May 31, 1938. H. KAHL 2,119,212

VOLUME INDICATOR

Filed Sept. 4, 1937 2 Sheets-Sheet 1

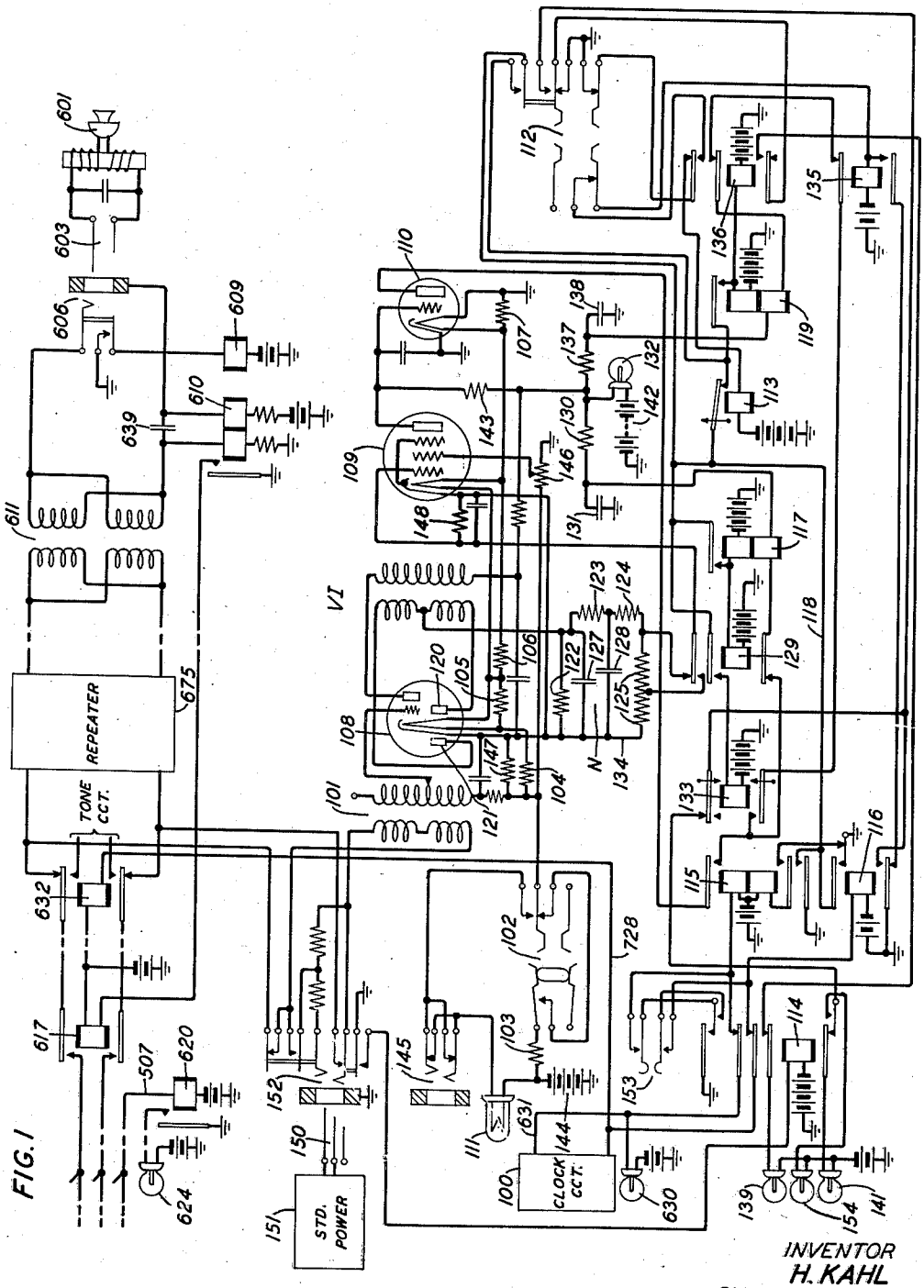

FIG. 1

INVENTOR
H. KAHL
BY P. C. Smith
ATTORNEY

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FIG. 2

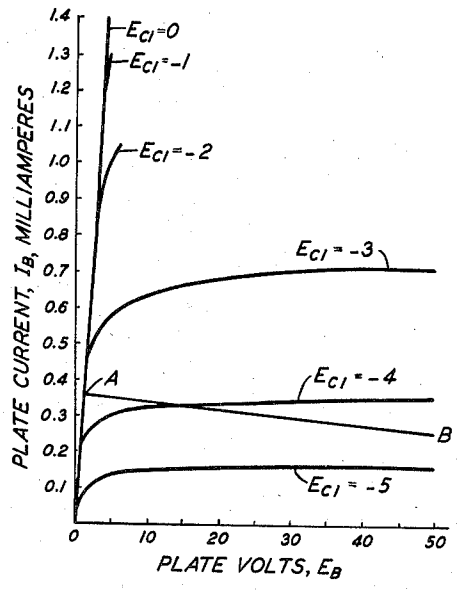
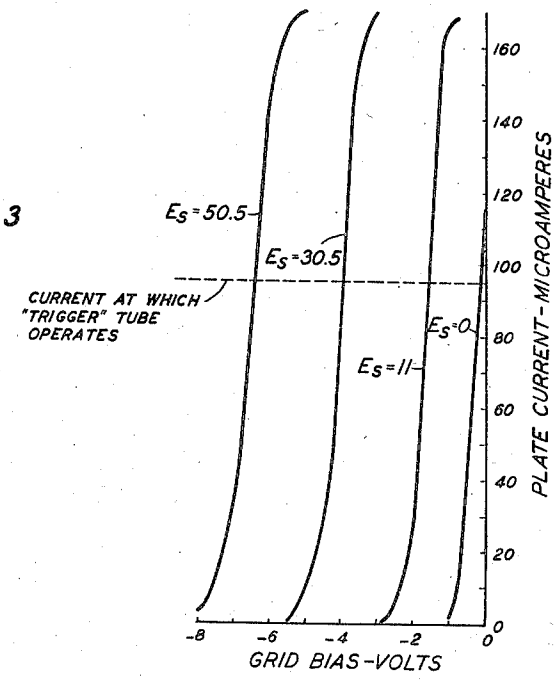


FIG. 3



INVENTOR
H. KAHL
BY
P. C. Smith
ATTORNEY

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2,119,212

VOLUME INDICATOR

Henry Kahl, Forest Hills, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application September 4, 1937, Serial No. 162,416

9 Claims. (Cl. 179—2)

This invention relates to telephone exchange systems and more particularly to systems in which a subscriber by calling a particular line designation may obtain a connection with a central time announcing system over which at specific intervals announcements are made by a special operator of the correct time of day.

It is the object of the invention to enable the announcing operator to maintain the volume of her announcements within a desired range.

In general, volume indicators employ some type of graduated dial by which the operator may make an estimate of the volume of the announcements. In accordance with the present invention, an indicator is provided which by a lamp signal indicates to the operator that the voice level is satisfactory. In the control of this indication, applicant's volume indicator employs a pentode tube operated at a low plate voltage range wherein the plate current changes rapidly with a small change in the applied grid voltage, the critical grid voltage being determined by the adjustment of the screen grid voltage. Following response at a first level, the indicator is reset by means of a gas-filled tube to respond at a second level.

The invention will be more clearly understood from a consideration of the following description in connection with the drawings in which:

Fig. 1 discloses the volume indicator circuit as applied to a time of day announcement trunk, and

Figs. 2 and 3 show the characteristics of the direct-current amplifier used.

The time of day announcement trunk may conveniently be of the type disclosed in Patent 1,863,141 granted June 14, 1932 to W. B. Prince. The reference numerals of the six-hundred series appearing on the drawings refer to similar apparatus disclosed and described in this patent.

When the announcing operator comes on duty she connects her announcing transmitter **601** by inserting plug **603** into jack **606** of the desk circuit and consequently relay **609** is operated over a make spring of jack **606**. Likewise relay **610** is operated in the circuit from battery through the right winding of relay **610**, sleeves of jack **606** and plug **603**, transmitter **601**, tips of plug **603** and jack **606**, right windings of repeating coil **611** to ground through the left winding of relay **610**. Relay **610** in turn initiates a chain of operations resulting in the operation of relay **617** as described in the above-identified patent. When a call reaches the announcing position, ground is connected to conductor **507**, operating relay **620** and causing lamp **624** to light as a signal to the operator that a call for time of day has been initiated by a calling subscriber. Under the control of the clock circuit **100** ground is connected to conductor **631** in order to light lamp **630** at such a time that the lighting of the lamp **630** is a signal to the operator that she should announce into her transmitter **601** the time indicated before her by a clock (not shown) controlled from the clock circuit **100**. A predetermined interval thereafter ground is connected to conductor **728**, winding of relay **632** and battery, operating relay **632** to connect tone to the trunk to mark the exact time as described in the Prince patent. The volume indicator VI may be connected in any desired manner across the announcing trunk at the output of the repeater **675**.

The volume indicator circuit is first carefully calibrated for the proper speech volume before it is connected into service. This is accomplished as follows: The plug **150** connected to source **151**, of 1000 cycle one milliwatt standard testing power, is inserted in jack **152** thus disconnecting the volume indicator from the desk circuit and operating relay **114**. The filaments of the vacuum tubes of the volume indicator are then heated by operating key **102** to its middle position, connecting battery **144** through low resistance **103** over the right and left contacts of key **102** and through resistances **104**, **105**, **106** and **107** to ground, the filaments of the tubes **108**, **109** and **110** being connected around resistances **105**, **106** and **107**, respectively. When the filaments have become heated, key **102** is thrown to the right thereby substituting ballast lamp **111** for resistance **103**. The heating current is then adjusted to the proper value by means of a milliammeter connected into jack **145**. When the tubes are ready, key **153** is operated closing obvious circuits for relays **115** and **116**. The locking of relay **115** is prevented by blocking open the upper normal contacts of relay **116**. With relay **114** operated, lamp **154** is lighted in a circuit from battery through lamp **154**, lower alternate contacts of relay **114**, upper normal contacts of relay **133** to ground at the lower front contact of relay **116**.

The current from the test source **151** is first amplified by the full wave rectifier tube **108** and the output from the tube **108** is applied to the control grid of the direct current amplifier pentode **109**, the output of which is applied to the input of the trigger tube **110**. Condenser **131** is normally charged from battery **142** through lamp **132** and resistance **130**. Potentiometer **146**

is then adjusted until tube 110 just breaks down and completes a discharge circuit for condenser 131 extending from ground over the cathode-anode circuit of tube 110, upper front contact of relay 115, lower back contact of relay 129, lower winding of relay 117 to condenser 131. Relay 117 operates in this circuit and locks in a circuit from battery through its upper winding and upper front contact to ground on conductor 118. It also extends its locking ground to the winding of relay 129 which operates, opening the operating circuit of relay 117. Relay 129 connects grounded conductor 118 over the inner upper front contact of relay 129 to the winding of relay 133 and battery. Relay 129 also opens the discharge circuit of tube 110 thereby extinguishing it. With relay 133 operated the test lamp 154 is extinguished. If necessary, the tap on the secondary winding of transformer 101 may be adjusted to bring about the desired operation. After the adjustments have been made they may be tested by momentarily releasing key 153 to reset the circuit. After calibrating the circuit, key 153 is restored, the contact of relay 116 is released and plug 150 is removed from jack 152 thus putting the volume indicator into service with the input of repeating coil 101 connected across the output of repeating coil 675 of the desk circuit. With key 112 normal, relay 113 is operated holding its contact normally closed.

As previously stated, at the beginning of each announcement period which occurs every fifteen seconds, ground is connected to conductor 631 by the clock circuit 100 thereby completing a circuit over the outer upper contact of test relay 114 through the upper winding of relay 115 to battery. Relay 115 locks in a circuit from battery through its lower winding and inner lower front contact to ground through the normal contacts of relay 116. The operation of relay 115 closes one point in the circuit of relay 117 and connects ground to conductor 118 preparing locking circuits for relays 117 and 119.

During the announcement, the volume indicator receives a portion of the speech current as it emerges from the desk repeater 675 by means of repeating coil 101. This speech current is first amplified by the full wave rectifier tube 108 which also acts as a buffer so that no modulation current, resulting from the rectification of the speech by the diodes 120 and 121 of tube 108 will interfere with the announcement. The output from the full wave rectifier is supplied to the network N, comprising resistances 122 to 125 and condensers 127 and 128, which modifies the potential so that the potential fluctuates exactly as would the pointer of a dial type volume indicator. This fluctuating potential is applied to the control grid of the direct current amplifier pentode 109 which acts as a voltage amplifier. The trigger type tube 110 indicates any volume in excess of a certain amount, for example, one decibel, by breaking down. Condenser 131 was previously charged from battery 142 through lamp 132 and resistance 130. When tube 110 breaks down it completes a discharge circuit for condenser 131 extending from ground over the cathode-anode circuit of tube 110, upper front contact of relay 115, lower back contact of relay 129, lower winding of relay 117 to condenser 131. Relay 117 operates in this circuit and locks in a circuit from battery through its upper winding and upper front contact to ground on conductor 118. It also extends its locking ground to the winding of relay 129 which operates, opening the operating circuit of relay 117. Relay 129 connects grounded conductor 118 over the inner upper front contact of relay 129 to the winding of relay 133 and battery. Relay 129 also opens the discharge circuit of tube 110 thereby extinguishing it. It also transfers the connection of the grid of pentode 109 from the right terminal of resistance 125 to the mid-point of that resistance.

It may be noted that the cathode of tube 109 is connected to conductor 134, while the grid of tube 109 is normally connected over the back contact of relay 129 to a point between resistances 125 and 124 so that the input circuit of tube 109 is connected across resistance 125. Following the operation of relay 129 the connection of the grid of tube 109 is transferred to the mid-point of resistance 125 so that the input circuit now is connected across only half of the resistance 125. This change in the connection of the control grid of tube 109 reduces the fluctuating voltage supplied thereto by approximately 6 decibels. The operation of relay 133 opens the circuit of lamp 141 and connects the plate of tube 110 over the front contacts of relays 115 and 133, upper back contact of relay 135, inner upper back contact of relay 136, lower winding of relay 119 to resistance 137 and condenser 138. Condenser 138 is charged by battery through lamp 132 and resistance 137 in the same manner as was condenser 131. If now the volume of speech is such as to be in excess of 6 decibels higher than the low critical volume, the trigger tube 110 again breaks down thus causing the operation of relay 119 by closing a discharge path for condenser 138. Relay 119 locks in a circuit from battery through its upper winding and inner upper front contact, the normally closed contact of relay 113 to grounded conductor 118 and extends its locking ground to the winding of relay 136. Relay 136 operates in turn closing a circuit from battery through the winding of relay 135, left normal contacts of key 112, upper front contact of relay 136 to ground over the lower right normal contacts of key 112. Relay 135 locks over its lower front contact to the ground over the lower back contact of relay 116, and opens the discharge circuit for tube 110 and the operating circuit of relay 119.

Immediately after the announcement, the associated clock circuit connects ground to conductor 728 for approximately one-half second and disconnects ground from conductor 631. The connection of ground to conductor 728 operates relay 116 over the middle upper contact of relay 114. The disconnection of ground from conductor 631 opens the operating circuit of relay 115 and with relay 116 operated, relay 115 now releases. The operation of relay 116 supplies a substitute holding ground for conductor 118, holding relays 133, 129, 117, 119 and 136 operated, thereby completing a circuit from battery through lamp 139, inner upper contact of relay 114, lower front contact of relay 136 to ground over the inner upper normal contacts of key 112, causing lamp 139 to be lighted while relay 116 is held operated. The lighting of lamp 139 indicates to the operator when the speech volume is too high. The removal of ground from conductor 728 releases relay 116 thus extinguishing lamp 139 and releasing relays 133, 129, 117, 119 and 136 restoring the circuit to normal.

If the operator's voice is not of sufficient volume when making the announcement the trigger tube 110 will not break down at all. Under this con-

dition, when ground is connected to conductor 728 and relay 116 is operated, lamp 141 will be lighted over the lower back contact of relay 114, upper back contact of relay 133 and front contact of relay 116 indicating that the operator's speech is too low. Should the operator's announcement be within the desired limits of speech level, the trigger tube 110 will break down only once, thus operating relays 117, 129 and 133 as previously described, but will not operate relays 119 and 136 and neither lamp will light, indicating to the operator that the volume of her speech was satisfactory.

In this volume indicator, the tubes 108 and 110 operate under fairly normal conditions and in the conventional manner. However, important advantages are obtained by operating the tube 109 at a very low plate voltage, a condition which results in non-linear amplification. The plate voltage is supplied from source 142 which is +130 volts and is connected to the plate through the resistance 143 which is 500,000 ohms. The screen grid voltage is adjusted to approximately +36 volts, being supplied by a potentiometer included in the circuit from the −48 volt battery 144, ballast lamp 111, contacts of jack 145, contacts of key 102, potentiometer 146 and ground. The cathode is connected through resistance 147 and ballast lamp 111 to source 144 while the control grid is connected to the filament through a one-megohm resistance 148. With no signal applied, current flows through the anode-cathode circuit and while the control grid is at zero potential with respect to the filament, the plate is only slightly positive. The cathode of the trigger tube 110 being directly grounded is biased 48 volts positive with respect to the cathode of tube 109, therefore the effective negative bias on the trigger tube grid is about 47 volts. As the control grid of tube 109 is carried negative by an incoming signal, the plate voltage changes by only an inappreciable amount for biases up to about −3.5 volts, and at −4.0 volts the plate voltage has risen only to about +15. However, an increase in the signal voltage to 4.5 volts carries the plate voltage up to about +48 volts or the potential of the trigger tube cathode, causing the latter to break down. Thus the tube 109 differentiates very sharply between signals relatively close together in amplitude and the individual characteristics of the trigger tube becomes relatively unimportant in determining the signal level at which the latter will be tripped. The characteristic curves of Fig. 2 illustrate the principles involved in the action of tube 109. In this figure the load line AB gives the relationship between the instantaneous plate voltage and plate current under the operating conditions.

Besides serving to distinguish clearly between signals of very nearly the same amplitude, tube 109 has an additional advantage over a three-element vacuum tube for this use. By adjusting the screen grid voltage suitably, the gain of the circuit may be adjusted conveniently and precisely and in addition the effects of the manufacturing variations between tubes can be eliminated for all practical purposes. The characteristic curves of Fig. 3 indicate how the response of tube 109 may be varied by the adjustment of the screen grid voltage due to the adjustment of the potentiometer 146.

What is claimed is:

1. In a sound volume indicator, a sound current carrying channel, a high resistance, means for establishing a potential across said resistance proportional to the volume of sound current in said channel, indicating means normally connected across said resistance comprising a direct current amplifier and a gas-filled discharge tube responsive to a predetermined potential, and means controlled by said gas-filled discharge tube for connecting said indicating means across a portion of said resistance.

2. In a sound volume indicator, a sound current carrying channel, a high resistance, means for establishing a potential across said resistance proportional to the volume of sound current in said channel, indicating means normally connected across said resistance comprising a direct current amplifier and a gas-filled discharge tube responsive to a predetermined potential, and means controlled by said gas-filled discharge tube for connecting said indicating means across a portion of said resistance and for resetting said gas-filled discharge tube.

3. In a sound volume indicator, a sound current carrying channel, a high resistance, means for establishing a potential across said resistance proportional to the volume of sound current in said channel, indicating means normally connected across said resistance comprising a direct current amplifier and a gas-filled discharge tube responsive to a predetermined potential, means controlled by said gas-filled discharge tube for connecting said indicating means across a portion of said resistance and for resetting said gas-filled discharge tube, a lamp, and means for lighting said lamp responsive to the second functioning of said discharge tube.

4. In a sound volume indicator, a sound current carrying channel, a high resistance, means for establishing a potential across said resistance proportional to the volume of sound current in said channel, indicating means normally connected across said resistance comprising a direct current amplifier and a gas-filled discharge tube responsive to a predetermined potential, means controlled by said gas-filled discharge tube for connecting said indicating means across a portion of said resistance and for resetting said gas-filled discharge tube, two lamps, means for lighting one of said lamps if said discharge tube fails to function, and means to light the other of said lamps if said discharge tube functions in response to the connection of said indicating means across the portion of said resistance.

5. In a sound volume indicator, a sound current carrying channel, a high resistance, means for establishing a potential across said resistance proportional to the volume of sound current in said channel, indicating means normally connected across said resistance comprising a direct current amplifier and a gas-filled discharge tube responsive to a predetermined potential, means controlled by said gas-filled discharge tube for connecting said indicating means across a portion of said resistance and for resetting said gas-filled discharge tube, and time controlled means for resetting said volume indicator following each application of sound current to said channel.

6. In a sound volume indicator, a sound current carrying channel, a high resistance, means for establishing a potential across said resistance proportional to the volume of sound current in said channel, indicating means normally connected across said resistance comprising a direct current amplifier and a gas-filled discharge tube responsive to a predetermined potential, means controlled by said gas-filled discharge tube for

connecting said indicating means across a portion of said resistance and for resetting said gas-filled discharge tube, a lamp, means for lighting said lamp responsive to the second functioning of said discharge tube, and time controlled means for resetting said volume indicator following each application of sound current to said channel.

7. In a sound volume indicator, a sound current carrying channel, a high resistance, means for establishing a potential across said resistance proportional to the volume of sound current in said channel, indicating means normally connected across said resistance comprising a direct current amplifier and a gas-filled discharge tube responsive to a predetermined potential, means controlled by said gas-filled discharge tube for connecting said indicating means across a portion of said resistance and for resetting said gas-filled discharge tube, two lamps, means for lighting one of said lamps if said discharge tube fails to function, means to light the other of said lamps if said discharge tube functions in response to the connection of said indicating means across the portion of said resistance, and time controlled means for resetting said volume indicator following each application of sound current to said channel.

8. In a sound volume measuring system, a source of sound current, means for generating a potential proportional to the volume of said sound, and means for indicating when said potential exceeds a predetermined value comprising a vacuum tube having at least a cathode, an anode and a control electrode, a gas-filled trigger tube having a cathode, an anode and a control electrode, the anode of said vacuum tube being connected to the control electrode of said trigger tube, means for operating said vacuum tube at a relatively low anode potential to render said vacuum tube sensitive to critical input potentials, means for applying said sound generated potentials to the control electrode of said vacuum tube, and indicating means connected to the anode of said trigger tube.

9. In a volume measuring system, a source of sound current, means for generating a potential proportional to the volume of said sound and means for indicating when said potential exceeds a predetermined value comprising a vacuum tube having at least a cathode, an anode, a control electrode and a screen electrode, a gas-filled trigger tube having a cathode, an anode and a control electrode, the anode of said vacuum tube being connected to the control electrode of said trigger tube, means for operating said vacuum tube at a relatively low anode potential to render said vacuum tube sensitive to critical input potentials, means for applying said sound generated potentials to the control electrode of said vacuum tube, indicating means connected to the anode of said trigger tube, and means for controlling the volume at which said indicating means shall be responsive comprising means for applying a potential to said screen electrode and means for adjusting said potential to a desired value.

HENRY KAHL.