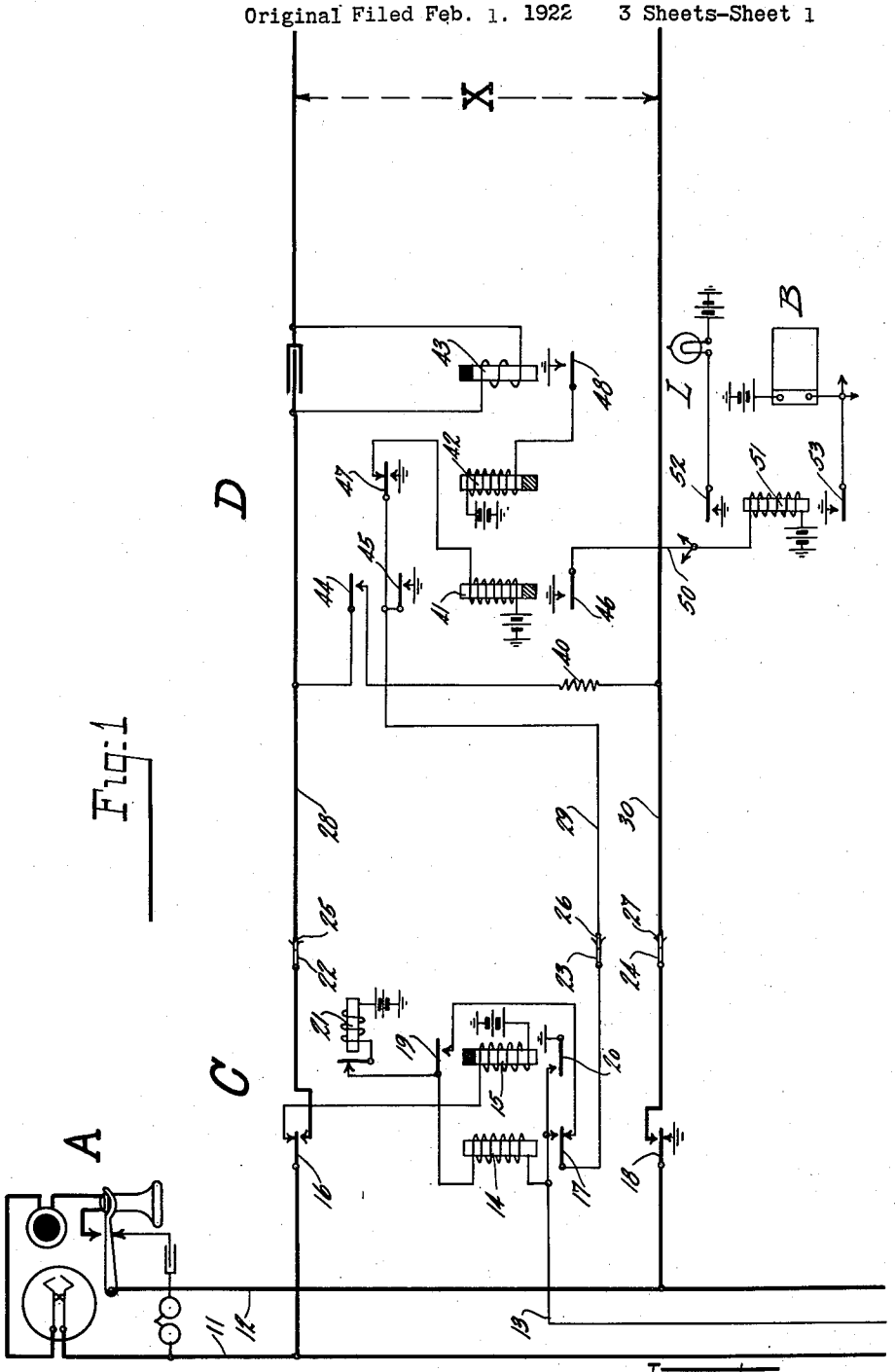
Dec. 14, 1926. 1,610,346

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AUTOMATIC TELEPHONE SYSTEM

Original Filed Feb. 1. 1922 3 Sheets-Sheet 1



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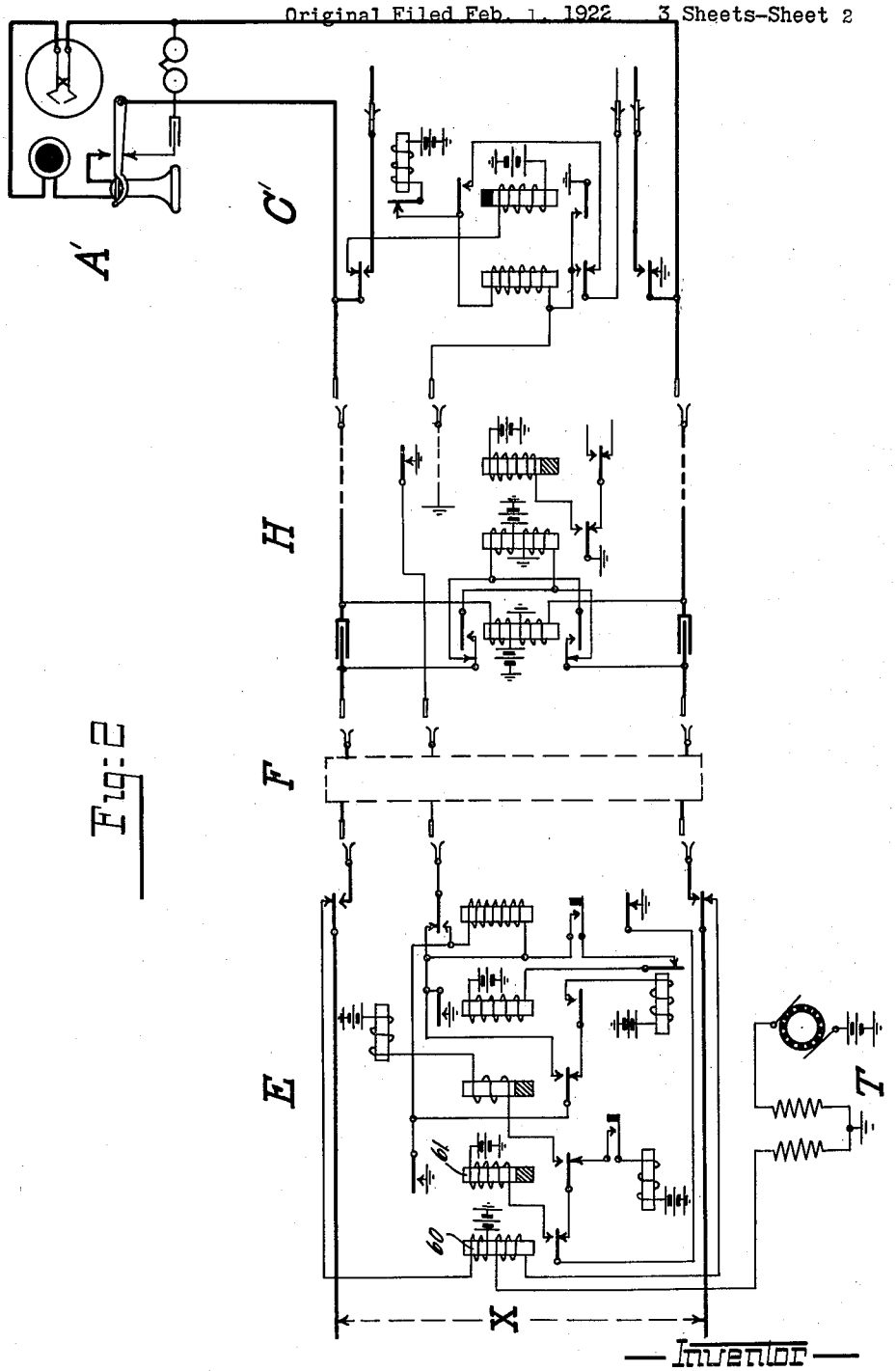


Fig: 2

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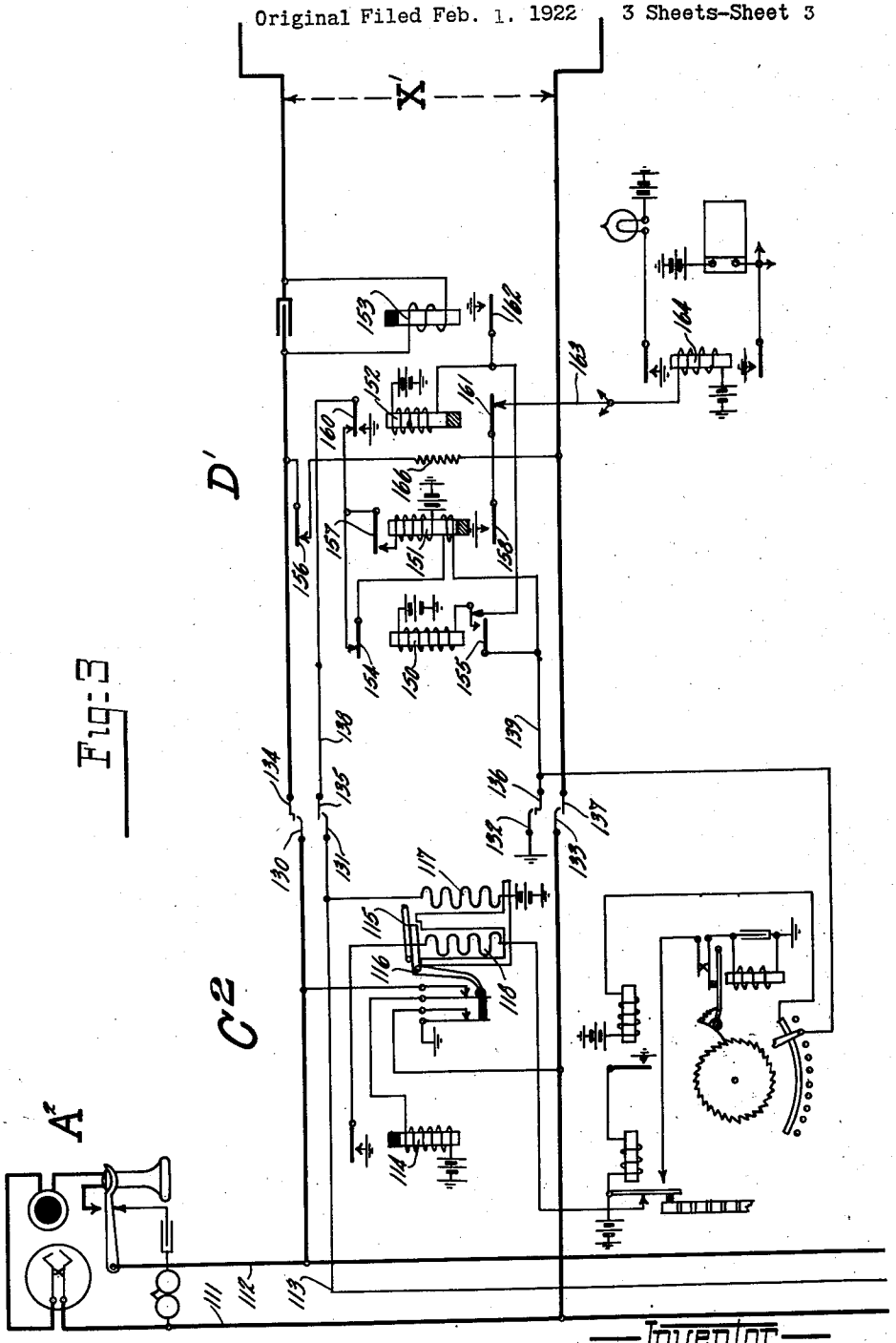


Fig-3

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

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The present invention relates to automatic telephone systems in general but is concerned more particularly with such systems as comprise main and subexchanges and the object, briefly stated, is the provision of new and improved circuit arrangements whereby the operation of the holding circuits employed on sub to main exchange trunks is improved and rendered more efficient and reliable.

A further object of the invention is the prevention of preliminary impulses which may occur when a subexchange subscriber removes his receiver.

Other objects which have to do with the detailed operations of the circuits involved will be pointed out and explained in the detailed course of the specification.

Referring now to the drawings, which comprise Figs. 1, 2, and 3, Figs. 1 and 2, when placed in order with the corresponding lines at the ends thereof in alignment, represent by means of the usual circuit diagrams a sufficient amount of apparatus for a complete connection between a calling subexchange substation and a called main exchange substation.

Fig. 3 shows a desirable modification of the equipment shown in Fig. 1, which is used when the so called plunger type of line switch is used.

The apparatus shown in Figs. 1 and 3 is assumed to be located in the subexchange and the apparatus shown in Fig. 2 is assumed to be located in the main exchange.

The substations A and A^2, Figs. 1 and 3, respectively, are of the usual automatic type.

The line switch C, Fig. 1, in which the line of substation A terminates, is of the well known rotary type in which the wipers have no normal position and move in a forward direction only. The line switch C′, Fig. 2, is an exact duplicate of the line switch C.

The holding circuit D, Fig. 1, is provided primarily for the purpose of permitting the third conductor to be eliminated from the trunk X which extends to the main exchange. Other functions of this device will be explained fully hereinafter.

The selector E, Fig. 2, is mechanically of the well known vertical and rotary type in which the bank contacts are arranged in horizontal rows or levels. The circuit operations and functions of such a switch are well known and consequently they do not need to be dwelt upon at this time. The selector F, which is denoted by the dotted rectangle bearing that reference character, is assumed to be an exact duplicate of the selector E with the exception of the addition of an incoming release trunk conductor which is connected to the upper armature of the release relay thereof.

The connector H is mechanically identical with the selector E or the selector F. Most of the circuits of this connector, being old and well known, have been omitted, only the line, release, and back bridge relays being shown.

Referring now to Fig. 3, the line switch C^2 shown therein is of the well known plunger type; and the holding circuit D′ is a modification of the holding circuit D, Fig. 1, as will be pointed out fully hereinafter.

Certain of the slow-acting relays such as 15 have a copper slug on the armature end and are both slow to energize and slow to deenergize; while other slow-acting relays such as 41 have the slug on the end opposite the armature, and are only slow to deenergize. This distinction is indicated in the drawings by showing the slugs on relays such as 15 in solid black, and the slugs on relays such as 41 by section lines.

The apparatus, having been described in general, will now be described in connection with a detailed description of its operation. For this purpose it will be assumed that the subscriber at substation A, Fig. 1, in the subexchange, desires to converse with the subscriber at substation A′, Fig. 2, in the main exchange. When the receiver is removed at the calling substation A, a circuit is closed over line conductors 11 and 12 for line relay 15 of the line switch C. Line relay 15, upon energizing, places ground upon private normal conductor 13 at armature 20, thereby closing a circuit for switching relay 14 and stepping magnet 21 in series, and at armature 19 connects test wiper 23 to the circuit at a point between switching relay 14 and stepping magnet 21.

From this point the operation depends upon whether the trunk upon which the wipers of the line switch are standing is busy or idle. If it is idle, switching relay 14 energizes immediately, but if it is busy the said switching relay 14 is short circuited by the ground potential which is present upon the test contact of the busy trunk, and stepping magnet 21 by its buzzer like action advances the wipers 22–24, inclusive, step by step until they arrive upon the contacts of an idle trunk.

Assuming that the trunk comprising conductors 28–30, inclusive, is the first one found to be idle, switching relay 14 being no longer short circuited after the switch wipers arrive upon contacts 25–27, inclusive, energizes in series with stepping magnet 21 but the said stepping magnet 21 does not energize at this time on account of the high resistance of switching relay 14. As a result of the energization of switching relay 14, it opens the test circuit and prepares the holding circuit at armature 17, thereby placing ground upon release trunk conductor 29 of the seized trunk and making the said trunk busy immediately. As a further result of the energization of switching relay 14, it disconnects the incoming line conductors from the winding of line relay 15 and from ground and extends them by way of armatures 16 and 18 and their working contacts, wipers 22 and 24, and bank contacts 25 and 27, to the conductors 28 and 30 of the seized trunk. Line relay 43 of the holding circuit D and line relay 60 of the selector E, Fig. 2, energizes in series with each other. The energization of line relay 60 of the selector E closes a circuit for release relay 61, whereupon the said release relay 61 energizes, thereby preparing the switch for operation in the usual manner.

Before going further with the explanation of the operation of the holding circuit D, Fig. 1, certain of its functions will be considered in a general way. One function of the holding circuit D is to lock a calling line switch in its operated position and give a signal to an attendant when the said holding circuit is seized, in case the trunk X is open. A second function of the holding circuit D which logically follows after the first named one is to prevent a subscriber from locking his line switch in on a trunk by raising his switch hook just sufficiently to close the line circuit, thereby operating the line switch C; and then permanently opening the line circuit by lowering his switch hook after his line switch has been locked in on a trunk and before it has been unlocked by the subsequent operation of the line and release relays of the seized holding circuit.

Another function of this holding circuit is to prevent an accidental opening of the line, after the receiver has been removed sufficiently to allow the line to be closed and before the receiver has been entirely removed from the switch hook, from delivering a preliminary impulse to a first selector.

With these functions in view, the operation of the holding circuit D will now be proceeded with. When the ground potential is placed upon release trunk conductor 29 at armature 17 of switching relay 14 of the line switch C, a circuit is closed for relay 41 of the holding circuit D by way of armature 47 of release relay 42 and its resting contact. Relay 41, upon energizing, places a multiple ground upon release trunk conductor 29 at armature 45, thereby completing the usual holding circuit for switching relay 14 of the line switch C and completing a locking circuit for itself. It will be seen now that if line and release relays 43 and 42 do not energize, or in other words if the trunk X is open, relay 41 will remain energized and the line switch C will remain locked on the seized trunk.

In order to give an alarm to an attendant, relay 41, upon energizing, places ground upon the common alarm conductor 50 at armature 46, thereby closing a circuit for alarm relay 51 whereupon the said relay energizes; closes a circuit for the lamp L at armature 52; and at armature 53 closes a circuit for the alarm buzzer B. The attendant, upon hearing the buzzer B and noting the lighted condition of the lamp L, may take the necessary steps to clear the trouble.

It will be observed that when relay 41 energizes to lock the line switch C on the seized trunk resistance 40 is bridged across conductors 28 and 30 at armature 44. This is done so that the subscriber cannot leave the line switch locked in on a trunk which is not open by opening his line conductors immediately after having closed them.

Another object accomplished by the bridging of the resistance 40 across the conductors 28 and 30 is to prevent the subscriber from accidentally opening the circuit of line relay 60 of the selector E, while removing his receiver, after the holding circuit D has been seized.

Assuming now that the trunk line X is not open, in which case line relays 60 and 43 of the selector E, and trunk circuit D, respectively, energize, as described, upon the seizure of the trunk X. Line relay 43 of the holding circuit D, upon energizing, closes a circuit for release relay 42 at armature 48. Release relay 42, upon energizing, opens the circuit of relay 41 at armature 47, at the same time placing a multiple ground upon release trunk conductor 29. Relay 41, upon deenergizing, after a slight interval, opens the alarm circuit at armature 46, whereupon

alarm relay 51 deenergizes. It may be said that in the ordinary operation of the system that the energization of alarm relay 51 is not of sufficient duration to attract the attention of the attendant. As a further result of the deenergization of relay 41 it removes ground from the release trunk conductor 29 at armature 45, leaving the said conductor 29 grounded at armature 47 of release relay 42. As a still further result of the deenergization of relay 41, it removes the resistance 40 from in bridge of the conductors 28 and 30 at armature 44, thereby leaving the control of line relay 60 of the selector E and of line relay 43 of the holding circuit D with the calling subscriber. By this time, however, he will have removed his receiver entirely from the switch hook so that there is no further likelihood of an accidental opening of the line.

It will be noted that the lower winding of line relay 60 of the selector E is not connected to ground directly but is lead through the left hand winding of the transformer associated with the tone machine T. Consequently, as soon as the resistance 40, Fig. 1, is removed from in bridge of the conductors 28 and 30, upon the deenergization of relay 41, the calling subscriber hears the tone produced by the tone machine T, not having heard it before on account of the shunting effect of the non inductive resistance 40, and begins to operate his calling device in accordance with the various digits in the desired number.

The remaining operation, which has to do with the setting up of the connection is old and will not need to be explained. It will suffice to say that, after the connection is finally extended to the called line, by way of second selector F, connector H, and line switch C′, and after the subscriber at the called substation A′ has answered, the two subscribers may converse with each other over the talking circuit shown which is outlined by the heavy conductors.

After the conversation is completed the two subscribers replace their receivers. When the receiver is replaced at substation A the selectors E and F and the connector H are restored to normal position in the usual manner. In the subexchange, line relay 43 of the holding circuit D, upon deenergizing, opens the circuit of release relay 42 at armature 48. Release relay 42, upon deenergizing, removes ground from release trunk conductor 29 at armature 47, whereupon switching relay 14 of the line switch C deenergizes, thereby restoring conditions in the said line switch C to normal. The entire connection is now released and the apparatus used therein is restored to normal condition.

Referring now particularly to Fig. 3, the apparatus shown therein, which corresponds to the apparatus shown in Fig. 1, will be explained. The trunk line X′, it will be understood, extends to a selector in the main exchange similar to the selector E, Fig. 2. Assuming now that the subscriber at substation A^2 desires to make a call, a circuit is closed over line conductors 111 and 112 for line relay 114 of the line switch C^2. Upon energizing, line relay 114 closes a circuit for pull in winding 118 whereupon plunger arm 115 and cut off armature 116 are operated. Plunger arm 115, upon being operated, through the medium of a plunger (not shown) forces the bank springs 130—133, inclusive, into engagement with bank contacts 134—137, inclusive, thereby connecting line conductors 111 and 112 through to the trunk line X′ at springs 130 and 133, and closing a locking circuit for holding winding 117 at springs 131 and 132, which locking circuit includes the lower winding of relay 151 of the holding circuit D′ and armatures 154 and 160. Relay 151 of the holding circuit D′, upon energizing in series with holding winding 117, closes a locking circuit for itself at armature 157 which locking circuit includes the resting contact of armature 154 and said armature, and spring 132 and its associated contact. As a further result of the energization of relay 151 it places ground upon the common alarm conductor 163 at armature 158, thereby operating alarm relay 164. As a further result of the energization of relay 151 it places resistance 166 in bridge of the conductors of the seized trunk at armature 156, thereby guarding against a lock up being caused by a momentary removal of the receiver or a like cause and preventing preliminary impulses, in the previously described manner. It will be seen now that if one of the conductors of the trunk X′ is open, or if line and release relays 153 and 152 fail to energize, the line switch C^2 will remain locked on the seized trunk and the attendant will be given the usual alarm.

Assuming now that the conductors of the trunk X′ are continuous, line relay 153, upon energizing, closes a circuit for release relay 152 at armature 162. Release relay 152, upon energizing, removes the initial ground potential from release trunk conductor 138 and places direct ground thereon at armature 160, and opens the alarm circuit at armature 161. Relay 150, upon energizing in multiple with release relay 152, opens its initial circuit and closes a locking circuit for itself, including spring 132 and contact 136 at armature 155. As a further result of the energization of relay 150, it opens the circuit of relay 151 at armature 154. Relay 151, upon deenergizing, removes resistance 166 from in bridge of the trunk conductors, thereby leaving the control of the connection with the calling subscriber and permitting him to hear the trunk tone placed on

the line by the selector to which the trunk X′ extends.

When the calling subscriber replaces his receiver, after having called his number, the circuit of line relay 153 is opened and the said relay, upon deenergizing, opens the circuit of release relay 152 at armature 162. Release relay 152, upon deenergizing, removes ground from release trunk conductor 138 at armature 160, whereupon the plunger arm 115 of the line switch C^2 is withdrawn and cut off armature 116 restores. In response to spring 132 breaking away from contact 136, relay 150 deenergizes, thereby connecting its winding in multiple with release relay 152 at armature 155 and preparing a circuit for relay 151 at armature 154. The line switch C^2 and the holding circuit D′ are now in normal condition.

The various features of the invention, having been described and ascertained, will now be pointed out in the following claims.

What is claimed is:

1. In a telephone system, an automatic switch, a trunk line terminating in said switch, a line relay in said switch bridged across the said trunk line, means for extending a calling line to said trunk line, means at the exchange for automatically completing a circuit for said relay over a talking conductor of said trunk to energize the said relay independent of the calling line, a second relay connected in the said trunk in series with said line relay, and means controlled by said second relay for opening said circuit.

2. In a telephone system, a calling line and a called line, a switch controlling device on said calling line, means including a subscriber controlled automatic switch for extending a connection from said calling line to said called line, means responsive to an initiation of a call by a subscriber on said calling line for connecting said calling line and said switch together whereby said switch is placed under the control of said switch controlling device, means at the exchange for closing a temporary shunt around said switch controlling device, and means for notifying the calling subscriber when said shunt is opened.

3. In a telephone system, a calling and a called line, means including a subscriber controlled automatic switch for extending a connection from said calling line to said called line, means responsive to the initiation of a call by a subscriber on said calling line for connecting said calling line and said switch together and for placing said switch under the control of the calling line, means for rendering the control of the calling line over said switch ineffective for an interval, and means for giving the calling subscriber a distinctive tone when said interval is ended.

4. In a telephone system, a calling and a called line, means including a subscriber controlled automatic switch for extending a connection from said calling line to said called line, means responsive to the initiation of a call by a subscriber on said calling line for connecting said calling line and said switch together and for placing said switch under the control of the subscriber on the calling line, means for rendering the control of the subscriber over said switch ineffective, means for rendering said last named means inoperative, and means for notifying the calling subscriber when said switch is again placed under his control.

5. In a telephone system, a calling line, trunk lines, an automatic switch controlled over the calling line to connect the same with an idle trunk line, a locking circuit for retaining said switch in operated position established responsive to the completion of the connection with the selected trunk, and means operated automatically and independent of the calling line for opening said locking circuit.

6. In a telephone system, a calling line, trunk lines, an automatic switch controlled over the calling line to connect the same with an idle trunk line, a locking circuit for retaining said switch in operated position established responsive to the completion of the connection with the selected trunk, a relay connected to each trunk, means for closing a local energizing circuit for the relay associated with the trunk in use, and means controlled by said relay for opening said locking circuit.

7. In a telephone system, an automatic trunk selecting switch having movable contacts, trunk lines accessible to said switch and terminating in fixed contacts, means controlled over a calling line for operating said switch to select and connect with an idle trunk, a locking circuit for holding said switch in operated position including a movable switch contact and a fixed contact associated with the selected trunk, a holding circuit for said switch closed after said locking circuit, means for opening said locking circuit when the holding circuit is closed, a relay controlling the closure of said holding circuit, and a circuit for said relay including a talking conductor of the trunk but excluding both conductors of the calling line.

8. In a telephone system, an automatic trunk selecting switch having movable contacts, trunk lines accessible to said switch and terminating in fixed contacts, means for operating said switch to select and connect with an idle trunk, a locking circuit for retaining said switch in operated position established automatically responsive to the engagement of a non-talking movable contact of said switch with a fixed contact associated with the selected trunk, a relay for

closing said locking circuit, contacts on said relay for closing a bridge across the talking conductors of the selected trunk, and means responsive to the closure of said bridge for opening said locking circuit.

9. In a telephone system, an automatic trunk selecting switch having movable contacts, trunk lines accessible to said switch and terminating in fixed contacts, means controlled over a calling line for operating said switch to select and connect with an idle trunk, a locking circuit for holding said switch in operated position including a movable switch contact and a fixed contact associated with the selected trunk, means initially controlled over the selected trunk alone for closing a holding circuit to retain said switch in operated position, said last means controlled thereafter over the calling line and trunk in series, and means for opening said locking circuit after the said holding circuit is closed.

10. In a telephone system, a sub-exchange trunk line including two talking conductors and a local third conductor, subscribers' individual line switches in the sub-exchange having access to said trunk line, means controlled over a calling line for operating one of said switches to connect with said trunk, relay equipment in said trunk line adapted to complete a holding circuit for the operated line switch, a locking circuit including the third conductor of said trunk established when the trunk is connected with for retaining the switch in operated position until the said holding circuit is established, and means for initially operating said relay equipment independent of the calling line.

11. In a telephone system, a trunk hunting switch comprising a relay, a trunk accessible to said switch, means controlled by a calling subscriber through the medium of said relay for operating said switch to seize said trunk, means independent of the calling subscriber for locking said switch on said trunk responsive to the seizure thereof, and additional means independent of the calling subscriber for breaking said locking circuit after a predetermined time has expired.

12. In a telephone system, a calling line, trunk lines, a rotary line switch controlled over the calling line to connect the same with an idle trunk line, a locking circuit for retaining said switch in operated position established responsive to the completion of a connection with the selected trunk, said circuit including a wiper of said line switch, and means operated automatically and independent of the calling line for opening said locking circuit.

13. In a telephone system, a calling line, trunk lines, a rotary line switch controlled over the calling line to connect the same with an idle trunk line, a locking circuit for retaining said switch in operated position established responsive to the completion of a connection with the selected trunk, said circuit including a wiper of said line switch, a relay connected to each trunk, means for closing a local energizing circuit for said relay associated with the trunk in use, and means controlled by said relay for opening said locking circuit.

14. In a telephone system, an automatic switch having movable contacts, trunk lines accessible to said switch terminating in fixed contacts, means controlled over a calling line for operating said switch to connect with an idle trunk, a relay in said trunk, a locking circuit for holding said switch in operated position established responsive to the completion of a connection with the said trunk, said circuit including two movable switch contacts, two fixed contacts associated with said trunk, and a winding of said relay in series, and contacts on said relay for closing a bridge across the talking conductors of said trunks.

15. In a telephone system, an automatic switch having movable contacts, trunk lines accessible to said switch and terminating in fixed contacts, means controlled over a calling line for operating said switch to connect with an idle trunk, a locking circuit for holding said switch in operated position established automatically when the trunk is connected with, said circuit including two moveable contacts and two fixed contacts associated with said trunk, a holding circuit of said switch including only one of said moveable and one of said fixed contacts, and means operated independent of the continuity of the calling line for closing said holding circuit and for opening said locking circuit.

In witness whereof, I hereunto subscribe my name this twentieth day of January, A. D. 1922.

BERNARD D. WILLIS.