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TELEPHONE SYSTEM

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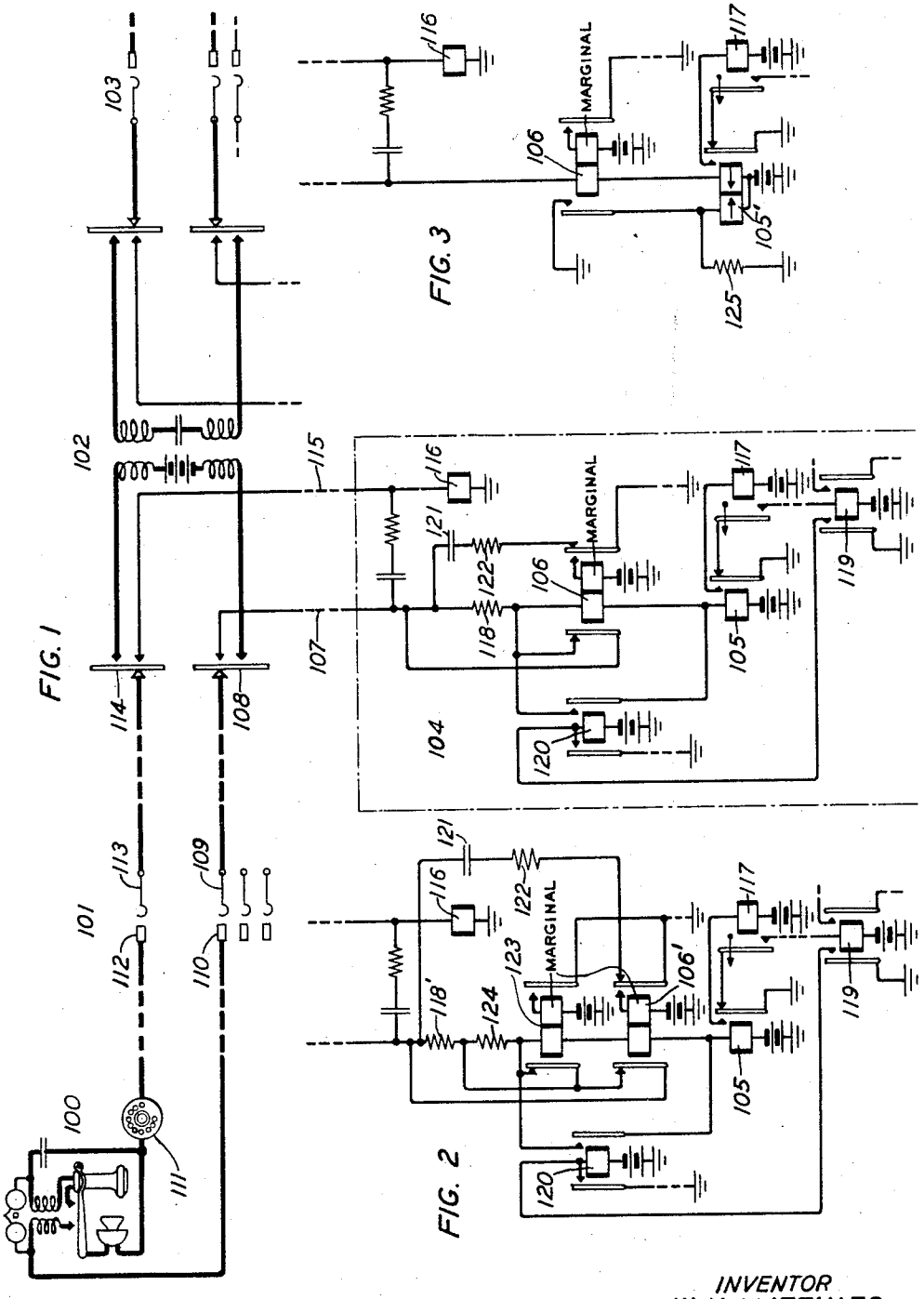

FIG. 3

FIG. 1

FIG. 2

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TELEPHONE SYSTEM

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This invention relates to automatic telephone systems in which switching apparatus is controlled to establish connections under the control of a subscriber's impulse dial.

The invention has been disclosed as applied to the impulse receiving circuit of a common register sender in which registers are provided which are successively set in response to series of impulses dialed by a calling subscriber, such registers being instrumental in controlling the setting of the selector switches to establish a telephone connection from the calling subscriber's line to the line whose designation the calling subscriber has caused to be registered on such registers. Obviously, the invention is also applicable to selector switch circuits of the types which are set directly by dialed impulses rather than through the intervention of a common sender.

Since a common sender may be taken into service by any one of a large number of subscribers' lines, it will be apparent that the dialing loops which may be established between the subscribers' substations and the impulse responsive relay of the sender will vary considerably in length and consequently in resistance. An impulse responsive relay which will operate satisfactorily over long loops of relatively high resistance, that is, release quickly each time the loop circuit is opened at the contacts of the subscriber's dial, will not operate as well over short loops of relative low resistance, since with the lower resistance, the relay will receive more current and its magnet core will become saturated to a point which will render the relay sluggish to release on circuit openings. On the other hand an impulse relay which will operate satisfactorily over short loops of relatively low resistance, will not operate as well over long loops of relatively high resistance, since with the higher resistance the relay will not receive sufficient operating current between loop openings to properly saturate its magnet core and will thus release too quickly. To render the impulse relay operable under such wide operating conditions requires a very careful design and adjustment of the relay. It is therefore the object of the present invention to obviate the aforementioned difficulties by providing for the automatic adjustment of the responsiveness of the impulse relay so that when an impulsing loop is established thereto of less than average resistance, the impulse relay is rendered less sensitive than when an impulsing loop of more than average resistance is established. Thereby the impulse relay performs more uniformly regardless of the resistance of the connected impulsing loop.

In accordance with the present invention this object may be attained in several ways. In one embodiment of the invention a normally shunted resistance and the operating winding of a marginally adjusted relay are connected in series with the winding of the impulse responsive relay in one leg of the impulsing loop. The shunt of the series resistance normally extends through contacts of the marginal relay. Should a line be connected to complete an impulsing loop of more than average length through the winding of the impulsing relay, the resistance of such loop will be high enough to prevent the operation of the serially connected marginal relay. Should, however, a shorter loop be established of less than average length and consequently of lower resistance, the current flowing thereover will be of sufficient strength to operate both the impulse responsive relay and the marginal relay. The marginal relay upon operating will first establish a locking circuit for itself and will then remove the shunt from the series resistance thereby increasing the resistance of the loop. By this means the resistance of short loops is increased to substantially the resistance of the longer loops and the impulse responsive relay is therefore always operated over loops having a smaller variation in resistance.

If a closer adjustment of loop resistance is found to be desirable, a plurality of resistances and differently margined relays may be employed in series with the impulse responsive relay, the margins of such relays being so selected that the shorter the connecting impulsing loop is, the more compensating resistance will be added in series with the impulse responsive relay.

In accordance with a further embodiment

of the invention, the impulse responsive relay may be normally biased by a differential winding connected into a biasing circuit through a resistance, and the marginal relay connected in series with the operating winding of the impulse relay may be arranged when it operates over a low resistance impulsing loop to short circuit the resistance, thereby increasing the bias of the impulse relay. Thus, when the impulse relay is connected into a long impulsing loop, it is less biased than when it is connected into a short loop.

For a more complete understanding of the invention reference may be had to the following detailed description taken in connection with the accompanying drawing in which

Fig. 1 shows diagrammatically a subscriber's line, a line finder-district selector trunk circuit and such portions of a common sender as are necessary to disclose the invention;

Fig. 2 shows a modification of the invention by means of which a finer compensation of resistance in the dialing loop is attained; and

Fig. 3 shows a further embodiment of the invention.

Referring to Fig. 1 of the drawing, a subscriber's substation of an automatic telephone system is disclosed at 100 having the usual impulse dial 111. In response to the removal of the receiver at the substation 100 for initiating a call, the calling line becomes extended by line finder 101 to the trunk circuit 102 terminating in the district selector 103 and by the usual link circuit, not shown, to the common sender disclosed in the dot and dash rectangle 104. Following the connection of the calling substation 100 with the sender 104 an impulsing loop is established from battery through the impulse responsive relay 105, the left winding of marginal relay 106, the left normal contact of relay 106, conductor 107, the upper contacts of cam 108, brush 109 and terminal 110 of line finder 101 over the substation loop through the dial 111, terminal 112 and brush 113 of the line finder 101, lower contacts of cam 114, conductor 115 to ground through the winding of coil 116. Impulse responsive relay 105 operates over this circuit and closes a circuit for the slow-to-release relay 117 in the usual manner.

It will first be assumed that the substation 100 is connected over a long line loop of high resistance with the sender 104 and that consequently the marginal relay 106 does not receive sufficient current to operate. Resistance 118, therefore, remains shunted at the left contact of relay 106 and relay 105 receives the maximum possible operating current. Upon the operation and release of the dial 111 the impulse loop is interrupted in the usual manner to thereby cause the impulse responsive relay to release and operate.

When the relay 105 releases upon the initial opening of its circuit, a circuit is established for relay 119 which in turn closes the circuit of relay 120. Relay 120 operates and locks to off-normal ground and closes a shunt around the left winding of relay 106 to remove its impedance from the impulsing loop. In view of the fact that the resistance of a long loop may be high enough to prevent the impulse relay from receiving a sufficiently high enough saturation, a branch of the impulsing loop is also extended from conductor 107 through condenser 121, resistance 122, back contact of relay 106 to off-normal ground for the purpose of shunting the winding of the impulse relay 105 when connected to long, high resistance loops thereby slowing up the release of the impulse responsive relay 105.

Should the sender become connected to a subscriber's line over a short loop having low resistance, marginal relay 106 will become energized as well as impulse relay 105. Relay 106 upon operating first operates its right armature to close a locking circuit through its right winding from off-normal ground and to disconnect the branch of the impulsing loop through condenser 121 and resistance 122. Thereafter relay 106 opens its left contacts to remove the shunt from resistance 118. Resistance 118 is now included in the impulsing loop thereby increasing the resistance of the loop to a point more nearly commensurate with the resistance of the longest loops.

In Fig. 2 a modification of the invention is disclosed similar to Fig. 1 except that an additional marginal relay 123 and an additional resistance 124 are provided. The marginal relays 106′ and 123 have different operating margins. When the sender becomes connected to a subscriber's substation over a long line the current flowing through the operating windings of relays 106′ and 123 is not sufficient to operate either of them. If a line of medium length is connected, relay 106′ will operate but relay 123 will not and therefore resistance 118′ is included in the impulsing loop. If a short line is connected both marginal relays 106′ and 123 will operate thereby including both resistances 118′ and 124 in the impulsing loop. Thus compensation is made for lines of three average lengths. It will be obvious that a closer compensation might be obtained through the use of additional marginal relays and serially connected resistance units. The impedance of relays 106′ and 123 may be removed through the operation of relay 120 as described in connection with Fig. 1.

In accordance with the modification disclosed in Fig. 3 the impulsing loop at the sender includes the operating winding of a marginal relay 106 and the operating winding of impulse responsive relay 105′. The impulse responsive relay 105′ is provided with a biasing winding connected in circuit with a resistance 125. The two windings of relay 105′ are differentially wound so that

relay 105′ is normally biased against operation. When the sender is seized over a long, high resistance dialing loop, marginal relay 106 does not receive sufficient current to operate but relay 105′ operates and since its biasing winding is connected in circuit with the resistance 125 it is not biased to such an extent as to prevent it from responding quickly to dialed impulses. When the sender is seized over a short loop of low resistance relay 106 operates and locks to off-normal ground and at its left contact shunts the resistance 125 thereby increasing the current flowing through the left biasing winding of relay 105′. Relay 105′ is now more heavily biased and will not become over-saturated by the stronger current flowing over the short line loop. If desired a shunt path through a condenser and resistance such as is disclosed in Fig. 1 could be employed controllable over a back contact of marginal relay 106.

As previously stated the invention is not to be construed as limited in its application to the impulsing circuit of central office senders since it is equally applicable to the impulse responsive circuit of switches of the type which respond directly to impulse dialed by calling subscribers.

What is claimed is:

1. In a signaling system, a responsive device, means for establishing operating circuits of different resistance to said responsive device, means operative over said circuits for determining whether a particular established circuit is of relatively high or low resistance, and means controlled by said means for rendering said responsive device less responsive if said circuit is found to be of low resistance.

2. In a signaling system, a responsive device, means for establishing operating circuits of different resistance to said responsive device, and means independent of said responsive device operative over said circuits for automatically changing the resistance of said circuits whereby the resistance of all of said circuits is more nearly equalized.

3. In a signaling system, a responsive device, means for establishing operating circuits to said device, the resistance of certain of said circuits being lower than the resistance of other of said circuits, and means independent of said responsive device operative only over the circuits of lower resistance for adding resistance thereto whereby the resistance of all of said circuits is more nearly equalized.

4. In a signaling system, a responsive device, means for establishing operating circuits to said device, the resistance of certain of said circuits being lower than the resistance of other of said circuits, and a marginal relay connected in series with said responsive device and operative only over the circuits of lower resistance for adding resistance to said circuits of lower resistance whereby the resistance of all of said circuits is more nearly equalized.

5. In a telephone exchange system, a plurality of substations, a responsive device, means for establishing an operating circuit to said device from any of said substations, said operating circuits having different resistance in accordance with the distance of said substations from said device, and means independent of said responsive device operative only over such circuits as have relatively low resistance for adding resistance thereto whereby said responsive device is always operable over circuits of more nearly equal resistance.

6. In a telephone exchange system, a plurality of substations, a responsive device, means for establishing an operating circuit to said device from any of said substations, said operating circuits having different resistance in accordance with the distance of said substations from said device, and a marginal relay associated in series with said responsive device and operative only over the circuits of relatively low resistance for adding resistance thereto whereby said responsive device is always operable over circuits of more nearly equal resistance.

7. In a telephone exchange system, a plurality of calling line substations, each having an impulse dial, an impulse responsive relay common thereto, means for establishing an operating circuit to said relay from any of said substations, said operating circuits having different resistance in accordance with the distance of said substation from said relay, and marginally adjusted means associated in series with said relay and operative only over the circuits of relatively low resistance for adding resistance thereto whereby said relay is always responsive to dialed impulses over circuits of more nearly equal resistance.

8. In a telephone exchange system, a plurality of calling line substations, each having an impulse dial, an impulse responsive relay common thereto, means for establishing an operating circuit to said relay from any of said substations, said operating circuits having different resistance in accordance with the distance of said substations from said relay, and a marginal relay associated in series with said relay and operable only over the circuits of relatively low resistance for adding resistance thereto whereby said impulse relay is always responsive to dialed impulses over circuits of more nearly equal resistance.

9. In a signaling system, a responsive device, means for establishing operating circuits to said device, the resistance of certain of said circuits being lower than the resistance of other of said circuits, a normally shunted resistance, and a marginal relay connected in series with said responsive device, said marginal relay operative only over the

circuits of lower resistance, and contacts controlled by the operation of said marginal relay for removing the shunt from said resistance whereby the resistance of all of said circuits is more nearly equalized.

10. In a telephone exchange system, a plurality of calling line substations, each having an impulse dial, an impulse responsive relay common thereto, means for establishing an operating circuit to said relay from any of said substations, said operating circuits having different resistances in accordance with the distance of said substations from said relay, a normally shunted resistance and a marginal relay connected in series with said impulse relay, said marginal relay operable only over the circuits of relatively low resistance, and contacts controlled by the operation of said marginal relay for removing the shunt from said resistance whereby the resistance of all of said circuits is more nearly equalized.

11. In a signaling system, a responsive relay, means for establishing operating circuits to said relay, the resistance of certain of said circuits being lower than the resistance of other of said circuits, means normally in shunt of said responsive relay for rendering it sluggish to release, and means operative only over the circuits of lower resistance for removing said shunt.

12. In a signaling system, a responsive relay, means for establishing operating circuits to said relay, the resistance of certain of said circuits being lower than the resistance of other of said circuits, a circuit comprising a condenser and resistance normally in shunt of the winding of said relay, and means operative only over the circuits of lower resistance for opening said shunt circuit.

13. In a signaling system, a responsive relay, means for establishing operating circuits to said relay, the resistance of certain of said circuits being lower than the resistance of other of said circuits, a circuit comprising a condenser and resistance normally in shunt of the winding of said relay, and means operative only over the circuits of lower resistance for opening said shunt and for thereafter adding resistance to the operating circuit of said relay.

14. In a telephone exchange system, a plurality of calling line substations, each having an impulse dial, an impulse responsive relay common thereto, means for establishing an operating circuit to said relay from any of said substations, said operating circuits having different resistances in accordance with the distance of said substations from said relay, a circuit comprising a condenser and resistance normally in shunt of the winding of said relay, a normally shunted resistance and a marginal relay connected in series with said impulse relay, said marginal relay operable only over the circuits of relatively low resistance, and contacts controlled by the operation of said marginal relay for first removing the shunt of the impulse relay and for then removing the shunt from said resistance.

In witness whereof, I hereunto subscribe my name this 13th day of October, 1931.

WILLIAM H. MATTHIES.