Oct. 14, 1941. R. H. HERRICK 2,258,650

SIGNALING SYSTEM AND APPARATUS

Filed March 4, 1940

Fig. 1

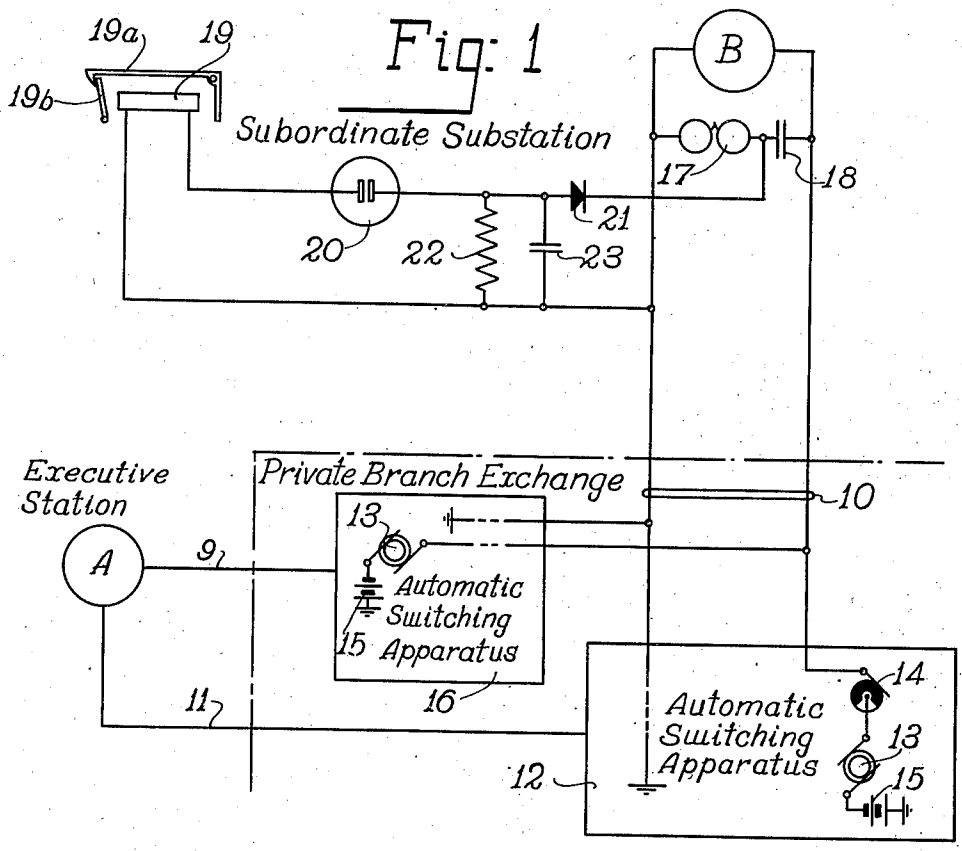
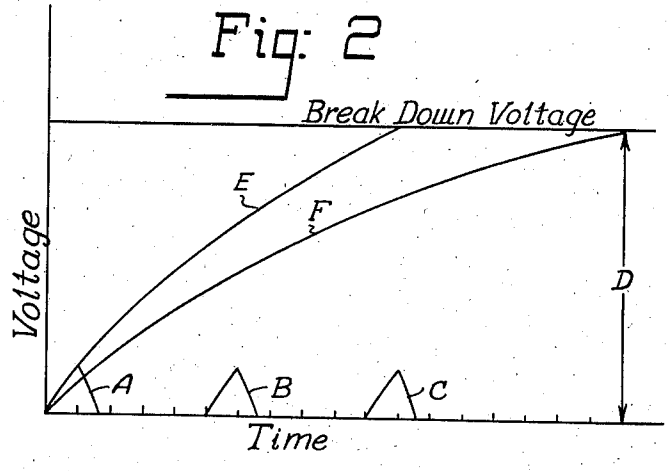


Fig. 2



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SIGNALING SYSTEM AND APPARATUS

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22 Claims. (Cl. 179—86)

The present invention relates to communicating systems and more particularly to improved apparatus particularly adapted for use in telephone systems to indicate the presence of calls incoming to one or more of the substations of the system.

In certain communicating systems it is desirable to provide at predetermined substations of the system incoming calls signaling apparatus which functions to indicate the character of different types of calling substations. Thus, in Patent No. 2,187,902, R. H. Herrick, granted January 23, 1940, for example, there is disclosed a system of the executive direct line type wherein an executive is given access to certain subordinate lines through the provision of key controlled automatic switching apparatus individual to the executive substation and having direct access to the subordinate lines. The subordinate lines also terminate in private branch exchange switching equipment so that the subordinate substation apparatus may also be utilized in handling regular PBX calls. In a system of this character it is particularly desirable to provide at the subordinate substations signaling equipment which is selectively operable to indicate whether incoming calls are regular PBX calls or originating at the executive substation. It is also desirable to so arrange the incoming call signaling apparatus at the subordinate stations that calls routed to these substations from the executive substation, but not answered, are visually indicated, whereby the subordinates are informed that they have been called from the executive substation.

It is an object of the present invention, therefore, to provide in a system of the character described, improved call indicating apparatus which is simple in arrangement and is selectively operable to distinguish between different types of calls routed to the substations at which it is located.

It is another object of the invention to provide improved incoming call signaling apparatus of the character described which, when operated, remains in its operated position, thereby visually to indicate its response to a call of predetermined character, until manually restored to normal.

It is a further object of the invention to provide an improved and exceedingly simple signal control network which is so arranged that the signal device thereof is only operated when signal voltage of a predetermined character is impressed upon the circuit.

In the illustrated embodiment of the invention there are provided a plurality of subordinate substation lines which individually extend to different subordinate substations and commonly terminate in the automatic switching apparatus of a private branch exchange. The arrangement of this automatic switching apparatus is such that in setting up connections between any two of the lines or between these lines and the other lines of the system interrupted ringing current is utilized for the purpose of operating the ringers or signal devices conventionally provided at the substations. The system further comprises an executive substation together with automatic switching apparatus individual to this substation and having direct access to each of the subordinate lines whereby the executive may, by certain key operations, set up a connection to any one of the subordinate lines without resorting to the expedient of dialing the directory number designating the desired subordinate substation. The automatic switching apparatus which is individual to the executive substation is provided with ringing equipment which functions to transmit ringing current over any selective subordinate line continuously until the call is abandoned or is answered at the called substation. In accordance with the present invention there is provided at each subordinate substation an incoming call signal network which is connected in parallel with the substation ringer and includes a signal device of the visual type which is energized and operates in response to ringing current continuously transmitted over the associated line. This circuit as provided at each subordinate station further comprises means for preventing the visual signal device embodied therein from responding to ringing current intermittently transmitted over the associated line at less than a predetermined rate. Thus provisions are made in the network whereby the signal device thereof is only operated to indicate an incoming call when the call originates at the executive substation. More specifically, each network comprises an electric discharge device of the gaseous type which is serially included in the operating circuit for the associated signal device. These two elements, namely, the signal device and the series connected electric discharge device are connected in parallel with a resistor and a capacitor which prevent the voltage impressed across the terminals of the discharge device from rising to a value exceeding the breakdown voltage of the discharge device unless ringing voltage is continuously applied to the network or is applied thereto intermittently at a rate which is above a predetermined value.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the accompanying drawing in which Fig. 1 illustrates a communicating system having embodied therein a signaling network connected and ar-

ranged in accordance with the present invention, and Fig. 2 graphically illustrates the mode of operation of the signaling network illustrated in Fig. 1.

Referring to the drawing, the automatic telephone system there illustrated is of the type frequently used to provide telephone facilities between the offices of a large manufacturing organization. Briefly described, the system comprises a plurality of substation lines, two of which are indicated at 10 and 11, and automatic switching apparatus schematically indicated at 12 for setting up connections between the various lines. This automatic switching apparatus may be of any conventional arrangement although preferably it is of the well-known Strowger type having embodied therein finder-connector links, a link distributor, and power and supervisory apparatus for providing the usual operating and signaling currents. The power and supervisory apparatus includes a source of alternating ringing current 13 and a ringing interrupter 14 which is operative intermittently to apply the voltage of the source 14 to the conductors of a selected called line in series with the exchange battery 15 in the usual manner.

The lines 10 and 11 respectively extend to a subordinate substation B and an executive substation A, substation apparatus of conventional arrangement being provided at these substations to terminate the associated lines. In order to facilitate the routing of calls from the executive substation A to any one of a number of subordinate substations, additional automatic switching apparatus 16 is provided which is individual to the executive substation A and has direct access to each of the subordinate substation lines. Thus the switching apparatus 16 is illustrated as having direct access to the subordinate line 10. For the purpose of transmitting ringing current over a subordinate line selected through operation of the automatic switching apparatus 16, the ringing current source 13 is arranged to be connected across the conductors of any selected one of the subordinate lines in series with the exchange battery 15. It will be noted that the ringing interrupter 14 is excluded from the ringing current circuits established through operation of the switching apparatus 16 so that when the ringing current source 13 is connected to a selected one of the subordinate lines ringing current is continuously transmitted over the selected line. Preferably the automatic switching apparatus 16 is of the character disclosed and claimed in the above cited Herrick Patent No. 2,187,902. As explained in this patent, control of the automatic switching apparatus 16 is effected through the provision of a plurality of call keys provided at the executive substation A which individually correspond to the various subordinate lines. These keys and the other control elements provided at the executive substation A are connected to the switching apparatus 16 through the conductors of a cable 9.

For the purpose of signaling the subordinate attending the substation B when a call is extended to the subordinate line 10, there is provided at this substation a ringer 17 which is bridged across the conductors of the line 10 in series with a condenser 18. This signal device is arranged to respond to ringing current transmitted over the line 10 from the source 13 regardless of whether the line 10 is seized through the regular automatic switching apparatus 12 or the automatic switching apparatus 16 individual to the executive substation A. In order visually to indicate calls routed to the subordinate substation B from the executive substation A, there is further provided at the subordinate substation an incoming call signal network which is connected in parallel with the ringer 17. This network comprises a drop 19 having an operating armature 19a and a flag 19b. The operating circuit for the drop 19 serially includes an electric discharge device 20 of the gas-filled type and a rectifying element 21. Preferably the discharge device 20 is in the form of a neon lamp. A lamp of this type possesses the characteristic of being nonconductive until a predetermined voltage commonly known as the breakdown voltage is impressed across the terminals thereof, at which time the lamp is rendered conductive and the resistance thereof is reduced from an exceedingly high value to a relatively small value. After a lamp of this character is rendered conductive, the voltage across the terminals thereof must be reduced to a value somewhat less than the breakdown value before the lamp is extinguished and again rendered nonconductive. The auxiliary signal network further comprises a resistor 22 which is connected in parallel with a capacitor 23 across the operating circuit for the drop 19 to limit the voltage developed across the discharge tube 20.

Briefly to consider the operation of the system, if a call intended for the subordinate substation B and initiated at the executive substation A in the usual manner, is routed to the automatic switching apparatus 12 over the line 11, the finder portion of an assigned one of the finder-connector links embodied in this apparatus operates to seize the calling line. In response to this operation the usual dial tone signal is transmitted to the calling executive. The executive may upon receipt of the dial tone signal, dial the digits of the directory number designating the desired substation B, whereby the wipers of the connector portion of the assigned link are positioned on the terminals to which the conductors of the line 10 are connected. Following this operation the called line 10 is tested in the usual manner to determine the idle or busy condition thereof, and if busy, the usual busy tone signal is returned to the calling executive. If the line 10 is idle, a ringing relay of the assigned link is caused to operate to connect the ringing current source 13 across the conductors of the line 10 in series with the interrupter 14 and the exchange battery 15 so that interrupted ringing current is projected over the line 10. The circuit traversed by the ringing current may be traced as extending from the upper terminal of the ringing current generator 13 through the conductive segment of the interrupter 14 and the operated contacts of certain of the relays embodied in the link in use, and by way of the negative side of the line 10, the condenser 18, the windings of the ringer 17, the positive side of the line 10, certain additional operated contacts of the relays embodied in the link in use, and the exchange battery 15 to the lower terminal of the generator 13. Each time the interrupter 14 operates to complete this circuit, the ringer 17 is energized and operates to emit a signal indicative of the presence of a call on the line 10. The interrupted character of the signal serves to inform the subordinate attending the substation B that the call is a regular PBX call. When the call is answered at the called substation, a direct current bridge is established between the conductors of the line 10 which results in operation of the ring cut-off relay conven-

tionally embodied in the link in use. When this relay operates, the ringing circuit is interrupted and the desired talking circuit is established between the calling executive station A and the called subordinate station B. The link embodied in the automatic switching apparatus 12 and utilized in setting up the connection is released in the usual manner when the connection is cleared out at the called and calling substations.

If the executive for whose service the automatic switching operation 16 is alone provided, desires, he may route the connection directly to the subordinate substation B by operating the call key individually corresponding to this substation. In response to this operation the automatic siwtching apparatus 16 operates to select the line 10, to test this line for the purpose of determining the idle or busy condition thereof, and to return the usual busy tone signal to the calling executive if the line 10 is busy. If the called subordinate line 10 is idle at the time it is thus selected, the ringing relay embodied in the apparatus 16 operates to connect the ringing current source 13 across the conductors of this line in series with the exchange battery 15. In this case, since the ringing interrupter 14 is excluded from the circuit traversed by the ringing current, the ringer 17 is continuously energized and continuously operates, thus informing the subordinate attending the substation B that a call originating at the executive substation A is present upon the line 10. When the call is answered at the called substation B, the ring cut-off relay embodied in the switching apparatus 16 operates to arrest the ringing operation and to establish the desired talking circuit between the substations A and B.

As indicated above, the arrangement of the auxiliary incoming call signal network connected in shunt with the ringer 17, is such that the drop 19 only responds to ringing voltage continuously impressed between the conductors of the line 10 through operation of the automatic switching apparatus 16. The mode of operation of this circuit will best be understood by reference to Fig. 2 of the drawing, wherein the voltages appearing across the electric discharge device 20 when different forms of ringing voltages are impressed across the conductors of the line 10, are plotted as a function of time. Assuming that the interrupter 14 is arranged for ringing intervals of one second to be followed by silent intervals of four seconds, the voltage of the ringing current source 13 is impressed upon the conductors of line 10 for only one second out of each five seconds. The current traversing the line 10 during each ringing interval causes a voltage to build up across the winding of the ringer 17, which is impressed across the parallel connected resistor 22 and capacitor 23 through the rectifier 21. As a result, a direct current of rising amplitude traverses each of the two circuit elements 22 and 23. With the condenser 23 uncharged, the impedance thereof is exceedingly low so that no substantial voltage is built up across this capacitor and the resistor 22 during the initial portion of each one second ringing interval. Immediately a voltage is impressed across the condenser 23 this condenser starts to discharge through the resistor 22. Accordingly, by properly proportioning the resistance value of the resistor 22, the maximum voltage developed across the capacitor 23 during each ringing interval may be held below the voltage required to produce ionization or breakdown of the electric discharge tube 20. This action, plotted in terms of voltage appearing across the capacitor 23 during three successive ringing intervals of one second each is illustrated in Fig. 2 of the drawing by the three curves A, B and C. It will be noted from these three curves that during the spacing or silent interval between each pair of ringing periods, the capacitor 23 completely discharges through the resistor 22 so that the voltage across these parallel circuit elements is reduced to zero. It will further be noted that the peak voltage developed across these elements during each ringing interval is substantially less than the voltage D required to cause ionization or breakdown of the discharge tube 20. Accordingly, when interrupted ringing current is, through operation of the interrupter 14, transmitted over the line 10, the drop 19 is not energized and does not operate.

When, however, ringing voltage is continuously applied to the line 10 through operation of the automatic switching apparatus 16, the build-up of voltage across the capacitor 23 continues even though this capacitor is continuously discharged through the resistor 22. If the ringing voltage persists for a predetermined interval the voltage across the parallel connected elements 22 and 23 equals the voltage required to cause ionization of the tube 20, the voltage rise in this case being indicated by the curve E in Fig. 2 of the drawing. When the voltage across the parallel connected circuit elements 22 and 23 equals the voltage D required to ionize the discharge tube 20 this tube is rendered conductive to pass current through the winding of the drop 19. As a result, the drop 19 operates its armature 19*a* to release the flag 19*b*, thereby to produce a visual indication that the substation B has been signaled from the executive substation A. It will be observed that the flag 19*b* of the drop 19 remains in its operated position until manually restored to normal by the subordinate attending the substation B.

Although the operation of the auxiliary signal network provided at the substation B is described above with reference to its action to discriminate between interrupted and continuous ringing currents, it will be understood that this network may easily be designed to distinguish between interrupted ringing currents of different frequencies. Thus, in any case where the spacing of the ringing intervals is so related to the constants of the capacitor 23 and the resistor 22 that the capacitor 23 is not fully discharged during each silent period, the voltage across these two parallel connected elements is gradually built up during successive ringing intervals and may, if ringing persists for a sufficiently long period of time, equal the voltage value required to cause ionization of the discharge tube 20. For example, the periodicity of the ringing intervals and the constants of the elements 22 and 23 may be so related that the voltage developed across the parallel connected elements 22 and 23 follows the curve F illustrated in Fig. 2 of the drawing. In this case, while a longer time interval is required to cause ionization of the discharge tube 20, this tube will be rendered conductive to pass current through the winding of the drop 19 if the ringing persists for a sufficiently long period of time.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein and it is contemplated to cover in the appended claims

all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system, a first substation, a line extending to said substation, an exchange terminating said line and including means for transmitting signaling current over said line, a second substation, automatic switching apparatus individual to said second substation and having direct access to said line, said automatic switching apparatus including means for transmitting signaling current over said line, a signal device provided at said first substation and operative in response to signaling current transmitted over said line through operation of said last-named means, and means for preventing said signal device from operating in response to signaling current transmitted over said line from said exchange.

2. In a telephone system, a subordinate substation, a line extending to said subordinate substation, an exchange terminating said line and including means for transmitting signaling current over said line, an executive substation, automatic switching apparatus individual to said executive substation and having direct access to said line, said automatic switching apparatus including means for transmitting signaling current over said line, a non-restoring visual signal device provided at said subordinate substation and operative in response to signaling current transmitted over said line through operation of said last-named means, and means for preventing said signal device from operating in response to signaling current transmitted over said line from said exchange.

3. In a telephone system, a subordinate substation, a line extending to said subordinate substation, an exchange terminating said line and including means for transmitting signaling current over said line, an executive substation, automatic switching apparatus individual to said executive substation and having direct access to said line, said automatic switching apparatus including means for transmitting signaling current over said line, a signal device provided at said subordinate substation and operative in response to signaling current transmitted over said line through operation of said last-named means, means for preventing said signal device from operating in response to signaling current transmitted over said line from said exchange, and an additional signal device provided at said subordinate substation and operative in response to signaling current transmitted over said line both from said exchange and under the control of said switching apparatus.

4. In a telephone system, a subordinate substation, a line extending to said subordinate substation, an exchange terminating said line and including means for transmitting signaling current of one character over said line, an executive substation, automatic switching apparatus individual to said executive substation and having direct access to said line, said automatic switching apparatus including means for transmitting signaling current of a different character over said line, a signal device provided at said subordinate substation and operative in response to the transmission of signaling current of said different character over said line, and means for preventing said signal device from operating in response to signaling current of said one character transmitted over said line.

5. In a telephone system, a subordinate substation, a line extending to said subordinate substation, an exchange terminating said line and including means for transmitting signaling current of one character over said line, an executive substation, automatic switching apparatus individual to said executive substation and having direct access to said line, said automatic switching apparatus including means for transmitting signaling current of a different character over said line, a nonrestoring signal device provided at said subordinate substation and operative in response to the transmission of signaling current of said different character over said line, and means for preventing said signal device from operating in response to signaling current of said one character transmitted over said line.

6. In a telephone system, a subordinate substation, a line extending to said subordinate substation, an exchange terminating said line and including means for transmitting signaling current of one character over said line, an executive substation, automatic switching apparatus individual to said executive substation and having direct access to said line, said automatic switching apparatus including means for transmitting signaling current of a different character over said line, a signal device provided at said subordinate substation and operative in response to the transmission of signaling current of said different character over said line, means for preventing said signal device from operating in response to signaling current of said one character transmitted over said line, and an additional signal device provided at each subordinate substation and operative in response to the transmission of signaling current of either character over said line.

7. In a telephone system, a subordinate substation, a line extending to said subordinate substation, an exchange terminating said line and including means for transmitting interrupted ringing current over said line, an executive substation, automatic switching apparatus individual to said executive substation and having direct access to said line, said automatic switching apparatus including means for transmitting continuous ringing current over said line, a signal device provided at said subordinate substation and operative in response to the transmission of continuous ringing current over said line, and means for preventing said signal device from operating in response to interrupted ringing current transmitted over said line.

8. In a telephone system, a subordinate substation, a line extending to said subordinate substation, an exchange terminating said line and including means for transmitting interrupted ringing current over said line, an executive substation, automatic switching apparatus individual to said executive substation and having direct access to said line, said automatic switching apparatus including ringing means for transmitting continuous ringing current over said line, a nonrestoring visual signal device provided at said subordinate substation and operative in response to the transmission of continuous ringing current over said line, and means for preventing said signal device from operating in response to interrupted ringing current transmitted over said line.

9. In a telephone system, a subordinate substation, a line extending to said subordinate substation, an exchange terminating said line and including means for transmitting interrupted ringing current over said line, an executive sub-

station, automatic switching apparatus individual to said executive substation and having direct access to said line, said automatic switching apparatus including ringing means for transmitting continuous ringing current over said line, a non-restoring visual signal device provided at said subordinate substation and operative in response to the transmission of continuous ringing current over said line, means for preventing said signal device from operating in response to interrupted ringing current transmitted over said line, and an audible signal device provided at said subordinate substation and operative in response to the transmission of continuous and interrupted ringing current over said line.

10. In combination, a signal device, a circuit for energizing said device, means for energizing said circuit with splashes of current, and means for preventing the operation of said device in response to energization of said circuit with splashes of current occurring at less than a predetermined rate.

11. In combination, a signal device, an operating circuit for said device, means for energizing said circuit with splashes of current, an electric discharge device serially included in said circuit, and means comprising said discharge device for preventing the operation of said signal device in response to energization of said circuit with splashes of current occurring at less than a predetermined rate.

12. In combination, a signal device, an operating circuit for said device, means for energizing said circuit with splashes of current, an electric discharge device serially included in said circuit, a resistor and a capacitor connected in parallel across said circuit, and means comprising said resistor and capacitor for preventing the breakdown of said discharge device in response to energization of said circuit with splashes of current occurring at less than a predetermined rate, thereby to prevent operation of said signal device when said circuit is energized by splashes of current occurring at less than said predetermined rate.

13. In combination, a signal device, an operating circuit for said device, means for periodically energizing said circuit, and means comprising an electric discharge device serially included in said circuit for preventing said signal device from operating in response to energization of said circuit at less than a predetermined periodicity.

14. In combination, a signal device, an operating circuit for said device, means for continuously energizing said circuit, thereby to cause the operation of said device, additional means for intermittently energizing said circuit, and means for preventing said device from operating in response to intermittent energization of said circuit.

15. In combination, a signal device, an operating circuit for said device, means for continuously energizing said circuit, thereby to cause the operation of said device, additional means for intermittently energizing said circuit, and means comprising an electric discharge device serially included in said circuit for preventing said signal device from operating in response to intermittent energization of said circuit.

16. In combination, a signal device, an operating circuit for said device, means for continuously energizing said circuit, additional means for intermittently energizing said circuit, an electric discharge device serially included in said circuit, a resistor and a capacitor connected in parallel across said circuit, and means comprising said resistor and capacitor for causing the breakdown of said discharge device in response to continuous energization of said circuit, thereby to cause the operation of said signal device, and for preventing the breakdown of said discharge device in response to intermittent energization of said circuit, thereby to prevent the operation of said signal device.

17. A circuit network comprising a signal device, an electric discharge device connected in series with said device and having a predetermined breakdown voltage, a resistor connected in parallel with said series connected devices, and means comprising a capacitor shunting said resistor for limiting the voltage developed across said resistor to a value less than said predetermined voltage when said network is intermittently energized at less than a predetermined rate.

18. A circuit network comprising a signal device, and means comprising an electric discharge device connected in circuit with said signal device for preventing the operation of said device when said network is intermittently energized at less than a predetermined rate.

19. A signalling system comprising a line, a first signal device connected to be energized over said line, means for transmitting continuous and interrupted ringing currents over said line to energize said device, a second signal device, a circuit for energizing said second signal device in response to ringing current transmitted over said line, and means for preventing said second signal device from operating in response to the transmission of interrupted ringing current over said line.

20. A signaling system comprising a line, a first signal device connected to be energized over said line, means for transmitting continuous and interrupted ringing currents over said line to energize said device, a second signal device, a circuit connecting said second signal device in parallel with said first signal device, and means comprising an electric discharge device serially included in said circuit for preventing said second signal device from operating in response to the transmission of interrupted ringing current over said line.

21. In a telephone system, a first substation, a line extending to said substation, an exchange terminating said line and including means for transmitting signaling current over said line, a second substation, means individual to said second substation for transmitting signaling current over said line, a signal device provided at said first substation and operative in response to signaling current transmitted over said line through operation of said last-named means, and means for preventing said signal device from operating in response to signaling current transmitted over said line from said exchange.

22. In a telephone system, a line, a signal device, a circuit including the conductors of said line for energizing said device, means for transmitting splashes of ringing current over said line, thereby to energize said circuit, and means for preventing said device from operating in response to the energizaion of said circuit with splashes of ringing current occurring at less than a predetermined rate.

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