on said condenser upon the completion of the measured interval for rendering said audible device responsive thereafter to the alternating current flowing in said line.

4. The combination in a telephone system of a subscriber's line having a station thereon, a source of alternating current, means for connecting said source to the line, a lamp at said station energized by the current flowing in said line to give a visual signal, an audible device at said station, means at said station for rectifying the alternating current in said line, a timing condenser charged at a definite rate by said rectified current to measure a desired interval of time, a discharge tube ionized by the charge on said condenser at the end of the measured interval, and a circuit rendered effective by the ionization of said tube for connecting said audible device to said line to respond thereafter to the alternating current flowing therein.

5. The combination in a telephone system of a subscriber's line having a station thereon, a source of signaling current, means for connecting said source to said line, a visual device at said station energized by the signaling current flowing in said line, an audible device at said station, a time measuring condenser at said station charged at a given rate by the signaling current flowing in said line, means responsive to the charge accumulated on said condenser at the end of a measured interval for rendering said audible device responsive to the signaling current in said line, a storage condenser charged by the signaling current, and means for supplying the charge on said storage condenser to the time measuring condenser.

6. The combination in a telephone system of a subscriber's line having a station thereon, a source of alternating current, means for connecting said source to the line, a lamp at said station energized by the current flowing in said line to give a visual signal, an audible device at said station, means at said station for rectifying the alternating current in said line, a timing condenser charged at a definite rate by said rectified current to measure a desired interval of time, means controlled by the charge on said condenser upon the completion of the measured interval for rendering said audible device responsive thereafter to the alternating current flowing in said line, and means controlled by the subscriber in answering a call for discharging said condenser.

7. In a telephone system, a subscriber's line, a source of alternating signaling current, means for connecting said source to the line, a ringer at the substation of said line, a time measuring mechanism for rendering said ringer responsive to said signaling current after a measured interval following the connection of said source to the line, and a gas-filled tube at said substation responsive to the signaling current to emit a glow as a calling signal and to supply rectified current for the operation of said time measuring mechanism.

8. The combination in a telephone system of a subscriber's line having a station thereon, a source of signaling current, means for connecting said source to the line, a visual signal at said station energized by the current flowing in said line, an audible signal at said station, a timing condenser charged at a definite rate by the signaling current flowing in said line to measure a desired interval of time, a discharge tube ionized by the charge on said condenser at the end of the measured interval, a circuit rendered effective by the ionization of said tube for rendering said audible signal responsive to the signaling current flowing in said line, and a storage condenser charged by the signaling current in said line and serving to charge said timing condenser.

9. The combination in a telephone system of a telephone line having a station thereon, a source of signaling current, means for connecting said source to the line intermittently, a visual signal at said substation energized by the signaling current flowing over said line, an audible signal at said station, a timing condenser charged at a definite rate by the signaling current for measuring a desired interval of time, a discharge tube ionized by the charge on said condenser at the end of the measured interval, circuit means controlled by said discharge tube for rendering said audible signal responsive to the signaling current flowing over said line, and a storage condenser charged by the signaling current in said line and serving to replenish the charge on said timing condenser during the intervals when no signal current is flowing in said line.

10. The combination in a telephone system of a subscriber's line having a station thereon, a source of signaling current, means for connecting said source to said line, a visual device at said station energized by the signaling current flowing in said line, an audible device at said station, a time measuring condenser charged at a given rate by the signaling current flowing in said line, means responsive to the charge on said condenser at the end of the measured interval for rendering said audible device responsive to the signaling current in said line, a storage condenser charged by the signaling current and serving to transfer its charge to the time measuring condenser, and means controlled by the subscriber in answering said signal devices for automatically discharging both of said condensers.

11. In a telephone system, a subscriber's line, a source of alternating signaling current, means for connecting said source to the line, an audible signal at the substation of said line, a condenser at said substation for measuring a predetermined interval of time following the connection of said source to the line, a gas-filled tube at said substation responsive to said alternating signaling current to emit a glow as a calling signal and to supply rectified current for charging said time measuring condenser, and means controlled by the charge on said condenser at the end of the measured interval for rendering said audible signal responsive to the signaling current flowing in said line.

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