

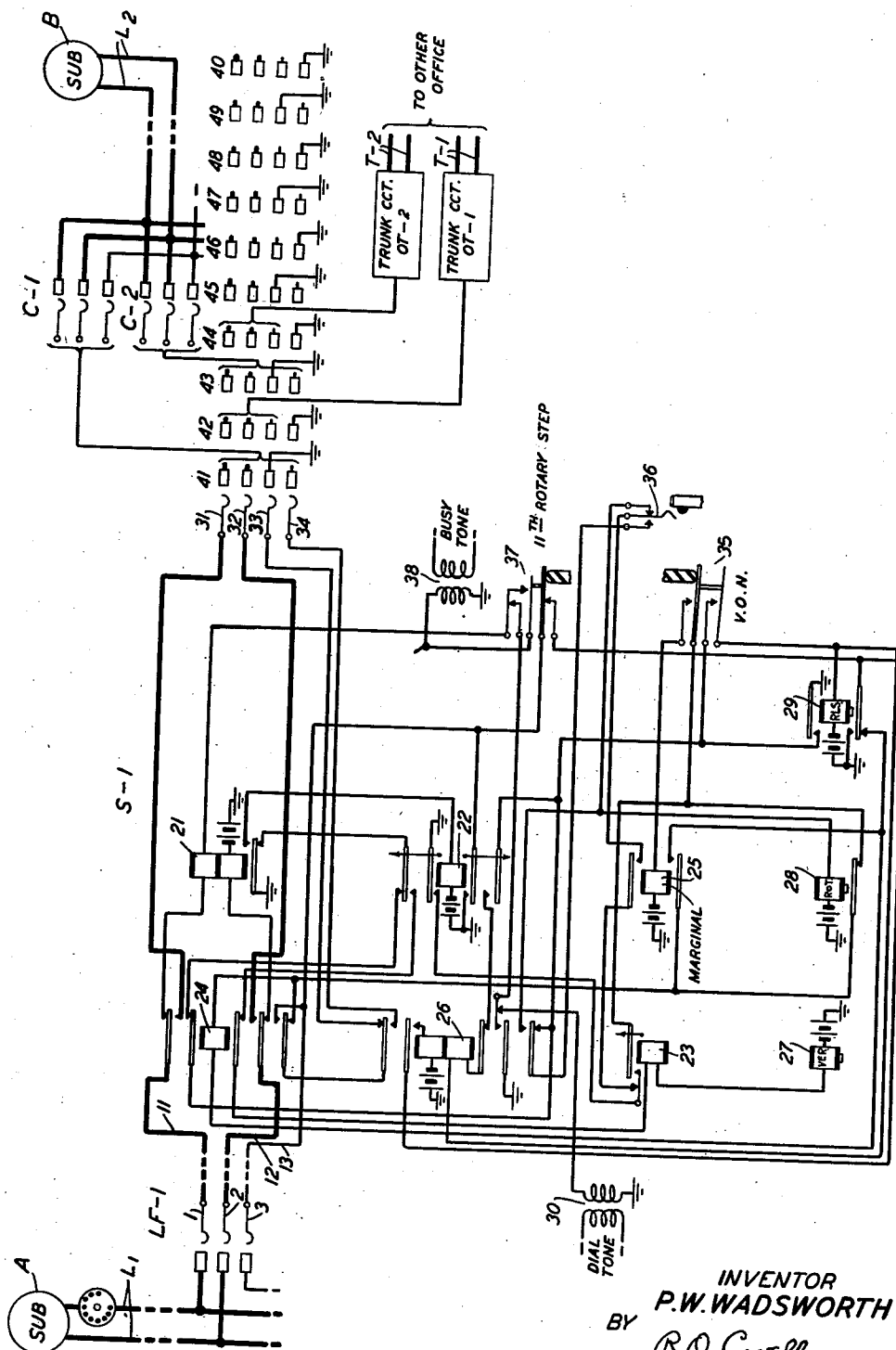
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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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This invention relates to telephone systems and particularly to systems comprising subscriber controlled automatic switches for establishing connections between calling and called lines.

Objects of the invention are an increase in the flexibility, adaptability and efficiency of group selector switches and the trunking arrangements of telephone systems comprising such switches.

This invention is a selector switch comprising groups of terminals, including one or more groups in which some of the terminals are connected to trunks in one group of trunks and in which some of the terminals are connected to trunks in another group of trunks, one brush being provided for testing the trunks in the one group and another brush being provided for testing the trunks in the other group, switching from one to the other of the test brushes being effected by the actuation of shaft-operated springs upon selection of a particular one of said groups of terminals whereby the shaft and brushes are restored to normal to cause the operation of a brush switching relay.

A feature of the invention is a selector of the above-described character comprising a brush switching relay which is partially operated by the energization of an operating winding in series with the release magnet when the shaft reaches normal, the complete operation being effected by closure of a circuit through a locking winding and contact.

A clear and complete understanding of the invention will be facilitated by considering a system and selector in which the invention is embodied, one such system and selector being shown schematically in the drawing which forms a part of this specification.

The drawing, which consists of a single figure, shows schematically a calling subscriber's station A and line L1, a line-finder switch LF—1, a selector S—1, outgoing trunk circuits OT—1 and OT—2, connector switches C—1 and C—2 and a called subscriber's line L2 and station B.

While only one selector is shown in a connection between a calling line and a called line, it is understood that intermediate selectors may be provided, the total number of switches required for establishing connections between calling and called lines depending upon the number of lines and the number of digits in the telephone numbers assigned to the subscriber.

The subscribers' stations A and B may be of known type, each comprising a dial or other impulse sender for controlling the operation of se-

lector switches. Each of the line-finder, selector and connector switches may be of the well-known two-motion step-by-step type and reference may be had to pages 53 to 65, inclusive 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 and connectors. Reference may be had to the patent to R. L. Stokely No. 1,799,654 granted April 7, 1931 for a description of the operation of such switches when used as line finders. Each of the line-finder and connector switches is represented in the drawing by a set of brushes and a single set of terminals, all operating magnets, relays and other associated apparatus being omitted.

The selector S—1, which is shown in detail, comprises a set of brushes 31 to 34 inclusive, a bank of terminals consisting of ten levels, each level consisting of ten sets of four terminals each and only one level being shown, a vertical-stepping magnet 21, a rotary-stepping magnet 28, a release magnet 29, vertical off-normal springs 35, shaft-operated springs 36 adjusted to be operated when the brushes have been raised to a particular level, "11th rotary step" springs 37, a line relay 21, release relay 22, change-over relay 23, cut-through relay 24, rotary-stepping and test-relay 25, and test brush switching relay 26.

Although the selector S—1 is shown as being a first selector connected directly to a line finder LF—1, it is, of course, to be understood that the invention is applicable to selectors other than first selectors, and that there may be one or more selectors in the connection between the calling line and the selector S—1. Two groups of trunks are connected to the terminals 40 to 49, inclusive, of the level shown in the drawing. A first group of trunks connect the odd-numbered terminal sets of the level shown to connector switches, including the switches C—1 and C—2. A second group of trunks connect the even-numbered terminal sets of outgoing trunk circuits and inter-office trunks, including trunk circuits OT—1 and OT—2 and trunks T—1 and T—2. The trunks in one group are tested by brush 33 and the trunks in the other group are tested by brush 34, the switching relay 26 being provided for transferring from brush 33 to brush 34. As shown, the odd-numbered terminals are tested by brush 34; and the terminals of these sets which are engageable by brush 33 are permanently connected to ground so as to prevent selection of any odd-numbered set when brush 33 is being used to test for an idle trunk. The

even-numbered terminals are tested by brush 33; and the terminals of these sets which are engageable by brush 34 are permanently connected to ground so as to prevent selection of any even-numbered set when brush 34 is being used to test for an idle trunk.

The number of trunks in each of the two groups may be varied as desired and it is, of course, not necessary that the groups be connected to alternate sets of terminals although such an arrangement tends to equalize the average time required for trunk hunting in each of the two groups. Although one group is shown as an interoffice group of trunks and the other as a local group of trunks leading directly to connector switches, each of the two groups of trunks connected to terminals in one level may be of any desired character. Furthermore, the local group of trunks may terminate in selector switches instead of leading directly to connector switches, the number of intermediate selectors required depending upon the number of digits in the subscribers' numbers. Each of the other levels of the bank, with the exception of the particular level with which the contact springs 36 are operatively associated, are arranged in like manner to give access to two groups of trunks. The operation of springs 36, upon selection of this particular level in response to the first train of dial impulses incoming to the selector S-1, effects the restoration of the brushes to normal and the operation of the brush switching relay 26 to connect test brush 34 to the test relay 25 in place of the normally connected test brush 33, all as hereinafter fully described.

The trunk circuits OT-1 and OT-2 and the other outgoing trunk circuits in the same group may be similar to the outgoing repeater circuit shown in Fig. 67 and described on pages 70 to 72 inclusive of the aforementioned second edition of "Automatic Telephony."

Assume that a call is originated at station A, and that a line finder LF-1 is operated in usual manner to connect the calling line L1 with a first selector S-1. Upon connection of a calling line with selector S-1, a circuit is closed from battery through the lower winding of relay 21, a lower back contact of relay 24, conductor 12, brush 2 of line finder LF-1, through line L1 and the telephone set and dial at station A, brush 1 of line finder LF-1, conductor 11, an upper back contact of relay 24, upper winding of relay 21, normally closed upper contact of the eleventh rotary step springs 37, a back contact of relay 26, and the right winding of the dial tone source 30, to ground. Relay 21 is operated by the current in this circuit, thereby closing a circuit for operating relay 22. Relay 22 connects ground to conductor 13 to hold the line finder LF-1 and the cut-off relay (not shown) of the line L1 in the usual manner.

No further operation takes place until the calling subscriber dials the number of the subscriber's station with which a connection is desired. When the first digit is dialed the impulse contacts of the dial alternately open and close the operating circuit of relay 21 as many times as there are units in the digit dialed. The release of relay 21, in response to the first dial impulse, closes a circuit from ground through the back contact of relay 21, a front contact of relay 22, a back contact of relay 24, winding of relay 23 and winding of vertical-stepping magnet 27 to battery. Relay 23 and magnet 27 are operated

by the current in this circuit. The operation of magnet 27 steps the shaft up one step so that the brushes 31 to 34 are aligned with the first level of terminals in the terminal bank. The actuation of the vertical off-normal springs 35 when the shaft moves out of normal position closes a circuit from battery through the winding of relay 25, upper contact of springs 35, front contact of relay 23, to ground at a front contact of relay 22. Relay 25 locks, independent of relay 23 in a circuit including the back contact of the rotary-stepping magnet 28, lower front contact of relay 25, back contact of release magnet 29, lower back contact of the eleventh rotary step springs 37, to ground at a front contact of relay 22. The reoperation of relay 21, at the end of the first impulse, opens the circuit through the windings of relay 23 and magnet 27 and the magnet 27 immediately releases; but relay 23 is slow in releasing and remains operated, during the response of relay 21, until all of the impulses in the train created by the dialing of the first digit have been received. Since relay 22 is slow in releasing it does not release during the response of relay 21 to dial impulses. Each release and reoperation of relay 21, in response to succeeding impulses of the train, causes a corresponding operation and release of magnet 27 thereby stepping the brushes into alignment with the level corresponding to the digit dialed.

When relay 23 releases after relay 21 has reoperated following receipt of the last impulse of the first digit, and the selected level is a level other than the one with which springs 36 are operatively associated, it closes a circuit from battery through the winding of the rotary-stepping magnet 28, normally closed contact of springs 36, upper front contact of relay 25, back contact of relay 23, to ground at a front contact of relay 22. The operation of magnet 28 steps the brushes 31 to 34, inclusive, into engagement with the first set of terminals in the selected level. When magnet 28 operates, it opens the locking circuit of relay 25; and the release of relay 25 opens the operating circuit of magnet 28. The release of magnet 28 closes a circuit path from the winding of relay 25, through the upper contact of springs 35, back contact of magnet 28, outer lower back contact of relay 24 and upper back contact of relay 26, to test brush 33. A branch circuit path may be traced from the back contact of magnet 28 through the winding of relay 24, back contact of release magnet 29, lower back contact of springs 37, to ground at relay 22. Since the trunk connected to the first set of terminals is a local trunk leading to a connector switch C-1, the terminal engaged by brush 33 is permanently connected to ground. Relay 24 is short-circuited by this ground and does not operate; but relay 25 reoperates, and again locks under control of magnet 28. The reoperation of relay 25 closes the circuit for operating magnet 28, thereby stepping the brushes into engagement with the second set of terminals in the selected level, the trunk T-1 connected to these terminals being the first trunk in the group leading to the called office as indicated by the first digit dialed. The operation of magnet 28 again causes the release of relay 25 and the release of relay 25 causes the release of magnet 28. If the trunk T-1 is busy, the terminal engaged by test brush 33 is connected to ground potential and relay 25 again reoperates to cause the advance of the brushes to the third set of terminals in the level. Since this set of terminals is connected to a local trunk, the ground perma-

nently connected to the terminal engaged by brush 33 causes the operation of relay 25 and magnet 28 to again advance the brushes one step. This cycle of operations is repeated until the brushes engage a set of terminals connected to an idle trunk in the group identified by the first digit dialed, whereupon since the terminal engaged by brush 33 is not connected to ground, relay 24 is no longer short-circuited and is operatively energized in series with relay 25. Relay 25 is marginal and does not reoperate in series with relay 24.

If all of the trunks in the group identified by the first digit dialed are busy, the advance of the brushes continues until all of the trunks have been tested and the brushes reach the eleventh rotary position in which case there is no circuit for reoperating relay 25; and the actuation of the "11th rotary step" springs 37 prevents the operation of relay 24 and closes a connection from the left winding of the busy tone source 38, through the upper front contact of springs 37, to the upper winding of relay 21 thereby effecting the transmission of a busy tone to the calling subscriber in usual manner.

The operation of relay 24, upon engagement of brushes 31 to 34 with the terminals of an idle trunk in the group including trunks T-1 and T-2, disconnects the calling line from the windings of relay 21 and extends the connection from the calling line through conductors 11 and 12, front contacts of relay 24, and brushes 31 and 32 to the selected outgoing trunk, which is thereupon effective to connect ground potential to the terminal engaged by brush 33 to hold relay 24 operated and also to prevent selection of this trunk by any other hunting selector having access thereto. Relay 21 releases, opening the operating circuit of relay 22; and, after the holding ground is connected by the outgoing trunk to the terminal engaged by brush 33, the release of relay 22 disconnects ground from conductor 13 so that the line finder LF-1 and cut-off relay of the subscriber's line circuit are thereafter held by the holding ground supplied by the outgoing trunk circuit. The impulses created by the dialing of the remaining digits of the called subscriber's number, are repeated in the outgoing trunk circuit and the connection is thereby completed in the called office in usual manner.

When the calling subscriber restores the telephone to normal, the holding ground in the outgoing trunk circuit is disconnected from the terminal engaged by brush 33 thereby causing the release of relay 24, the release of the line finder LF-1 and the release of the cut-off relay of the calling line in usual manner. The release of relay 24 closes a circuit including back contacts of relays 21, 22 and 24 and the lower contact of vertical off-normal springs 35, for operating the release magnet 29, thereby effecting return of the shaft and brushes to normal. Release magnet 29 locks under the sole control of the vertical off-normal springs 35 so that seizure of selector S-1 on another call before its brushes reach normal is ineffective to cause the release of magnet 29. When the shaft reaches normal, the return of springs 35 to normal position opens the operating circuit of release magnet 29.

Assume now that the dialing of the first digit after connection of the calling line L1 to the selector S-1 raises the brushes to the level with which springs 36 are operatively associated. In this case, the springs 36 are actuated and, when relay 23 releases after response of relay 21 to

the last impulse of the train, relay 23 closes a circuit for operating release magnet 29. This circuit includes the lower contact of springs 35, lowermost back contact of relay 26, normally open contact of springs 36, front contact of relay 25, back contact of relay 23, to ground at relay 22. The operation of magnet 29 causes the return of the shaft and brushes to normal. Although level springs 36 are restored to normal as soon as the brushes leave the level, release magnet 29 is held through the lower contact of the vertical off-normal springs 35 to ground at the upper front contact of magnet 29. When the shaft and brushes reach normal, this circuit is opened by the return of springs 35 to normal; whereupon the winding of release magnet 29 is energized in series with the lower winding of relay 26, back contact of relay 26, and front contact of relay 22, to ground at the upper front contact of magnet 29. Release magnet 29 is thus held operated and the energization of the lower winding of relay 26 is effective to close, at the inner upper front contact of this relay, a circuit for energizing the upper winding to complete the actuation of relay 26. Relay 26 is locked through its upper winding to ground at the lower front contact of release magnet 29 until this magnet releases. When magnet 29 releases, due to the opening of the circuit through the lower winding of relay 26 at the inner lower back contact of relay 26, the upper winding of relay 26 remains energized in a circuit which includes the lower contact of the eleventh rotary step springs 37 and the inner lower front contact of relay 22.

Thus the brushes are restored to normal to absorb the first digit and to render the test brush 34 operatively effective instead of brush 33. When the calling subscriber dials the second digit of the called subscriber's number, the brushes are raised step by step to the level corresponding to this digit. Relay 23 is reoperated in series with the vertical-stepping magnet upon release of relay 21 in response to the first impulse of the train. When the shaft moves out of normal position the actuation of springs 35 closes the circuit for operating relay 25 and relay 25 locks under control of the rotary-stepping magnet 28 as hereinbefore described. When relay 23 releases, after the response of relay 21 to the last impulse of the train, the rotary-stepping magnet 28 operates to advance the brushes into engagement with the first set of terminals in the selected level, which level we will again assume to be the level shown in the drawing. With relay 26 locked operated, the dial tone source 30 is disconnected and ground is connected directly to the upper winding of relay 21. And with relay 26 locked operated, the test brush 34 is connected through a front contact of relay 26, a back contact of relay 24, back contact of rotary-stepping magnet 28 and upper contact of the VON spring 35 to the winding of relay 25. If the connector C-1, which is connected to the first set of terminals, is busy, the ground potential encountered by brush 34 causes the reoperation of relay 25. Relay 25 locks and closes the circuit for operating the rotary-stepping magnet 28 to advance the brushes to the next set of terminals. Since the next set of terminals is not connected to a connector switch but to an interoffice trunk, the terminal engaged by brush 34 is permanently connected to ground to cause the brushes to be stepped to the next set of terminals. As soon as the brushes engage the terminals of an idle connector, in the group with C-1 and C-2, relay

25 is not reoperated, since the terminal engaged by test brush 34 is not connected to ground, but the winding of relay 24 is operatively energized in series with the winding of relay 25. Relay 24 disconnects test brush 34 from the winding of relay 25 and connects it to ground at the inner lower front contact of relay 22 to immediately guard against seizure of the selected connector switch by another selector having access thereto. The operation of relay 24 also causes the release of relay 21 and connects the calling line through conductors 11 and 12 and brushes 31 and 32 to the seized connector. The operation of the line and release relays (not shown) of the seized connector are effective in usual and well-known manner to connect a holding, ground potential to the terminal engaged by brush 34. The release of relay 21 opens the operating circuit of relay 22. Being slow in releasing relay 22 does not disconnect ground from conductor 13 until ground in the connector has been connected to the terminal engaged by brush 34 so as to hold relays 24 and 26 and to hold the line finder LF-1 and cut-off relay of line L1 in usual manner.

When the calling subscriber dials the last two digits of the called subscriber's number, the connector switch is selectively operated to connect with the terminals of the called subscriber's line. The testing of the called line, ringing of the called station, and establishment of the talking connection when the call is answered all occur in well-known manner, the connection being held under control of the calling station. When the calling subscriber releases the connection by restoring the telephone to normal, the holding ground in the connector circuit is disconnected from the terminal engaged by brush 34 to cause the release of relay 24 and the return of switches S-1 and LF-1 to normal.

Since the selector S-1 may be used as a second or other intermediate selector, the release magnet 29 when operated connects ground through its lower front contact and the lower back contact of springs 37 to conductor 13 thereby preventing reseizure of selector S-1 by a preceding selector having access thereto until the switch is completely restored. Otherwise reseizure of the selector after release by the calling subscriber on a first call might cause the immediate false operation and locking of relay 26.

The invention is, of course, applicable to other selector circuit arrangements. It may, for instance, be applied to the selector disclosed in the application of H. Hovland, Serial No. 319,993, filed February 21, 1940, in which selector the brush switching relay has a single winding and its operating circuit is arranged so as to prevent false operation in case the selector is used as an incoming selector and is seized on a second call after the release magnet is energized at the end of a first call.

What is claimed is:

1. In a telephone system, a selector switch comprising a bank of terminals divided into levels and a set of brushes including two test brushes for connecting with any set of terminals in any level, means responsive to a train of impulses incoming to said switch for stepping the brushes into alignment with the terminals of the level corresponding to the number of impulses in the train, means for stepping the brushes into engagement with any set of terminals in any selected level, groups of trunks connected to said bank, two of said groups being connected to terminals in one level, a test relay, a control relay

having a normally closed contact for connecting said test relay to one of said test brushes and a normally open contact for connecting said test relay to the other of said test brushes, and means comprising a set of contact springs actuated when said brushes are stepped into alignment with a particular level for returning the brushes to normal to condition the switch for selective response to a second train of impulses and for operating said control relay.

2. In a telephone system, a selector switch comprising a bank of terminals divided into levels and a set of brushes including two test brushes for connecting with any set of terminals in any level, means responsive to a train of impulses incoming to said switch for stepping the brushes into alignment with the terminals of the level corresponding to the number of impulses in the train, means for stepping the brushes into engagement with any set of terminals in any selected level, groups of trunks, a different two of said groups being connected to each of a plurality of levels of said bank, a test relay, a control relay for connecting the one or the other of said test brushes to said test relay, and means comprising a set of contact springs actuated when said brushes are stepped into alignment with a particular level for returning the brushes to normal to condition the switch for selective response to a second train of impulses and for operating said control relay to switch from one test brush to the other.

3. In a telephone system, a selector switch comprising a bank of terminals divided into levels and a set of brushes including two test brushes for connecting with any set of terminals in any level, means responsive to a train of impulses incoming to said switch for stepping the brushes into alignment with the terminals of the level corresponding to the number of impulses in the train, means for stepping the brushes into engagement with any set of terminals in any selected level, groups of interoffice trunks, a different group for each of a plurality of levels, groups of local trunks, a different group for each level, a test relay for testing the trunks of any level, a control relay having a normally closed contact for connecting one of said test brushes to said test relay and a normally open contact for connecting the other of said test brushes to said test relay, and means comprising a set of contact springs actuated when said brushes are stepped into alignment with a particular one of said levels for returning the brushes to normal to condition the switch for selective response to a second train of impulses and for operating said control relay to switch from one test brush to the other.

4. In a telephone system, a selector switch comprising a bank of terminals divided into levels and a set of brushes including two test brushes for connecting with any set of terminals in any level, means responsive to a train of impulses incoming to said switch for stepping the brushes into alignment with the terminals of the level corresponding to the number of impulses in the train, means for stepping the brushes into engagement with any set of terminals in any selected level, groups of trunks connected to said bank, two of said groups being connected to terminals in one level, the test conductors of the trunks in one group being connected to test terminals engageable by one of said test brushes and the test conductors of the trunks in the other group being connected to test terminals engage-

able by the other of said test brushes, the other terminals in said level engageable by said test brushes being permanently marked with busy potential, a test relay, a control relay having a normally closed contact for connecting said test relay to one of said test brushes and a normally open contact for connecting said test relay to the other of said test brushes, and means comprising a set of contact springs actuated when said brushes are stepped into alignment with a particular level for returning the brushes to normal to condition the switch for selective response to a second train of impulses and for operating said control relay.

5. In a telephone system, a selector switch comprising a bank of terminals divided into levels and a set of brushes including two test brushes for connecting with any set of terminals in any level, means responsive to a train of impulses incoming to said switch for stepping the brushes into alignment with the terminals of the level corresponding to the number of impulses in the train, means for stepping the brushes into engagement with any set of terminals in any selected level, groups of trunks, a different two of said groups being connected to each of a plurality of levels of said bank, the test conductors of the trunks in one group of each of said plurality of levels being connected to test terminals engageable by one of said test brushes and the test conductor of the trunks in the other group of each of said plurality of levels being connected to test terminals engageable by the other of said test brushes, the other test terminals in each of said plurality of levels being permanently marked with busy potential, a test relay, a control relay for connecting the one or the other of said test brushes to said test relay, and means comprising a set of contact springs actuated when said brushes are stepped into alignment with a particular level for returning the brushes to normal to condition the switch for selective response to a second train of impulses and for operating said control relay to switch from one test brush to the other.

6. In a telephone system, a selector switch comprising a bank of terminals divided into levels and a set of brushes including two test brushes for connecting with any set of terminals in any level, means responsive to a train of impulses incoming to said switch for stepping the brushes into alignment with the terminals of the level corresponding to the number of impulses in the train, means for stepping the brushes into engagement with any set of terminals in any selected level, groups of trunks connected to said bank, two of said groups being connected to terminals in one level, a test relay, a control relay having a normally closed contact for connecting said test relay to one of said test brushes and a normally open contact for connecting said test relay to the other of said test brushes, means comprising a release magnet for restoring the brushes to normal, means comprising a set of contact springs actuated when said brushes are stepped into alignment with a particular level for operating said release magnet, a shaft-controlled contact for opening the operating circuit of said magnet when the brushes reach normal, a holding circuit for said magnet including a front contact of said magnet in series with an operating winding and a back contact of said control relay, said circuit effective to hold said magnet operated and operatively energize said winding of the control relay

upon the opening of said shaft-controlled contact, and means comprising another winding of said control relay and a contact of said control relay closed by the energization of said operating winding for maintaining said control relay operated, the energization of said other winding being effective to actuate said back contact of said control relay to open said holding circuit and thereby release said magnet.

7. In a telephone system, subscribers' lines, a selector switch comprising a bank of terminals divided into levels and a set of brushes including two test brushes, groups of trunks connected to said bank, two different groups to each of a plurality of levels, means for connecting a calling one of said lines to said switch, an impulse sender at the calling station, means responsive to a train of impulses from said sender for moving the brushes from normal to select a desired level, a set of contact springs actuated only upon selection of a particular level, means comprising a release magnet for restoring the shaft and brushes from any off-normal position to normal, means including a normally open contact of said springs for operating said release magnet upon selection of said particular level in response to the first train of impulses incoming to said switch to restore said brushes to normal, a test relay, a brush-switching relay having a contact normally connecting said test relay to one of said test brushes and a normally open contact for connecting said test relay to the other of said test brushes, means for operating said switching relay upon restoration of said brushes from said particular level when selected in response to the first train of impulses and for locking said relay until the connection is released by the calling subscriber, means for advancing the brushes step by step in a level other than said particular level selected responsive to a first train of impulses and in any level selected responsive to the next train of impulses after the restoration of the brushes from said particular level to hunt for a set of terminals connected to an idle trunk in the selected level, means including said test relay and said one of the test brushes for testing the terminals in said level when the level is selected responsive to the first train of impulses, means including said test relay and said other test brush for testing the terminals in said level when the level is selected responsive to a train of impulses following restoration from said particular level when selected in response to a first train of impulses, means associated with trunks in the group tested by said one test brush connecting a busy potential to the test terminals engageable by said other test brush, means associated with trunks in the group tested by said other test brush connecting busy potential to the test terminals engageable by said one test brush, means including said test relay for seizing the first idle trunk in the group being tested, means including said seized trunk for completing a talking connection with a called line, means for maintaining the connection between said calling line and said seized trunk until the connection is released by the calling subscriber, means responsive to the release of the calling subscriber for operating said release magnet to restore the brushes to normal, and contacts actuated by said release magnet for preventing connection of another calling line to said switch until the brushes have been restored to normal.