Dec. 30, 1941. T. F. CROCKER 2,268,019

TELEPHONE SYSTEM

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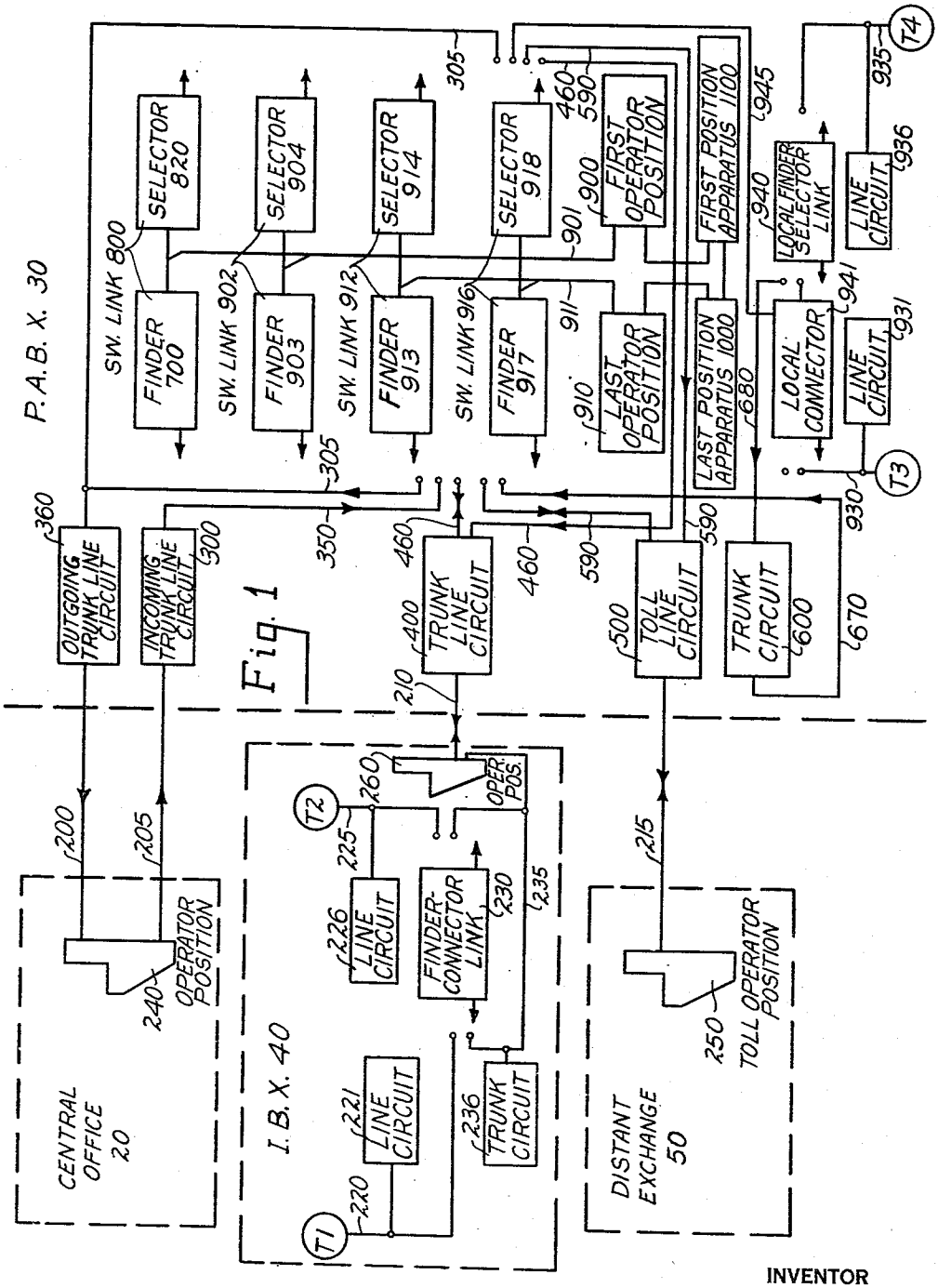


Fig. 1

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TELEPHONE SYSTEM

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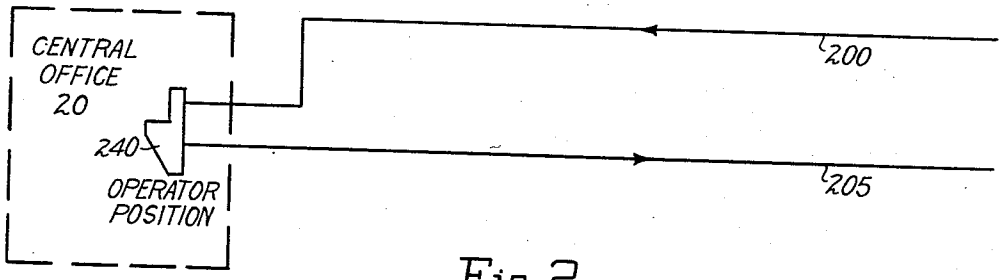


Fig. 2

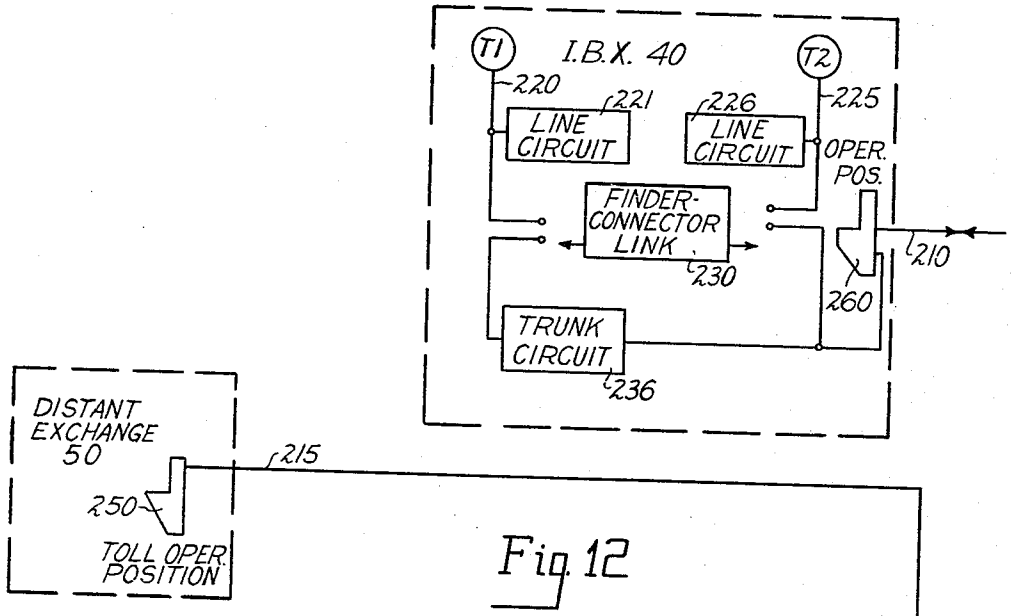
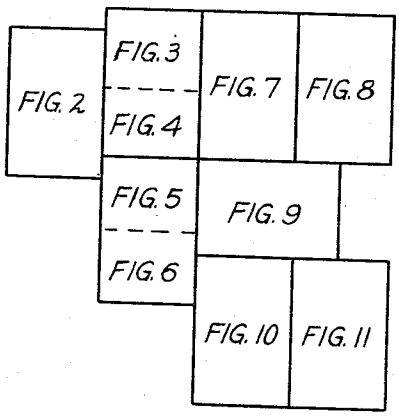


Fig. 12



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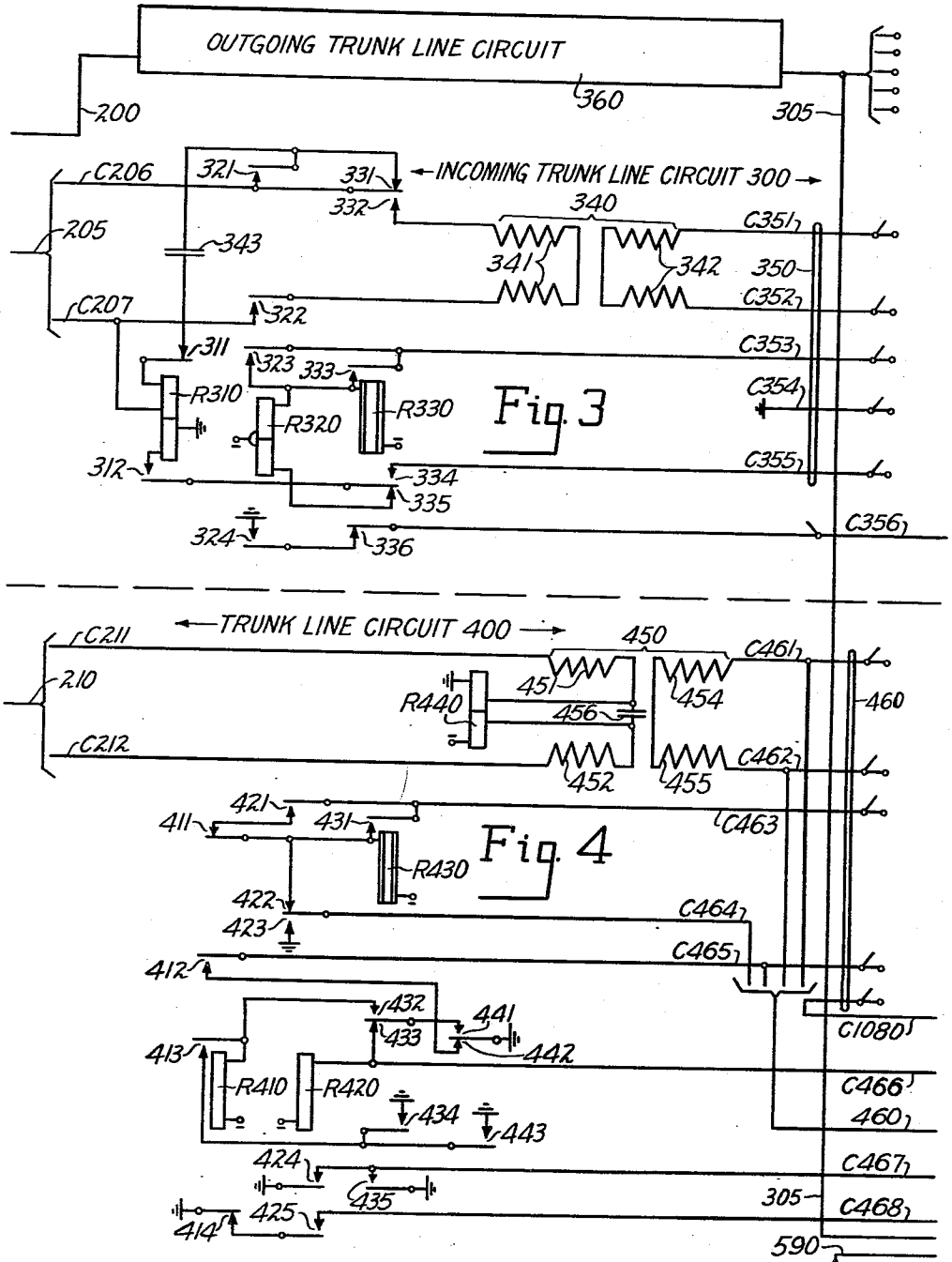


Fig. 3

Fig. 4

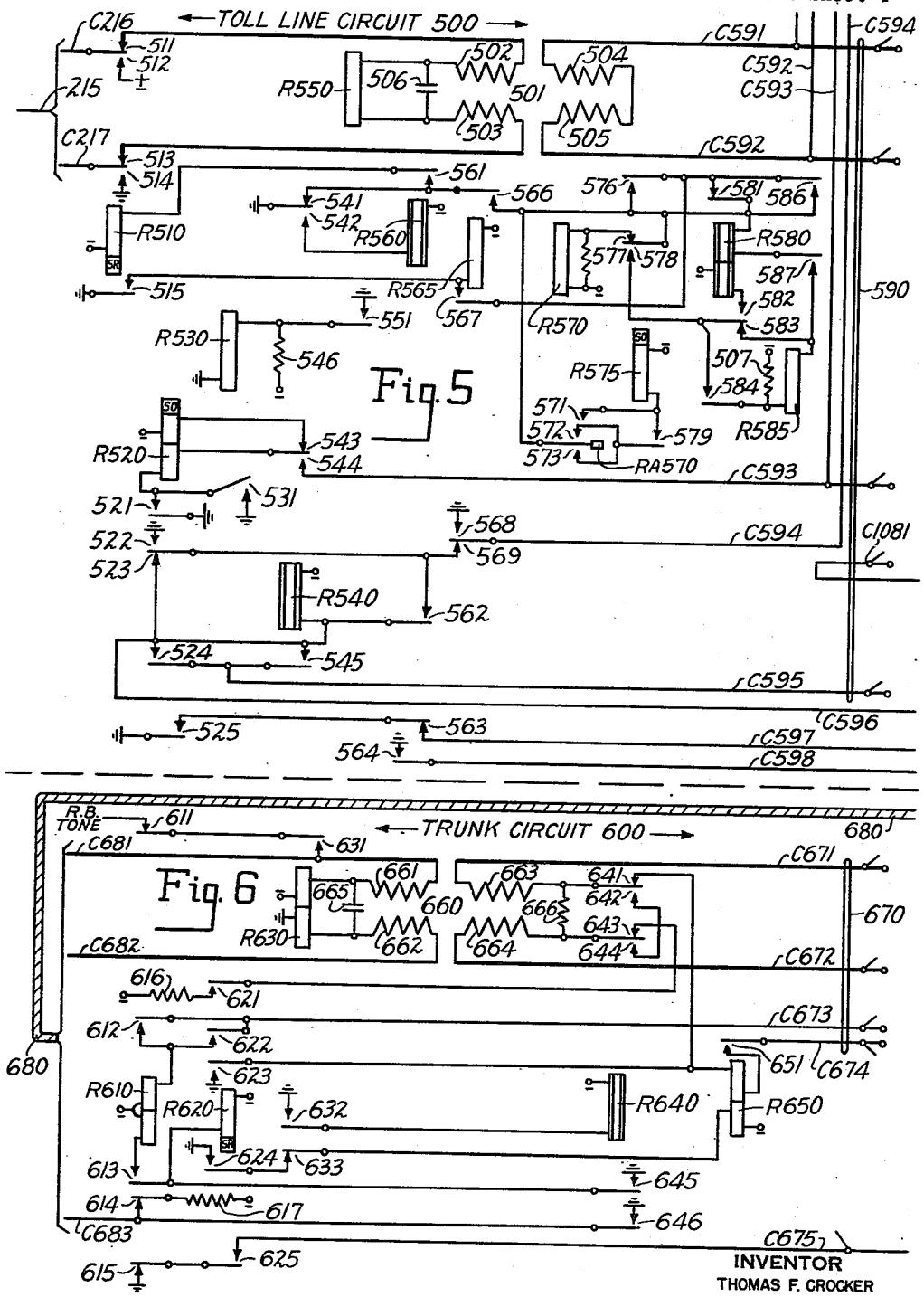
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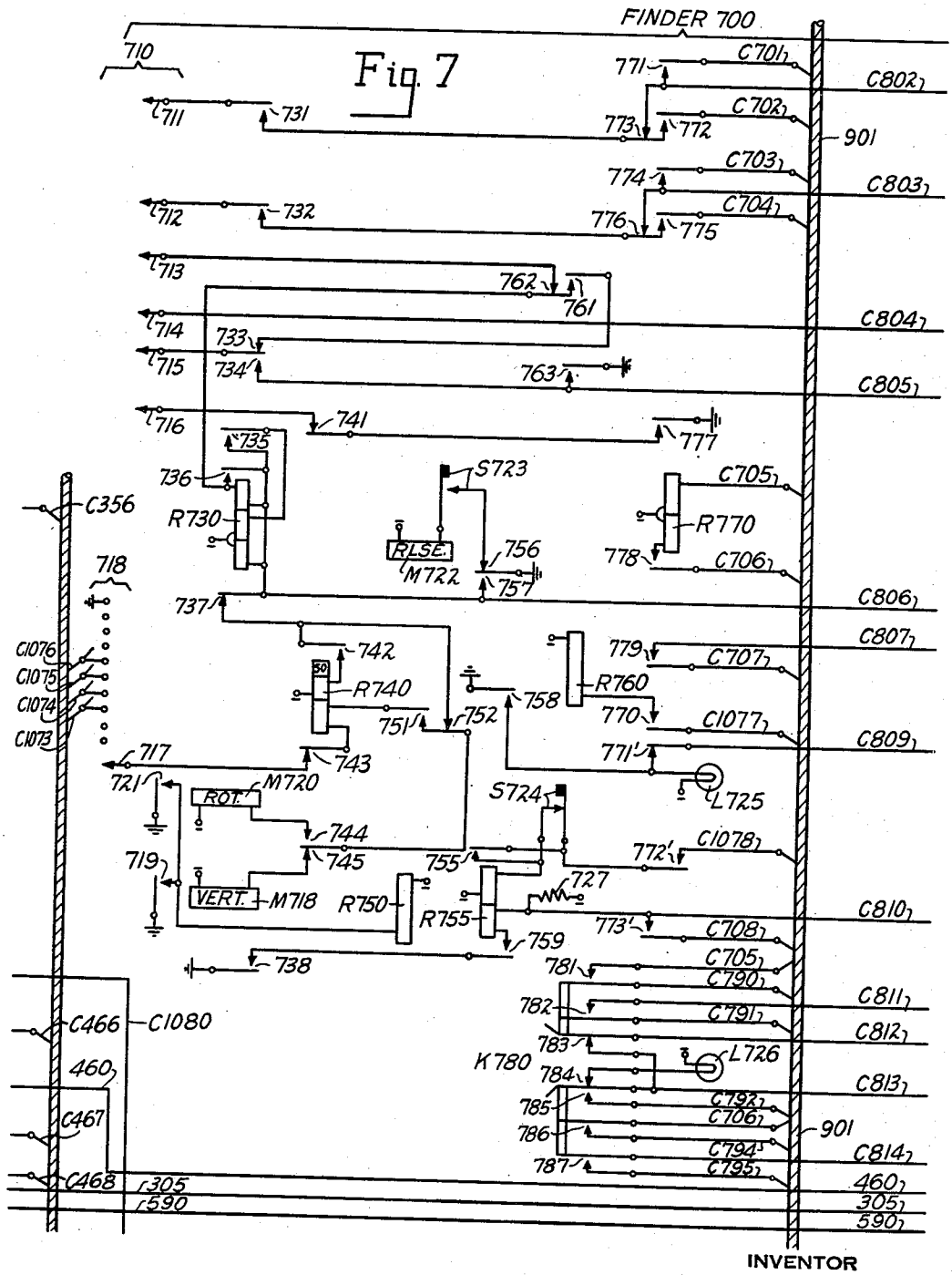
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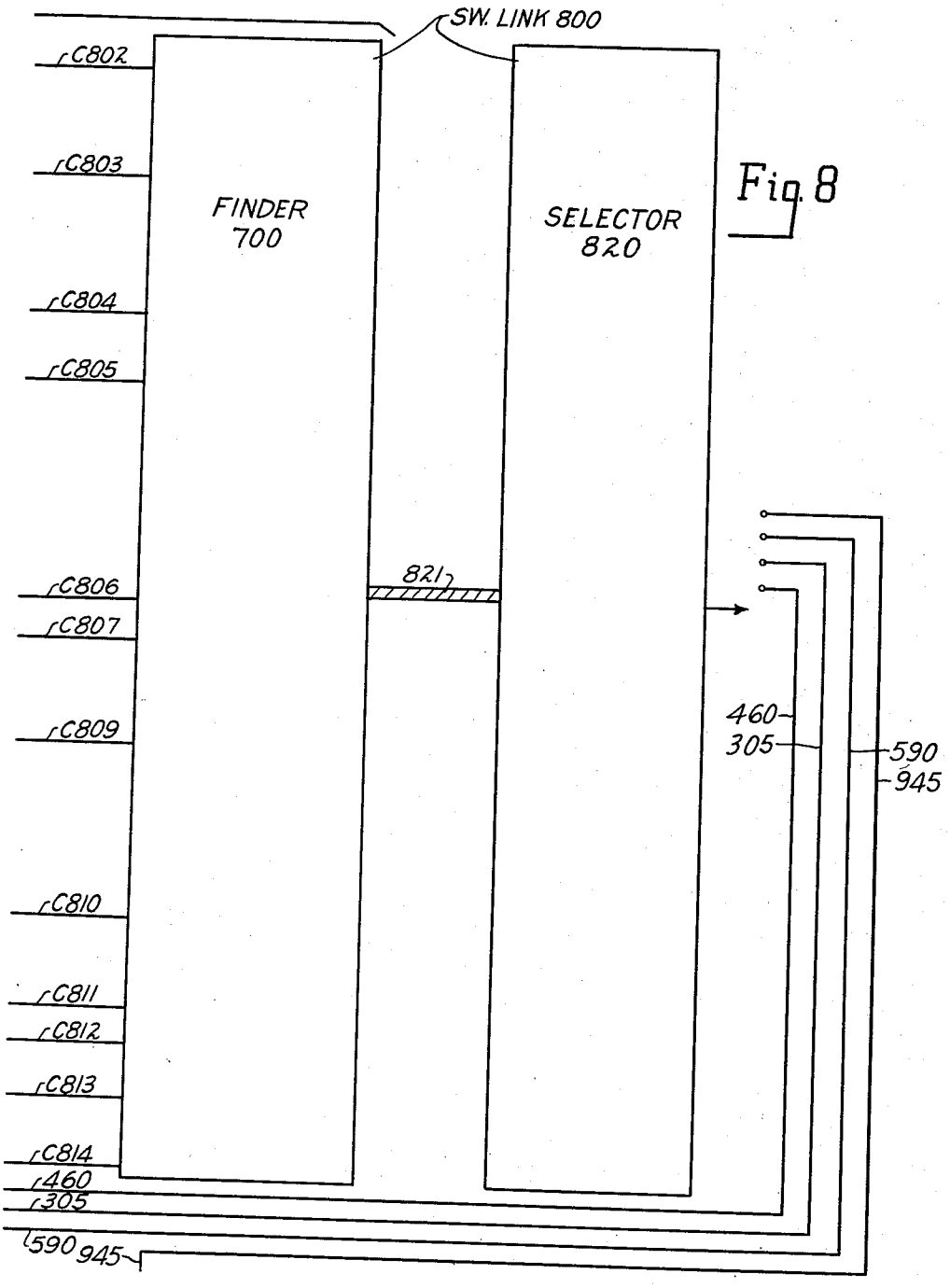


Fig. 8

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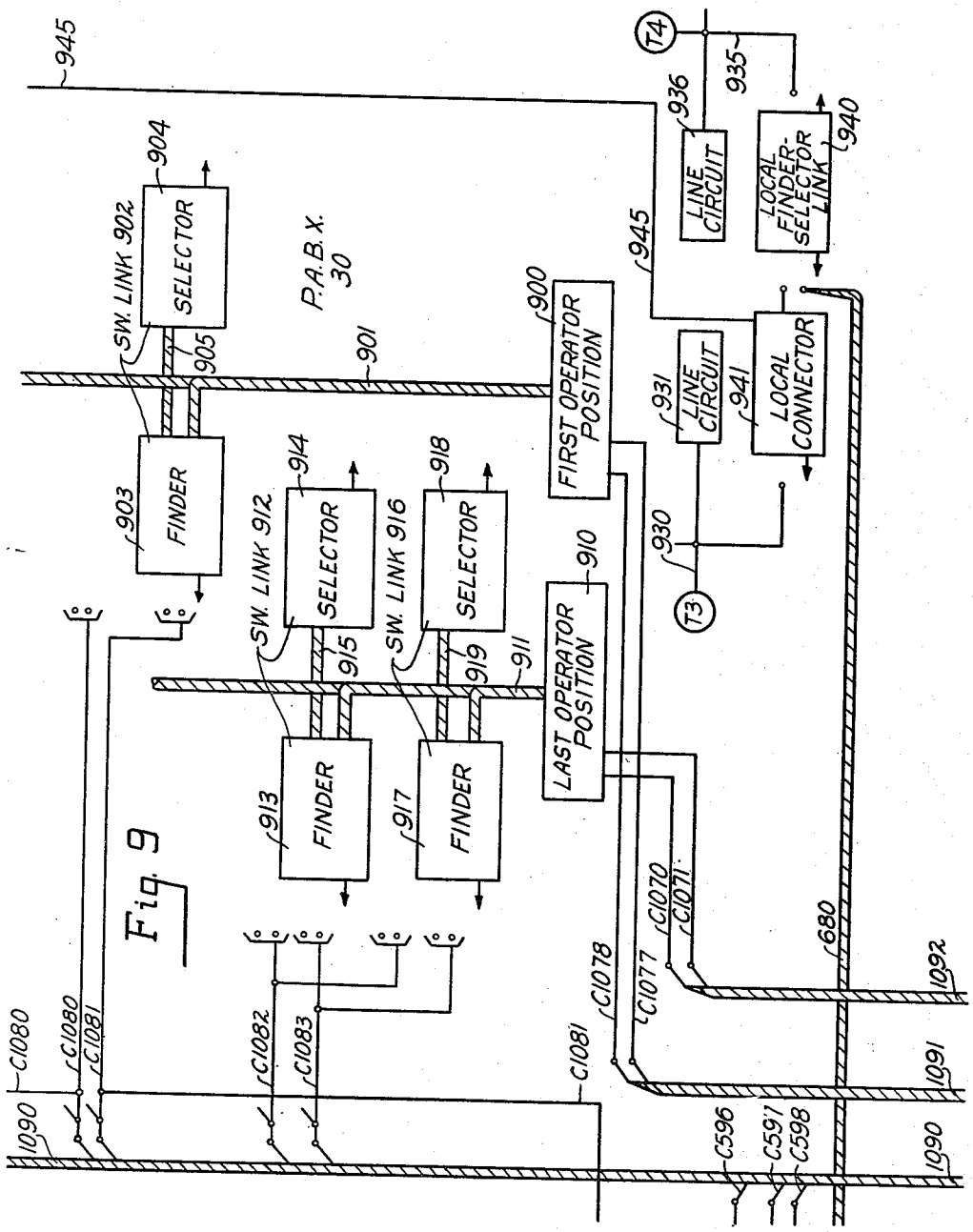


Fig. 9

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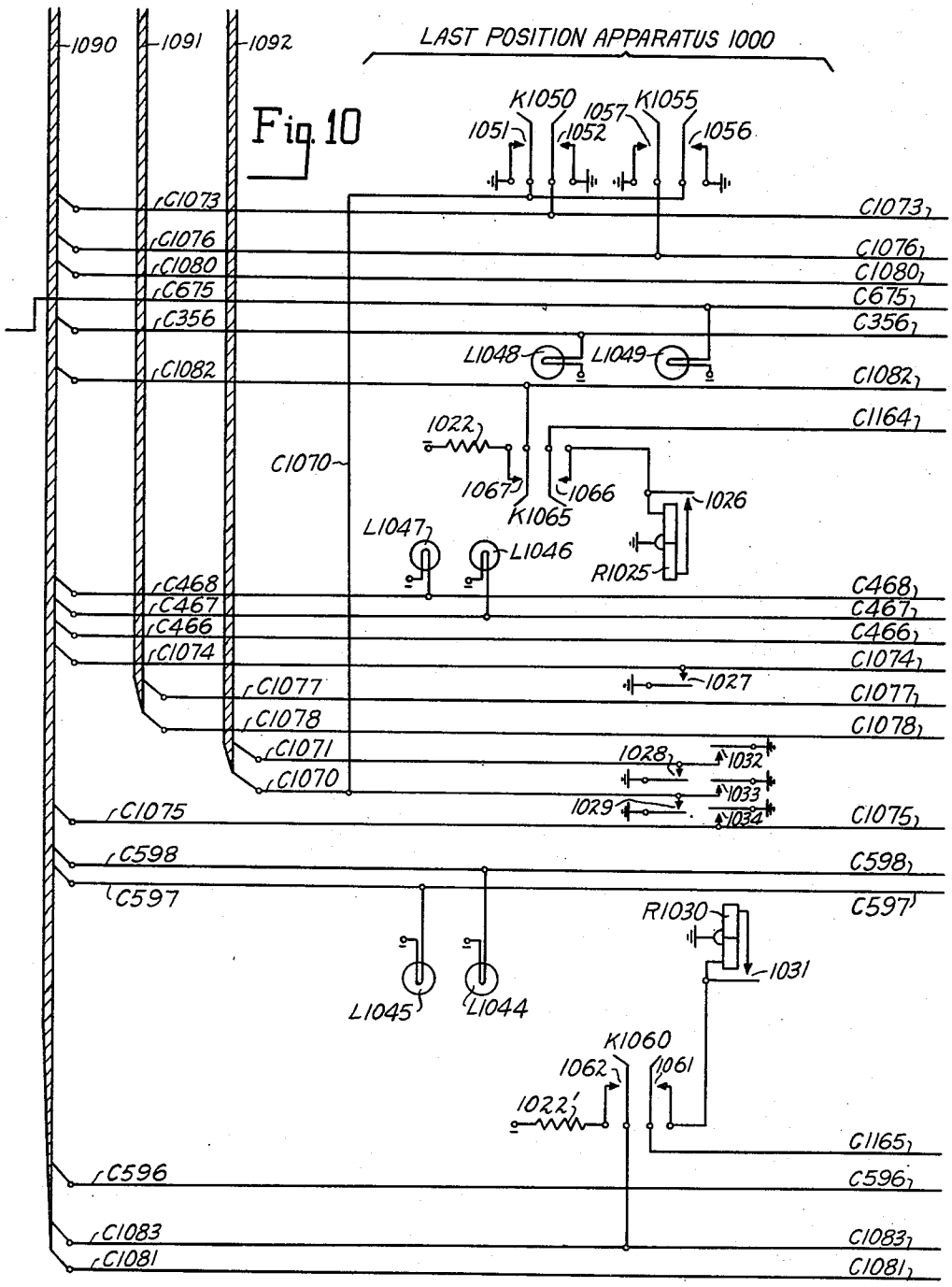
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TELEPHONE SYSTEM

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Fig. 10



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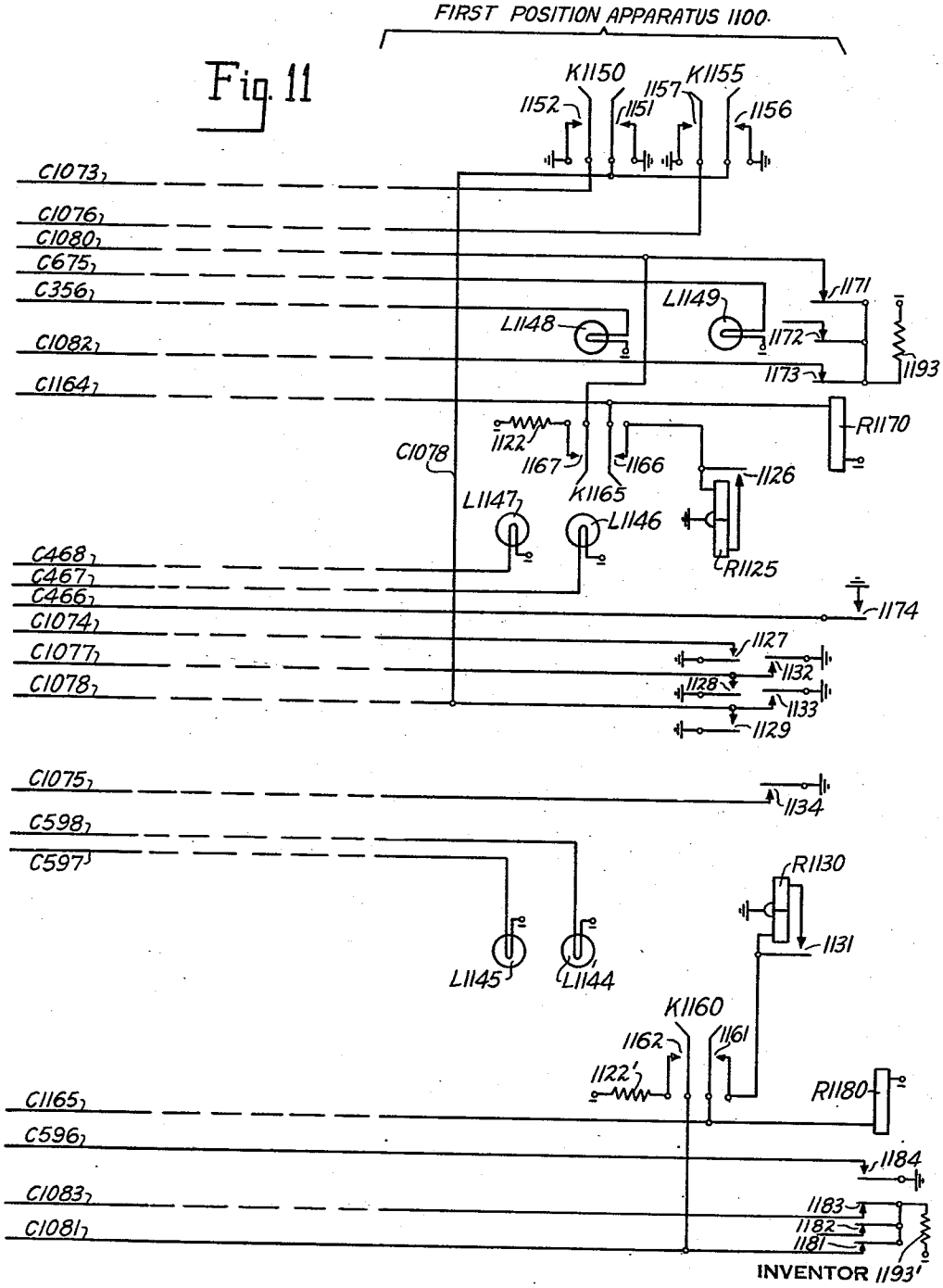
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TELEPHONE SYSTEM

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Fig. 11



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Patented Dec. 30, 1941

2,268,019

UNITED STATES PATENT OFFICE

2,268,019

TELEPHONE SYSTEM

Thomas F. Crocker, Chicago, Ill., assignor to Associated Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

Application June 8, 1940, Serial No. 339,431

13 Claims. (Cl. 179—27)

The present invention relates to telephone systems and more particularly to improved automatic switching apparatus of the character of that disclosed and claimed in U. S. Patent No. 2,070,874, John H. Voss and Thomas F. Crocker, issued February 16, 1937, which apparatus is connected and arranged to handle switchboard traffic.

It is the principal object of the present invention to provide, at an operator switchboard position in a telephone system, improved position equipment of the character of that disclosed and claimed in the copending application of Smart S. McAndrew, Serial No. 339,475, filed June 8, 1940, in order to facilitate the answering of calls and the extension and supervision of established connections at the operator switchboard position in a ready and efficient manner.

A further and more specific object of the invention is to provide, at a number of operator switchboard positions in a telephone system, improved position equipment which is so connected and arranged that automatic switches individually associated with the operator switchboard positions may be selectively controlled to select lines accessible thereto without interfering in any way with each other in the selection of the lines.

The invention is illustrated as being embodied in a telephone system comprising a central office of any suitable type, a private automatic branch exchange or P. A. B. X, an intermediate branch exchange or I. B. X of the automatic type and a distant exchange of any suitable type. A switchboard is arranged in the P. A. B. X which comprises a number of operator positions. Further a toll switch train is arranged in the P. A. B. X which comprises a number of groups of switching links individually associated with the operator positions, each switching link including an answer switch and a call switch, the answer switch and the call switch of each switching link having access to trunk lines and toll lines interconnecting the central office, the I. B. X and the distant exchange with the P. A. B. X.

In accordance with one feature of the invention, the telephone system comprises a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with the operator positions and having access to the lines, normally effective means selectively controllable from each of the operator positions for causing the associated switch to operate and select any particular one of the lines thereby to complete a connection between the operator position and the last-mentioned line, and means controlled while one of the switches is operating to select a given line for restricting the operation of each of the other of the switches, whereby each of the other of the switches is operative to select any particular one of the lines excepting the given line while the one switch is operating to select the given line.

In accordance with another feature of the invention, the system comprises a plurality of devices at each of the operator positions individually corresponding to the lines, the devices at the operator positions corresponding to the same line constituting a group, a plurality of relays individually associated with the devices, the relays associated with the same group of devices constituting a group, means responsive to the first device operated in any given group of devices for causing operation of the associated relay in the associated group of relays and for preventing operation of the remainder of the relays in the associated group of relays, and means responsive to the operation of any given relay in any given group of relays for causing the associated switch to operate and select the corresponding line, thereby to complete a connection between the associated operator position and the last-mentioned line. More particularly, any given relay in any given group of relays is operative to mark the corresponding line and to initiate operation of the associated switch, means being provided which is controlled when one of the switches selects a marked line for arresting operation of the switch. More specifically, the relays are of the marginal type and are so connected and arranged that, when any given relay in any given group of relays is energized, it completes a locking circuit for itself which prevents adequate energization of the remainder of the relays in the given group of relays and consequently operation of the remainder of the relays in the given group of relays.

Further features of the invention pertain to the particular arrangement of the circuit elements of the system, whereby the above-outlined and additional operating features are attained.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings in which Figure 1 illustrates the general arrangement of a telephone system embodying the pres-

ent invention; Figs. 2 to 11, inclusive, taken together, illustrate the details of a system having incorporated therein the features of the invention, as briefly outlined above; and Fig. 12 illustrates the mode of combining Figs. 2 to 11, inclusive, to form a unified system.

Description of the apparatus incorporated in the telephone system

Referring now more particularly to Fig. 1 of the drawings the telephone system there illustrated comprises a central office **20**, a P. A. B. X **30**, an I. B. X **40** and a distant exchange **50**. The central office **20** and the distant exchange **50** are of any well-known type, each serving a number of subscriber substations not shown; while the P. A. B. X **30** and the I. B. X **40** are of the automatic type, each serving a number of automatic subscriber substations. More particularly, the P. A. B. X **30** serves a number of subscriber substations, including the subscriber substations T3 and T4; while the I. B. X **40** serves a number of subscriber substations, including the subscriber substations T1 and T2. The central office **20** and the P. A. B. X **30** are interconnected by a group of one-way trunk lines, including the trunk line **205**, extending from the central office **20** to the P. A. B. X **30**, and a group of one-way trunk lines, including the trunk line **200**, extending from the P. A. B. X **30** to the central office **20**. The I. B. X **40** and the P. A. B. X **30** are interconnected by a group of two-way trunk lines, including the trunk line **210**, extending therebetween; while the distant exchange **50** and the P. A. B. X **30** are interconnected by a group of two-way toll lines, including the toll line **215**, extending therebetween.

The central office, **20** the I. B. X **40** and the distant exchange **50** respectively comprise an operator position **240**, an operator position **260**, and a toll operator position **250**; while the P. A. B. X **30** comprises an automatic dial switchboard provided with a number of operator positions, including a first operator position **900** and a last operator position **910**. Each trunk line in the group of trunk lines extending from the central office **20** to the P. A. B. X **30** terminates at the operator position **240** in the central office **20** and in an incoming trunk line circuit in the P. A. B. X **30**, the trunk line **205** terminating at the operator position **240** and in the incoming trunk line circuit **300**. Similarly, each trunk line in the group of trunk lines extending from the P. A. B. X **30** to the central office **20** terminates in an outgoing trunk line circuit in the P. A. B. X **30** and at the operator position **240** in the central office **20**, the trunk line **200** terminating in the outgoing trunk line circuit **360** and at the operator position **240**. Also, each trunk line in the group of trunk lines extending between the I. B. X **40** and the P. A. B. X **30** terminates in a trunk line circuit in the P. A. B. X **30**, and at the operator position **260** in the I. B. X **40**, the trunk line **210** terminating in the trunk line circuit **400** and at the operator position **260**. Finally, each toll line in the group of toll lines extending between the distant exchange **50** and the P. A. B. X **30** terminates at the operator position **250** in the distant exchange **50** and in a toll line circuit in the P. A. B. X **30**, the toll line **215** terminating at the operator position **250** and in the toll line circuit **500**.

The I. B. X **40** is provided with a switch train comprising a number of finder-connector links, including the finder-connector link **230**. Also, a telephone line having a line circuit individually associated therewith extends to each of the subscriber substations in the I. B. X **40**, the telephone lines **220** and **225** respectively extending to the subscriber substations T1 and T2 and having the line circuits **221** and **226** respectively associated therewith. Finally, a number of trunk circuits are provided in the I. B. X **40** which are individually associated with trunks terminating at the operator position **260** in the I. B. X **40**, the trunk circuit **236** being individually associated with the trunk **235** terminating at the operator position **260**. It is noted that each finder-connector link in the I. B. X **40** has access to each telephone line therein and to each trunk terminating at the operator position **260**.

The P. A. B. X **30** is provided with a local switch train comprising a number of local finder-selector links, including the local finder-selector link **940**, and a number of local connectors, including the local connector **941**. Also, telephone lines having line circuits individually associated therewith extend to each subscriber substation in the P. A. B. X **30**, the telephone lines **930** and **935** respectively extending to the subscriber substations T3 and T4 and having the line circuits **931** and **936** respectively associated therewith. A number of trunk circuits, including the trunk circuit **600**, is provided in the P. A. B. X **30**. It is noted that each of the local finder-selector links has access to each telephone line in the P. A. B. X **30**, to each local connector and to a number of trunks individually extending to the trunk circuits, the trunk **680** individually extending to the trunk circuit **600**.

Further the P. A. B. X **30** is provided with a toll switch train comprising a number of groups of switching links individually associated with the operator positions, one of the groups, including the switching links **800** and **902**, being individually associated with the first operator position **900**, and another of the groups, including the switching links **912** and **916**, being individually associated with the last operator position **910**. Each of the switching links comprises a finder and a selector, the switching links **800**, **902**, **912** and **916** respectively comprising the finders **700**, **903**, **913** and **917** and the selectors **820**, **904**, **914** and **918**. Also it is noted that each of the switching links in the group, including the switching links **800** and **902**, is commonly associated with a cable **901** extending to the first operator position **900**; while each of the switching links in the group, including the switching links **912** and **916**, is commonly associated with a cable **911** extending to the last operator position **910**.

It is noted that each of the finders has access to a group of trunks individually extending to the group of outgoing trunk line circuits, this group including the trunk **305** extending to the outgoing trunk line circuit **360**; to a group of trunks individually extending to the group of incoming trunk line circuits, this group including the trunk **350** extending to the incoming trunk line circuit **300**; to a group of trunks individually extending to the group of trunk line circuits, this group including the trunk **460** extending to the trunk line circuit **400**; to a group of trunks individually extending to the group of toll line circuits, this group including the trunk **590** extending to the toll line circuit **500**; and to a group of trunks individually extending to the group of trunk circuits, this group including the trunk **670** extending to the trunk circuit **600**. Similarly, each of the selectors has access to the group of trunks individually extending to the group of outgoing

trunk line circuits, this group including the trunk 305 extending to the outgoing trunk line circuit 360; to the group of trunks individually extending to the group of trunk line circuits, this group including the trunk 460 extending to the trunk line circuit 400; to the group of trunks individually extending to the group of toll line circuits, this group including the trunk 590 extending to the toll line circuit 500; and to a group of trunks individually extending to the local connectors in the local switch train, this group including the trunk 945 extending to the local connector 941.

Each operator position at the switchboard in the P. A. B. X 30 comprises position equipment including position apparatus, the position equipment provided at the first operator position 900 and at the last operator position 910 respectively including the first position apparatus 1100 and the last position apparatus 1000.

The operator position 240 in the central office 20, as best shown in Fig. 2, the operator position 260 in the I. B. X 40, as best shown in Fig. 2, and the toll operator position 250 in the distant exchange 50, as best shown in Fig. 2, are connected and arranged in a conventional manner. Also the subscriber substations T1 and T2 in the I. B. X 40, as best shown in Fig. 2, comprise conventional substation equipment; while the line circuits and trunk circuits respectively associated with the telephone lines and the trunks in the I. B. X 40, as best shown in Fig. 2, are connected and arranged in a conventional manner. Further the finder-connector links in the switch train in the I. B. X 40, as best shown in Fig. 2, are connected and arranged in a conventional manner; preferably, each of these links comprising a finder and a connector of the well-known Strowger type.

Preferably, each of the outgoing trunk line circuits is identical to the outgoing trunk line circuit 360, shown in Fig. 3, which is connected and arranged in a conventional manner; while each of the incoming trunk line circuits is identical to the incoming trunk line circuit 300, shown in Fig. 3. The incoming trunk line circuit 300 comprises a repeater 340 and a number of relays, including a ring-up relay R310, a start relay R320 and a cutoff relay R330, connected and arranged in a manner more fully described subsequently.

Preferably, each of the trunk line circuits is identical to the trunk line circuit 400, shown in Fig. 4, which comprises a repeater 450 and a number of relays, including a control relay R410, a start relay R420, a cutoff relay R430 and a line relay R440, connected and arranged in a manner more fully described subsequently.

Preferably, each of the toll line circuits is identical to the toll line circuit 500, shown in Fig. 5, which comprises a repeater 501 and a number of relays, including a ring-off relay R510, a start relay R520, two control relays R530 and R560, a cutoff relay R540, a ring-up relay R550, a guard relay R565, a timer relay R570, a hold relay R575 and two count relays R580 and R585, connected and arranged in a manner more fully described subsequently.

Preferably, each of the trunk circuits is identical to the trunk circuit 600, shown in Fig. 6, which comprises a repeater 660 and a number of relays, including a cutoff relay R610, a start relay R620, a line relay R630, a hold relay R640 and a recall relay R650, connected and arranged in a manner more fully described subsequently.

The subscriber substations T3 and T4 in the P. A. B. X 30, as best shown in Fig. 9, comprise conventional substation equipment; while the line circuits associated with the telephone lines in the P. A. B. X 30, as best shown in Fig. 9, are connected and arranged in a conventional manner. Further the local finder-selector links and the local connectors in the local switch train in the P. A. B. X 30, as best shown in Fig. 9, are connected and arranged in a conventional manner; preferably, each of the local finder-selector links comprising a local finder and a local selector, the local finders, the local selectors and the local connectors being of the well-known Strowger type.

Preferably, each of the switching links 800, 902, 912, 916, etc., shown in Figs. 7, 8 and 9, are identical, each of these switching links comprising a finder and a selector. The finder of each switching link, such as the finder 700, shown in Figs. 7 and 8, of the switching link 800, is connected and arranged in a manner substantially identical to that of the finder shown in Fig. 7, part 1 and Fig. 7, part 2 of the previously mentioned Voss and Crocker patent; while the selector of each switching link, such as the selector 820, shown in Fig. 8, of the switching link 800, is connected and arranged in a manner substantially identical to that of the selector shown in Fig. 8 of the previously mentioned Voss and Crocker patent. More particularly, the finder 700 comprises a switching mechanism 710 of the Strowger type, including a main wiper set provided with a number of wipers 711 to 716, inclusive, and capable of both vertical and rotary movements, and an associated main contact bank, including ten vertical levels of contact sets arranged in circumferentially spaced-apart relationship. Also the mechanism 710 includes a vertical control wiper 717, capable of vertical movement, and an associated vertical control contact bank 718. The mechanism 710 is provided with a vertical magnet M718 for moving the wiper set thereof in the vertical direction, a rotary magnet M720 for moving the wiper set thereof in the rotary direction and a release magnet M722 for releasing the wiper set thereof and for causing the wiper set thereof to be returned to its normal position. Finally the switching mechanism 710 has a number of sets of switch springs S723 and S724 operatively associated therewith, which are controlled in accordance with the movements of the wiper set thereof, in a manner more fully described subsequently.

Further the finder 700 comprises a group of relays, including a switching relay R730, a transfer relay R740, a step relay R750, a start relay R755, a test relay R760 and a connect relay R770, connected and arranged in a manner more fully described subsequently. Moreover, the finder 700 has individually associated therewith a link listening or talk key K780 and a monitor key, not shown, which are operative to associate the finder 700 with the cable 901 extending to the first operator position 900. Finally, a number of supervisory lamps L725 and L726 are associated with the finder 700 for supervisory purposes.

Each operator position at the switchboard in the P. A. B. X 30, such as the first operator position 900 and the last operator position 910, shown in Fig. 9, comprises position equipment including a trunk circuit, a telephone instrument, key sender apparatus, a number of control keys operative selectively to render different types of services over connections established at the operator position, and position apparatus. More particularly, the trunk circuit, the telephone instrument

and the control keys in the position equipment at each operator position are connected and arranged in the manner of the trunk circuit, telephone instrument and control keys in the position equipment, shown in Fig. 21, part 1, Fig. 21, part 2 and Fig. 21, part 3, of the previously mentioned Voss and Crocker patent; while the key sender apparatus in the position equipment at each operator position is connected and arranged in the manner of the key sender apparatus in the position equipment, shown in Fig. 22, part 1, Fig. 22, part 2 and Fig. 23 of the previously mentioned Voss and Crocker patent.

The first position apparatus **1100** in the position equipment at the first operator position **900** comprises, as best shown in Fig. 11, a number of group line keys, including the group line keys K1150 and K1155, a number of individual line keys, including the individual line keys K1160 and K1165, a number of group line supervisory lamps, including the group line supervisory lamps L1148 and L1149, a number of individual line answer lamps, including the individual line answer lamps L1147 and L1145, and a number of individual line busy lamps, including the individual line busy lamps L1146 and L1144. Also, the first position apparatus **1100** comprises a number of lockout relays, including the lockout relays R1125 and R1130, individually associated with the individual line keys, the locking relays R1125 and R1130 being respectively individually associated with the individual line keys K1165 and K1160.

Similarly, the last position apparatus **1000** in the position equipment at the last operator position **910** comprises, as best shown in Fig. 10, a number of group line keys, including the group line keys K1050 and K1055, a number of individual line keys, including the individual line keys K1060 and K1065, a number of group line supervisory lamps, including the group line supervisory lamps L1048 and L1049, a number of individual line answer lamps, including the individual line answer lamps L1047 and L1045, and a number of individual line busy lamps, including the individual line busy lamps L1046 and L1044. Also, the last position apparatus **1000** comprises a number of lockout relays, including the lockout relays R1025 and R1030, individually associated with the individual line keys, the locking relays R1025 and R1030 being respectively individually associated with the individual line keys K1065 and K1060.

Further, it is noted that a number of line marking relays including the line marking relays R1170 and R1180 are commonly associated with the individual line keys in both the first position apparatus **1100** and the last position apparatus **1000** in a manner more fully explained subsequently. Further, in connection with the last position apparatus **1000** and the first position apparatus **1100**, it is noted that the group line keys K1050 and K1150 commonly correspond to the group of incoming trunk line circuits, including the incoming trunk line circuit **300**; while the group line keys K1055 and K1155 commonly correspond to the group of trunk circuits, including the trunk circuit **600**. Similarly, in the last position apparatus **1000** and the first position apparatus **1100** the individual line keys K1060 and K1160 commonly correspond to the individual toll line circuit **500** in the associated group of toll line circuits; while the individual line keys K1065 and K1165 commonly correspond to the individual trunk line circuit **400** in the associated group of trunk line circuits.

More particularly, it is noted that the individual line keys which correspond to the same circuit constitute a group. For example, the individual line keys K1065, K1165, etc., constitute a group, while the individual line keys K1060, K1160, etc., constitute a group. Also, the lockout relays which are associated with the individual line keys in a given group of individual line keys constitute a group. For example, the lockout relays R1025, R1125, etc., respectively individually associated with the individual line keys K1065, K1165, etc., in this group of individual line keys, constitute a group; while the lockout relays R1030, R1130, etc., respectively individually associated with the individual line keys K1060, K1160, etc., in this group of individual line keys, constitute a group. Further, it is noted that each group of lockout relays has a line marking relay individually associated therewith, the group of lockout relays including the lockout relays R1025, R1125, etc., having the line marking relay R1170 individually associated therewith and the group of lockout relays including the lockout relays R1030, R1130, etc., having the line marking relay R1180 individually associated therewith.

A better understanding of the connection and arrangement of the apparatus incorporated in the telephone system will be facilitated from a consideration of the detailed operation of the various pieces of apparatus incident to the handling of the various toll and trunk calls at the switchboard, as will appear hereinafter.

Local call from a subscriber substation in the P. A. B. X to the switchboard in the P. A. B. X

In order to extend a call from a subscriber substation, such as the subscriber substation T4 in the P. A. B. X **30** to the switchboard therein, a call operation is first performed at the calling subscriber substation T4, thereby to cause the line circuit **936** individually associated with the telephone line **935** extending to the subscriber substation T4 to operate. Upon operating, the line circuit **936** initiates operation of one of the local finder-selector links, such as the local finder-selector link **940** in the local switch train, whereupon the local finder-selector link **940** operates to seize the telephone line **935** extending to the calling subscriber substation T4. When the local finder-selector link **940** seizes the telephone line **935** extending to the calling subscriber substation T4, the line circuit **936** operates to mark the telephone line **935** as busy to the local connectors having access thereto and the local finder-selector link **940** is rendered responsive to a digit dialed thereinto. The subscriber at the subscriber substation T4 then dials a predetermined digit thereat, thereby to cause the local finder-selector link **940** to operate and select an idle trunk in the associated group of trunks extending to the group of trunk circuits. Assuming that the local finder-selector link **940** operates to seize the trunk **680** extending to the trunk circuit **600**, when the trunk **680** is thus seized a circuit is completed for energizing in series the upper and lower windings of the line relay R630 in the trunk circuit **600**, this circuit extending from ground by way of the lower winding of R630 and the winding **662** of the repeater **660** to the line conductor C682 of the trunk **680**, and from battery by way of the upper winding of the line relay R630 and the winding **661** of the repeater **660** to the line conductor C681 of the trunk **680**, the

line conductors C681 and C682 of the trunk 680 being connected by way of the local finder-selector link 940 to the telephone line 935. Accordingly, at this time, an operative connection is completed between the calling subscriber substation T4 and the repeater 660.

When thus energized the line relay R630 operates to complete, at the contacts 631, an obvious path for returning ring-back tone current over the trunk 680, the local finder-selector link 940 and the telephone line 935 to the calling subscriber substation T4, thereby to simulate at the subscriber substation T4 a ringing condition. Also the line relay R630 completes, at the contacts 632, an obvious circuit for energizing the winding of the hold relay R640, thereby to cause the latter relay to operate. Upon operating, the hold relay R640 completes, at the contacts 642 and 644, an obvious metallic connection, including the windings 663 and 664 of the repeater 660, between the line conductors C671 and C672 of the trunk 670. Further the hold relay R640 completes, at the contacts 646, an obvious path for applying ground potential to the control conductor C683 of the trunk 680, thereby to mark the trunk 680 as busy to the local finder-selector links having access thereto, the trunk 680 being previously marked for selection due to the completion of an obvious path for applying battery potential by way of the resistor 617 to the control conductor C683 thereof. Finally the hold relay R640 completes, at the contacts 645, an obvious circuit for energizing the winding of the start relay R620, thereby to cause the latter relay to operate. Upon operating, the start relay R620 completes, at the contacts 622, an obvious path for applying battery potential by way of the upper winding of the cutoff relay R610 to the control conductor C673 of the trunk 670, thereby to mark the rotary position of the trunk 670 in the main contact banks of the switching mechanisms of the finders having access thereto. Further the start relay R620 completes, at the contacts 625, an obvious path for applying ground potential to the control conductor C675, the control conductor C675 being commonly associated with the group of trunk circuits including the trunk circuit 600. The application of ground potential to the control conductor C675 completes obvious multiple circuits for illuminating the group line supervisory lamps L1049, L1149, etc., at the various operator positions at the switchboard in the P. A. B. X 30, thereby to indicate to the operators thereat that there is a call waiting to be answered on a trunk in the group of trunks including the trunk 670.

The call on the trunk 670 may be answered at any operator position at the switchboard. For example, the operator at the first operator position 900 at the switchboard may answer the call on the trunk 670 by first selecting, in the event this has not previously been done, an idle one of the switching links in the associated group of switching links and then by operating the group line key K1155 away from its normal position. In order to select an idle one of the switching links in the group of switching links individually associated with the first operator position 900 the operator thereat first determines that a given switching link is idle and then operates the talk key of the finder thereof away from its normal position. For example, assuming that the switching link 800 is selected by the operator at the first operator position 900 at this time, this switching link is indicated as being idle by the extinguished condition of the supervisory lamp L725. When the talk key K780 of the finder 700 of the switching link 800 is operated away from its normal position there is completed, at the contacts 781 thereof, a circuit for energizing the upper winding of the connect relay R770, this circuit extending from ground in the position equipment at the first operator position 900 by way of the conductor C790 in the cable 901, the contacts 781 of the talk key K780, the conductor C705 in the cable 901 and the upper winding of R770 to battery. When thus energized the connect relay R770 operates to complete, at the contacts 778, a holding circuit for energizing the lower winding thereof, this circuit extending from ground in the position equipment at the first operator position 900 by way of the conductor C794 in the cable 901, the contacts 786 of the talk key K780, the conductor C706 in the cable 901, the contacts 778 and the lower winding of R770 to battery. Also when this holding circuit is completed, apparatus in the position equipment at the first operator position 900 operates, thereby to cause ground potential to be removed from the conductor C790 in the cable 901 in order positively to prevent any of the other switching links in the associated group of switching links from being connected to the cable 901, as the switching link 800 in this group of switching links is operatively connected to the cable 901 at this time. Further, at the contacts 782, 785 and 787, operative connections are completed to the position equipment at the first operator position 900 by way of the conductors C791, C792 and C795 in the cable 901 and the conductors C811, C813 and C814 extending by way of the finder 700 and the trunk 821 to the selector 820.

Also the connect relay R770 interrupts, at the contacts 773 and 776, the normally prepared connection between the wipers 711 and 712 of the switching mechanism 710 of the finder 700 and the conductors 802 and 803 extending by way of the finder 700 and the trunk 821 to the selector 820; prepares, at the contacts 772 and 775, a connection between the wipers 711 and 712 of the switching mechanism 710 of the finder 700 and the position equipment at the first operator position 900 by way of the conductors C702 and C704 in the cable 901; and completes, at the contacts 771 and 774, a connection between the position equipment at the first operator position 900 and the selector 820 by way of the conductors C701 and C703 in the cable 901 and the conductors C802 and C803 extending by way of the finder 700 and the trunk 821 to the selector 820. Further the connect relay R770 prepares, at the contacts 770, a circuit traced hereinafter for energizing the winding of the test relay R760; interrupts, at the contacts 771', a point in a circuit traced hereinafter for illuminating the supervisory lamp L725, prepares, at the contacts 772', a circuit traced hereinafter for energizing the winding of the start relay R755; and prepares, at the contacts 773', a path traced hereinafter for short-circuiting the lower winding of the start relay R755. Further the connect relay R770 completes, at the contacts 779, a further connection between the position equipment at the first operator position 900 and the selector 820 by way of the conductor C707 in the cable 901, the contacts 779 and the conductor C807 extending by way of the finder 700 and the trunk 821 to the selector 820. At this time the switching link 800 is operatively associated with the cable 901 extending to the first operator position 900 and

the finder 700 of the switching link 800 is in readiness to be operated in order to route a call to the first operator position 900.

When the operator at the first operator position 900 operates the group line key K1155 away from its normal position there is completed, at the contacts 1157 thereof, an obvious path for applying ground potential to the marking conductor C1076 in the cable 1090. This application of ground potential to the marking conductor C1076 in the cable 1090 marks the vertical level in the vertical control contact banks of the switching mechanisms of the finders of the switching links, wherein the trunk 670 extending to the trunk circuit 600 is terminated. Also, at the contacts 1156 of the group line key K1155, there is completed an obvious path for applying ground potential to the start conductor C1078 in the cable 1091 extending to the first operator position 900, which ground potential is forwarded by way of the position equipment at the first operator position 900 to the start conductor C1078 in the cable 901. This application of ground potential to the start conductor C1078 in the cable 901 completes the previously mentioned circuit for energizing the upper winding of the start relay R755, this circuit extending from the grounded start conductor C1078 in the cable 901 by way of the contacts 772', the set of switch springs S724 and the upper winding of R755 to battery. When thus energized the start relay R755 operates to complete, at the contacts 755, an obvious point in multiple with the set of switch springs S724 in the previously traced circuit for energizing the upper winding thereof, to complete, at the contacts 758, an obvious circuit for illuminating the supervisory lamp L725, thereby to indicate to the operator at the first operator position 900 that the switching link 800 is busy at this time. Also the start relay R755 completes, at the contacts 757, an obvious holding circuit for energizing the lower winding of the switching relay R730, thereby to render the switching relay R730 exceedingly fast to operate when the upper winding thereof is energized, the switching relay R730 being of the polarized type. Further the start relay R755 completes, at the contacts 757, a circuit for energizing the vertical magnet M718, this circuit extending from ground by way of the contacts 757, 737, 752 and 745 and the vertical magnet M718 to battery. When thus energized the vertical magnet M718 operates to drive the wiper set of the switching mechanism 710 one step in the vertical direction and to complete, at the contacts 719, an obvious circuit for energizing the winding of the step relay R750, thereby to cause the latter relay to operate. Upon operating, the step relay R750 interrupts, at the contacts 752, the previously traced circuit for energizing the vertical magnet M718 and prepares, at the contacts 751, a test circuit traced hereinafter for energizing the lower winding of the transfer relay R740. The vertical magnet M718 then restores to interrupt, at the contacts 719, the previously mentioned circuit for energizing the winding of the step relay R750, thereby to cause the latter relay to restore. Upon restoring, the step relay R750 interrupts, at the contacts 751, a point in the previously mentioned test circuit for energizing the lower winding of the transfer relay R740 and recompletes, at the contacts 752, the previously traced circuit for energizing the vertical magnet M718. Accordingly, the vertical magnet M718 and the step relay R750 interact in the manner described above, thereby to cause the wiper set of the mechanism 710 to be driven step by step in the vertical direction until the vertical control wiper 717 engages a contact in the associated vertical control contact bank 718 having ground potential thereon.

In the present example, the vertical magnet M718 is energized intermittently six times, whereupon the vertical control wiper 717 engages the contact in the associated vertical control contact bank 718 terminating the marking conductor C1076 having ground potential thereon, whereupon the previously mentioned test circuit for energizing the lower winding of the transfer relay R740 is completed. This circuit extends from the grounded marking conductor C1076 by way of the vertical control wiper 717 and engaged contact in the associated vertical control contact bank 718, the contacts 743, the lower winding of R740, the contacts 751 and 745 and the vertical magnet M718 to battery. When this series circuit is completed the vertical magnet M718 remains in its operated position, thereby to retain the step relay R750 in its operated position and the transfer relay R740 is operated shortly thereafter, the transfer relay R740 being of the slow-to-operate type. Upon operating, the transfer relay R740 completes, at the contacts 742, a holding circuit for energizing the upper winding thereof, this circuit extending from ground by way of the contacts 757, 737 and 742 and the upper winding of R740 to battery. Further the transfer relay R740 interrupts, at the contacts 743, the previously traced series circuit for energizing the lower winding of the transfer relay R740 and the vertical magnet M718, thereby to cause the vertical magnet M718 to restore. Finally, the transfer relay R740 interrupts, at the contacts 745, a further point in the previously traced circuit for energizing the vertical magnet M718 and prepares, at the contacts 744, a circuit traced hereinafter for energizing the rotary magnet M720. Upon restoring, the vertical magnet M718 interrupts, at the contacts 719, the previously mentioned circuit for energizing the winding of the step relay R750, thereby to cause the latter relay to restore.

Upon restoring, the step relay R750 interrupts, at the contacts 751, a further point in the previously traced series circuit for energizing the lower winding of the transfer relay R740 and the vertical magnet M718 and completes, at the contacts 752, the previously mentioned circuit for energizing the rotary magnet M720. This circuit extends from ground by way of the contacts 757, 737, 752 and 744 and the rotary magnet M720 to battery. When thus energized the rotary magnet M720 operates to drive the wiper set of the switching mechanism 710 one step in the rotary direction and to complete, at the contacts 721, an obvious circuit for energizing the winding of the step relay R750, thereby to cause the latter relay to operate. Upon operating, the step relay R750 interrupts, at the contacts 752, the previously traced circuit for energizing the rotary magnet M720, thereby to cause the rotary magnet M720 to restore. Accordingly, the rotary magnet M720 and the step relay R750 interact in the above-described manner, thereby to cause the wiper set of the switching mechanism 710 to be driven step by step in the rotary direction until the control wiper 713 of the wiper set of the switching mechanism 710 engages the contact in the associated contact set terminating the control conductor C673 of the trunk 670; whereupon a circuit is completed for energizing in series the

upper winding of the switching relay R730 in the finder 700 and the upper winding of the cutoff relay R610 in the trunk circuit 600. This circuit extends from ground by way of the contacts 757, the upper winding of R730, the contacts 762, the control wiper 713 of the switching mechanism 710, the control conductor C673 of the trunk 670, the contacts 622 and the upper winding of R610 to battery. When this series circuit is completed the switching relay R730 operates exceedingly fast, thereby to interrupt, at the contacts 737, a further point in the previously traced circuit for energizing the rotary magnet M720 in order positively to prevent further operation of the switching mechanism 710. Also the switching relay R730 completes, at the contacts 735, a holding circuit for energizing the intermediate winding thereof, this circuit extending from ground by way of the contacts 757 and 735 and the intermediate winding of R730 to battery. Further the switching relay R730 completes, at the contacts 736, an obvious path for short-circuiting the upper winding thereof, thereby to decrease the series resistance of the previously traced circuit for energizing the upper winding of the cutoff relay R610, whereupon the latter relay is operated. Upon operating, the cutoff relay R610 completes, at the contacts 613, a holding circuit for energizing the lower winding thereof, this circuit extending from ground by way of the contacts 645 and 613 and the lower winding of R610 to battery. Further the cutoff relay R610 completes, at the contacts 612, a multiple point in the previously traced circuit for energizing the upper winding thereof, interrupts, at the contacts 614, the initial path for applying battery potential to the control conductor C683 of the trunk 680 and interrupts, at the contacts 611, the previously mentioned path for causing ring-back tone current to be returned over the trunk 680, the local finder-selector link 940 and the telephone line 935 to the calling subscriber substation T4, thereby to indicate to the subscriber thereat that the call has been answered at the switchboard in the P. A. B. X 30. Finally, the cutoff relay R610 interrupts, at the contacts 615, the previously traced multiple circuits for illuminating the group line supervisory lamps L1049, L1149, etc., at the various operator positions at the switchboard in order to indicate to the operators thereat that the call on the trunk in the group of trunks, including the trunk 670, has been answered at one of the operator positions at the switchboard.

Further the switching relay R730 completes, at the contacts 738, a holding circuit for energizing the lower winding of the start relay R755, this circuit extending from ground by way of the contacts 738 and 759, the lower winding of R755 and the resistor 727 to battery. Finally the switching relay R730 completes, at the contacts 731 and 732, an operative connection between the position equipment at the first operator position 900 and the repeater 660 in the trunk circuit 600, thereby operatively to connect the first operator position 900 at the switchboard to the calling subscriber substation T4. More particularly, the position equipment at the first operator position 900 is connected by way of the line conductors C702 and C704 in the cable 901, the contacts 772 and 775 and the contacts 731 and 732 to the line wipers 711 and 712 of the switching mechanism 710. Further this connection extends from the line wiper 711 of the switching mechanism 710 by way of the line conductor C671 of the trunk 670, the winding 663 of the repeater 660, the contacts 642 and 644, the winding 664 of the repeater 660 and the line conductor C672 of the trunk 670 to the line wiper 712 of the switching mechanism 710. Also the windings 663, 664 and the windings 661, 662 of the repeater 660 are inductively coupled, the windings 661 and 662 of the repeater 660 being included in the previously traced loop circuit extending from the repeater 660 by way of the trunk 680, the local finder-selector link 940 and the telephone line 935 to the calling subscriber substation T4. Hence, at this time, an operative connection is completed between the calling subscriber substation T4 and the first operator position 900 at the switchboard in the P. A. B. X 30, whereupon the operator at the first operator position 900 is advised concerning the extension of the call, and then extends the call in a manner more fully explained hereinafter.

After the operator at the first operator position 900 answers the call she returns the group line key K1155 back to its normal position, thereby to interrupt, at the contacts 1157 thereof, the previously mentioned path for applying ground potential to the marking conductor C1076 in the cable 1090 in order to remove the marking from the corresponding contacts in the vertical control contact banks in the switching mechanisms of the finders of the switching links. Also, at the contacts 1156 of the group line key K1155, the previously mentioned path for applying ground potential to the start conductor C1078 in the cable 1091 is interrupted, thereby to interrupt the previously traced circuit for energizing the upper winding of the start relay R755, the latter relay remaining in its operated position at this time due to the completed holding circuit for energizing the lower winding thereof.

In view of the foregoing explanation of the mode of operation of the finder 700 of the switching link 800 in the group of switching links associated with the first operator position 900 to seize the trunk 670, it will be understood that the finder 903 of the switching link 902 in this group of switching links is operative in a similar manner to find the trunk 670. In other words, the operator at the first operator position 900 may answer the call on the trunk 670 by utilizing any one of the switching links in the associated group of switching links merely by operating the link key of the finder of the selected switching link in combination with the group line key K1155, in the manner previously explained.

After the operator at the first operator position 900 answers the call on the trunk 670 and receives the information concerning the extension of the call she operates the key sender apparatus in the position equipment at the first operator position 900, thereby to control the operation of the selector of the selected switching link. More particularly, assuming that the call on the trunk 670 is answered at the first operator position 900 by utilizing the switching link 800, the selector 820 is controlled in order to seize one of the trunks accessible thereto, after which the call is extended by way of the seized trunk to its destination. After extending the call to its destination the operator at the first operator position 900 returns the talk key K780 of the finder 700 of the switching link 800 back to its normal position, thereby to interrupt, at the contacts 786 thereof, the previously traced holding circuit for energizing the lower winding of the connect relay R770 and to interrupt, at the contacts 782, 785 and 787, the previously traced connections

between the various conductors in the cable 901 and the various conductors extending by way of the finder 700 and the trunk 821 to the selector 820. The connect relay R770 then restores to interrupt, at the contacts 771, 774 and 772, 775, the previously traced connections between the finder 700 and the selector 820 and the position equipment at the first operator position 900. Also the connect relay R770 completes, at the contacts 773 and 776, a direct connection between the finder 700 and the selector 820, thereby to complete an established connection, including the calling subscriber substation T4, the telephone line 935, the local finder-selector link 940, the trunk 680, the trunk circuit 600, the trunk 670 and the switching link 800 independent of the first operator position 900. Further the connect relay R770 completes, at the contacts 771', an obvious multiple circuit for illuminating the supervisory lamp L725 and interrupts, at the contacts 773', a further point in the previously mentioned path for short-circuiting the lower winding of the start relay R755. Further it is noted that, at the contacts 784 of the talk key K780 of the finder of the switching link 800, there is prepared a circuit traced hereinafter for illuminating the supervisory lamp L726.

The supervision and release of the established connection, including the switching link 800, is primarily under the control of the operator at the first operator position 900 and is effected in the manner explained in the previously mentioned Voss and Crocker patent.

More particularly, when a release operation is performed at the calling subscriber substation T4 the local finder-selector link 940 is released and the line circuit 936 is controlled, thereby to mark the telephone line 935 extending to the subscriber substation T4 as idle to the local connectors having access thereto. When the local finder-selector link 940 is released the previously traced circuit for energizing the upper and lower windings of the line relay R630 in the trunk circuit 600 is interrupted, thereby to cause the latter relay to restore. Upon restoring, the line relay R630 completes, at the contacts 633, a circuit for energizing the lower winding of the recall relay R650, this circuit extending from ground by way of the contacts 624 and 633 and the lower winding of R650 to battery. When thus energized the recall relay R650 operates to complete, at the contacts 651, a holding circuit for energizing the upper winding thereof and for illuminating the supervisory lamp L726, this circuit extending from ground by way of the contacts 623, the upper winding of R650, the contacts 651, the control conductor C674 of the trunk 670, the control wiper 714 of the switching mechanism 710, the conductors C804 and C813 in the finder 700, the contacts 784 of the talk key K780 of the finder 700 and the supervisory lamp L726 to battery. The illumination of the supervisory lamp L726 indicates to the operator at the first operator position 900 that the established connection routed by way of the switching link 800 has been released.

Also the line relay R630 interrupts, at the contacts 632, the previously mentioned circuit for energizing the winding of the hold relay R640, thereby to cause the latter relay to restore shortly thereafter, the hold relay R640 being of the slow-to-release type. Upon restoring, the hold relay R640 interrupts, at the contacts 642 and 644, the previously mentioned direct connection between the windings 663 and 664 of the repeater 660, completes, at the contacts 643, an obvious path for applying battery potential by way of the resistor 616 to the line conductor C672 of the trunk 670 and completes, at the contacts 641, an obvious path for applying ground potential to the line conductor C671 of the trunk 670, the application of ground and battery potentials to the line conductors C671 and C672 of the trunk 670 being utilized for supervisory purposes. Further the hold relay R640 interrupts, at the contacts 645, the previously traced multiple circuit for energizing the winding of the start relay R620 and the lower winding of the cutoff relay R610, thereby to cause the start relay R620 to restore shortly thereafter, the latter relay being of the slow-to-release type. However, the cutoff relay R610 remains in its operated position due to the completed circuit for energizing the upper winding thereof. Upon restoring, the start relay R620 interrupts, at the contacts 621 and 623, the previously mentioned paths for applying battery and ground potentials to the line conductors C672 and C671 of the trunk 670. Also the start relay R620 interrupts, at the contacts 624, the previously traced circuit for energizing the lower winding of the recall relay R650 and interrupts, at the contacts 623, the previously traced holding circuit for energizing the upper winding of the recall relay R650, thereby to cause the recall relay R650 to restore.

The operator at the first operator position 900 then operates the talk key K780 of the finder 700 away from its normal position, thereby to cause reoperation of the connect relay R770 in the finder 700, in the manner previously explained. Upon reoperating, the connect relay R770 again connects the position equipment at the first operator position 900 to the switching link 800, thereby to enable the operator at the first operator position 900 to release the switching link 800.

In order to release the switching link 800 the operator at the first operator position 900 controls the position equipment thereat, thereby to cause ground potential to be applied to the release conductor C708 in the cable 901. This application of ground potential to the release conductor C708 in the cable 901 completes a path for short-circuiting the lower winding of the start relay R755, this path extending from the grounded release conductor C708 in the cable 901 by way of the contacts 773', the lower winding of R755 and the contacts 759 and 738 to ground. When the lower winding of the start relay R755 is thus short-circuited the latter relay restores.

At this point it is noted that, when the wiper set of the switching mechanism 710 of the finder 700 is driven one step in the vertical direction, the sets of switch springs S723 and S724 are respectively actuated into engagement and disengagement. When the set of switch springs S723 is actuated into engagement a circuit traced hereinafter is prepared for energizing the release magnet M722; and when the set of switch springs S724 is actuated into disengagement the previously traced original circuit for energizing the upper winding of the start relay R755 is interrupted. Accordingly, upon restoring, the start relay R755 interrupts, at the contacts 759, the previously traced path for short-circuiting the lower winding thereof and completes, at the contacts 756, the previously mentioned circuit for energizing the release magnet M722, the last-mentioned circuit extending from ground by way of the contact 756, the set of switch springs S723

and the release magnet M722 to battery. When thus energized the release magnet M722 operates to release the wiper set of the switching mechanism 710, whereupon the wiper set of the switching mechanism 710 is returned to its normal position. Also upon restoring, the start relay R755 interrupts, at the contacts 757, the previously traced holding circuit for energizing the upper winding of the transfer relay R740 and the previously traced holding circuit for energizing the intermediate switching relay R730, thereby to cause the latter relays to restore. When the wiper set of the switching mechanism 710 is returned to its normal position the sets of switch springs S723 and S724 are respectively actuated into disengagement and engagement. When the set of switch springs S723 is actuated into disengagement the previously traced circuit for energizing the release magnet M722 is interrupted, thereby to cause the release magnet M722 to restore. Finally, the start relay R755 interrupts, at the contacts 758, the previously traced original circuit for illuminating the supervisory lamp L725, thereby to cause the supervisory lamp L725 to be extinguished when the selector 820 is released in order to indicate that the switching link 800 is idle at this time. Also, the release of the selector 820 is under the control of the operator at the first operator position 900, and is effected in the manner explained in the previously mentioned Voss and Crocker patent. When the selector 820 is released the previously mentioned alternative circuit for illuminating the supervisory lamp L725 is interrupted, as previously explained.

The operator at the first operator position 900 then returns the talk key K780 of the finder 700 of the switching link 800 back to its normal position, thereby to interrupt, at the contacts 786 thereof, the previously traced holding circuit for energizing the lower winding of the connect relay R770, whereupon the latter relay restores. At this time, both the finder 700 and the selector 820 of the switching link 800 are completely released and the switching link 800 is available for further use.

When the finder 700 of the switching link 800 is released the previously traced circuit for energizing the upper winding of the cutoff relay R610 in the trunk circuit 600 is interrupted, thereby to cause the latter relay to restore. Upon restoring, the cutoff relay R610 recompletes, at the contacts 614, the previously mentioned path for applying battery potential by way of the resistor 617 to the control conductor C683 of the trunk 680 in order to mark the trunk 680 as idle to the local finder-selector links having access thereto.

At this time, the apparatus utilized in the established connection between the calling subscriber substation T4 and the first operator position 900 at the switchboard is completely released and available for further use.

Similarly, it will be understood that an operator at any other operator position at the switchboard in the P. A. B. X 30 may answer the call on the trunk 670. For example, the operator at the last operator position 910 may answer the call on the trunk 670 by operating the group line key K1055 away from its normal position after selecting one of the switching links in the associated group. More particularly, when the operator at the last operator position 910 operates the group line key K1055 away from its normal position there is completed, at the contacts 1057 thereof, an obvious path for applying ground potential to the marking conductor C1076 in the cable 1090, thereby to complete a path substantially identical to that previously traced for marking the vertical level in the contact banks of the switching mechanisms of the finders of the switching links wherein the trunk 670 is terminated. Also, at the contacts 1056 of the group line key K1055, there is completed an obvious path for applying ground potential to the start conductor C1070 in the cable 1092 extending to the position equipment at the last operator position 910. This application of ground potential to the start conductor C1070 in the cable 1092 causes ground potential to be forwarded by way of the position equipment at the last operator position 910 and the start conductor, not shown, in the cable 911 into the finder of the selected switching link, thereby to cause operation of the finder of the selected switching link, in the manner previously explained, whereupon an operative connection is completed between the calling subscriber substation T4 and the last operator position 910. After the call is answered at the last operator position 910 the operator thereat returns the group line key K1055 to its normal position, thereby to interrupt, at the contacts 1057 and 1056, respectively, the previously mentioned paths for applying ground potential to the marking conductor C1076 in the cable 1090 and to the start conductor C1070 in the cable 1092, for the purpose previously explained. After the operator at the last operator position 910 answers the call on the trunk 670 she is advised concerning the extension of the call and then operates the position equipment at the last operator position 910 in order to cause the call to be extended in the manner previously explained. The extension, supervision and release of the connection at the last operator position 910 are the same as that previously explained in connection with the first operator position 900.

Call from the central office to the P. A. B. X

In order to extend a call from the central office 20 to the switchboard in the P. A. B. X 30, the operator at the operator position 240 in the central office 20 first selects an idle trunk line in the group of trunk lines extending from the central office 20 to the P. A. B. X 30, such as the trunk line 205, and then operates the apparatus at the operator position 240, thereby to cause ringing current to be projected over the trunk line 205. The projection of ringing current over the trunk line 205 completes a circuit for energizing the upper winding of the ring-up relay R310 in the incoming trunk line circuit 300, this circuit extending from the line conductor C206 of the trunk line 205 by way of the contacts 331, the condenser 343, the contacts 311 and the upper winding of R310 to the line conductor C207 of the trunk line 205, the line conductors C206 and C207 of the trunk line 205 having ringing voltage impressed therebetween. When thus energized the ring-up relay R310 operates to complete, at the contacts 312, a holding circuit for energizing in series the lower winding thereof and the lower winding of the start relay R320, this circuit extending from ground by way of the lower winding of R310, the contacts 312 and 335 and the lower winding of R320 to battery. When this holding circuit is completed the ring-up relay R310 remains in its operated position while the start relay R320 operates. Also the ring-up relay R310 interrupts, at the contacts 311, the previously traced original circuit for energizing the upper winding thereof. Upon operating, the start relay R320 completes, at the contacts 323, a path

for applying battery potential by way of the upper winding thereof to the control conductor C353 of the trunk 350, thereby to mark the rotary position of the trunk 350 in the main contact banks of the switching mechanisms of the finders of the switching links having access thereto. Further the start relay R320 completes, at the contacts 324, an obvious path for applying ground potential to the control conductor C356 in the cable 1090, thereby to complete obvious multiple circuits for illuminating the group line supervisory lamps L1048, L1148, etc., at the various operator positions at the switchboard in order to indicate to the operators thereat that there is an incoming call from the central office 20 to the P. A. B. X 30 on one of the trunks in the group of trunks, including the trunk 350.

This call may be answered at any one of the operator positions at the switchboard. For example, in order to answer the call on the trunk 350 at the first operator position 900, the operator thereat operates the group line key K1150 away from its normal position, thereby to complete, at the contacts 1151 thereof, the previously traced path for applying ground potential to the start conductor C1078 in the cable 1091 extending to the first operator position 900 in order to initiate operation of the finder of the previously selected switching link in the associated group of switching links. Also, at the contacts 1152 of the group line key K1150, there is completed an obvious path for applying ground potential to the marking conductor C1073 in the cable 1090, thereby to mark the vertical level in the vertical control contact banks of the switching mechanisms of the finders of the switching links, wherein the trunk 350 extending to the incoming trunk line circuit 300 is terminated.

The operation of the finder of the selected switching link in the group of switching links associated with the first operator position 900 to seize the trunk 350 is substantially the same as that previously explained; and after the trunk 350 is seized by the finder of the selected switching link the group line key K1150 is returned to its normal position, thereby to interrupt, at the contacts 1151 and 1152 thereof, the previously traced path for applying ground potential respectively to the start conductor C1078 in the cable 1091 and to the marking conductor C1073 in the cable 1090.

When the finder of the selected link associated with the first operator position 900 seizes the trunk 350 ground potential is applied to the control conductor C353 thereof, thereby to complete an obvious holding circuit for energizing the upper winding of the start relay R320 and to complete an obvious circuit for energizing the winding of the cutoff relay R330. When thus energized the cutoff relay R330 operates to complete, at the contacts 333, an obvious holding circuit for energizing the winding thereof and to interrupt, at the contacts 335, the previously traced holding circuit for energizing the lower winding of the ring-up relay R310 in series with the lower winding of the start relay R320, thereby to cause the ring-up relay R310 to restore, ringing voltage being impressed between the line conductors C206 and C207 of the trunk line 205 only momentarily by the operation of the apparatus at the operator position 240 in the central office 20. Also the cutoff relay R330 interrupts, at the contacts 336, the previously mentioned path for applying ground potential to the control conductor C356 in the cable 1090, thereby to interrupt the previously traced multiple circuits for illuminating the group line supervisory lamps L1048, L1148, etc., at the various operator positions at the switchboard in order to indicate to the operators thereat that the call on the trunk in the group of trunks, including the trunk 350, has been answered at one of the operator positions at the switchboard. Finally the cutoff relay R330 completes, at the contacts 332, an operative connection between the operator position 240 in the central office 20 and the repeater 340 in the incoming trunk line circuit 300, this connection extending from the line conductor C206 of the trunk line 205 by way of the contacts 332, the windings 341 of the repeater 340 and the contacts 322 to the line conductor C207 of the trunk line 205, the line conductors C206 and C207 of the trunk line 205 being operatively connected to the operator position 240 in the central office 20. Also it is noted that the windings 341 and 342 of the repeater 340 are inductively coupled, thereby to establish a connection between the trunk line 205 extending from the operator position 240 in the central office 20 to the incoming trunk line circuit 300 and the trunk 350 seized by the finder of the switching link operatively associated with the first operator position 900.

The subsequent extension and supervision of the connection at the first operator position 900 are the same as that previously explained. The release of the established connection is initiated by the operator at the operator position 240 in the central office 20 and is accomplished when the operator at the operator position 240 operates the apparatus thereat, thereby to cause ring-off current to be projected over the trunk line 205. The projection of ring-off current over the line conductor C205 completes an alternative circuit for energizing the upper winding of the ring-up relay R310, this circuit extending from the line conductor C206 of the trunk line 205 by way of the contacts 321, the condenser 343, the contacts 311 and the upper winding of R310 to the line conductor C207 of the trunk line 205, the line conductors C206 and C207 of the trunk line 205 having ring-off potential impressed therebetween at the operator position 240 in the central office 20. When thus energized the ring-up relay R310 operates to complete, at the contacts 312, a holding circuit for energizing the lower winding thereof in series with the supervisory lamp L727, this circuit extending from ground by way of the winding of R310, the contacts 312 and 334, the control conductor C355 of the trunk 350, the control wiper 714 of the switching mechanism 710 of the finder 700, the conductors C804 and C813 of the finder 700, the contacts 784 of the talk key K780 and the supervisory lamp L726 to battery. The operator at the operator position 240 in the central office 20 then operates the apparatus thereat, thereby to interrupt the projection of ring-off current over the trunk line 205 in order further to interrupt the previously traced circuit for energizing the upper winding of the ring-up relay R310. The illumination of the supervisory lamp L726 indicates to the operator at the first operator position 900 that the established connection routed by way of the switching link 800 has been released, whereupon the operator at the first operator position 900 effects the release of the switching link 800, in the manner previously explained.

When the switching mechanism 710 in the finder 700 of the switching link 800 is released

the previously traced multiple holding circuit for energizing the upper winding of the start relay R320 and the winding of the cut-off relay R330 is interrupted, thereby to cause the start relay R320 to restore immediately and to cause the cut-off relay R330 to restore shortly thereafter, the cutoff relay R330 being of the slow-to-release type. Also when the switching mechanism 710 in the finder 700 of the switching link 800 is released the previously traced holding circuit for energizing the lower winding of the ring-up relay R310 is interrupted, thereby to cause the latter relay to restore. At this time the equipment utilized in the established connection between the operator position 240 in the central office 20 and the first operator position 900 in the P. A. B. X 30 is completely released and available for further use.

Also it is noted that the operator at any other operator position at the switchboard in the P. A. B. X 30 may answer the call on the trunk 350. For example, the operator at the last operator position 910 may answer the call on the trunk 350 by operating the group line key K1050 in combination with the talk key of the finder of one of the switching links in the group of switching links individually associated with the last operator position 910. More particularly, the group line key K1050 is operated away from its normal position, thereby to complete, at the contacts 1052 thereof, an obvious path for applying ground potential to the marking conductor C1073 in the cable 1090 in order to mark the vertical level in the contact banks of the switching mechanisms of the finders of the switching links, wherein the trunk 350 is terminated. Also, at the contacts 1051 of the group line key K1050, there is completed an obvious path for applying ground potential to the start conductor C1070 in the cable 1092 extending to the last operator position 910, thereby to initiate operation of the finder of the selected switching link in the group of switching links individually associated with the last operator position 910. The subsequent operation of the apparatus at the last operator position 910 to answer, to extend and to supervise the established connection, and the subsequent release of the established connection are the same as that previously explained.

Call from the I. B. X to the P. A. B. X

In order to extend a call from the I. B. X 40 to the switchboard in the P. A. B. X 30, the operator at the operator position 260 in the I. B. X 40 first selects an idle trunk line in the group of trunk lines extending between the I. B. X 40 and the P. A. B. X 30, such as the trunk line 210, and then establishes a connection thereto. When a connection is established at the operator position 260 to the trunk line 210, a circuit is completed for energizing in series the upper and lower windings of the line relay R440 in the trunk circuit 400, this circuit extending from ground by way of the upper winding of R440 and the winding 451 of the repeater 450 to the line conductor C211 of the trunk line 210; and from battery by way of the lower winding of R440 and the winding 452 of the repeater 450 to the line conductor C212 of the trunk line 210, the line conductors C211 and C212 of the trunk line 210 being connected together at the operator position 260 in the I. B. X 40.

When thus energized the line relay R440 operates to complete, at the contacts 441, a circuit for energizing the winding of the start relay R320, this circuit extending from ground by way of the contacts 441 and 433 and the winding of R420 to battery. When thus energized the start relay R420 operates to complete, at the contacts 423, an obvious path for applying ground potential to the control conductor C464 of the trunk 460, thereby to mark the trunk 460 as busy to the selectors of the switching links having access thereto. Also the start relay R420 completes, at the contacts 424 and 425, obvious paths for applying ground potential to the control conductors C467 and C468, respectively, in the cable 1090. The application of ground potential to the control conductor C467 in the cable 1090 completes obvious circuits for illuminating the individual line busy lamps L1046, L1146, etc., at the various operator positions at the switchboard in the P. A. B. X 30, thereby to indicate to the operators thereat that the trunk line 210 extending between the P. A. B. X 30 and the I. B. X 40 is busy at this time. The application of ground potential to the control conductor C468 in the cable 1090 completes obvious circuits for illuminating the individual line answer lamps L1047, L1147, etc., at the various operator positions at the switchboard in the P. A. B. X 30, thereby to indicate to the operator thereat that there is a call waiting to be answered on the trunk 460 operatively associated, by the trunk line circuit 400, with the trunk line 210.

The call on the trunk 460 may be answered at any one of the operator positions at the switchboard in the P. A. B. X 30. For example, in order to answer the call on the trunk 460 at the first operator position 900, the operator thereat operates the individual line key K1165 in combination with the talk key of the finder of a selected one of the switching links in the group of switching links individually associated with the first operator position 900. Assuming that the switching link 800 is selected at this time, the talk key K780 of the finder 700 of the switching link 800 is operated away from its normal position, in the manner previously explained.

When the individual line key K1165 is operated away from its normal position, there is completed at the contacts 1167 thereof an obvious path for applying battery potential by way of the resistor 1122 to the marking conductor C1080 in the cable 1090, thereby to mark the rotary position of the contact sets in the contact banks of the switching mechanisms of the finders of the switching links in the group of switching links individually associated with the first operator position 900, wherein the trunk 460 is terminated. Also, at the contacts 1166 of the individual line key K1165, there is completed an obvious circuit for energizing in series the winding of the line marking relay R1170 and the upper winding of the lockout relay R1125. When thus energized, the lockout relay R1125 and the line marking relay R1170 operate. Upon operating, the lockout relay R1125 completes at the contacts 1126 an obvious holding circuit for energizing in series the lower winding thereof and the winding of the line marking relay R1170, whereby both the upper and lower windings of the lockout relay R1125 are energized in multiple series relationship with respect to the winding of the line marking relay R1170. Also, upon operating, the lockout relay R1125 completes at the contacts 1129 an obvious path for applying ground potential to the start conductor C1078 in the cable 1091 extending to the

first operator position 900, thereby to complete the previously traced circuit for energizing the upper winding of the start relay R755 in the finder 700 of the selected switching link 800 in order to initiate operation of the finder 700 in the manner previously explained. Further, the lockout relay R1125 completes at the contacts 1128 an obvious path for applying ground potential to the control conductor C1077 in the cable 1091 extending to the first operator position 900, thereby to complete an obvious path for applying ground potential to the control conductor C1077 in the cable 901 extending to the first operator position 900. This application of ground potential to the control conductor C1077 in the cable 901 completes an obvious circuit for energizing the winding of the test relay R760 in the finder 700, thereby to cause operation thereof. Upon operating, the test relay R760 interrupts at the contacts 762 the previously traced connection between the control wiper 713 of the switching mechanism 710 and the upper winding of the switching relay R730, and completes at the contacts 761 an obvious connection between the control wiper 715 of the switching mechanism 710 and the upper winding of the switching relay R730. Accordingly, the operated test relay R760 transfers the upper winding of the switching relay R730 from the control wiper 713 to the control wiper 715 of the switching mechanism 710 for a purpose more fully explained subsequently. Further, the lockout relay R1125 completes at the contacts 1127 an obvious path for applying ground potential to the marking conductor C1074 in the cable 1090, thereby to mark the vertical level in the contact banks of the switching mechanisms of the finders of the switching links, wherein the trunk 460 is terminated.

Upon operating, the line marking relay R1170 completes at the contacts 1174 an obvious path for applying ground potential to the control conductor C466 in the cable 1090, thereby to complete an obvious holding circuit for energizing the winding of the start relay R420 in the trunk circuit 400. Also, the line marking relay R1170 interrupts at the contacts 1171, 1172, 1173, etc., obvious paths for applying battery potential by way of the resistor 1193 to the various marking conductors including the marking conductors C1080, C1082, etc., for a purpose more fully explained hereinafter.

At this point, it is noted that, when the previously mentioned circuit for energizing the upper and lower windings of the lockout relay R1125 in multiple series relationship with respect to the winding of the line marking relay R1170 is completed, incident to the operation of the individual line key K1165 and the lockout relay R1125, resistance ground potential is applied by way of the lower winding of the lockout relay R1125, the contacts 1126, and the contacts 1166 of the individual line key K1165 to the control conductor C1164. This application of resistance ground potential to the control conductor C1164 positively prevents the upper winding of any of the other lockout relays in the group of lockout relays including the lockout relay R1125 from being adequately energized in order to cause operation thereof due to the facts that the resistance of the lower winding of the lockout relay R1125 is extremely low and that each of the lockout relays in this group of lockout relays is of the marginal type. Thus it will be understood that, when any one of the individual line keys K1065, K1165, etc., in this group of individual line keys is operated, the associated lockout relay R1025, R1125, etc., is operated only in the event that there is no previously operated lockout relay in this group of lockout relays and, upon operating, the lockout relay in this group of lockout relays positively prevents operation of any other lockout relay in this group of lockout relays.

The finder 700 of the selected switching link 800 then operates in the manner previously explained, thereby to cause the switching mechanism 710 to seize the trunk 460; whereupon a circuit is completed for energizing the upper winding of the switching relay R730 in the finder 700, this circuit extending from ground by way of the contacts 757, the upper winding of R730, the contacts 761 and 733, the control wiper 715 of the switching mechanism 710, the marking conductor C1080 in the cable 1090, the contacts 1167 of the individual line key K1165 and the resistor 1122 to battery. When thus energized the switching relay R730 operates to interrupt, at the contacts 733, the previously traced circuit for energizing the upper winding thereof and to complete, at the contacts 735, the previously traced holding circuit for energizing the intermediate winding thereof.

After the finder 700 of the selected switching link 800 operates to seize the trunk 460 the operator at the first operator position 900 returns the individual line key K1165 to its normal position, thereby to interrupt, at the contacts 1167 thereof the previously mentioned path for applying battery potential by way of the resistor 1122 to the marking conductor C1080 in the cable 1090, and to interrupt at the contacts 1166 thereof the previously mentioned holding circuit for energizing the upper and lower windings of the lockout relay R1125 in multiple series relationship with respect to the winding of the line marking relay R1170, whereupon these relays restore. Upon restoring, the lockout relay R1125 interrupts at the contacts 1128 and 1129, respectively, the previously traced circuit for energizing the upper winding of the start relay R755 and the previously traced circuit for energizing the winding of the test relay R760 in the finder 700. The start relay R755 remains in its operated position; however, the test relay R760 restores. Upon restoring the test relay R760 completes at the contacts 762 a circuit for energizing the winding of the cut-off relay R430 in the trunk circuit 400, this circuit extending from ground by way of the contacts 757, 736 and 762, the control wiper 713 of the switching mechanism 710, the control conductor C463 of the trunk 460, the contacts 421 and 411 and the winding of R430 to battery. When thus energized the cutoff relay R430 operates to complete, at the contacts 431, an obvious holding circuit substantially identical to that previously traced for energizing the winding thereof and to interrupt, at the contacts 433, the previously traced circuit for energizing the winding of the start relay R420, thereby to cause the latter relay to restore. Upon restoring, the start relay R420 interrupts, at the contacts 425, the previously mentioned path for applying ground potential to the control conductor C468 in the cable 1090, thereby to interrupt the previously traced circuits for illuminating the individual line answer lamps L1047, L1147, etc., at the various operator positions at the switchboard in order to indicate to the operators thereat that the call on the trunk 460 has been answered at one of the operator positions at the switch-

board. Also the cutoff relay R430 completes, at the contacts 435, an alternative path for applying ground potential to the control conductor C467 in the cable 1090, thereby to retain completed the previously mentioned circuits for illuminating the individual line busy lamps L1046, L1146, etc., at the various operator positions at the switchboard. Further the cutoff relay R430 completes, at the contacts 432, a circuit for energizing the winding of the control relay R410, this circuit extending from ground by way of the contacts 441 and 432 and the winding of R410 to battery. When thus energized the control relay R410 operates to complete, at the contacts 413, a holding circuit for energizing the winding thereof, this circuit extending from ground by way of the contacts 434 and 413 and the winding of R410 to battery.

Further, the lockout relay R1125 interrupts at the contacts 1127 the previously mentioned path for applying ground potential to the marking conductor C1074 in the cable 1090. Upon restoring, the line marking relay R1170 interrupts at the contacts 1174 the previously mentioned path for applying ground potential to the control conductor C466 in the cable 1090, thereby to interrupt the previously traced holding circuit for energizing the winding of the start relay R420 in the trunk circuit 400 as previously explained. Further, the line marking relay R1170 recompletes at the contacts 1171, 1172, 1173, etc., the previously mentioned paths for applying battery potential by way of the resistor 1193 to the various marking conductors including the marking conductors C1080, C1082, etc. The application of battery potential by way of the resistor 1193 to the marking conductor C1080 in the cable 1090 completes a path including the control wiper 715 of the switching mechanism 710 and the contacts 734 for applying battery potential to the conductor C805 extending by way of the finder 700 and the trunk 821 to the selector 820, the test relay R760 being restored at this time to interrupt at the contacts 763 an obvious path for applying ground potential to the conductor C805. This application of battery potential to the conductor C805 extending by way of the finder 700 and the trunk 821 to the selector 820 causes operation of meter apparatus, not shown, in the selector 820, thereby to register the answering of a call at the first operator position 900 upon a trunk in the group of trunks including the trunk 460.

It is noted that, after the individual line key K1065 is returned to its normal position, battery potential is applied by way of the winding of the line marking relay R1170 to the control conductor C1164, thereby to render each of the individual line keys in this group of individual line keys operative to cause operation of the associated lockout relay in this group of lockout relays.

The extension and supervision of the established connection at the first operator position 900 are the same as that previously explained. The release of the established connection is initiated when the operator at the operator position 260 in the I. B. X 40 operates the apparatus thereat, thereby to interrupt the connection to the trunk line 210. When the connection to the trunk 210 is interrupted, the previously traced circuit for energizing the winding of the line relay R440 in the trunk line circuit 400 is interrupted, thereby to cause the latter relay to restore. Upon restoring, the line relay R440 completes, at the contacts 442, a path for applying ground potential to the control conductor C465 of the trunk 460, this path extending from ground by way of the contacts 442 and 412 to the control conductor C465 of the trunk 460. This application of ground potential to the control conductor C465 of the trunk 460 completes a circuit for illuminating the supervisory lamp L726 at the first operator position 900, this circuit extending from the grounded control conductor C465 of the trunk 460 by way of the control wiper 714 of the switching mechanism 710 and the conductors C804 and C813 in the finder 700, the contacts 784 of the talk key K780 and the supervisory lamp L726 to battery. The illumination of the supervisory lamp L726 indicates to the operator at the first operator position 900 that the established connection, including the switching link 800, has been released.

The operator at the first operator position 900 then effects the release of the switching link 800, in the manner previously explained. When the switching mechanism 710 is released the previously traced circuit for energizing the winding of the cutoff relay R430 in the trunk circuit 400 is interrupted, thereby to cause the latter relay to restore shortly thereafter, the cutoff relay R430 being of the slow-to-release type. Upon restoring, the cutoff relay R430 interrupts, at the contacts 434, the previously traced holding circuit for energizing the winding of the control relay R440, thereby to cause the latter relay to restore. Further the cutoff relay R340 interrupts, at the contacts 435, the previously mentioned path for applying ground potential to the control conductor C467 in the cable 1090, thereby to interrupt the previously mentioned circuits for illuminating the individual line busy lamps L1046, L1146, etc., at the various operator positions at the switchboard, thereby to indicate to the operators thereat that the trunk 460 is idle at this time. The apparatus included in the established connection between the operator position 260 in the I. B. X 40 and the first operator position 900 in the P. A. B. X 30 is completely released and available for further use at this time.

The call on the trunk 460 may be answered at any other operator position at the switchboard in the P A. B. X 30. For example, the call on the trunk 460 may be answered at the last operator position 910 at the switchboard by operating the individual line key K1065 in combination with the talk key of the finder of a selected one of the switching links in the group of switching links individually associated with the last operator position 910. More particularly, when the individual line key K1065 is operated away from its normal position there is completed, at the contacts 1067 thereof, an obvious path for applying battery potential by way of the resistor 1022 to the marking conductor C1082 in the cable 1090. The application of battery potential to the marking conductor C1082 in the cable 1090 marks the rotary position of the contact sets in the contact banks of the switching mechanisms of the finders of the switching links in the group of switching links individually associated with the last operator position 910, wherein the trunk 460 is terminated. Also, at the contacts 1066 of the individual line key K1065, there is completed an obvious circuit for energizing in series the upper winding of the lockout relay R1025 and the winding of the line marking relay R1170, thereby to cause operation of the lockout relay R1025 and the line marking relay R1170. Upon operating, the lockout relay R1025 completes, at

the contacts 1026, an obvious holding circuit for energizing in series the lower winding thereof and the winding of the line marking relay R1170, whereupon the upper and lower windings of the lockout relay R1025 are energized in multiple series relationship with respect to the winding of the line marking relay R1170 in order to prevent operation of the other lockout relays in this group of lockout relays in the manner previously explained.

Also, the lockout relay R1025 completes at the contacts 1027 an obvious path for applying ground potential to the marking conductor C1074 in the cable 1090. The application of ground potential to the marking conductor C1074 in the cable 1090 marks the vertical level in the contact banks of the switching mechanisms of the finders of the switching links, wherein the trunk 460 is terminated. Further, the lockout relay R1025 completes at the contacts 1028 and 1029, respectively, obvious paths for applying ground potential to the control conductor C1071 in the cable 1092 and to the start conductor C1070 in the cable 1092. The application of ground potential to the control conductor C1071 and to the start conductor C1070 causes operation of the finder of a selected switching link in the group of switching links individually associated with the last operator position 910 in the manner previously explained.

Upon operating, the line marking relay R1170 completes at the contacts 1174 the previously mentioned path for applying ground potential to the control conductor C466 in the cable 1090, thereby to complete the previously traced holding circuit for energizing the winding of the start relay R420 in the trunk line circuit 400 as previously explained. Further, the line marking relay R1170 interrupts at the contacts 1171, 1172, 1173, etc., the previously mentioned paths for applying battery potential by way of the resistor 1193 to the various marking conductors including the marking conductor C1080, C1082, etc., for the purpose previously explained. The subsequent operation of the apparatus individually associated with the last operator position 910 to answer the call and to extend, to supervise and to release the established connection is the same as that previously explained.

Call from the distant exchange to the P. A. B. X

In order to extend a call from the distant exchange 50 to the switchboard in the P. A. B. X 30, the operator at the toll operator position 250 in the distant exchange 50 first selects an idle toll line in the group of toll lines extending between the distant exchange 50 and the P. A. B. X 30, such as the toll line 215, and then operates the apparatus at the toll operator position 250, thereby to cause ringing current to be projected over the toll line 215. The projection of ringing current over the toll line 215 completes a circuit for energizing the winding of the ring-up relay R550 in the toll line circuit 500, this circuit extending from the line conductor C216 of the toll line 215 by way of the contacts 511, the winding 502 of the repeater 501, the winding of R550, the winding 503 of the repeater 501 and the contacts 513 to the line conductor C217 of the toll line 215, the line conductors C216 and C217 of the toll line 215 having ringing voltage impressed therebetween. The ring-up relay R550 is thus energized for a short time interval, after which the operator at the toll operator position 250 in the distant exchange 50 operates the apparatus thereat, thereby to interrupt the projection of ringing current over the toll line 215. Accordingly, the ring-up relay R550 operates and then restores. Upon operating, the ring-up relay R550 completes, at the contacts 551, an obvious path for short-circuiting the winding of the control relay R530, thereby to cause the latter relay to restore, an obvious circuit for energizing the winding of the control relay R530 being normally completed from battery by way of the resistor 546. Shortly thereafter the ring-up relay R550 restores, thereby to interrupt, at the contacts 551, the previously mentioned path for short-circuiting the winding of the control relay R530 in order to cause the latter relay to reoperate. Upon restoring, the control relay R530 completes, at the contacts 531, a circuit for energizing in series the upper and lower windings of the start relay R520, this circuit extending from ground by way of the contacts 531, the lower winding of R520, the contacts 543 and the upper winding of R520 to battery. Shortly after the start relay R520 is thus energized this relay operates, the start relay R520 being of the slow-to-operate type. Upon operating, the start relay R520 completes, at the contacts 521, an obvious holding circuit substantially identical to that previously traced for energizing in series the upper and lower windings thereof, and completes, at the contacts 522, an obvious path for applying ground potential to the control conductor C594 of the trunk 590 extending to the toll line circuit 500, thereby to mark the trunk 590 as busy to the selectors of the switching links having access thereto. Further, the start relay R520 completes, at the contacts 525, an obvious path for applying ground potential to the control conductor C597 in the cable 1090. This application of ground potential to the control conductor C597 in the cable 1090 completes obvious multiple circuits for illuminating the individual line answer lamps L1045, L1145, etc., at the various operator positions at the switchboard in the P. A. B. X 30, thereby to indicate to the operators thereat that a call on the trunk 590 is waiting to be answered.

The call on the trunk 590 may be answered at any one of the operator positions at the switchboard in the P. A. B. X 30. For example, in order to answer the call on the trunk 590 at the first operator position 900, the operator thereat operates the individual line key K1160 in combination with the talk key of the finder of a selected one of the switching links in the group of switching links individually associated with the first operator position 900. Assuming that the switching link 800 is selected at this time, the talk key K780 of the finder 700 of the switching link 800 is operated away from its normal position, in the manner previously explained.

When the individual line key K1160 is operated away from its normal position there is completed, at the contacts 1162 thereof an obvious path for applying battery potential by way of the resistor 1122' to the marking conductor C1081 in the cable 1090, thereby to mark the rotary position of the contact sets in the contact banks of the switching mechanisms of the finders of the switching links in the group of switching links individually associated with the first operator position 900, wherein the trunk 590 is terminated. Also, at the contacts 1161 of the individual line key K1160, there is completed an obvious circuit for energizing in series the winding of the line marking relay R1180 and the lower winding of the lockout relay R1130. When thus energized,

the lockout relay R1130 and the line marking relay R1180 operate. Upon operating, the lockout relay R1130 completes at the contacts 1131 an obvious holding circuit for energizing in series the upper winding thereof and the winding of the line marking relay R1180, whereby both the upper and lower windings of the lockout relay R1130 are energized in multiple series relationship with respect to the winding of the line marking relay R1180. Also, upon operating, the lockout relay R1130 completes at the contacts 1133 an obvious path for applying ground potential to the start conductor C1078 in the cable 1091 extending to the first operator position 900, thereby to complete the previously traced circuit for energizing the upper winding of the start relay R755 in the finder 700 of the selected switching link 800 in order to initiate operation of the finder 700 in the manner previously explained. Further, the lockout relay R1130 completes at the contacts 1132 an obvious path for applying ground potential to the control conductor C1077 in the cable 1091 extending to the first operator position 900, thereby to complete an obvious path for applying ground potential to the control conductor C1077 in the cable 901 extending to the first operator position 900. This application of ground potential to the control conductor of C1077 in the cable 901 completes an obvious circuit for energizing the winding of the test relay R760 in the finder 700, thereby to cause operation thereof. Upon operating, the test relay R760 interrupts at the contacts 762 the previously traced connection between the control wiper 713 of the switching mechanism 710 and the upper winding of the switching relay R730, and completes at the contacts 761 an obvious connection between the control wiper 715 of the switching mechanism 710 and the upper winding of the switching relay R730. Accordingly, the operated test relay R760 transfers the upper winding of the switching relay R730 from the control wiper 713 to the control wiper 715 of the switching mechanism 710 for the purpose previously explained. Further, the lockout relay R1130 completes at the contacts 1134 an obvious path for applying ground potential to the marking conductor C1075 in the cable 1090, thereby to mark the vertical level in the contact banks of the switching mechanisms of the finders of the switching links, wherein the trunk 590 is terminated.

Upon operating, the line marking relay R1180 completes at the contacts 1184 an obvious path for applying ground potential to the control conductor C596 in the cable 1090, thereby to complete an obvious circuit for energizing the winding of the cutoff relay R540 in the toll line circuit 500. When thus energized, the cutoff relay R540 operates to complete at the contacts 542 an obvious circuit for energizing the winding of the control relay R560, thereby to cause the latter relay to operate. Also, the cutoff relay R540 interrupts at the contacts 543 the previously traced holding circuit for energizing in series the upper and lower windings of the start relay R520, thereby to cause the latter relay to restore. Upon restoring, the start relay R520 interrupts at the contacts 525 the previously mentioned path for applying ground potential to the control conductor C597 in the cable 1090, thereby to interrupt the previously mentioned circuits for illuminating the individual line answer lamps L1045, L1145, etc., at the various operator positions at the switchboard in order to indicate to the operators thereat that the call on the trunk 590 is being answered at one of the operator positions at the switchboard. Upon operating, the control relay R560 completes at the contacts 564 an obvious path for applying ground potential to the control conductor C598 in the cable 1090, thereby to complete obvious multiple circuits for illuminating the individual line busy lamps L1044, L1144, etc., at the various operator positions at the switchboard in order to indicate to the operators thereat that the trunk 590 is busy at this time.

Also, the line marking relay R1180 interrupts at the contacts 1181, 1182, 1183, etc., obvious paths for applying battery potential by way of the resistor 1193' to the various marking conductors including the marking conductors C1081, C1083, etc., for the purpose previously explained.

At this point, it is noted that, when the previously mentioned circuit for energizing the upper and lower windings of the lockout relay R1130 in multiple series relationship with respect to the winding of the line marking relay R1180 is completed, incident to the operation of the individual line key K1160 and the lockout relay R1130, resistance ground potential is applied by way of the upper winding of the lockout relay R1130, the contacts 1131, and the contacts 1161 of the individual line key K1160 to the control conductor C1165. This application of resistance ground potential to the control conductor C1165 positively prevents the lower winding of any of the other lockout relays in the group of lockout relays including the lockout relay R1130 from being adequately energized in order to cause operation thereof due to the facts that the resistance of the upper winding of the lockout relay R1130 is extremely low and that each of the lockout relays in this group of lockout relays is of the marginal type. Thus, it will be understood that, when any one of the individual line keys K1060, K1160, etc., in this group of individual line keys is operated, the associated lockout relay R1030, R1130, etc., is operated only in the event that there is no previously operated lockout relay in this group of lockout relays and, upon operating, the lockout relay in this group of lockout relays positively prevents operation of any other lockout relay in this group of lockout relays.

The finder 700 of the selected switching link 800 then operates in the manner previously explained, thereby to cause the switching mechanism 710 to seize the trunk 590; whereupon the operator at the first operator position 900 returns the individual line key K1160 to its normal position, thereby to interrupt, at the contacts 1162 thereof the previously mentioned path for applying battery potential by way of the resistor 1122' to the marking conductor C1081 in the cable 1090, and to interrupt at the contacts 1161 thereof the previously mentioned holding circuit for energizing the upper and lower windings of the lockout relay R1130 in multiple series relationship with respect to the winding of the line marking relay R1180, whereupon these relays restore. Upon restoring, the lockout relay R1130 interrupts at the contacts 1132 the previously traced circuit for energizing the winding of the test relay R760 in the finder 700, thereby to cause the latter relay to restore. Upon restoring, the test relay R760 completes at the contacts 762 the previously traced path for applying ground potential to the control wiper 713 of the switching mechanism 710 of the finder 700, thereby to complete a holding circuit for energizing the winding

of the cutoff relay R540 in the toll line circuit 500, this circuit extending from the grounded control wiper 713 of the switching mechanism 710 of the finder 700 by way of the control conductor C595 of the trunk 590, the contacts 545 and the winding of R540 to battery.

Further, the lockout relay R1130 interrupts at the contacts 1134 the previously mentioned path for applying ground potential to the marking conductor C1075 in the cable 1090. Upon restoring, the line marking relay R1180 interrupts at the contacts 1184 the previously mentioned path for applying ground potential to the control conductor C596 in the cable 1090, thereby to interrupt the previously traced original circuit for energizing the winding of the cutoff relay R540 in the toll line circuit 500. Further, the line marking relay R1180 recompletes at the contacts 1181, 1182, 1183, etc., the previously mentioned paths for applying battery potential by way of the resistor 1193' to the various marking conductors including the marking conductors C1081, C1083, etc. The application of battery potential by way of the resistor 1193' to the marking conductor C1081 in the cable 1090 completes a path including the control wiper 715 of the switching mechanism 710 and the contacts 734 for applying battery potential to the conductor C805 extending by way of the finder 700 and the trunk 821 to the selector 820, the test relay R760 being restored at this time to interrupt at the contacts 763 an obvious path for applying ground potential to the conductor C805. This application of battery potential to the conductor C805 extending by way of the finder 700 and the trunk 821 to the selector 820 causes operation of meter apparatus, not shown, in the selector 820, thereby to register the answering of a call at the first operator position 900 upon a trunk in the group of trunks including the trunk 590.

It is noted that, after the individual line key K1160 is returned to its normal position, battery potential is applied by way of the winding of the line marking relay R1180 to the control conductor C1165, thereby to render each of the individual line keys in this group of individual line keys operative to cause operation of the associated lockout relay in this group of lockout relays.

The extension and supervision of the established connection at the first operator position 900 are the same as that previously explained. The release of the established connection is initiated by the operator at the toll operator position 250 in the distant exchange 50. More particularly, the operator at the toll operator position 250 in the distant exchange 50 operates the apparatus thereat, thereby to cause ring-off current to be projected momentarily over the toll line 215, thereby to cause operation and subsequent restoration of the ring-up relay R550 in the toll line circuit 500. Upon operating, the ring-up relay R550 completes, at the contacts 551, the previously mentioned path for short-circuiting the winding of the control relay R530, thereby to cause the latter relay to restore. Upon restoring, the control relay R530 completes, at the contacts 531, a series circuit for energizing the lower winding of the start relay R520 and for illuminating the supervisory lamp L726, this circuit extending from ground by way of the contacts 531, the lower winding of R520, the contacts 544, the control conductor C593 of the trunk 590, the control wiper 714 of the switching mechanism 710, the conductors C804 and C813 in the finder 700, the contacts 784 of the talk key K780 and the supervisory lamp L726 to battery. The illumination of the supervisory lamp L726 at the first operator position 900 indicates to the operator thereat that the established connection, including the switching link 800, has been released. Also, when this circuit is completed the start relay R520 operates to complete an obvious holding circuit substantially identical to that previously traced for energizing the lower winding thereof. The operator at the first operator position 900 then effects the release of the swtiching link 800 in the manner previously explained. When the switching mechanism 710 is released the previously mentioned holding circuit for energizing the lower winding of the start relay R520 and the previously traced holding circuit for energizing the winding of the cutoff relay R540 are interrupted, thereby to cause the start relay R520 to restore immediately and the cutoff relay R540 to restore shortly thereafter, the cutoff relay R540 being of the slow-to-release type.

Upon restoring, the cutoff relay R540 interrupts, at the contacts 542, the previously mentioned circuit for energizing the winding of the control relay R560; however, the latter relay does not restore immediately, the control relay R560 being of the slow-to-release type. Also, the cutoff relay R540 completes, at the contacts 541, a circuit for energizing the windings of the ring-off relay R510, this circuit extending from ground by way of the contacts 541 and 561 and the winding of R510 to battery. When thus energized the ring-off relay R510 operates to complete, at the contacts 512 and 514, an obvious path for projecting ring-off current over the toll line 215 to the toll operator position 250 in the distant exchange 50, thereby to indicate to the operator thereat that the connection has been released in the P. A. B. X 30. Also, the ring-off relay R510 completes, at the contacts 515, an obvious circuit for energizing the winding of the guard relay R565, thereby to cause the latter relay to operate. Upon operating, the guard relay R565 completes, at the contacts 568, an obvious alternative path for applying ground potential to the control conductor C594 of the trunk 590, thereby to mark the trunk 590 as busy to the selectors of the switching links having access thereto. Further, the guard relay R565 completes, at the contacts 567, a holding circuit for energizing the winding thereof, this circuit extending from ground by way of the contacts 541, 566, 581 and 567 and the winding of R565 to battery. Shortly after the guard relay R565 operates, the control relay R560 restores to interrupt, at the contacts 561, the previously traced circuit for energizing the winding of the ring-off relay R510, thereby to cause the latter relay to restore shortly thereafter, the ring-off relay R510 being of the slow-to-release type. Upon restoring, the ring-off relay R510 interrupts, at the contacts 512 and 514, the previously mentioned path for projecting ring-off current over the toll line 215 and interrupts, at the contacts 515, the previously mentioned original circuit for energizing the winding of the guard relay R565. Further, the control relay R560 interrupts, at the contacts 564, the previously mentioned path for applying ground potential to the control conductor C598 in the cable 1090, thereby to interrupt the previously traced circuits for illuminating the individual line busy lamps L1044, L1144, etc., at the various operator positions at the switchboard in

order to indicate to the operators thereat that the trunk 590 is idle at this time.

Also, the guard relay R585 completes, at the contacts 566, a circuit for energizing the winding of the timer relay R570, this circuit extending from ground by way of the contacts 541, 566 and 577 and the winding of R570 to battery. When thus energized the timer relay R570 operates to complete, at the contacts 571 and 572, a circuit for energizing the winding of the hold relay R575, this circuit extending from ground by way of the contacts 541, 566, 572 and 571 and the winding of R575 to battery. Shortly after the hold relay R575 is thus energized this relay operates, the hold relay R575 being of the slow-to-operate type. Upon operating, the hold relay R575 completes, at the contacts 579, a holding circuit substantially identical to that previously traced for energizing the winding thereof and interrupts, at the contacts 577, the previously traced circuit for energizing the winding of the timer relay R570, thereby to cause the latter relay to restore. Also, the hold relay R575 completes, at the contacts 578, a circuit for energizing the winding of the count relay R585, this circuit extending from ground by way of the contacts 541, 566, 578 and 583, the winding of R585 and the resistor 507 to battery. When thus energized the count relay R585 operates to complete, at the contacts 587, a path for short-circuiting the upper winding of the count relay R580, this path extending from one terminal of the upper winding of the count relay R580 by way of the contacts 578, 583 and 587 to the other terminal of the upper winding of the count relay R580.

Upon restoring, the timer relay R570 interrupts, at the contacts 571 and 572, the original circuit for energizing the winding of the hold relay R575 and sets the armature RA570 thereof into vibration, whereupon the previously traced holding circuit for energizing the winding of the hold relay R575 is alternately completed at the contacts 572 and 573. After a predetermined time interval the armature RA570 assumes an intermediate position, thereby to interrupt, at the contacts 572 and 573, the previously traced holding circuit for energizing the winding of the hold relay R575 in order to cause the latter relay to restore. Upon restoring, the hold relay R575 interrupts, at the contacts 578, the previously traced path for short-circuiting the upper winding of the count relay R580, whereupon a circuit is completed for energizing in series the upper winding of the count relay R580 and the winding of the count relay R585, this circuit extending from ground by way of the contacts 541, 566, the upper winding of R580, the contacts 587, the winding of R585 and the resistor 507 to battery. When thus energized the count relay R580 operates. Also, upon restoring, the hold relay R575 recompletes, at the contacts 577, the previously traced circuit for energizing the winding of the timer relay R570, thereby to cause the latter relay to operate, whereupon the previously traced circuit for energizing the winding of the hold relay R575 is recompleted. The hold relay R575 then reoperates to complete, at the contacts 578, a path for short-circuiting the winding of the count relay R585 in series with the upper winding of the count relay R580, this path extending from one terminal of the upper winding of the count relay R580 by way of the contacts 578 and 584, the winding of the count relay R585 and the contacts 587 to the other terminal of the upper winding of the count relay R580. When this short-circuiting path is completed the count relay R585 restores. However, the count relay R580 is retained in its operated position due to a completed holding circuit for energizing the lower winding thereof, this holding circuit extending from ground by way of the contacts 541, 566, 578 and 582 and the lower winding of R580 to battery. Also, the hold relay R575 interrupts, at the contacts 577, the previously traced circuit for energizing the winding of the timer relay R570, thereby to cause the timer relay R570 to restore and effect the restoration of the hold relay R575 shortly thereafter. Upon restoring, the hold relay R575 interrupts, at the contacts 578, the previously traced holding circuit for energizing the lower winding of the count relay R580, thereby to cause the latter relay to restore shortly thereafter, the count relay R580 being of the slow-to-release type. Finally, the hold relay R575 interrupts, at the contacts 576, a holding circuit for energizing the winding of the guard relay R565, the last-mentioned circuit extending, when completed, from ground by way of the contacts 541, 566, 576 and 567 and the winding of R565 to battery. When this holding circuit is interrupted the guard relay R565 restores to interrupt, at the contacts 568, the previously mentioned path for applying ground potential to the control conductor C594 of the trunk 590 and to complete, at the contacts 569, a path for applying battery potential by way of the winding of the cutoff relay R540 to the control conductor C594 of the trunk 590, this path extending from battery by way of the winding of R540 and the contacts 523 and 569 to the control conductor C594 of the trunk 590. This application of battery potential to the control conductor C594 of the trunk 590 marks the trunk 590 as idle to the selectors of the switching links having access thereto. The apparatus included in the established connection between the operator position 250 at the distant exchange 50 and the first operator position 900 in the P. A. B. X 30 is completely released and available for further use at this time.

The call on the trunk 590 may be answered at any other operator position at the switchboard in the P. A. B. X 30. For example, the call on the trunk 590 may be answered at the last operator position 910 at the switchboard by operating the individual line key K1060 in combination with the talk key of the finder of a selected one of the switching links in the group of switching links individually associated with the last operator position 910. More particularly, when the individual line key K1060 is operated away from its normal position there is completed, at the contacts 1062 thereof, an obvious path for applying battery potential by way of the resistor 1022' to the marking conductor C1083 in the cable 1090. The application of battery potential to the marking conductor C1083 in the cable 1090 marks the rotary position of the contact sets in the contact banks of the switching mechanisms of the finders of the switching links in the group of switching links individually associated with the last operator position 910, wherein the trunk 590 is terminated. Also, at the contacts 1061 of the individual line key K1060, there is completed, an obvious circuit for energizing in series the lower winding of the lockout relay R1030 and the winding of the line marking relay R1180, thereby to cause operation of the lockout relay R1030 and

the line marking relay R1180. Upon operating, the lockout relay R1030 completes, at the contacts 1031, an obvious holding circuit for energizing in series the upper winding thereof and the winding of the line marking relay R1180, whereupon the upper and lower windings of the lockout relay R1030 are energized in multiple series relationship with respect to the winding of the line marking relay R1180 in order to prevent operation of the other lockout relays in this group of lockout relays in the manner previously explained.

Also, the lockout relay R1030 completes at the contacts 1034 an obvious path for applying ground potential to the marking conductor C1075 in the cable 1090. The application of ground potential to the marking conductor C1075 in the cable 1090 marks the vertical level in the contact banks of the switching mechanisms of the finders of the switching links, wherein the trunk 590 is terminated. Further, the lockout relay R1030 completes at the contacts 1032 and 1033, respectively, obvious paths for applying ground potential to the control conductor C1071 in the cable 1092 and to the start conductor C1070 in the cable 1092. The application of ground potential to the control conductor C1071 and to the start conductor C1070 causes operation of the finder of a selected switching link in the group of switching links individually associated with the last operator position 910 in the manner previously explained.

Upon operating, the line marking relay R1180 completes at the contacts 1184 the previously mentioned path for applying ground potential to the control conductor C596 in the cable 1090, thereby to complete the previously traced circuit for energizing the winding of the cutoff relay R540 in the toll circuit 500 as previously explained. Further, the line marking relay R1180 interrupts at the contacts 1181, 1182, 1183, etc., the previously mentioned paths for applying battery potential by way of the resistor 1193' to the various marking conductors including the marking conductor C1081, C1083, etc., for the purpose previously explained. The subsequent operation of the apparatus individually associated with the last operator position 910 to answer the call and to extend, to supervise and to release the established connection is the same as that previously explained.

At this point, it is noted that the resistance of each of the resistors 1022, 1022', 1122, 1122', etc., is relatively low in order to cause the finders of the various switching links to switch through upon marking battery by way of these resistors as previously explained, whereas the resistance of each of the resistors 1193, 1193', etc., is relatively high in order to prevent the finders of the various switching links from switching through upon metering battery by way of these resistors.

Extension of calls from the switchboard in the P. A. B. X

As previously explained, when the operator at any one of the operator positions at the switchboard in the P. A. B. X 30 operates the position equipment thereat to answer a call to the switchboard, she operates the position equipment at the operator position further, thereby to extend the call from the switchboard to its destination. More particularly, the key sender apparatus included in the position equipment at the operator position answering a call to the switchboard is selectively controlled, thereby selectively to govern the operation of the selector of the selected switching link in the group of switching links individually associated with the operator position.

For example, a call answered at the first operator position 900 at the switchboard upon the finder 700 of the switching link 800 may be extended by way of the selector 820 to a subscriber substation, such as the subscriber substation T3 in the P. A. B. X 30, by selectively controlling the key sender apparatus at the first operator position 900, thereby to cause the selector 820 of the switching link 800 to seize an idle trunk in the group of trunks extending to the local switch train in the P. A. B. X 30. For example, the call may be extended from the selector 820 of the switching link 800 by way of the trunk 945 and the local connector 941 in the local switch train in the P. A. B. X 30 and the telephone line 930 to the called subscriber substation T3. The operation of the local connector 941 incident to the selection of the telephone line 930 extending to the subscriber substation T3 is in accordance with conventional practice.

After the subscriber at the called subscriber substation T3 answers the call, the operator at the first operator position 900 returns the talk key K780 of the finder 700 of the switching link 800 back to its normal position, thereby to complete an established connection to the called subscriber substation T3 independent of the position equipment at the first operator position 900. The release of this established connection is primarily under the control of the operator at the first operator position 900 and is effected in accordance with conventional practice in order to cause the selector 820 of the switching link 800 to be released. When the selector 820 is released the local connector 941 is released; whereupon the line circuit 931 individually associated with the telephone line 930 extending to the subscriber substation T3 operates, thereby to mark the telephone line 930 as idle to the local connectors having access thereto.

Also, a call answered at the first operator position 900 at the switchboard upon the finder 700 of the switching link 800 may be extended by way of the selector 820 to the operator position 240 in the central office 20 by selectively controlling the key sender apparatus at the first operator position 900, thereby to cause the selector 820 of the switching link 800 to seize an idle trunk in the group of trunks extending to the group of outgoing trunk line circuits. For example, the call may be extended from the selector 820 of the switching link 800 by way of the trunk 305, the outgoing trunk line circuit 360 and the trunk line 200 to the operator position 240 in the central office 20.

The operator at the operator position 240 then answers the call and extends it to its destination in the central office 20 in accordance with conventional practice. The release of this established connection is primarily under the control of the operator at the first operator position 900 and is effected in accordance with conventional practice in order to cause the selector 820 of the switching link 800 to be released. When the selector 820 is released a release signal is transmitted over the trunk line 200 to the operator position 240 in the central office 20, whereupon the operator at the operator position 240 releases the connection in the central office 20 in accordance with conventional practice.

Further, a call answered at the first operator position 900 at the switchboard upon the finder

700 of the switching link 800 may be extended by way of the selector 820 to the operator position 260 in the I. B. X 40 by selectively controlling the key sender apparatus at the first operator position 900, thereby to cause the selector 820 of the switching link 800 to seize an idle trunk in the group of trunks extending to the group of trunk line circuits. For example, the call may be extended from the selector 820 of the switching link 800 by way of the trunk 460, the trunk line circuit 400 and the trunk line 210 to the operator position 260 in the I. B. X 40.

The operator at the operator position 260 then answers the call and extends it by way of the switch train in the I. B. X 40 to its destination, in accordance with conventional practice. The release of this established connection is primarily under the control of the operator at the first operator position 900 and is effected in accordance with conventional practice in order to cause the selector 820 of the switching link 800 to be released. When the selector 820 is released a release signal is transmitted over the trunk line 210 to the operator position 260 in the I. B. X 40, whereupon the operator at the operator position 260 releases the connection in the I. B. X 40, in accordance with conventional practice.

Finally, a call answered at the first operator position 900 at the switchboard upon the finder 700 of the switching link 800 may be extended by way of the selector 820 to the toll operator position 250 in the distant exchange 50 by selectively controlling the key sender apparatus at the first operator position 900, thereby to cause the selector 820 of the switching link 800 to seize an idle trunk in the group of trunks extending to the group of toll line circuits. For example, the call may be extended from the selector 820 of the switching link 800 by way of the trunk 590, the toll line circuit 500 and the toll line 215 to the operator position 250 in the distant exchange 50.

The operator at the operator position 250 then answers the call and extends it to its destination in accordance with conventional practice. The release of this established connection is primarily under the control of the operator at the first operator position 900 and is effected in accordance with conventional practice in order to cause the selector 820 of the switching link 800 to be released. When the selector 820 is released a release signal is transmitted over the toll line 215 to the operator position 250 in the distant exchange 50, whereupon the operator at the operator position 250 releases the connection in the distant exchange 50 in accordance with conventional practice.

Delayed calls in the P. A. B. X

The operator at each operator position at the switchboard in the P. A. B. X 30 may set up a delayed call by utilizing any one of the switching links in the group of switching links associated with the operator position. For example, the operator at the first operator position 900 may set up a delayed call by utilizing the switching link 800 in the group of switching links individually associated with the first operator position 900. More particularly, the finder 700 of the switching link 800 is first controlled in order to extend the delayed call in one direction and then the selector 820 of the switching link 800 is controlled in order to extend the delayed call in the other direction.

For example, the finder 700 may be controlled to extend the delayed call by way of an idle trunk in the associated group to the local switch train in the P. A. B. X 30 and therefrom to a subscriber substation therein by operating the talk key K780 of the finder 700 in combination with a delayed call key, not shown, in the position equipment at the first operator position. When the talk key K780 and the delayed call key are thus operated the finder 700 operates automatically to find a trunk extending to an idle delayed call selector, not shown, accessible thereto in the manner explained in the previously mentioned Voss and Crocker patent.

Also, the finder 700 may be controlled to extend the delayed call by way of an idle trunk line in the associated group to the operator position 240 in the central office 20 by operating the talk key K780 of the finder 700 in combination with the group line key K1150. When the talk key K780 and the group line key K1150 are thus operated the finder 700 operates automatically to find an idle trunk in the group of trunks, including the trunk 305, in a manner similar to that previously explained.

Further, the finder 700 may be controlled to extend the delayed call by way of any particular trunk line in the associated group to the operator position 260 in the I. B. X 40 by operating the talk key K780 of the finder 700 in combination with the corresponding one of the individual line keys in the associated group. For example, the finder 700 may be controlled to extend the delayed call by way of the particular trunk line 210 in the associated group to the operator position 260 in the I. B. X 40 by operating the talk key K780 of the finder 700 in combination with the individual line key K1165 in the associated group. When the talk key K780 and the individual line key K1165 are thus operated the finder 700 operates automatically to seize the particular trunk 460 in the associated group connected by way of the trunk line circuit 400 to the trunk line 210 extending between the operator position 260 in the I. B. X 40 and the P. A. B. X 30, in the manner previously explained. At this point it is noted that the finder 700 operates to seize the particular trunk 460 in the associated group, regardless of the idle or busy condition thereof, in view of the fact that the upper winding of the switching relay R730 in the finder 700 is energized by way of the control wiper 715 instead of the control wiper 713 in the switching mechanism 710 in the present example. Accordingly, the idle or busy condition of the particular trunk 460 in the associated group exercises no control upon the operation of the finder 700 to seize the particular trunk 460.

Further, the finder 700 may be controlled to extend the delayed call by way of any particular toll line in the associated group of toll lines to the toll operator position 250 in the distant exchange 50 by operating the talk key K780 of the finder 700 in combination with the corresponding one of the individual line keys in the associated group. For example, the finder 700 may be controlled to extend the delayed call by way of the particular toll line 215 in the associated group to the operator position 250 in the distant exchange 50 by operating the talk key K780 of the finder 700 in combination with the individual line key K1160 in the associated group. When the talk key K780 and the individual line key K1160 are thus operated the finder 700 operates automatically to seize the particular trunk 590 in the associated group connected by way of the toll line circuit 500 to the toll line 215 extending between

the operator position 250 in the distant exchange 50 and the P. A. B. X 30, in the manner previously explained. At this point it is noted that the finder 700 operates to seize the particular trunk 590 in the associated group, regardless of the idle or busy condition thereof, in view of the fact that the upper winding of the switching relay R730 in the finder 700 is energized by way of the control wiper 715 instead of the control wiper 713 in the switching mechanism 710 in the present example. Accordingly, the idle or busy condition of the particular trunk 590 in the associated group exercises no control upon the operation of the finder 700 to seize the particular trunk 590.

The control of the selector 820 to extend the delayed call to a local subscriber substation in the P. A. B. X 30, to the operator position 240 in the central office 20, to the operator position 260 in the I. B. X 40 or to the operator position 250 in the distant exchange 50 is the same as that previously explained. Finally, the release of a delayed call routed by way of the switching link 800 is primarily under the control of the operator at the first operator position 900 and is effected in the manner previously explained.

Local calls in the P. A. B. X and the I. B. X

Local calls in the P. A. B. X 30 are completed and released between the automatic subscriber substations therein by way of the local switch train in the P. A. B. X 30 and entirely under the control of the subscribers at the subscriber substations in accordance with conventional practice.

Also, local calls in the I. B. X 40 are completed and released between the automatic subscriber substations therein by way of the switch train in the I. B. X 40 and entirely under the control of the subscribers at the subscriber substations in accordance with conventional practice. Furthermore, calls in the I. B. X 40 between the subscriber substations and the operator position 260 are completed in either direction by way of the switch train therein in accordance with conventional practice.

Conclusions

From the foregoing it is apparent that a telephone system is provided which comprises an exchange, including an automatic switchboard provided with a number of operator positions, and improved switching apparatus selectively controllable from the operator positions for performing the various toll and trunk services in an efficient manner, thereby to insure that the toll and trunk calls may be easily set up and supervised at the operator positions at the switchboard.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system, a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, means responsive to the presence of a call on any one of said lines for transmitting a signal to each of said operator positions identifying the one line, normally effective means selectively controllable from each of said operator positions for causing the associated switch to operate and select any particular calling one of said lines, thereby to extend the call on said last-mentioned line to said last-mentioned operator position to be answered, and means controlled while one of said switches is operating to select a given line for restricting the operation of each of the other of said switches, whereby each of the other of said switches is operative to select any particular one of said lines except said given line while said one switch is operating to select said given line.

2. In a telephone system, a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, means responsive to the presence of a call on any one of said lines for transmitting a signal to each of said operator positions identifying the one line, a plurality of devices at each of said operator positions individually corresponding to said lines, the devices at said operator positions corresponding to the same line constituting a group, a plurality of relays individually associated with said devices, the relays associated with the same group of said devices constituting a group, means responsive to the first device operated in any given group of devices for causing operation of the associated relay in the associated group of relays and for preventing operation of the remainder of the relays in the associated group of relays, and means responsive to the operation of any given relay in any given group of relays for causing the associated switch to select the corresponding line, thereby to extend the call on said last-mentioned line to the associated operator position to be answered.

3. In a telephone system, a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, normally effective means selectively controllable from each of said operator positions for causing the associated switch to operate and select any particular one of said lines, thereby to complete a connection between the operator position and said last-mentioned line, and means controlled while one of said switches is operating to select a given line for restricting the operation of each of the other of said switches, whereby each of the other of said switches is operative to select any particular one of said lines except said given line while said one switch is operating to select said given line.

4. In a telephone system, a plurality of lines, a plurality of operator positions, signal means for indicating at said operator positions the idle or busy condition of each of said lines, a plurality of automatic switches individually associated with said operator positions and having access to said lines, normally effective means selectively controllable from each of said operator positions for causing the associated switch to operate and select any particular one of said lines regardless of the idle or busy condition thereof, thereby to complete a connection between the operator position and said last-mentioned line, means controlled when an idle line is selected by one of said switches for rendering it busy and for governing said signal means, and means controlled while one of said switches is operating to select a given line for restricting the operation of each of the other of said switches, whereby each of the other of said switches is operative to select any particular one of said lines except said given line while said one switch is operating to select said given line.

5. In a telephone system, a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, position equipment at each of said operator positions normally controllable to cause the associated switch to operate and select any particular one of said lines, thereby to complete a connection between the operator position and said last-mentioned line, and means governed when the position equipment at one of said operator positions is controlled for restricting the control of the position equipment at each of the other of said operator positions, whereby the operation of each of the other of said switches is restricted to that of selecting any particular one of said lines except a given line while one of said switches is operating to select said given line.

6. In a telephone system, a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, a plurality of normally effective devices at each of said operator positions individually corresponding to said lines, any given device at any given operator position being operative only when it is effective to cause the associated switch to operate and select the corresponding line, thereby to complete a connection between said given operator position and said last-mentioned line, and means controlled by the operation of any given device at any given operator position for rendering ineffective only the other of the corresponding devices at the other of said operator positions.

7. In a telephone system, a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, each of said switches being operative to select a marked line, thereby to complete a connection between the associated operator position and said last-mentioned line, means controllable from each of said operator positions for initiating operation of the associated switch, means controlled when one of said switches selects a marked line for arresting operation thereof, a plurality of normally effective devices at each of said operator positions individually corresponding to said lines, any given device at any given operator position being operative only when it is effective to mark the corresponding line, and means controlled by the operation of any given device at any given operator position for rendering ineffective only the other of the corresponding devices at the other of said operator positions.

8. In a telephone system, a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, each of said switches being operative to select a marked line, thereby to complete a connection between the associated operator position and said last-mentioned line, means controllable from each of said operator positions for marking any particular one of said lines, a plurality of normally effective devices at each of said operator positions individually corresponding to said lines, any given device at any given operator position being operative only when it is effective to initiate operation of the associated switch, means controlled when one of said switches selects a marked line for arresting operation thereof, and means controlled by the operation of any given device at any given operator position for rendering ineffective only the other of the corresponding devices at the other of said operator positions.

9. In a telephone system, a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, each of said switches being operative to select a marked line, thereby to complete a connection between the associated operator position and said last-mentioned line, a plurality of normally effective devices at each of said operator positions individually corresponding to said lines, any given device at any given operator position being operative only when it is effective to mark the corresponding line and to initiate operation of the associated switch, means controlled when one of said switches selects a marked line for arresting operation thereof, and means controlled by the operation of any given device at any given operator position for rendering ineffective only the other of the corresponding devices at the other of said operator positions.

10. In a telephone system, a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, a plurality of devices at each of said operator positions individually corresponding to said lines, the devices at said operator positions corresponding to the same line constituting a group, a plurality of relays individually associated with said devices, the relays associated with the same group of said devices constituting a group, means responsive to the first device operated in any given group of devices for causing operation of the associated relay in the associated group of relays and for preventing operation of the remainder of the relays in the associated group of relays, and means responsive to the operation of any given relay in any given group of relays for causing the associated switch to operate and select the corresponding line, thereby to complete a connection between the associated operator position and said last-mentioned line.

11. In a telephone system, a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, a plurality of devices at each of said operator positions individually corresponding to said lines, the devices at said operator positions corresponding to the same line constituting a group, a plurality of relays individually associated with said devices, the relays associated with the same group of said devices constituting a group, a plurality of normally effective operating circuits and a plurality of holding circuits for said relays, means responsive to the first device operated in any given group of devices for completing the operating circuit of the associated relay, thereby to cause operation thereof, means responsive to the operation of any given relay for completing the holding circuit thereof and for causing the associated switch to select the corresponding line, thereby to complete a connection between the associated operator position and said last-mentioned line, and means controlled when the holding circuit of any given relay in any given group of relays is completed for rendering ineffective the operating circuits of the other of the relays in said given group of relays in order to prevent operation thereof.

12. In a telephone system, a plurality of lines,

a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, each of said switches being operative to select a marked line, thereby to complete a connection between the associated operator position and said last-mentioned line, a plurality of devices at each of said operator positions individually corresponding to said lines, the devices at said operator positions corresponding to the same line constituting a group, a plurality of relays individually associated with said devices, the relays associated with the same group of said devices constituting a group, means responsive to the first device operated in any given group of devices for causing operation of the associated relay in the associated group of relays and for preventing operation of the remainder of the relays in said given group of relays, means responsive to the operation of any given relay in any given group of relays for marking the corresponding line and for initiating operation of the associated switch, and means controlled when one of said switches selects a marked line for arresting operation thereof.

13. In a telephone system, a plurality of lines, a plurality of operator positions, a plurality of automatic switches individually associated with said operator positions and having access to said lines, a plurality of keys at each of said operator positions individually corresponding to said lines, the keys at said operator positions corresponding to the same line constituting a group, a plurality of relays individually associated with said keys, the relays associated with the same group of said keys constituting a group, a plurality of operating circuits for said relays, each of said keys being operative to complete the operating circuit of the associated relay, the relays in any given group of relays being so connected and arranged that only the relay in said given group of relays the operating circuit of which is first completed is operated, and means responsive to the operation of any given relay in any given group of relays for causing the associated switch to select the corresponding line, thereby to complete a connection between the associated operator position and said last-mentioned line.

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