

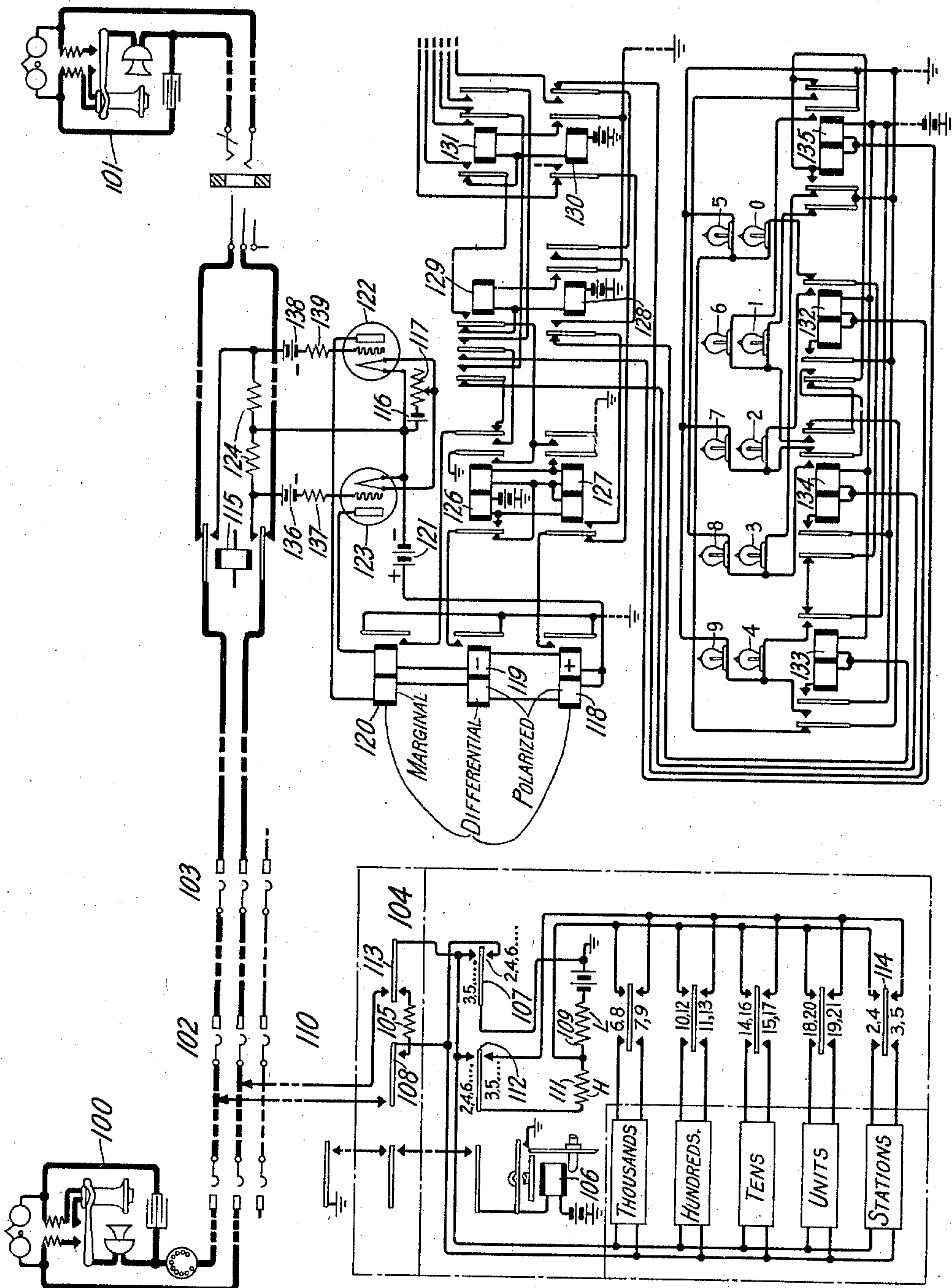
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SIGNALING SYSTEM

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UNITED STATES PATENT OFFICE

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SIGNALING SYSTEM

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This invention relates to signaling systems wherein signaling is accomplished by electrical impulses varying in polarity and strength and has for its object to increase the accuracy with which said signals are received and recorded over long lines.

In accordance with the present invention, a thermionic amplifier is employed at the receiving station, having a plurality of relays connected in series with its plate element, which relays are variably responsive to potentials applied to the grid element of the amplifier.

More specifically, the relays are differentially wound and are polarized or marginal in operation, and the potentials are applied to the grid element by means of an automatically operable sender at the distant office.

In the present disclosure the invention has been applied to a telephone system, although it is applicable to other forms of signaling. Where both manual and machine switching offices exist in the same exchange area, it is customary to employ a relay call indicator at manual offices to record the number of the wanted subscriber. This indicator is usually controlled by a pair of polarized relays and a marginal relay which are, in turn, operated by impulses of current flowing over the inter-office trunk. The strength and direction of current flow and the order in which the impulses are sent out are controlled by a sender at the machine switching office. In large exchange areas the inter-office trunks may be of considerable length so that the resistance and capacity of the trunks may reduce the current strength and retard the impulses to such an extent as to fail to operate the control relays properly or to require the use of a tandem office.

The arrangement embodying the present invention leads to increased accuracy in two ways: The circuits are so arranged that the signaling takes place by changes in potential rather than changes in current; and the use of differentially wound relays renders the voltage variation doubly effective on the control relays.

It is believed that the invention will be more clearly understood from a considera-

tion of the following description in connection with the drawing which discloses as much of a machine switching office and a manual office as necessary for setting forth the invention.

When the subscriber at substation 100 in a machine switching office desires a connection with the subscriber at substation 101, located in a manual office, he will operate his dial in accordance with the called number in the same manner as though he were calling a subscriber in his own office. The sender 110 will be associated with his line and the dial impulses will be recorded on a plurality of registers in the sender. The sender will then function to control the operation of district selector 102 and office selector 103 to select a trunk outgoing to the manual office in the well known manner. In accordance with the usual practice the class sequence switch indicated by the rectangle 104 will be positioned to control the action of the sender in extending the call to a manual office. In addition, if the called office is one at a considerable distance so that the equipment embodying the present invention, will be used, the class sequence switch will be positioned to connect resistance 105 across the pulsing conductors.

Following the selection of the distant office, and the response of the operator at the called office, a circuit will be closed from ground in the sender control circuit through the class switch to operate the impulser sequence switch 106. The pulsing circuit is also established at this time. As the sequence switch rotates, it alternately connects the positive and negative terminals of the central office battery to the tip conductor of the trunk under the control of the registers. For example, in position 2 of sequence switch 106 the grounded positive terminal of battery is connected over the lower contact of sequence switch cam 107, upper contact of cam 108, to the tip conductor, and the negative terminal of the battery is connected through low resistance 109 and high resistance 111, over the upper contact of cam 112, upper contact of cam 113, to the ring conductor producing what is known as a light negative impulse.

At the same time a circuit is extended through low resistance 109, and the upper contacts of cam 114 to the stations register, the setting of which determines whether or not the circuit shall be completed through to the upper contact of cam 112 in shunt of high resistance 111. If this shunt circuit is completed the impulse becomes heavy. Similar circuits are closed in the even positions of the sequence switch. In the odd positions the negative terminal of battery is connected to the tip conductor producing a positive impulse, only if the register setting completes the connection. The shunt cannot be closed in the odd positions. It is customary in such circuits to use a voltage of approximately 50 volts, a low resistance of the order of 50 ohms and a high resistance of the order of 6500 ohms. Resistance 105 is about 2000 ohms, hence the current flow in the local circuit varies from 5 milliamperes for a light impulse to 25 milliamperes for a heavy impulse and the potential across the trunk conductors varies from 10 volts for a light impulse to 47 volts for a heavy impulse. For a complete disclosure of the impulser switch and the manner of controlling the strength and polarity of the impulses as heretofore used, reference is made to United States Patent 1,589,402 to O. H. Kopp, granted June 22, 1926.

At the called manual office, the response of the operator causes the operation of relay 115, which connects the tip and ring conductors of the inter-office trunk through to the receiving apparatus. The receiving apparatus at this office consists of two polarized relays and a marginal relay controlled by an amplifier made up of a pair of electron discharge devices. These tubes have the usual cathode, anode and control electrode. The cathode is heated in any suitable manner, in the present disclosure in a circuit including a battery 116 and resistance 117. The grid or control elements of the tubes are connected to the tip and ring conductors of the inter-office trunk and are connected together by means of an extremely high resistance 124. This resistance has a value of approximately 100,000 ohms and the midpoint thereof is connected to the filaments completing the input circuit. Batteries 136 and 138, with resistances 137 and 139, are used in the usual way to give the grids a negative bias and to reduce the normal current flow in the plate circuits to a desired minimum. Relay 118 is polarized so as to attract its armature only in response to positive impulses, while relay 119 is polarized to respond only to negative impulses and relay 120 responds only to the heavy impulses caused when the high resistance 111 is short circuited.

The three relays are differentially wound and have both windings normally energized so that no force is exerted on their armatures. The left windings of the relays are energized

in a circuit from the positive side of the battery 121, left windings of relays 118, 119 and 120, plate and filament of tube 122, to the negative side of battery, while the right windings are energized in a circuit from the positive side of battery 121, right windings of relays 118, 119 and 120, plate and filament of tube 123, to the negative side of battery 121.

When the impulser switch 103 is operated to send out impulses over the inter-office trunk circuit, it is obvious that the current flow over the trunk circuit and through resistance 124 is negligible varying from .1 to .4 milliamperes. The potential drop across the trunk conductors therefore is largely independent of the resistance of the inter-office trunk, the addition of 6,000 ohms in the inter-office trunk reducing the potential by less than 1/10 of a volt.

The application of this difference in potential to the grid electrodes of the tubes 123 and 122 causes a change in the drop in potential between the grid and filament of each tube which will be in opposite directions in the two tubes. For example, if a negative potential is applied to the grid of the tube 123, and ground to the grid of tube 122, the potential of the grid of tube 123 will be made more negative, whereas the potential of the grid of tube 122 will be less negative than before. According to the well-known operation of vacuum tubes it will result that the space current flow in tube 123 will be decreased while the space current flow in tube 122 will be increased. In consequence, the flow in the left windings of relays 118 to 120 will be increased while the current in the right windings will be decreased. They will, therefore, exert a force on their armatures. Due to the polarization of relays 118 and 119, only relay 119 will attract its armature in response to such a negative impulse. If high resistance 111 is shunted by the register, the potential difference across the trunk conductors will be increased so that the effect of the grid elements will be greater and the marginal relay will attract its armature.

If, for example, negative potential is applied at the sender over the tip conductor of the interoffice trunk to the grid of the tube 122 and ground potential is applied over the ring conductor of the trunk to the grid of the tube 123, the potential of the grid of tube 122 will be made more negative, whereas the potential of the grid of tube 123 will be made less negative than before. As a result the space current flow in tube 122 will be decreased while the space current flow in tube 123 will be increased. In consequence the current flow in the right windings of relays 118 to 120 will be increased while the current flow in the right windings will be decreased and due to the polarization of relays 118 and 119 only relay 118 will attract its armature.

Relay 119 in operating, controls a relay combination 126 and 127 which, in turn, controls the transfer relays 128 to 131 which render the registers of the call indicator successively effective. Relay 118 determines the operation of relays 132 and 133 while marginal relay 120 determines the operation of relays 134 and 135. These relays when operated in various combinations cause the lighting of one of the numbered lamps. When the indicator registers have all been positioned, one lamp for each register will be lighted, displaying the called number to the operator. Relay 115 will be released at this time and the insertion of plug 136 in jack 137 will complete the connection to the called subscriber.

For a detailed description of the operation of relays 126 to 135 together with the remaining transfer relays and indicator registers, reference is made to United States Patent 1,464,084 to A. E. Lundell et al, granted August 7, 1923.

The present invention is an improvement over former arrangements in the case of long inter-office trunks in a number of different ways. For example, under the worst resistance conditions likely to be encountered in practice, the minimum voltage for a heavy impulse is several times the maximum voltage for a low pulse so that there is a wider margin for adjustment of the marginal relay. The pulsing circuit at either end is non-inductive and the current flow in the inter-office trunk is small, wherefore the effect of the inductance and capacity in the line itself is minimized. Furthermore, the inclusion of the control relays in local circuits permits the use of high resistance, high speed relays with the result that reception is more accurate. These advantages culminate in the possibility of using longer trunks without having to resort to tandem operation.

What is claimed is:

1. In a signaling system, a thermionic amplifier, a plurality of relays the windings of which are connected to the plate element of said amplifier, and means to variably operate said relays by impressing a potential of variable polarity and variable strength upon the grid element of said amplifier.

2. In a signaling system, a thermionic amplifier, a plurality of polarized relays the windings of which are connected to the plate element of said amplifier, an automatically operable potentiometer associated with a direct current source and means to variably operate said relays by varied operation of said potentiometer impressing potentials of variable polarity upon the grid element of said amplifier.

3. In a signaling system, a thermionic amplifier, a plurality of relays the windings of which are connected to the plate element of

said amplifier, one at least of said relays being marginal, and means to variably operate said relays by impressing potentials of variable polarity and variable strength upon the grid element of said amplifier.

4. In a signaling system, a thermionic amplifier, a plurality of polarized and marginal relays the windings of which are connected to the plate elements of said amplifier, and means to variably operate said relays by impressing potentials of variable polarity and variable strength upon the grid element of said amplifier.

5. In a signaling system, a thermionic amplifier, a plurality of differentially wound relays the windings of which are connected to the plate circuits of said amplifier, means to impress a potential upon the grid circuits of said amplifier to cause a change in the current flow in both windings of said relays, and means to vary the polarity and strength of said potential for variably operating said relays.

6. In a signaling system, a thermionic amplifier, a plurality of differentially wound polarized relays the windings of which are connected to the plate circuits of said amplifier, and a variable automatically operable potentiometer associated with a direct current source arranged to impress potentials upon the grid circuit of said amplifier to cause a change in the current flow in both windings of said relays.

7. In a signaling system, a thermionic amplifier, a plurality of differentially wound relays the windings of which are connected to the plate element of said amplifier, at least one of said relays being marginal, means to impress a potential upon the grid circuit of said amplifier to cause a change in the current flow in both windings of said relays, and means to vary the polarity and strength of said potential for operating said relays.

8. In a signaling system, a thermionic amplifier, a plurality of differentially wound polarized and marginal relays, the windings of which are connected to the plate circuits of said amplifier, means to impress a potential upon the grid circuits of said amplifier, to cause a change in the current flow in both windings of said relays, and means to vary the polarity and strength of said potential for operating said relays.

9. In a telephone system, a plurality of offices, interoffice trunks of different resistance interconnecting said offices, variably operable apparatus at one office controllable from a second office over said inter-office trunks, means at said second office for automatically impressing potentials of variable strength and polarity on the inter-office trunk and means at said first office effective regardless of trunk resistance for causing substantially the same current flow in said apparatus

for potential of any given strength and polarity.

10. In a telephone system, machine switching offices, a manual office, interoffice trunks of different resistance interconnecting said offices, a call indicator at said manual office operable from any of machine switching offices over said inter-office trunks, means at said machine switching offices for automatically impressing potentials of variable strength and polarity on any of said inter-office trunks and means at said manual office for operating said indicator in accordance therewith effective regardless of trunk resistance for causing substantially the same current flow in said apparatus for potential of any given strength and polarity.

11. In a telephone system, machine switching offices, a manual office, interoffice trunks of different resistance interconnecting said offices, a relay call indicator at said manual office, a plurality of relays for controlling said indicator operable from a machine switching office over an inter-office trunk, means at the machine switching offices for automatically impressing potentials of variable strength and polarity on any of the inter-office trunks and means at said manual office responsive to said variable potentials for operating said relays, said means being effective regardless of trunk resistance for causing substantially the same current flow in the windings of said relays for potential of any given strength and polarity impressed upon the conductors of said trunks.

12. In a telephone system, machine switching offices, a manual office, a relay call indicator at said manual office, a plurality of relays for controlling said indicator operable from a machine switching office over an inter-office trunk, and means comprising means at the machine switching office for automatically impressing potentials of variable strength and polarity on the inter-office trunk, a thermionic amplifier at said manual office having said relays connected to the plate element of said amplifier and means for impressing said variable potentials on the grid element of said amplifier, whereby said indicator is controllable over long inter-office trunks.

13. In a telephone system, machine switching offices, a manual office, a relay call indicator at said manual office, a plurality of relays for controlling said indicator operable from a machine switching office over an inter-office trunk, and means comprising means at the machine switching office for automatically impressing potentials of variable strength and polarity on the inter-office trunk, a thermionic amplifier at said manual office having a plurality of differentially wound relays connected to the plate elements of said amplifier and means for impressing said variable potentials on the grid elements

of said amplifier, whereby said indicator is controllable over long interoffice trunks.

14. In a telephone system, machine switching offices, a manual office, a relay call indicator at said manual office, a plurality of relays for controlling said indicator operable from a machine switching office over an inter-office trunk and means comprising means at the machine switching office for automatically impressing potentials, of variable strength and polarity on the inter-office trunk, a pair of thermionic amplifiers at said manual office having a plurality of differentially wound relays connected to the plate elements thereof, and means to impress said variable potentials on the grid elements of said amplifiers to cause a change in the current flow in both windings of said relays, to operate said indicator, whereby said indicator is controllable over long inter-office trunks.

15. In a signaling system, lines of different resistance, means for automatically impressing potentials of variable strength and polarity on any of said lines, a bridge associable with said lines of such resistance that the resistance of the longest line is negligible by comparison, apparatus connected electrically with said bridge, and means including said bridge effective regardless of line resistance for causing substantially the same current flow in said apparatus for potential of any given strength and polarity.

16. In a signaling system, lines of different resistance, an automatically adjustable potentiometer associable with one end of said lines, a bridge associable with the alternate end of said lines of such resistance that the resistance of the longest line is negligible by comparison, apparatus connected electrically with said bridge, means to variably operate said apparatus by varied adjustments of said potentiometer impressing potentials of variable polarity and strength upon said bridge over any of said lines, and means including said bridge effective regardless of line resistance for causing substantially the same current flow in said apparatus for potential of any given strength and polarity.

17. In a signaling system, lines of different resistance, means for automatically impressing potentials of variable strength and polarity on any of said lines, a bridge associable with said lines of such resistance that the resistance of the longest line is negligible by comparison, a plurality of relays electrically connected with said bridge, and means including said bridge effective regardless of line resistance for causing substantially the same current flow in said relays for potential of any given strength and polarity for selectively operating said relays.

18. In a signaling system, lines of different resistance, means for automatically impressing potentials of variable strength and polarity on any of said lines, a bridge associable

with said lines of such resistance that the resistance of the longest line is negligible by comparison, polarized and marginal relays electrically connected with said bridge, and means including said bridge effective regardless of line resistance for causing substantially the same current flow in said relays for potential of any given strength and polarity for selectively operating said relays.

19. In a signaling system, lines of different resistance, a bridge associable with one end of said lines of such resistance that the resistance of the longest line is negligible by comparison, a thermionic amplifier connected with said bridge, a plurality of polarized and marginal magnetically operable devices connected to the plate element of said amplifier, means for automatically impressing potentials of variable strength and polarity on any of said lines which, because of said bridge and amplifier, are effective regardless of line resistance for causing substantially the same current flow in said magnetically operable devices for potential of any given strength and polarity for selectively operating said devices.

20. A signaling system, a plurality of stations, lines of different resistance inter-connecting said stations, means for automatically impressing potentials of variable strength and polarity on lines at certain of said stations, thermionic amplifiers, and bridges electrically connected with said thermionic amplifiers and associable with lines at other said stations, of such resistance that the resistance of the longest line is negligible by comparison, effective regardless of line resistance for causing substantially the same current flow in said thermionic amplifier for potential of any given strength and polarity.

In testimony whereof, I have signed my name to this specification this 14th day of January, 1927.

CHARLES G. MILLER.