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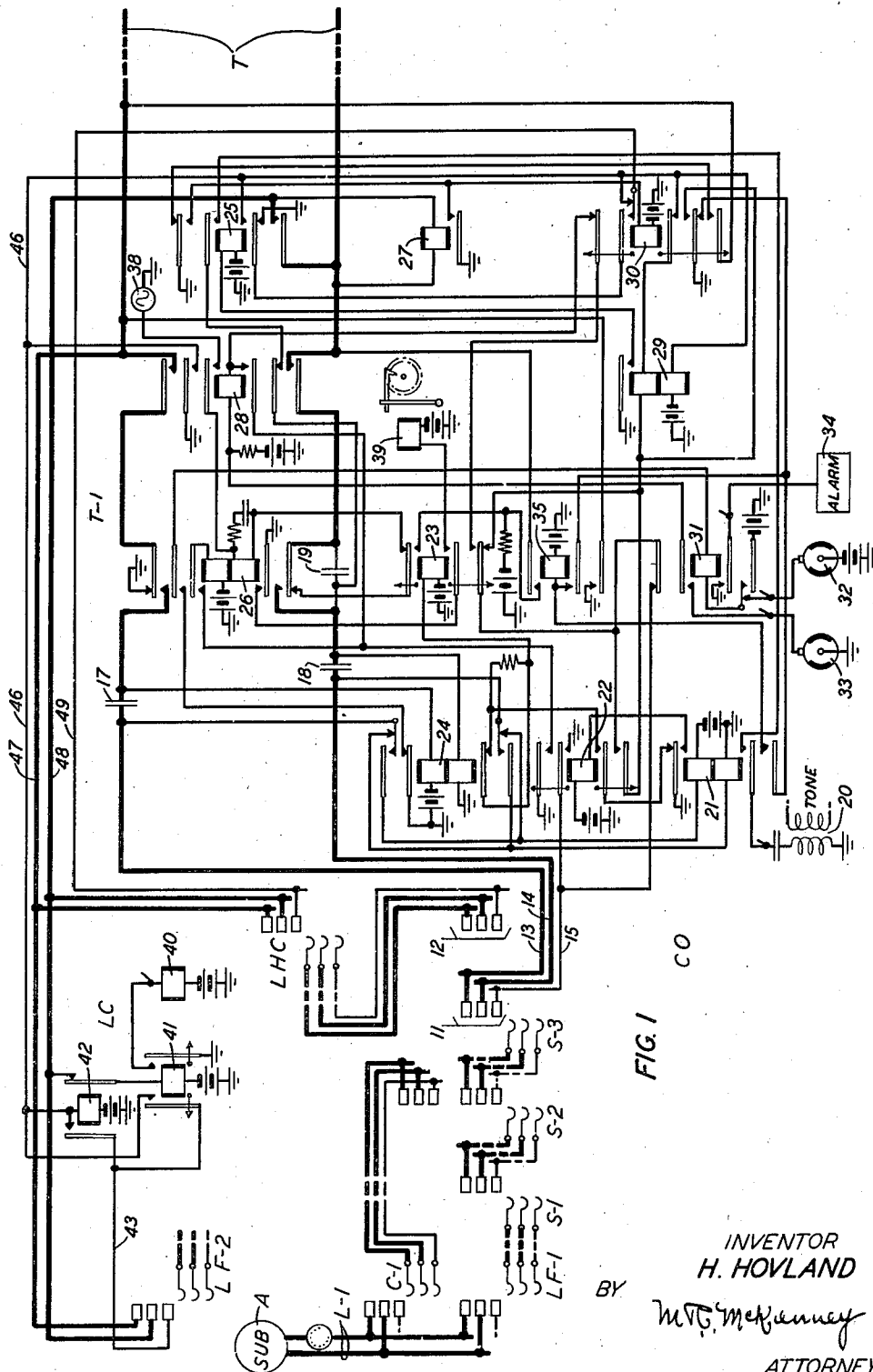
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2,247,055

TELEPHONE SYSTEM

Filed Nov. 28, 1939

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

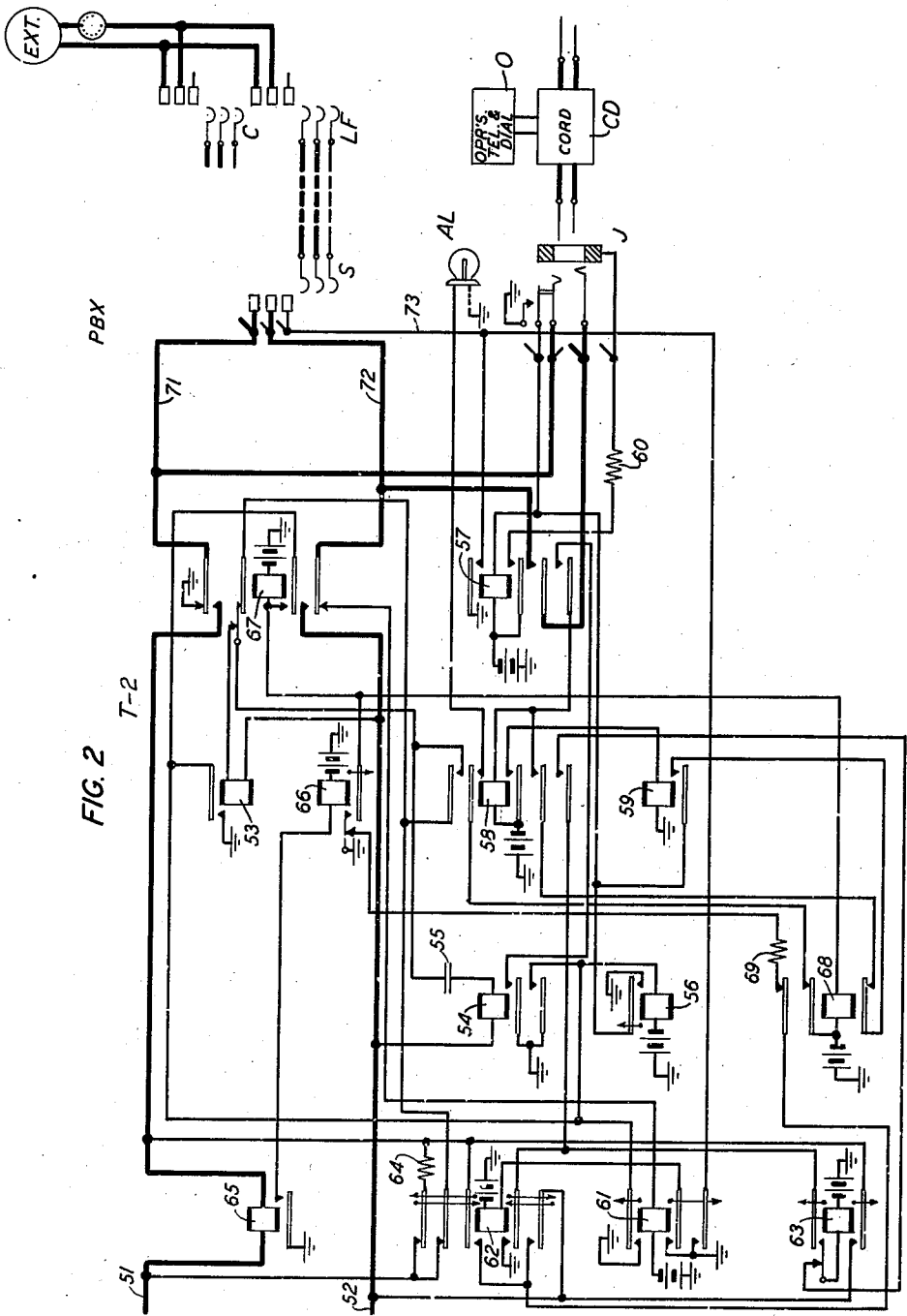


FIG. 2

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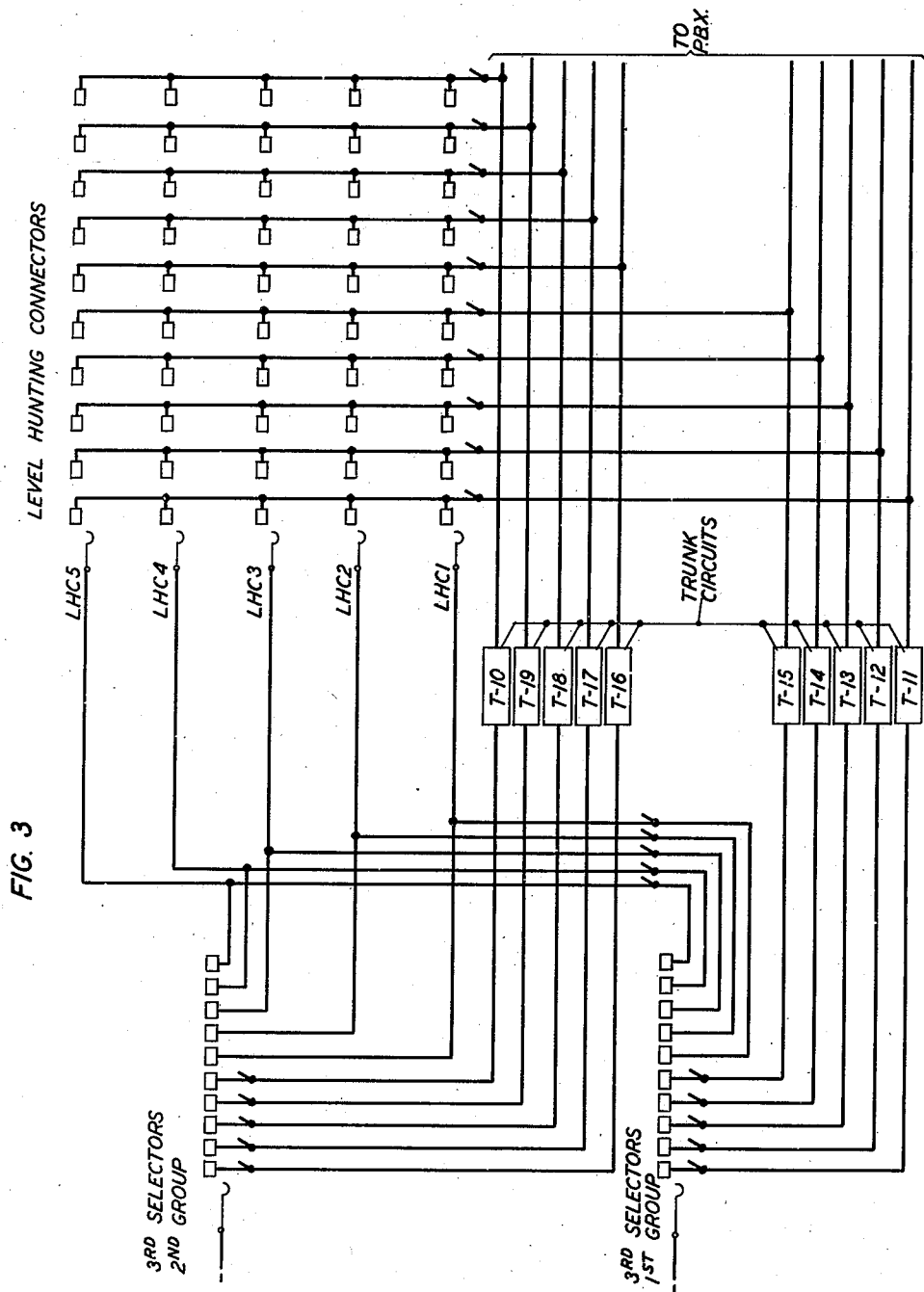
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2,247,055

TELEPHONE SYSTEM

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Application November 28, 1939, Serial No. 306,470

14 Claims. (Cl. 179—27)

This invention relates to telephone systems and particularly to systems comprising subscriber-controlled switches for completing connections between calling and called lines including lines to a private branch exchange.

Objects of the invention are an increase in the efficiency of the trunking between an automatic central exchange and a private branch exchange, and the provision of a trunking arrangement which will permit the use of a single large group of trunks therebetween, the assignment of fewer subscribers' numbers to the private branch exchange than there are trunks in the group, and a reduction in the number of level hunting connector switches needed for connecting with trunks to the private branch exchange.

The invention is a trunking arrangement in which each trunk of a group between a central office and a private branch exchange is connected to a set of terminals in the bank of a connector switch and to a set of terminals in the bank of a selector switch, the selector switch being directly responsive to the tens digit of the number assigned to the private branch exchange. Each connector switch having access to the trunks to the private branch exchange is multiplied to terminals in the banks of selector switches which are reached by the hundreds digit of the private branch exchange number and which are directly responsive to the tens digit of this number. In the level of these selectors which corresponds to the tens digit of a private branch exchange number, the first choice terminals, for instance, the first five sets of terminals, are connected directly to five trunks to the private branch exchange; and the last choice terminals, for instance, the last five sets of terminals, are connected to five of the connectors having access to the trunks to the private branch exchange.

A feature of the invention is the provision of selector switches corresponding to the hundreds digit of numbers assigned to one or more private branch exchanges, each of these selectors having direct access in the level corresponding to the tens digit of a private branch exchange number to some of the trunks to the private branch exchange and also having access to connector switches each of which has access to all of the trunks to the private branch exchange. If there are a plurality of private branch exchanges each having a group of connector switches individual thereto, each level of the aforesaid selector switches corresponds to the tens digit of, and gives access to, one of the private branch exchanges. The first choice terminals, for in-

stance, the first five sets of terminals in each level, are connected directly to trunks to the private branch exchange; and each of the last choice terminals, for instance, the last five sets of terminals, are connected to one of the connectors having access to all of the trunks to the private branch exchange. The selectors are divided into two or more groups, the selectors in each group having access to some or all of the connectors associated with each of the private branch exchanges.

Another feature of the invention is a trunk circuit associated with the central office end of a two-way trunk to a private branch exchange, the trunk circuit being connected to terminals in the banks of connectors, to terminals in the banks of selectors, and to terminals in the banks of line finders. A relay is provided for protecting the trunk against double connections, a low resistance winding being normally connected between the test terminals of the connectors and the test terminals of the selectors and an operating winding being normally connected to the test terminals of the connectors. The connection of ground to the test terminal in the bank of any one of the selectors immediately guards the trunk against seizure by a connector, and the connection of ground to the test terminal in the bank of any one of the connectors immediately guards the trunk against seizure by a selector. In case of seizure of the trunk of a selector, the windings of the relay are differentially energized in series but the relay does not operate; if seized by a connector, the energization of the operating winding effects immediate operation so that, if the trunk is simultaneously seized by a selector, the call from the connector is completed but a busy tone is transmitted to the other calling subscriber. A line circuit is associated with each trunk to the branch exchange, the cut-off relay being normally connected in parallel with the operating winding of the differential relay of the associated trunk circuit, the operation of the line relay on a call originating in the branch exchange being effective to connect the operating winding of the differential relay to the test terminal of the trunk in the banks of the line finders.

These and other features of the invention are further described by disclosure of a system in which the invention is embodied, one such system being shown schematically in the drawings which form a part of this specification. The invention is, of course, not limited in its application to the particular system shown nor to switches of the type shown but is generally ap-

plicable to all automatic switching systems comprising an automatic central office and a private branch exchange.

Referring to the drawings:

Fig. 1 represents a central office CO comprising a subscriber's line L—1, line finder switches LF—1 and LF—2, selector switches S—1, S—2 and S—3, connector switches C—1 and LHC, a line circuit LC and a trunk circuit T—1 associated with a trunk outgoing to a private branch exchange;

Fig. 2 shows a private branch exchange PBX comprising a trunk circuit T—2 associated with a trunk to the central office, a line-finder switch LF, a selector S, a connector C and a cord circuit CD at an attendant's position; and

Fig. 3 shows the manner in which ten trunk circuits between a central office and a private branch exchange are multiplexed to terminals in the banks of both selectors and level hunting connectors.

The line finder, selector and connector switches are of the well-known two-motion step-by-step type and reference may be had to pages 53 to 65 of the second edition of "Automatic Telephony" by Smith and Campbell for a description of the structure of such switches and their operation when used as selectors or connectors. Reference may be had to the R. L. Stokely Patent No. 1,799,654, April 7, 1931, for disclosure of a two-motion step-by-step switch arranged for use as a line finder. Each of the switches LF—1, LF—2, LF, S—1, C—1 and LHC are represented in the drawings by a set of brushes and a single set of terminals. The selector S—2 is represented by a set of brushes and a single set of terminals in each of two levels. The selector S—3 is represented by a set of brushes and two sets of terminals in one level. As shown in Fig. 1, calls between subscribers in the central office are completed by two selectors and a connector but the arrangement may, of course, include additional selectors depending upon the numbering scheme and the total number of subscribers.

The selector S—3 represents third selectors in an office in which only first selectors, second selectors and connectors are needed for completing connections between calling and called lines, the third selectors being provided for giving direct access to trunks leading to private branch exchanges which are large enough to require the use of level hunting connectors in which the entire bank serves a single private branch exchange. An idle third selector S—3 is seized in response to the dialing of the hundreds digit of the number of any one of as many as ten private branch exchanges. This selector is directly operated in response to the tens digit of the called number to select a level in which the first choice sets of terminals, such as 11, are connected directly to trunks leading to the private branch exchange and the last choice sets of terminals such as 12 are connected to level hunting connectors LHC which have access to all of the trunks leading to the called private branch exchange. Each of the level hunting connectors, which may be similar to that disclosed in the patent to H. Hovland No. 1,747,169 of February 18, 1930, are accessible to some or all of the third selectors S—3. These selectors are divided into groups, each group having access to certain of the level hunting connectors as is more particularly illustrated in Fig. 3. In this figure there are ten trunk circuits, five of which connect to the first five sets of terminals in a level

of the banks of a first subgroup of third selectors, the other five trunks being connected to the first five sets of terminals in the same level of the banks of a second subgroup of third selectors. Each of the ten trunks is also connected to a set of terminals in the banks of all of the level hunting connectors, five of which are shown in this figure. Each of the selectors in the first subgroup have first choice access to the trunk circuits T—11 to T—15 and second choice access to the five level hunting connectors LHC—1 to LHC—5, and each of the selectors in the second subgroup have first choice access to the five trunk circuits T—16 to T—20 and second choice access to the same five level hunting connectors LHC—1 to LHC—5. If more than five connectors are required, they may be divided into groups, each group accessible to some of the third selectors.

The trunks between the central office and the private branch exchange may be two-way trunks and the trunk circuits T—1 and T—2 shown in the drawings are arranged for two-way service. On a call from a central office subscriber, the trunk T—1 may be seized either by a selector S—3 or by a level hunting connector LHC; and, in either case, seizure effects the lighting of an answering lamp AL associated with a jack J at the attendant's position in the private branch exchange. On a call from the private branch exchange to the central office the trunk circuit T—2 may be seized either by the insertion of the plug of an operator's cord CD in jack J or by the selection of this trunk circuit by a selector S in response to the dialing of the first digit at a calling station in the private branch exchange. The seizure of the trunk circuit T—2 effects the operation of the line circuit LC in the central office thereby connecting the trunk through a line finder LF—2 to an associated first selector, not shown in the drawings; and the connection is completed by selector and connector switches in response to the dialing of the number of the central office subscriber.

Assume first that the subscriber A in the central office CO calls a private branch exchange accessible to the selector S—3. In usual and well-known manner, the calling line L—1 is connected through a line-finder switch LF—1 to a first selector S—1 which is directly operated by the dialing of the first digit of the number of the private branch exchange to select a corresponding level and automatically operated to seize a set of terminals therein connected to an idle second selector S—2. The second selector S—2 responds to the second digit dialed, which is the hundreds digit, to select a corresponding level and a set of terminals therein leading to an idle third selector S—3. The seized selector S—3 is directly operated in response to the tens digit of the called subscriber's number to select a corresponding level and to automatically hunt therein. Assume that one of the first choice sets of terminals, such as 11, is idle and is seized by the selector S—3 and that this set of terminals is connected to the trunk circuit T—1. Upon seizure of terminals 11, a circuit is closed for operating the line relay 21 of trunk circuit T—1. This circuit is traced from battery through the upper winding of relay 21, a back contact of relay 24, conductor 14, through the middle brush of each of switches S—3, S—2, S—1 and LF—1, through the calling subscriber's line and station, back through the upper brushes of each of switches LF—1, S—1, S—2 and S—3, conductor

13, a back contact of relay 24, and through the lower winding of relay 21 to ground. Relay 21 closes a circuit for operating relay 22. Relay 22 connects ground through its inner upper front contact to conductor 15 to hold switches S—3, S—2, S—1 and LF—1 in usual manner. Relay 22 also connects ground through its inner upper front contact, the upper back contact of relay 31, the outer lower front contact of relay 22 in parallel with the lower back contact of relay 23, upper winding of relay 29, inner lower back contact of relay 30, thence through the lower winding of relay 29 to battery. Relay 29 does not operate because its upper and lower windings are oppositely energized. The inner lower back contact of relay 30 is also connected through the inner upper back contact of relay 30 and through conductor 49 to the test terminals in the banks of level hunting connectors having access to trunk circuit T—1. Since the upper winding of relay 29 is a low resistance winding, the potential thus connected to these test terminals is effective to guard against seizure of trunk circuit T—1 by any of these connectors.

The aforementioned operation of relay 21 also closes a circuit for operating relay 35; and relay 35 locks to ground at the back contact of relay 30, independent of relay 21. Relay 35 connects battery to the lower conductor and ground to the upper conductor of trunk T, thereby effecting the operation of relay 53 of trunk circuit T—2 in the private branch exchange, the winding of relay 53 being normally bridged across the conductors of trunk T. Relay 53 closes a circuit for operating relay 56. Relay 56 closes a circuit for operating relay 57. Relay 57 connects ground to conductor 73, to mark the trunk circuit T—2 busy in the banks of all selectors S having access to this trunk circuit, and connects battery through resistor 60 to the sleeve of jacks J to mark the trunk circuit T—2 busy at each of these jacks.

When the calling subscriber dials the next digit of the private branch exchange number, relay 21 is alternately released and reoperated in response to each of the impulses in the train. Relay 22 is slow to release and remains operated during the response of relay 21 to dial impulses. The release of relay 21, in response to the first impulse, closes a circuit for operating relay 23. Relay 23 is a slow-to-release relay which remains operated until all of the impulses in the train have been received. Relay 23 closes a circuit, including its outer lower front contact and an upper back contact of relay 30, for operatively energizing the winding of relay 28. Relay 28 closes a locking circuit through its inner lower front contact to ground at a front contact of relay 22. At its middle upper front contact, relay 28 connects ground to conductor 46, operatively energizing the winding of cut-off relay 42 of line circuit LC. The connection of ground to conductor 46 short-circuits the upper winding of relay 29 and maintains the energization of the lower winding of relay 29. Relay 29 is thereupon operated by its lower winding, closing a circuit for operating relay 25. Relay 25 closes a circuit for operating relay 30 and closes a short circuit around the winding of relay 27. Relay 30 opens the operating circuit of relay 29, closes a connection from ground through the middle upper front contact of relay 23, conductor 46, the inner lower front contact of relay 25, upper front contact of relay 30, to conductor 49 to continue the marking of the trunk circuit T—1 as busy in the banks of the level hunting connectors. Relay 30 also opens

the connection between the two windings of relay 29, and connects ground through its inner lower front contact, the lower back contact of relay 23 in parallel with the outer lower front contact of relay 22, and through the upper back contact of relay 31, to conductor 15. The operation of relay 30 also causes the release of relay 35; and the release of relay 35 disconnects battery and ground from the conductors of trunk T, releasing relay 53. Relay 53 opens the operating circuit of relay 56 but relay 56 is slow in releasing and, before it can release, another operating circuit is closed by the operation of relay 54 as hereinafter described. With relay 28 operated and relay 23 released, a circuit is closed from the grounded, ringing current generator 38, through the inner upper front contact of relay 23, lower winding of relay 26, upper back contact of relay 23, lower back contact of relay 26, lowermost front contact of relay 28, lower conductor of trunk T, conductor 52 of trunk circuit T—2, winding of relay 53 in parallel with winding of relay 54 and condenser 55 in series, through upper back contacts of relay 67, an upper back contact of relay 62, conductor 51, the upper conductor of trunk T, uppermost front contact of relay 28, to ground at a back contact of relay 26. While this ringing circuit is closed, ringing tone is transmitted through condensers 19 and 18 and conductor 14 to the calling subscriber. The ringing current operatively energizes the winding of relay 54 and may cause relay 53 to vibrate. Relay 53 will be operated by direct current from the tripping battery during the silent part of the ringing cycle. Relay 54 closes a circuit through the winding of relay 56 and so also does relay 53. Relay 56 maintains the circuit for operating relay 57. With relays 54 and 57 both operated, a circuit is closed for operating relay 58; and relay 53 closes a circuit for lighting the answering lamp AL. Relay 58 also closes a circuit for operating relay 59; and relay 59 closes a circuit through the lower back contact of relay 68 for locking relay 53.

When an attendant at the private branch exchange answers the call by inserting the plug of a cord CD in jack J, a circuit is closed at the jack for holding relay 57 operated; and a circuit is closed through the tip and ring springs of the jack, middle lower front contact of relay 57 and outer back contacts of relay 67 for operating relay 61. Relay 61 closes a holding circuit for relay 56, closes a circuit for operating relay 62, and connects ground to conductor 73. Relay 62, which is slow in operating, opens the shunt through resistor 64 across the winding of relay 65, and completes a circuit path from conductor 51 through the winding of relay 65, inner upper and outer lower front contacts of relay 62, to conductor 52. The winding of relay 65 is thus bridged across the conductors of trunk T and ground is connected through resistor 69 and a lower front contact of relay 62 to conductor 52 to cause an increase in the current through the lower, tripping winding of relay 26 of trunk circuit T—1. Relay 62 also closes a circuit for operating relay 63. Relay 63 locks independent of relay 58 and connects the winding of relay 65 across conductors 51 and 52 independent of relay 62. Relay 26 is operated sufficiently to close its inner upper front contact; and the energization of its upper, locking winding completes the operation of relay 26. Relay 26 opens the ringing circuit and connects relay 24 to the conductors of trunk T; and relays 24 and 65 operate in series through resistor 69 to ground

at relay 66. Relay 65 closes a circuit for operating relay 66; and relay 66 disconnects the tripping ground from conductors 51 and 52 and closes circuits for operating relays 67 and 68. Relay 67 closes a circuit for holding relay 56 operated and opens the circuits through the windings of relays 61 and 53. Relay 61 releases relay 62, reconnecting resistor 64 in shunt with relay 65. Relays 61, 62 and 63 are slow in releasing so as to insure the operation of relay 26 in case relay 65 is prematurely operated by the ringing current. With relay 58 operated and relay 62 released, the ringing relay 54 and condenser 55 remain bridged across the trunk. With relay 26 of trunk circuit T-1 and relay 67 of trunk circuit T-2 both operated, a talking connection is completed from the calling line through condensers 17 and 18 of trunk circuit T-1, the outer front contacts of relays 26 and 28, the conductors of trunk T, conductors 51 and 52 of trunk circuit T-2, winding of relay 65, outer front contacts of relay 67, a front contact of relay 57, through the tip and ring conductors of jack J and plug of cord CD, to the operator's telephone set.

When the calling subscriber releases the connection, relay 21 releases, closing the circuit for operating relay 23. The continued release of relay 21 causes the release of relay 22. Relay 22 disconnects ground from conductor 15 thereby effecting the return to normal of switches LF-1, S-1, S-2 and S-3 in usual and well-known manner. The release of relay 22 also effects the release of relays 23, 26 and 28. The release of relay 26 disconnects relay 24 from the trunk thus releasing relay 65 of trunk circuit T-2 and causing a disconnect signal in the operator's cord circuit CD. The release of relay 65 causes the release of relay 66. The release of relay 66 causes the release of relays 67, 68 and 56. Relay 57 is held to ground at jack J until the operator disconnects the cord from jack J. When the plug is removed from jack J, relay 57 releases and the busy ground is disconnected from conductor 73. The release of relay 28 of trunk circuit T-1 causes the release of relays 29 and 25 in succession. The release of relay 25 opens the energizing circuit of the slow-to-release relay 30. If the operator at the private branch exchange has released the trunk in response to the disconnect signal, relay 30 releases and the trunk circuit T-2 is in normal condition ready for use on another call.

If the operator at the private branch exchange fails to remove the plug of cord CD from jack J in response to the disconnect signal, relay 61 reoperates when relay 67 releases; and relay 61 holds relay 56 operated and reoperates relay 62. Relay 61 connects ground potential to conductor 73 to prevent seizure of the trunk circuit T-2, bridges the winding of relay 65 across conductors 51 and 52, and also connects ground at the back contact of relay 66 through resistor 69 and conductor 52 to the lower conductor of trunk T, thereby operating the line relay 41 of the line circuit LC associated with trunk T in the central office. Relay 65 does not reoperate since the upper conductor of trunk T is not connected to ground in the central office. Relay 27 of trunk circuit T-1 operates in series with the line relay 41, the short circuit across the winding of relay 27 having been opened by the release of relay 25. The operation of relay 27 closes a holding circuit for relay 30 so that the release of relay 25 does not cause the release

of relay 30. With relay 30 operated, ground potential is connected through its inner lower front contact, lower back contact of relay 23, and upper back contact of relay 31 to conductor 15 to prevent seizure of trunk circuit T-2 by any of the selectors S-3, and ground potential is connected through the lower back contact of relay 25 and upper front contact of relay 30 to conductor 49 to prevent seizure of trunk circuit T-2 by any of the level hunting connectors LHC. The line relay 41 connects the winding of the cut-off relay 42, through conductor 43 to test terminals in the banks of line-finder switches LF-2 having access to the trunk T. Relay 41 also closes a circuit for operating a group relay 49 and relay 40 initiates the operation of an idle one of the line finders to connect the trunk T to a first selector in usual and well-known manner. When a line finder finds the terminals of the calling trunk, ground is connected to the test terminal in usual manner to effect the operation of the cut-off relay 42; and the operation of relay 42 causes the release of relays 41 and 49. The connection of ground to the test terminal also causes the energization of the operating winding of relay 29. Relay 29 closes the circuit for operating relay 25; and relay 25 closes the circuit for operating relay 30 and closes the short circuit around the winding of relay 27. Relay 30 continues to connect busy ground to conductor 15 and connects the test terminal of the line finder to the test terminals in the banks of the connectors. The trunk T and associated trunk circuits are thus held until the attendant at the private branch exchange removes the plug and a permanent signal alarm may be operated in the central office. When the plug is removed, the release of relays 61 and 62 causes the release of relays 56 and 57 in succession. The release of relay 57 disconnects guarding potential from conductor 73 and from jacks J. Relay 62 disconnects resistor 69 from conductors 51 and 52 thereby causing the release of the first selector and line-finder switches in the central office. When ground is disconnected from the test terminal of the line finder, relays 42 and 29 release. The release of relay 29 causes the successive release of relays 25 and 30 thereby disconnecting the busy ground potential from conductors 15 and 49. The trunk T is now free for seizure at either end.

If a selector S-3 is operated to select the level including trunks T to a private branch exchange and all of the first choice sets of terminals are busy, the brushes continue to hunt over the second choice sets of terminals until an idle level hunting connector LHC is found. The selected level hunting connector receives the last digit dialed by the calling subscriber and is operated in well-known manner to select an idle trunk T to the private branch exchange. Upon seizure of trunk T by a level hunting connector LHC, ground potential is connected, in usual manner, through its test brush to conductor 49 to guard against seizure by any other level hunting connector, and is further connected through the upper low resistance winding of relay 29 to conductor 15 to guard against seizure of the trunk by any of the selectors. This ground connection also causes the operation of cut-off relay 42 and causes the successive operation of relays 29, 25 and 30. Relay 42 prevents the operation of line relay 41. Relay 30 connects ground potential directly to conductor 15 as hereinbefore described to prevent seizure of trunk circuit T-1 by any

of the selectors S—3. The connector LHC transmits ringing current over trunk T; and the trunk circuit T—2 operates as hereinbefore described to light the answering lamp AL and mark the trunk circuit T—2 busy. When the call is answered by an attendant at the private branch exchange, the trunk circuit T—2 functions as hereinbefore described and the talking connection is completed by the level hunting connector in usual manner. When the calling subscriber releases the connection, the connector and preceding switches in the central office are returned to normal and the trunk circuits T—1 and T—2 are restored to normal.

If, on a call from the private branch exchange to the central office, the trunk circuit T—2 is seized by an attendant, the insertion of a plug in jack J causes the operation of relays 57 and 61. If the trunk circuit T—2 is seized by a selector S in the private branch exchange, relay 61 operates in series with the calling extension. In either case, relay 61 closes circuits for operating relays 56 and 62 and connects ground potential to conductor 73 to prevent seizure of trunk circuit T—2 by a selector S. Relay 56 closes a circuit for operating relay 57 and relay 57 connects busy potential to the sleeves of jacks J. With relay 62 operated, ground is connected through resistor 69 to conductor 52 to effect the operation of the line relay 41 in the central office and extension of the trunk through a line finder to a first selector. Relay 27 of trunk circuit T—1 is operated in series with relay 41, closing the circuit for operating relay 39. Relay 39 connects busy-marking, ground potential to conductors 15 and 49 as above described. When a line finder finds the terminals of trunk T, ground is connected through the test brush, operating the cut-off relay 42 to release relays 40 and 41. Relay 42 also extends this ground potential through its left front contact to conductor 46 and the lower winding of relay 29. Relay 29 operates closing the circuit for operating relay 25 and relay 25 short-circuits relay 27. With relays 25 and 30 both operated, the ground connected through the test brush of the line finder LF—2 to conductor 46 is extended through conductor 49 to the test terminals in the banks of the level hunting connectors. Upon connection of trunk T through the brushes of a line finder LF—2 to the line relay (not shown) of an associated first selector, relay 65 of trunk circuit T—2 is operated. Relay 65 closes the circuit for operating relay 66. Relay 66 disconnects ground from conductors 51 and 52 and closes the circuits for operating relays 67 and 68. Relay 67 connects the conductors of the trunk to the calling operator or calling extension, and causes the release of relays 61 and 62. The release of relay 62 reconnects resistor 64 in parallel with the winding of relay 65 and opens the short circuit across conductors 51 and 52 thereby clearing the connection for transmission of dial impulses to the switches in the central office. Relay 65 may follow dial impulses; but, being slow in releasing, relay 66 holds relays 67 and 68. The impulses, transmitted from the calling operator's or subscriber's dial, effect the operation of selector and connector switches in the central office to complete the connection. If the call is to a subscriber's line, the connection is under the control of the calling subscriber or operator in the private branch exchange. If the call is to an operator, the connection is under the joint control of the called operator and the

calling subscriber or operator, in which case release only by the calling subscriber or operator effects the successive release of relays 65, 66, 67 and 68. The release of relay 67 bridges the winding of relay 53 across the trunk to hold the switches in the central office. Relay 53 operates, closing a circuit for holding relay 56; and relay 56 holds relay 57 to maintain the busy-marking of trunk circuit T—2 and hold the switches in the private branch exchange. When the calling subscriber again removes the receiver or the attendant again inserts the plug of a cord, relays 61 and 62 are reoperated, relay 53 releases, relays 65, 66, 67 and 68 reoperate, and relays 61 and 62 again release. When the connection is released by the calling station or attendant in the private branch exchange and also by the called operator in the central office, the line finder, selector and connector switches in the central office are returned to normal, and ground is disconnected from conductor 43 to release the cut-off relay 42. Relays 29, 25 and 30 of trunk circuit T—1 are thereupon released. In the private branch exchange the release of relays 65, 66, 67 and 68 effects the release of relays 56 and 57 and the disconnection of ground potential from conductor 73 and the disconnection of guarding potential from jacks J.

If the trunk circuit T—2 is seized at substantially the same time by both a selector S—3 and a level hunting connector LHC, relay 29 is operated by the ground connected to conductor 49 by the level hunting connector. The operation of relay 29 causes the operation of relays 25 and 30. Relay 21 is operated in series with the line of the subscriber connected to trunk circuit T—2 through a selector S—3. Relay 21 closes the circuit for operating relay 22. The call incoming to trunk circuit T—1 from the level hunting connector may be completed but a busy tone signal is transmitted from tone source 20 through the inner lower front contact of relay 21, inner upper front contact of relay 25, lower back contact of relay 28, condenser 18 and conductor 14 to the subscriber calling through the selector S—3. If this subscriber dials, relay 23 cannot be operated since its operating circuit is open at the outer upper back contact of relay 39. When the subscriber receiving the busy tone releases, relays 21 and 22 release and relay 23 is temporarily operated. When relay 22 releases, ground is disconnected from conductor 15 to release the selector S—3 and preceding switches. When relay 23 releases, ground is reconnected to conductor 15 to prevent seizure by another selector.

If the trunk circuit T—1 is seized by a selector S—3, the call is answered by the attendant at the private branch exchange and if the attendant disconnects but the calling subscriber in the central office fails to release, relay 24 releases but relays 26 and 28 are held operated. The release of relay 24 connects ground through the middle upper front contact of relay 26 to one side of the winding of relay 31, the other side being connected to a common pick-up interrupter 32, the brush of which is momentarily connected to battery once every thirty seconds. As soon after the release of relay 24 as the interrupter 32 connects battery to relay 31, relay 31 operates and locks independent of the interrupter. Relay 31 connects ground to the conductor leading to the alarm 34 and connects interrupter 33 to the winding of relay 28. As soon after relay 31 operates as the brush of interrupter 33 is connected to ground, which may be

eighteen seconds after the brush of interrupter 32 is connected to battery, the winding of relay 28 is short-circuited and relay 23 releases. The release of relay 28 disconnects relay 24 and talking condensers 17 and 18 from the trunk thus preventing the call from the selector from interfering with the seizure of trunk T by a level hunting connector or from interfering with calls from the private branch exchange to the central office. If and when the subscriber calling through the selector releases, relays 21 and 22 release and relay 23 operates temporarily. The release of relay 22 causes the release of relay 26 and relay 26 causes the release of relay 31.

Each time the trunk circuit T—2 is seized by a selector S—3, the momentary operation of relay 23, when the connection is released, closes a circuit for operating the register 39.

Although in the arrangement shown in the drawing the trunks to the private branch exchange are connected to terminals in the banks of selectors and level hunting connectors in the central office, the invention is applicable to an arrangement in which the trunks are connected to the banks of rotary connectors instead of level hunting connectors.

What is claimed is:

1. In a telephone system, subscribers' lines, a central office, a private branch exchange, a group of trunks between said office and exchange, selectors and connectors in said central office, and means for connecting a calling line with a selector, the trunks in said group being multiplied to first choice sets of terminals in a level of the bank of each of said selectors and to terminals in the banks of said connectors, each of the remaining sets of terminals in said level of the banks of said selectors being connected to one of said connectors.
2. In a telephone system according to claim 1, a trunk circuit in said central office for each of said trunks, and means in each of the trunk circuits effective immediately upon seizure by one of said selectors for transmitting a seizure signal to said branch office.
3. In a telephone system, an automatic office comprising lines, subscribers' stations, a dial at each station, selectors, trunk hunting connectors, and means for connecting a calling line with a selector, a private branch exchange, a group of trunks between said office and said branch exchange, each of said trunks being connected to first choice terminals in a level of the banks of selectors and to terminals in the banks of trunk hunting connectors, each of said connectors being connected to other terminals in said level of the banks of selectors, means in each of said connectors for transmitting ringing current over any of said trunks, means in the branch exchange for each trunk for marking the trunk busy in the branch exchange in response to ringing current from the central office, and means for each trunk for marking the trunk busy in the branch exchange in response to seizure of the trunk by one of said selectors.
4. In a telephone system according to claim 3, means for each trunk effective upon seizure of the trunk by one of said selectors for marking the trunk busy to the other selectors and to said connectors, and means for each trunk effective upon seizure of the trunk by one of said connectors for marking the trunk busy to the other connectors and to said selectors.
5. In a telephone system, an automatic office comprising lines, subscribers' stations, a dial at

each station, selectors, trunk hunting connectors, and switching means for connecting a calling line with a selector, a private branch exchange, a group of two-way trunks between said office and said branch exchange, each of said trunks being connected to first choice terminals in a level of the banks of selectors in the central office and to terminals in the banks of said trunk hunting connectors, each of said connectors being connected to terminals in said level of the banks of selectors, trunk circuits in said office one for each of said trunks, signal means for each of said trunks in said branch exchange, circuit means at said branch exchange for each trunk for marking said trunk as busy in the branch exchange, means in each of said trunk circuits responsive to seizure by any one of said selectors in the central office for closing a circuit through the trunk to operate said circuit means, means in each trunk circuit effective upon seizure by a selector in the central office for absorbing the dial impulses thereafter created by the dialing of any remaining digits of the branch exchange number by the calling subscriber, and means in each trunk circuit effective after the absorption of said dial impulses for transmitting ringing current over said trunk to operate the signal means associated with said trunk in the branch exchange and to maintain the marking of said trunk as busy in the branch exchange.

6. In a telephone system, an automatic office comprising lines, subscribers' stations, a dial at each station, selectors, trunk hunting connectors, and switching means for connecting a calling line with a selector, a private branch exchange comprising selectors and a manual switchboard, a group of two-way trunks between said office and said branch exchange, each of said trunks being connected to a jack at said switchboard, to terminals in the banks of the selectors in the branch exchange, to first choice terminals in a level of the banks of selectors in the central office and to terminals in the banks of said trunk hunting connectors, each of said connectors being connected to terminals in said level of the banks of selectors, trunk circuits in said office one for each of said trunks, signal means for each of said trunks in said branch exchange, cords in the branch exchange for connecting with said jacks, circuit means at said branch exchange for each trunk for marking the trunk busy in the branch exchange, means in each of said trunk circuits responsive to seizure by any one of said selectors in the central office for closing a circuit through the trunk to operate said circuit means, means in each trunk circuit effective upon seizure by a selector in the central office for absorbing the dial impulses thereafter created by the dialing of any remaining digits of the branch exchange number by the calling subscriber, and means in each trunk circuit effective after the absorption of said dial impulses for transmitting ringing current over said trunk to operate the signal means associated with said trunk in the branch exchange and to maintain the marking of said trunk as busy in the branch exchange.

7. In a telephone system according to claim 6, a source of talking current in each trunk circuit, means in each trunk circuit responsive to the connection of a cord with the jack of the trunk to answer the call for disconnecting the ringing current source and closing a talking circuit, the closure of said talking circuit being effective to maintain the marking of said trunk

as busy in the banks of the selectors in the branch exchange.

8. In a telephone system, an automatic central office comprising lines, subscribers' stations, a dial at each station, selectors, and trunk hunting connectors, a private branch exchange, trunks between said office and said exchange, each of said trunks being connected to terminals in a level of the banks of selectors and to terminals in the banks of trunk hunting connectors; each of said connectors being connected to a set of terminals in said level of some of said selectors, means for connecting a calling line to a selector, means for each of said trunks responsive to seizure by any one of said selectors for closing a signaling circuit over said trunk, means in said branch exchange for each of said trunks for marking the trunk busy, means in the branch exchange for each of said trunks for operating the busy-marking means responsive to closure of the signaling circuit upon seizure of the trunk by a selector, means in said automatic office for each of said trunks for absorbing impulses transmitted from the dial at a calling station and for thereupon connecting a source of ringing current to the trunk, a calling signal in the branch exchange for each of said trunks, means in the branch exchange for each of said trunks responsive to ringing current from the central office for operating the calling signal and for operating the busy-marking means, means in the branch exchange for seizing any one of said trunks on a call to the central office, and means in the central office for each of said trunks responsive to seizure of the trunk by a selector or a connector in the central office and responsive to seizure in the branch exchange for marking the trunk busy in the central office.

9. In a telephone system, an automatic central office comprising lines, subscribers' stations, a dial at each station, line finders, selectors, and trunk hunting connectors, a private branch exchange, trunks between said office and said exchange, each of said trunks being connected to terminals in a level of the banks of selectors, to terminals in the banks of trunk hunting connectors and to terminals in the banks of line finders, each of said connectors being connected to a set of terminals in said level of some of said selectors, line circuits in said office, one for each of said trunks, means for connecting a calling line to a selector, means for each of said trunks responsive to seizure by any one of said selectors for closing a signaling circuit over said trunk, means in said branch exchange for each of said trunks for marking the trunk busy, means in the branch exchange for each of said trunks for operating the busy-marking means responsive to closure of the signaling circuit upon seizure of the trunk by a selector, means in said automatic office for each of said trunks for absorbing impulses transmitted from the dial at a calling station and for thereupon connecting a source of ringing current to the trunk, a calling signal in the branch exchange for each of said trunks, means in the branch exchange for each of said trunks responsive to ringing current from the central office for operating the calling signal and for operating the busy-marking means, means in the branch exchange for seizing one of said trunks on a call to the central office, and means in the central office for each of said trunks responsive to seizure of the trunk by a selector or a connector in the central office and responsive

to seizure in the branch exchange for marking the trunk busy in the central office.

10. In a telephone system, an automatic office comprising lines, subscribers' stations, a dial at each station, selectors, level hunting connectors, and means for connecting a calling line to a selector, a private branch exchange, trunks between said office and said branch exchange, each of said trunks being connected to first choice terminals in a level of the banks of some of said selectors and to terminals in the banks of all of said connectors, each of said connectors being connected to terminals in said level of some of said selectors, trunk circuits in said office, one for each of said trunks, trunk circuits in said exchange, one for each of said trunks, means in each of said trunk circuits at said office responsive to seizure by any one of said selectors for marking said trunk busy to the other selectors and to said connectors and for transmitting a seizure signal to the branch exchange, means in each of said trunk circuits at said office responsive to seizure of the trunk by any one of said connectors for marking the trunk busy to the other connectors and to said selectors, means in each of said connectors for connecting a source of ringing current to a seized one of said trunks, busy-marking means in each of said trunk circuits at the branch exchange responsive to a seizure signal transmitted from the trunk circuit at the central office end of the trunk, and means in each of said trunk circuits at the branch exchange responsive to ringing current from the central office.

11. In an automatic telephone office comprising dial subscribers' lines, selectors, trunk hunting connectors, trunks and trunk circuits, one for each of said trunks, connected to terminals in the banks of selectors and connectors, each of said connectors being connected to terminals in the banks of some of said selectors, and means in each of said trunk circuits responsive to seizure of the trunk circuit by a selector or connector for marking the trunk busy in the banks of the selectors and connectors, said last-mentioned means comprising a relay having a winding normally connected between the test terminals of the trunk in the banks of said selectors and the test terminals of the trunk in the banks of said connectors, said winding having a low resistance so that the connection of a busy-marking potential to either side of said winding upon seizure of the trunk by a selector or a connector marks the trunk as busy in the banks of all of said selectors and connectors, said relay having another winding normally connected in series with the low resistance winding to the test terminals of the trunk in the banks of said selectors, said windings being differentially and non-operatively energized upon seizure of the trunk by a selector, said other winding being operatively energized upon seizure of the trunk by a connector, and means controlled by the relay for continuing the busy-marking of the trunk in the banks of the selectors and connectors.

12. In an automatic telephone office comprising dial subscribers' lines, line finders, selectors, trunk hunting connectors, trunks and trunk circuits, one for each of said trunks, connected to terminals in the banks of line finders, selectors and connectors, each of said connectors being connected to terminals in the banks of some of said selectors, and means in each of said trunk circuits responsive to seizure of the trunk circuit by a line finder, selector, or connector for marking the trunk busy in the banks of the selectors

and connectors, said last-mentioned means comprising a relay having a winding normally connected between the test terminals of the trunk in the banks of said selectors and the test terminals of the trunk in the banks of said connectors, said winding having a low resistance so that the connection of a busy-marking potential to either side of said winding upon seizure of the trunk by a line finder, selector or connector marks the trunk as busy to all of said selectors and connectors, said relay having another winding normally connected in series with the low resistance winding to the test terminals of the trunk in the banks of said selectors, said windings being differentially and non-operatively energized upon seizure of the trunk by a selector, said other winding being operatively energized upon seizure of the trunk by a line finder or a connector, and means controlled by the relay for continuing the busy-marking of the trunk in the banks of the selectors and connectors.

13. In a telephone system, an automatic office, a private branch exchange, subscribers' lines, a group of two-way trunks between said office and said exchange, selectors and trunk hunting connectors in said automatic office, said trunks being multiplied to first choice terminals in a level of the banks of said selectors and to terminals in a level of said connectors, each of the other terminals in said level of the selectors being connected to one of the connectors, trunk circuits, one for each of said trunks, means for connecting a calling line in said automatic office with an idle one of said selectors, means comprising a dial at the calling subscriber's station for directly operating the associated one of said selectors to select said level, means in said selector for seizing the first idle set of terminals in said level, means in each of said connectors responsive to a train of dial impulses from a connected calling station for operating the connector to seize an idle one of said trunks, means in each of said trunk circuits effective upon seizure by said selector for absorbing the impulses thereafter created by the dialing of the remaining digits of the number of said private branch exchange, means in each of said trunk circuits effective only upon seizure by one of said selectors for immediately sending a seizure signal to said private branch exchange, selectors in said branch exchange, said trunks being multiplied to terminals in the bank of said selectors in the branch exchange, means in said branch exchange for each trunk responsive to said seizure signal from the trunk circuit in said office for marking said trunk busy in the banks of said selectors in the branch exchange, means in each of said trunk circuits effective only when seized by a selector and after receiving the dial impulses of said remaining digits for connecting a source of ringing current to the trunk, means in each

of said connectors for connecting a source of ringing current to a seized one of said trunks, an operator's position in said branch exchange, signaling means for each of said trunks at said operator's position operatively responsive to ringing current from the automatic office, means comprising a cord for answering the call, alarm means common to said trunk circuits, and means in each of said trunk circuits for operating said alarm means in the event that a calling subscriber fails to release the connection over a trunk to the branch exchange within a predetermined interval of time after the trunk is released by the answering operator.

14. In a telephone system, an automatic office, a private branch exchange, subscribers' lines, a group of two-way trunks between said office and said exchange, selectors and trunk hunting connectors in said automatic office, said trunks being multiplied to first choice terminals in a level of the banks of said selectors and to terminals in a level of said connectors, each of the other terminals in said level of the selectors being connected to one of the connectors, trunk circuits, one for each of said trunks, means for connecting a calling line in said automatic office with an idle one of said selectors, means comprising a dial at the calling subscriber's station for directly operating the associated one of said selectors to select said level, means in said selector for seizing the first idle set of terminals in said level, means in each of said connectors responsive to a train of dial impulses from a connected calling station for operating the connector to seize an idle one of said trunks, means in each of said trunk circuits effective upon seizure by said selector for absorbing the impulses thereafter created by the dialing of the remaining digits of the number of said private branch exchange, means in each of said trunk circuits effective only upon seizure by one of said selectors for immediately sending a seizure signal to said private branch exchange, selectors in said branch exchange, said trunks being multiplied to terminals in the bank of said selectors in the branch exchange, means in said branch exchange for each trunk responsive to said seizure signal from the trunk circuit in said office for marking said trunk busy in the banks of said selectors in the branch exchange, means in each of said trunk circuits effective only when seized by a selector and after receiving the dial impulses of said remaining digits for connecting a source of ringing current to the trunk, means in each of said connectors for connecting a source of ringing current to a seized one of said trunks, an operator's position in said branch exchange, and signaling means for each of said trunks at said operator's position operatively responsive to ringing current from the automatic office.

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