

July 11, 1939.

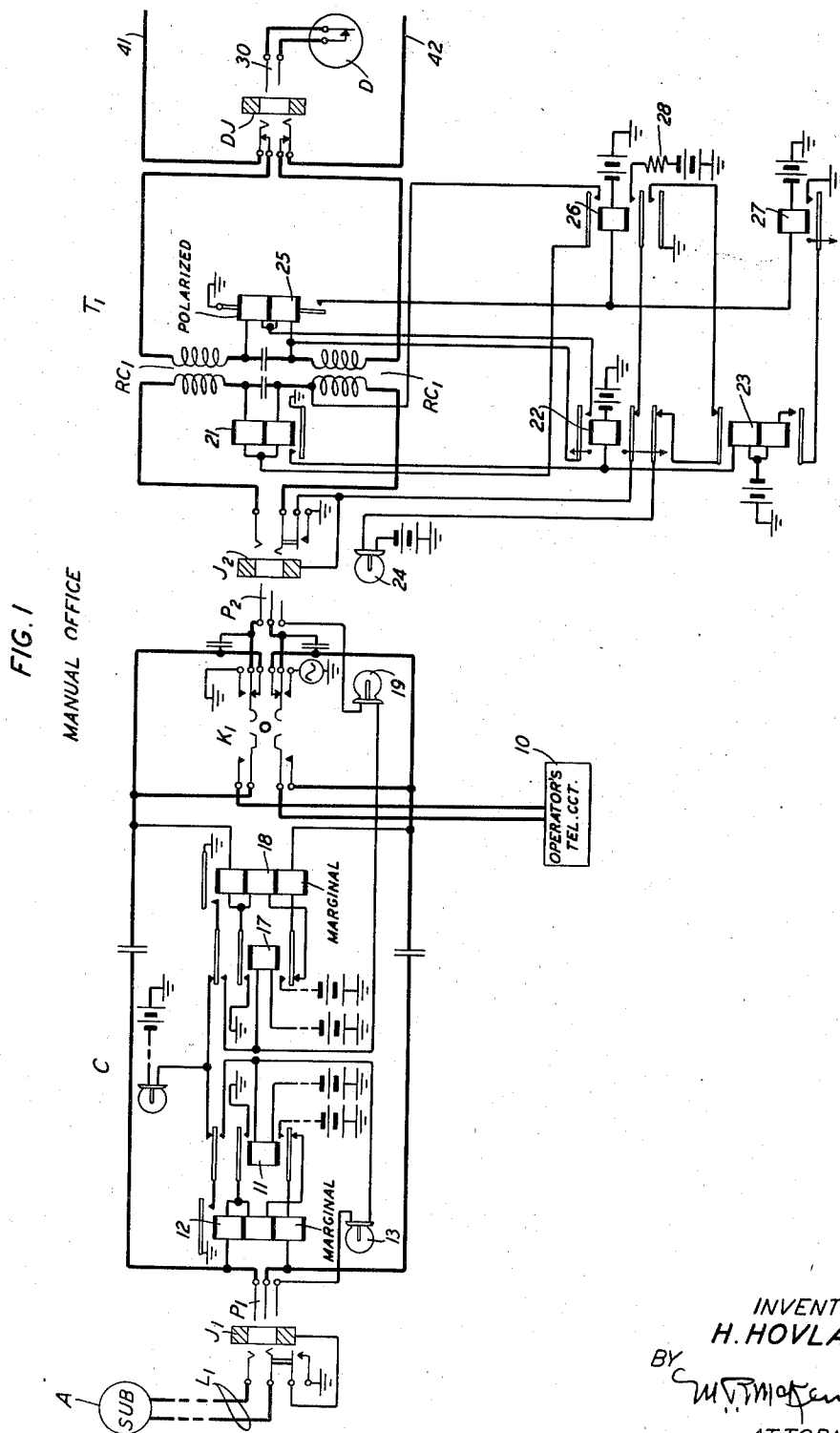
H. HOVLAND

2,165,855

TELEPHONE SYSTEM

Filed Nov. 6, 1937

3 Sheets-Sheet 1



INVENTOR
H. HOVLAND
BY *M. J. McFadden*
ATTORNEY

July 11, 1939.

H. HOVLAND
TELEPHONE SYSTEM

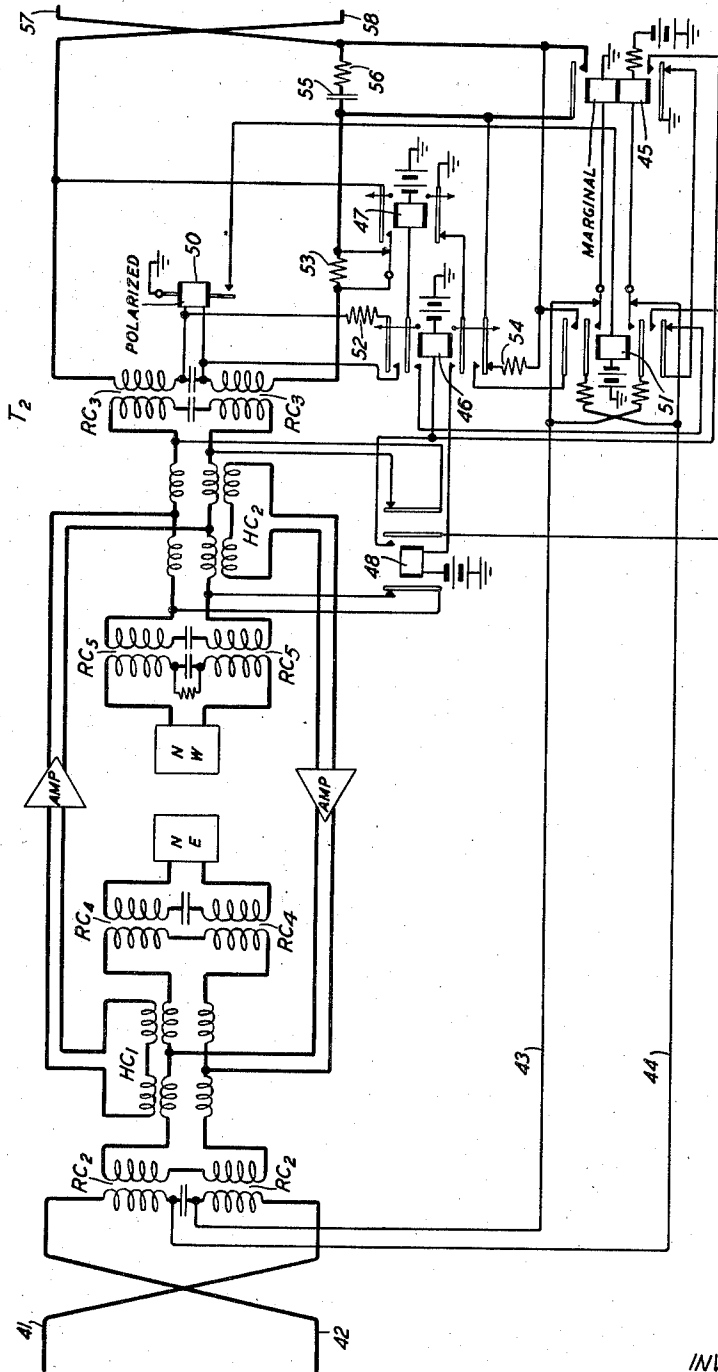
2,165,855

Filed Nov. 6, 1937

3 Sheets-Sheet 2

FIG. 2

INTERMEDIATE OFFICE



INVENTOR
H. HOVLAND
BY
W. M. McKenney
ATTORNEY

July 11, 1939.

H. HOVLAND

2,165,855

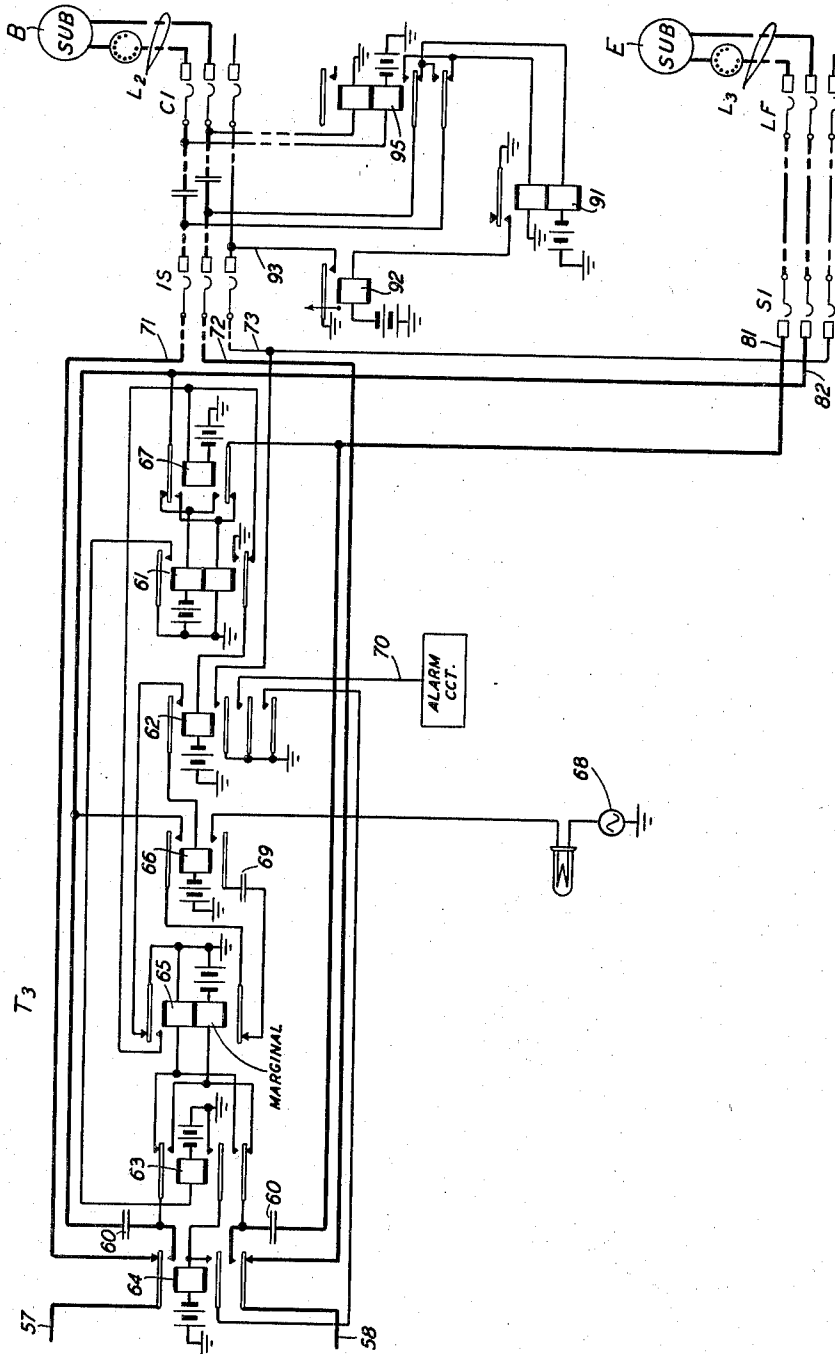
TELEPHONE SYSTEM

Filed Nov. 6, 1937

3 Sheets-Sheet 3

FIG. 3

DIAL OFFICE



INVENTOR
H. HOVLAND
BY
W. McKenney
ATTORNEY

UNITED STATES PATENT OFFICE

2,165,855

TELEPHONE SYSTEM

Henry Hovland, Williston Park, N. Y., assignor
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

Application November 6, 1937, Serial No. 173,142

8 Claims. (Cl. 179—27)

This invention relates to telephone systems and particularly to systems which include both manual and dial offices.

It is the object of the invention to facilitate the transmission of both voice and supervisory signals through an intermediate office on calls between a manual office and a dial office.

Heretofore two-way trunk circuits have been provided for interoffice traffic between manual and dial offices, a marginal relay being provided at the dial office end of a two-way trunk for receiving supervisory signals from the manual office and a polarized relay being provided in the manual office for receiving supervisory signals from the dial office. These trunk circuits have been arranged for either local or toll grade transmission. This invention is a two-way trunk circuit at an intermediate office for connecting a manual office with a dial office; the circuit comprises means for repeating impulses from the manual to the dial office, a telephone repeater for repeating voice currents in both directions, and means for repeating polarized supervisory signals from the dial to the manual office and for repeating marginal supervisory signals from the manual office to the dial office.

A feature of the invention is a two-way trunk circuit at an intermediate office for connecting a trunk from a manual office with a trunk from a dial office, a high resistance bridge normally connected across the trunk outgoing to the dial office being changed to a low resistance bridge upon seizure of the trunk from the manual office by an operator in the manual office, the maintenance of the low resistance bridge being controlled over the trunk from the dial office after the trunk from the manual office is released in the manual office.

The drawings which form a part of this specification show schematically a telephone system in which the invention is embodied; and a clear and complete understanding of the invention may be obtained from the following description of this system. It is, however, understood that the invention is not limited in its application to the particular system herein disclosed but is generally applicable to systems comprising both dial and manual offices.

Referring to the drawings:

Fig. 1 shows a manual office comprising a line L1, an operator's cord circuit C, and a two-way trunk circuit T1;

Fig. 2 shows an intermediate office comprising a two-way trunk circuit T2 and an associated two-way telephone repeater; and

Fig. 3 shows a dial office comprising the two-way trunk circuit T3, incoming selector IS, connector C1, first selector S1, line finder LF, and subscribers' lines L2 and L3.

The manual office is shown as being a local office, the line L1 being a local subscriber's station and the cord C being a local operator's cord. This office may, however, be a toll office, the line L1 being a toll line, in which case a toll operator's cord is provided and the trunk circuit T1 is arranged for use with such a cord. Each trunk circuit such as T1 terminates in one or more jacks J2 for completing calls incoming from and outgoing to the dial office. One or more jacks DJ are provided for connecting the operator's dial D to the trunk. The intermediate office may be either a toll or local office and comprises either manually or automatically operated switching equipment. The two-way trunk circuit T2 at the intermediate office is shown as directly connecting a trunk from the manual office with a trunk from the dial office; but manually or automatically operated switches could be included in this connection. The telephone repeater associated with trunk circuit T2 is of conventional type comprising hybrid coils HC1 and HC2 and two one-way thermionic amplifiers. The conductors 41 and 42 of the trunk from the manual office are connected through repeating coil RC2 to the hybrid coil HC1 and the conductors 57 and 58 of the trunk from the dial office are connected through repeating coil RC3 to hybrid coil HC2; and the balancing networks NE and NW are connected through repeating coils RC4 and RC5 to hybrid coils HC1 and HC2. To prevent singing, the repeating coils RC3 and RC5 are normally short-circuited at the back contacts of relay 48. The selector, connector and line finder switches in the dial office may be of the well-known two-motion step-by-step type; for a description of such switches and their operation reference may be had to the second edition of "Automatic Telephony" by Smith and Campbell, pages 52 to 65, inclusive, and to Patent No. 1,799,654 granted to R. L. Stokely, April 7, 1931. Each of the switches IS, S1 and LF is represented by a set of brushes and a single set of terminals; the magnets, relays and other associated apparatus are represented by the broken lines leading to the brushes of these switches. The connector C1 is represented by a set of brushes and a single set of terminals, the line relay 91, the release relay 92 and the supervisory relay 95; all other relays and operating magnets are represented by the broken lines.

Consider first the operation of the various circuits on a call originating in the manual office over line L1. The call is answered by inserting the plug P1 in jack J1, key K1 being operated to complete the talking connection between line L1 and the operator's telephone circuit 10. Relay 11 operates in a circuit through lamp 13 and the sleeve of jack J1. Relay 11 opens the connection between the lower and middle windings of relay 12 and closes a circuit through the lower and upper windings of relay 12 and the line L1. Relay 12 operates, closing a locking circuit for relay 11 which shunts and thereby prevents the lighting of supervisory lamp 13. If the called subscriber's station is in the dial office, plug P2 is inserted in the jack J2 of an idle trunk T1. A circuit is thereby closed through the winding of relay 17, lamp 19 and the sleeve of jack J2 for operating relay 17 and lighting lamp 19. Relay 20 17 opens the connection between the middle and lower windings of relay 18 and closes a circuit for operating relay 21 of trunk circuit T1; this circuit is traced from battery through the lower front contact of relay 17, lower winding of relay 25 18, ring conductors of plug P2 and jack J2, lower left winding of repeating coil RC1, both windings of relay 21, upper left winding of repeating coil RC1, tip conductors of jack J2 and plug P2, and through the upper winding of relay 13 to ground 30 at the inner upper front contact of relay 17. Relay 21 operates but the resistance of its lower winding is high enough to prevent the operation of the marginal supervisory relay 18. The operation of relay 21 closes circuits for operating relays 22 and 23, thereby preventing the lighting of line lamp 24 which is associated with jack J2 of trunk circuit T1. At its upper front contact, relay 22 short-circuits the lower high-resistance winding of polarized relay 25. Both windings of relay 25 are normally connected in series with the right windings of repeating coil RC1, conductors 41 and 42 of the trunk to the intermediate office, the left windings of repeating coil RC2, conductors 43 and 44, and the windings of marginal relay 45 of trunk circuit T2, the resistance of the lower winding of relay 25 being high enough to prevent the operation of relay 45 and the direction of current being in the non-operate direction as regards relay 25. When, however, relay 22 short-circuits the lower winding of relay 25, the current over trunk conductors 41 and 42 is increased sufficiently to cause the operation of relay 45 of trunk circuit T2 in the intermediate office. Relay 45 closes a circuit for operating the slow-to-release relay 46. Relay 46 connects resistor 52 in parallel with the winding of relay 50 and closes a circuit for operating relay 48. Resistor 52 prevents the false operation of relay 50 during the transmission of dial impulses as hereinafter described; and relay 48 opens the short circuits across the repeating coils RC3 and RC5. Normally there is a bridge, comprising the right windings of repeating coil RC3, the windings of polarized relay 50 and a high resistance 54, connected across conductors 57 and 58 of the trunk to the dial office and in series with the windings of the line relay (not shown) of the associated incoming selector IS in the dial office. The current in this normally closed circuit is insufficient to operate the line relay of the selector and is in the non-operate direction as regards relay 50. When relay 45 operates in response to seizure of the trunk circuit T1 in the manual office, as hereinbefore described, the upper front contact of relay 45 short-circuits the high resist-

ance 54, thereby increasing the current over conductors 57 and 58 sufficiently to cause the operation of the line relay of the incoming selector IS, ground potential being thereupon connected to sleeve conductor 73 in usual and well-known manner to guard against seizure of trunk T3 by any selector, such as S1, in the dial office. Dial tone is transmitted from the incoming selector over conductors 57 and 58, through repeating coil RC3, telephone repeater, repeating coil RC2, over conductors 41 and 42 through repeating coil RC1 to the calling operator in the manual office. The operator's dial D is connected through plug 30 and dial jack DJ across conductors 41 and 42, relay 25 being disconnected from these conductors while the called subscriber's number is being dialed. Relay 45 alternately releases and reoperates in response to each of the impulses created by the operation of the dial D. Being slow in releasing, relay 46 does not release during the response of relay 45 to dial impulses. The release of relay 45, in response to the first impulse of each train, closes a circuit for operating relay 47. Relay 47 is a slow-to-release relay and remains operated during the response of relay 45 to each train of impulses. The operation of relay 47 releases relay 48 so as to close the short circuits across repeating coils RC3 and RC5 during the transmission of dial impulses. At its upper contacts relay 47 short-circuits the bridge comprising the right windings of repeating coil RC3 and the winding of relay 50 in parallel with resistor 52. The resistor 53 is connected across conductors 57 and 58 to make the resistance of the impulse transmitting circuit meet the requirements for efficient impulse transmission to all of the step-by-step switches through which the connection is extended. At its upper contacts, relay 45 repeats the dial impulses received from the dial D over the conductors 57 and 58 to the line relay of the incoming selector IS. The brushes of selector IS are thereby advanced to select the required group of trunks and to hunt for and seize an idle trunk therein. After this selector has seized an idle trunk in the selected group, the impulse repeating circuit over trunk conductors 57 and 58 is extended to the line relay 91 of a connector switch C1. Relay 91 closes a circuit for operating relay 92, and relay 92 connects ground to sleeve conductor 93 and thence to the sleeve conductor 73 to guard trunk T3 against seizure on a call originating in the dial office. The connector switch C1 is selectively operated in response to the last two digits of the called subscriber's number to establish connection with the line L2 of the called station B. If the called station is idle, ringing current is transmitted to operate the ringer at station B in usual manner and, when the call is answered, relay 95 operates reversing the current over conductors 71 and 72 to cause the operation of polarized supervisory relay 50 of trunk circuit T2. Relay 50 closes a circuit for operating relay 51, thereby reversing the current over conductors 41 and 42 to cause the operation of polarized relay 25 of trunk circuit T1 in the manual office. Relay 25 closes circuits for operating relays 26 and 27. Relay 27 closes a locking circuit for relay 23 so as to prevent the lighting of lamp 24 in case the calling operator disconnects and relay 25 is being alternately operated and released by a line or trunks-busy signal. At its upper front contact relay 26 short-circuits the lower, high resistance, winding of relay 21 thereby increasing the current through the windings of the calling supervisory relay 18

sufficiently to cause its operation. The operation of relay 18 short-circuits and thereby extinguishes the calling cord supervisory lamp 19 to indicate to the operator that the called station has answered. If the called line is busy or the selector IS finds all connectors busy in the selected group, a busy tone is transmitted to the calling operator by intermittently reversing the current over conductors 57 and 58. The supervisory relays 50, 25 and 18 are thereby alternately operated and released to flash lamp 19.

When the calling operator removes plug P2 from jack J2, relays 17, 18, 21 and 22 release; but relay 23 is held operated under control of relay 27. With relay 22 released, battery is connected through resistor 28, the inner lower front contact of relay 26 and the inner lower back contact of relay 22 to the sleeve of jack J2 to make the trunk T1 test busy. The release of relay 22 opens the short circuit across the lower winding of relay 25, thereby causing the release of relays 45 and 46 of trunk circuit T2 at the intermediate office. With relays 45 and 46 released, the high resistance 54 is again connected in series with the winding of relay 50 across trunk conductors 57 and 58, thereby causing the release of relays 61 and 62 of the connector C1. The release of relay 62 disconnects ground from sleeve conductor 63, causing the return of selector IS to normal in usual and well-known manner. When the called subscriber returns the instrument to normal, relay 95 releases and the connector switch C1 is returned to normal in usual and well-known manner. When the selector IS returns to normal, relays 50 and 51 of trunk circuit T2 are released. The release of relay 51 causes the release of relays 25, 26, 27 and 23 of trunk circuit T1. Release of relay 26 disconnects the guarding potential from the sleeve of jack J2.

On a call from the dial office to the manual office, the line L3 of a calling station such as E is connected by the operation of a line finder switch LF, to a first selector S1. The selector S1 responds to the dialing of the first digit of the called number to select an idle trunk such as T3. Upon extension of the connection through switches LF and S1 to the trunk T3, relay 61 operates. Relay 61 closes circuits for operating relays 62 and 63. Relay 62 closes a circuit for operating relay 66, connects ground to conductor 70 to operate an alarm circuit in case a permanent signal condition exists, and connects ground to conductor 73 to hold the switches S1 and LF, and to guard the trunk T3 against seizure by another first selector. Relay 63 closes a circuit for operating relay 64. Relay 64 locks under control of relay 62 and connects trunk conductors 57 and 58 to the windings of marginal relay 65, thereby causing the operation of polarized relay 50 of trunk circuit T2. Relay 50 closes the circuit for operating relay 51. Relay 51 reverses the current over conductors 41 and 42, thereby operating relay 25 of trunk circuit T1 in the manual office. Relay 25 closes the circuits for operating relays 26 and 27. Relay 26 closes the circuit for lighting trunk lamp 24. A ringing signal is given the calling subscriber by connecting the ringing source 68 through contacts of relays 65 and 66, and condenser 69 to conductor 82.

When the call is answered, by inserting a plug P1 in jack J2, relays 11, 12, 21, 22 and 23 operate. Lamp 24 is extinguished and lamp 13 is not energized. Operation of key K1 to the talking position completes the connection between the operator's telephone circuit 10 and the calling

station E in the dial office, and the operator further extends the call as required, for instance, by inserting plug P2 in the jack J1 of a subscriber's line. The operation of relay 22 short-circuits the lower winding of relay 25, to cause the operation of marginal relay 45 of trunk circuit T2. Relay 45 closes the circuit for operating relay 46; and closure of the low resistance bridge across conductors 57 and 58 causes the operation of marginal relay 65 of trunk circuit T3. Relay 66 thereupon releases, opening the ringing tone circuit; and relay 67 operates to reverse the current over conductors 81 and 82. The talking connection includes condensers 60.

If the answering operator disconnects before the instrument is returned to normal at the calling station E, relays 11, 12, 21 and 22 release but relay 23 is held by relay 27 to prevent lighting lamp 24. When the instrument at station E is returned to normal, relays 61 and 63 release but relay 62 is held operated under control of relay 65. The release of relay 63 reverses the current over conductors 57 and 58, to cause the successive release of relays 50, 51, 25, 26, 27 and 12, thereby lighting lamp 13 as a disconnect signal. As soon as the plug P1 is disconnected from jack J2, relays 11, 21, 22, 23 of trunk circuit T1 release. The release of relay 22 opens the short circuit around the lower winding of relay 25, thereby causing the release of relays 45 and 46 of trunk circuit T2. The release of relays 45 and 46 changes the bridge across trunk conductors 57 and 58 to include the high resistance 54, thereby causing the release of relays 65, 67, 62 and 64 of trunk circuit T3. The release of relay 62 disconnects the guarding ground potential from conductor 73 so that trunk T3 may again be selected for use on a call originating in the dial office.

What is claimed is:

1. In a telephone system, a manual office, a dial office, an intermediate office, and a two-way trunk circuit at said intermediate office connecting said manual and dial offices, said trunk circuit comprising means for repeating talking current, means for repeating selective impulses to the dial office, and means for repeating supervisory signals in both directions.

2. In a telephone system, a trunk circuit interconnecting a manual office and a dial office, means in said trunk circuit for amplifying and repeating voice currents in both directions, means in said trunk circuit for repeating selective signals from said manual office to said dial office, means in said trunk circuit for repeating marginal supervisory signals from the manual office to the dial office, and means in said trunk circuit for repeating polarized supervisory signals from the dial office to the manual office.

3. In a telephone system, a manual office, a dial office, means comprising a two-way trunk circuit in said manual office, a two-way trunk circuit in said dial office, and a two-way trunk circuit at an intermediate point for use in connecting a calling line in either of said offices with a called line in the other of said offices, said intermediate two-way trunk circuit comprising means for amplifying and repeating talking current in both directions, means for repeating selective signals from the manual office to the dial office, and means for repeating supervisory signals in both directions.

4. In a telephone system, a manual office, a dial office, a two-way trunk circuit in said manual office for use in completing calls to and from said dial office, a two-way trunk circuit in said

dial office for use in completing calls to and from said manual office, another two-way trunk circuit interconnecting the first-mentioned two-way trunk circuit with the second-mentioned two-way trunk circuit, means in said trunk circuits for transmitting selective impulses from the manual office to the dial office, means in said trunk circuits for transmitting voice currents in both directions, means in said trunk circuits for transmitting marginal supervisory signals from the manual to the dial office, and means in said trunk circuits for transmitting polarized supervisory signals from the dial to the manual office.

5. In a multi-office telephone system, a two-way trunk circuit in a first office, a two-way trunk circuit in a second office, another two-way trunk circuit interconnecting the first-mentioned two-way trunk circuit with the second-mentioned two-way trunk circuit, means in each of said trunk circuits for repeating voice currents from a line in either one of said offices to a line in the other of said offices, means in the first-mentioned trunk circuit for transmitting selective signals and marginal supervisory signals to the third-mentioned trunk circuit, means in the second-mentioned trunk circuit for transmitting polarized supervisory signals to the third-mentioned trunk circuit, and means in the third-mentioned trunk circuit for repeating the selective signals received from the first-mentioned trunk circuit, and for repeating the supervisory signals from each of the first-mentioned and second-mentioned trunk circuits.

6. In a telephone system, a manual office, a dial office, an intermediate office, and means comprising a trunk between said manual and intermediate offices, a trunk between said dial and

intermediate offices, and a two-way trunk circuit at said intermediate office for connecting said manual and dial offices, said trunk circuit comprising a high resistance bridge across the trunk to the dial office, means responsive to seizure of the first-mentioned trunk by an operator in the manual office for changing said high resistance bridge to a low resistance bridge, and means controlled over the trunk from the dial office for maintaining said low resistance bridge after the operator releases said first-mentioned trunk.

7. In a telephone system, a manual office, a dial office, a trunk circuit in said manual office, a trunk circuit in said dial office, and a trunk circuit interconnecting the first-mentioned and second-mentioned trunk circuits, each of said trunk circuits being arranged to repeat voice currents in both directions, the first-mentioned trunk circuit being arranged to transmit selective signals and marginal supervisory signals to, and receive polarized supervisory signals from, the third-mentioned trunk circuit, the second-mentioned trunk circuit being arranged to transmit polarized supervisory signals to, and receive marginal supervisory signals from, the third-mentioned trunk circuit, and the third-mentioned trunk circuit being arranged to repeat selective signals and marginal supervisory signals from the first-mentioned trunk circuit to the second-mentioned trunk circuit and to repeat polarized supervisory signals from the second-mentioned trunk circuit to the first-mentioned trunk circuit.

8. In a telephone system according to claim 7, means in said third-mentioned trunk circuit for amplifying the voice currents.

HENRY HOVLAND.