

Feb. 23, 1926.

R. S. BAILEY
TELEPHONE EXCHANGE SYSTEM

1,573,794

Filed Nov. 12, 1923

2 Sheets-Sheet 1

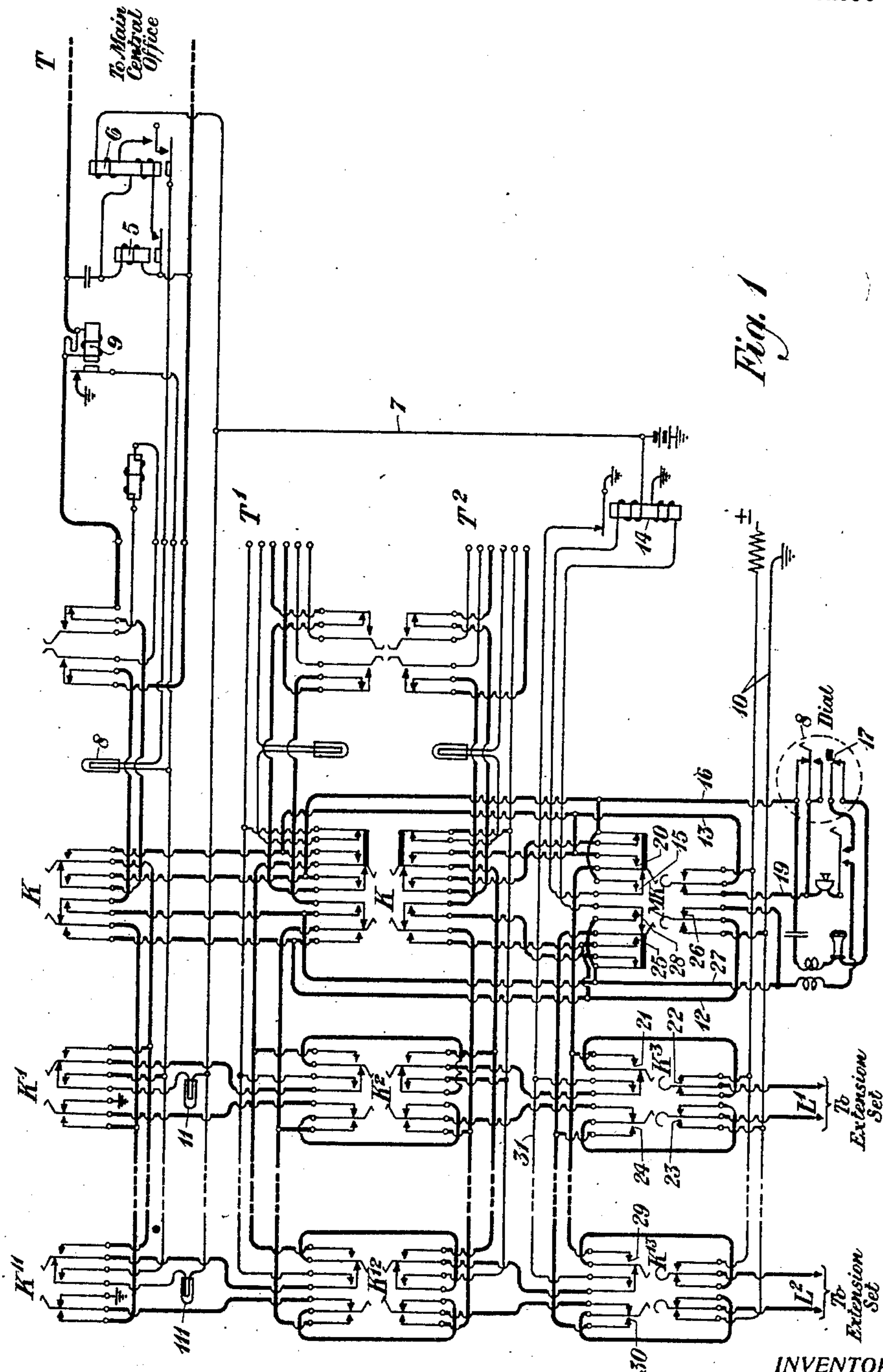


Fig. 1

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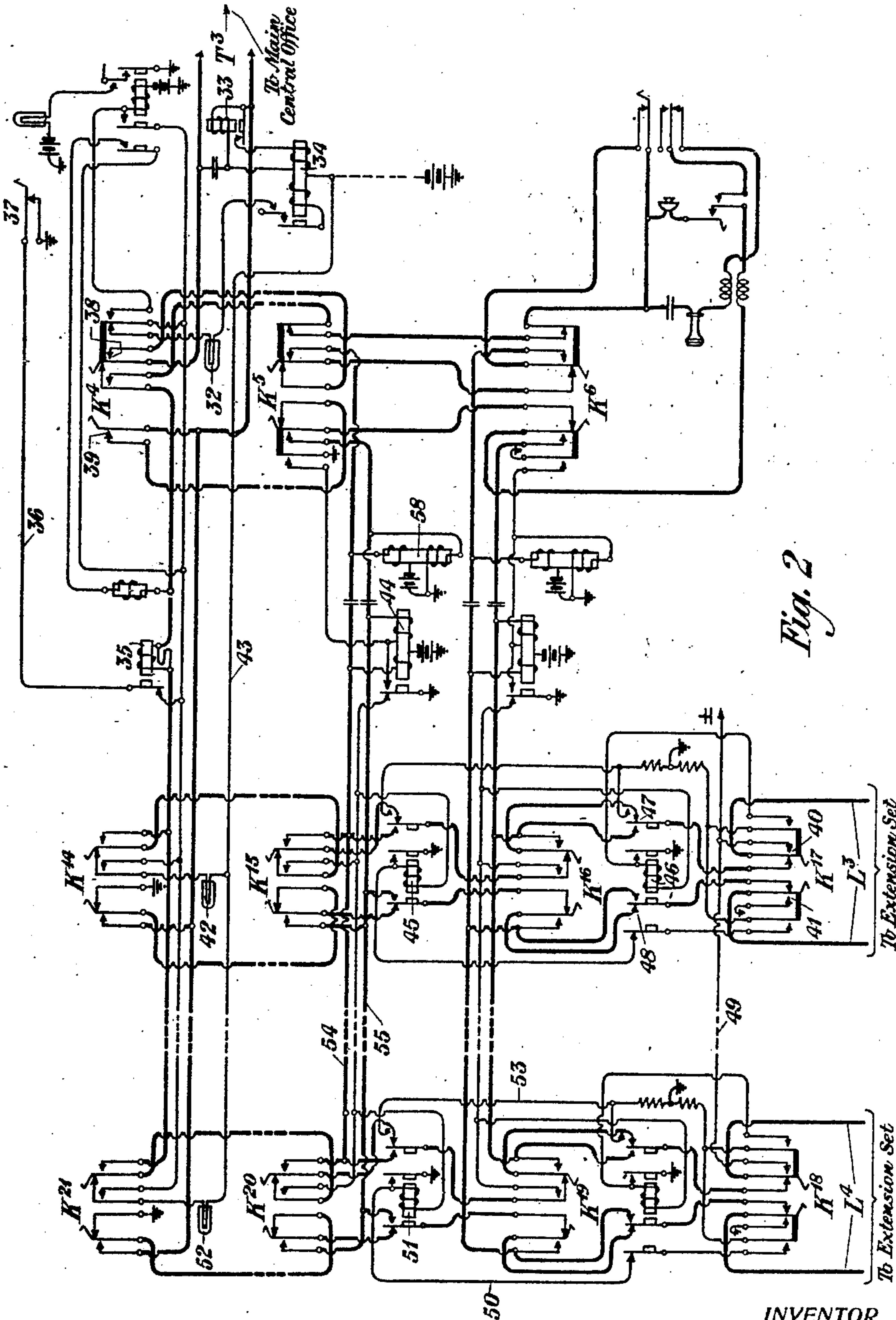


Fig. 2

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RAND S. BAILEY, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed November 12, 1923. Serial No. 674,301.

To all whom it may concern:

Be it known that I, RAND S. BAILEY, residing at Montclair, in the county of Essex and State of New Jersey, have invented certain Improvements in Telephone-Exchange Systems, of which the following is a specification.

This invention relates to telephone exchange systems, and more particularly to circuit arrangements for use at private branch exchanges.

An object of the invention is to provide an improved circuit for use at a private branch exchange to interconnect subscribers' extensions of the private branch exchange and to connect the subscribers' extensions of the private branch exchange with trunk lines leading to a main central office.

A feature of the invention consists in providing a circuit arrangement for this purpose which is of a simple and efficient character and which requires only a minimum amount of apparatus for its operation.

For a more complete understanding of the invention, reference may be had to the accompanying drawings in which Figures 1 and 2 illustrate embodiments of the invention applied to a private branch exchange.

Referring to Fig. 1 of the drawings, T represents a trunk which extends from a private branch exchange to a main central office and which is provided with supervisory and holding equipment. T¹ and T² represent additional trunks similar to trunk T but with said supervisory and holding equipment eliminated. Keys K are provided for the purpose of connecting the attendant's telephone set with the trunks, and additional keys which are serially connected with each other and associated with each trunk are also provided for connecting the subscribers' extensions with said trunks. These keys when thrown to a ringing position are also adapted to signal the subscribers connected with the extensions individually, and a master key MK is also provided for signaling any of the extensions. In Fig. 2, T³ represents a trunk extending from a private branch exchange to the main central office and K⁴ the key by which the private branch exchange attendant may connect the telephone set with said trunk. Additional trunks or transmission circuits

which are local to the branch exchange, are provided for the purpose of interconnecting the extensions, as will later appear. While the circuits shown in Figs. 1 and 2 are provided with a certain number of trunks and keys, it will be obvious that this number may be increased as desired.

In the operation of the improved arrangement, it will be assumed that a subscriber at the main central office desires to be connected to a subscriber at one of the extensions associated with the private branch exchange shown in Fig. 1. Ringing current will be transmitted over the tip and ring conductors of trunk T from the main central office thereby energizing relay 5. The operation of relay 5 closes a circuit through the lower winding of relay 6 thereby bridging the latter relay across the trunk causing it to operate in an obvious manner. The operation of relay 6 closes a locking circuit from battery, conductor 7, upper winding and make contacts of relay 6, filament of lamp 8, grounded back contact of supervisory relay 9, thus lighting the trunk lamp 8. The attendant at the private branch exchange, upon observing the trunk signal 8, actuates key K, thereby bridging the attendant's set across the tip and ring conductors of the trunk T, causing the operation of supervisory relay 9. The operation of relay 9 opens the locking circuit previously described in connection with relay 6, causing it to be released and the trunk lamp 8 extinguished. The attendant, upon connecting the telephone set with the trunk T and learning the number of the desired extension from the operator at the main central office restores key K thereby releasing relay 9, and actuates a key associated with such extension. In this instance it will be assumed that the desired extension is connected to the leads L¹ and that keys K¹ and K³ are operated. The operation of key K¹ connects the talking conductors leading to the extension with the tip and ring conductors of trunk T. The operation of key K³ to a ringing position causes ringing current to be impressed on the conductors of the extension to signal the subscriber over the following circuit: From ground and source of current, conductors 10, make contacts of key K³, conductors L¹, through the signal at the subscriber's extension. In response to the

signal the subscriber removes the receiver from its hook and converses with the party at the main central office. When the receiver at the extension is restored to its hook, a circuit is completed from battery, conductor 7, filament of lamp 11, inner make contact of key K^1 to grounded back contact of supervisory relay 9. The closure of this circuit causes the illumination of lamp 11. This serves as a signal to the attendant that the subscriber has terminated the call and that the key K^1 may be restored to normal. The restoration of said key extinguishes lamp 11.

A master key such as is indicated at MK for ringing any subscribers' extension at the private branch exchange may be provided instead of key K^3 which is used for ringing individual extensions. Assuming extension L^1 is desired the operation of key MK closes a circuit from ground and battery, over conductors 10, make contacts of key MK, conductors 12 and 13, outer make contacts of keys K and K^1 , these keys being operated at this time, through normal contacts of keys K^2 and K^3 , over the conductors L^1 leading to the subscriber's extension and through the polarized ringer, thus signaling the subscriber in the customary manner.

The initiation of a call by a subscriber at one of the extensions causes the illumination of the lamp associated with that extension. For instance, if the calling extension is connected with the conductors L^1 , the removal of the receiver from the switch hook at that extension closes a circuit from battery, conductor 7, filament of lamp 11, right-hand normal contact of key K^1 , grounded left-hand normal contact of said key, normal contacts of keys K^2 and K^3 , conductors L^1 , through the switch hook at the extension. In response to the lighting of lamp 11, the attendant operates keys MK and K^3 to a listening position thereby connecting the attendant and subscriber, talking battery for such connection being furnished over the following path: battery, upper winding of relay 14, contact 15 of key MK, conductor 16, attendant's telephone receiver, contact 17 of dial 18, attendant's switch hook and transmitter, conductors 19 and 13, make contact 20 of key MK, contacts 21 and 22 of key K^3 , conductors L^1 through subscriber's telephone, contacts 23 and 24 of key K^3 , contact 25 of key MK, conductor 12, contact 26 of key MK, conductor 27, contact 28, lower winding of relay 14 to ground. The subscriber informs the attendant of the number desired and restores the receiver at the extension to its hook it being assumed that the call is for a connection with the main central office. The attendant, upon learning the number of the desired connection restores keys K^3 and MK and operates the key associated with the idle trunk, for

instance key K. The operation of this key bridges the attendant's telephone set across the tip and ring conductors of the trunk T, causing illumination of a lamp at the main central office in the usual manner. In response to such signal, the operator at the main central office associates her telephone set with the incoming trunk and completes the connection desired. The attendant at this time operates keys K^1 and K^3 connected with the leads L^1 thereby ringing the subscriber as formerly outlined. When the extension is connected with the central office through supervision is provided, and supervisory relay 9 is operated over the talking conductors of the trunk and connected extension. When the extension subscriber hangs up the receiver, the supervisory relay 9 releases and causes the illumination of lamp 11 as a disconnect signal over a circuit formerly outlined. The attendant upon noting the lighting of this lamp restores key K^1 causing the circuit to return to normal.

If upon operating key MK and K^3 to a talking position it is found the connection desired is for another subscriber at the same private branch exchange, for instance, a subscriber connected with leads L^2 , the attendant restores key MK to normal and operates key K^{13} to a ringing position thereby completing a circuit from ground and source of current supply, conductors 10, lower make contacts of key K^{13} , conductors L^2 through the polarized ringer at the extension. The attendant after ringing on extension L^2 , restores key K^{13} to a talking position so that the conductors L^2 are bridged across the talking conductors through contacts 29 and 30 of key K^{13} as is also conductors L^1 through contacts 21 and 24 of key K^3 . The subscribers are thus connected with each other, talking current being supplied from battery and ground through the windings of relay 14 and the inner normal make contacts of key MK to said talking conductors. The connection of battery and ground through the windings of relay 14, in the manner indicated, causes its energization during the period of conversation between the subscribers, and until both restore their receivers to their hooks, at which time the lamps 11, 111 associated respectively with the extensions L^1 and L^2 will light as disconnect signals over the following circuit: from battery, conductor 7, filament of lamp 11, right-hand normal contacts of keys K^1 and K^2 , inner right-hand make contact of key K^3 , conductor 31 to grounded armature of relay 14. The circuit for lighting lamp 111 continues from conductor 7, through filament of said lamp, right-hand normal contacts of keys K^{11} and K^{12} , right-hand inner make contact of key K^{13} to ground over conductor 31. The attendant, upon noting the

illumination of lamps 11 and 111 operates keys K^3 and K^{13} to their normal position and the circuit is restored to normal.

The key MK may be also used to signal the called subscriber at the private branch exchange over the path previously outlined. In such instance, however, the key of the subscriber at the calling extension must be disconnected from the conductors during the ringing interval and the key connected with the called subscriber operated.

In the modification shown in Fig. 2 of the drawings, an incoming call from a main central office is indicated by the lighting of line lamp 32 in the following manner:

The operator at the main central office impresses ringing current on the tip and ring conductors of trunk T^3 in the usual way and causes the operation of relay 33 which is bridged across said trunk. The operation of relay 33 closes a circuit through its make contact and left-hand winding of relay 34, which bridges the latter relay across the talking conductors of the trunk and causes its operation. The operation of relay 34 closes a locking circuit through its winding and make contact from battery, filament of lamp 32, right normal contact of key K^4 , back contact of relay 35, conductor 36 to grounded contact of key 37, thereby lighting lamp 32.

The attendant, in response to the lighting of lamp 32, operates key K^4 and breaks the circuit just described for lighting lamp 32, causing it to be extinguished. The operation of key K^4 also bridges the attendant's telephone set across the tip and ring conductors of trunk T^3 through contacts 38 and 39 of said key and through the inner contacts of keys K^5 and K^6 , permitting the attendant to converse with the main central office. Assuming the call is for connection with an extension such as that terminating in conductors L^3 , the attendant operates key K^{17} causing the ringing current to be transmitted from source of current, make contact 40 of said key, over conductors L^3 through the customary polarized ringer at the subscriber's extension to grounded make contact 41. The attendant restores key K^{17} after ringing the called extension and operates key K^{14} which is associated with the incoming trunk T^3 connecting the subscriber's extension set to the tip and ring conductors of said trunk through the make contacts of key K^{14} and the normal contacts of keys K^{15} and K^{16} , thus permitting the subscriber connected with the leads L^3 to talk over the trunk T^3 with the main central office. Upon the termination of the conversation, when the receiver at the extension has been returned to its hook, lamp 42 lights as a disconnect signal whereupon the attendant restores K^4 and the circuit returns to normal.

Upon the initiation of a call from one of the subscribers' extensions, the removal of the receiver from its hook causes the illumination of the line lamp associated with that extension. For instance, if the subscriber 70 connected with leads L^3 originates a call, a circuit is established from battery, conductor 43, lamp 42, normal contacts of key K^{14} , the left-hand contact being grounded, inner normal contacts of keys K^{15} , K^{16} and K^{17} 75 through the subscriber's station in the usual manner. The attendant will respond to such signal by operating a key associated with one of the local paths; for instance K^{15} and also the attendant key associated with 80 the same path, such as key K^5 . The operation of key K^{15} closes a circuit from battery, left-hand winding of relay 44, and from grounded contact of key K^5 right-hand winding of relay 44, outer make contacts of 85 key K^{15} , back contacts of relay 45, normal contacts of key K^{16} , normal contacts 47 and 48 of relay 46, inner normal contacts of key K^{17} over leads L^3 through the subscriber's set at the extension. The closing of this cir- 90 cuit causes the energization of relay 44, which, upon operating, completes a locking circuit from its grounded armature and right-hand winding, and from battery through its left-hand winding through the 95 contacts of keys K^{15} and K^{16} as just outlined. The operation of key K^5 through its grounded left make contact also closes a circuit through the right-hand wind- 100 ing of relay 44 and over the same path. The operation of key K^5 through its inner make contacts connects the attendant's set through the inner normal contacts of key K^6 to the talking conductors at the ex- 105 tension. If the subscriber, after being connected with the attendant in the manner indicated, informs the latter that a connection is desired with another extension at the pri- 110 vate branch exchange, for instance, an extension connected with leads L^4 , the attendant depresses the ringing key K^{18} associated with that extension, ringing current being supplied from source of current, conductor 49, inner make contact of key K^{18} over leads 115 L^4 , through the ringer at the called extension to grounded inner left-hand make contact of key K^{18} . The operation of key K^{18} also closes a circuit from grounded lower winding of resistance coil, outer left make contact of said key, conductor 50, winding 120 of relay 51, inner right make contact of key K^{15} and right normal contact of key K^{14} , filament of lamp 42, conductor 43, to battery. The closure of this circuit causes the operation of relay 51 which provides a lock- 125 ing circuit through its winding and grounded armature to battery through filament of lamp 42, as just described. The lamp 42, however, is in series with relay 51, and will not light under this condition. Lamp 52 130

will be lighted dimly as a busy signal during this period over a circuit from ground and non-inductive resistance, conductor 53, outer right make contact of relay 51, right normal contacts of keys K^{20} and K^{21} , filament of lamp 52, conductor 43 to battery. After a suitable ringing interval key K^{18} is restored, and ringing current is disconnected. The operation of relay 51 connects extensions L^3 and L^4 to each other through the outer make contacts of key K^{15} , over talking conductors 54 and 55, outer make contacts of relay 51, normal contacts of keys K^{19} and K^{18} over the talking conductors L^4 , battery and ground being furnished over this path through the windings of relay 44. At the termination of the conversation, when both subscribers return the receivers to their hooks, the locking circuit previously described in connection with relay 44 becomes broken causing this relay to release. If the calling extension abandons the call and the receiver thereat is hung up, relay 44 will be also released and will not reoperate if the subscriber attempts to originate another call until key K^5 is reoperated. The release of relay 44 causes the illumination of line lamp 42 as a disconnect signal over a circuit extending from grounded armature of relay 44, right inner make contact of key K^{15} , right normal contact of key K^{14} , filament of lamp 42, conductor 43 to battery. The release of relay 44 short-circuits relay 51 causing its deenergization which, in turn, extinguishes lamp 52.

When the attendant is talking on a local transmission path, a separate source of battery supply is introduced for her set, as for instance through a relay bridged across the path as indicated at 58, so that she will not cause a relay associated with that path, such as relay 44 to operate. The relay 44 will therefore operate only when there is an extension bridged across the local path. This provision is made to prevent operating any of the transmission path connecting relays such as relays 45 or 51 associated with the extensions on half connections between the attendant and the extensions. These relays are protected from operating falsely in the following manner: Operating ground is connected to all said relays associated with a particular extension line whenever the individual ringing key of that line is depressed. When the connecting transmission paths are idle, the battery side of the windings of the said relays are also grounded on the back contacts of the associated battery supply, such relays as relay 44, in the connecting paths, and the path connecting relays cannot operate. When the connecting transmission paths are busy on established connections, the battery side of the windings of the path connecting relays will also be grounded, this time through an operated low

resistance path connecting relay. When a transmission path is just being used to establish a connection, the first extension to be rung will be connected to the path. As previously described, the operating transmission path is through the lamp of the calling subscriber, the path connecting relay and associated non-inductive resistance and ringing key of the called subscriber. The path connecting relay, when operating, short-circuits the associated non-inductive resistance and, being low wound, provides a sufficiently low resistance to ground on the path signaling lead, so that the depression of other ringing keys will not cause the associated path connecting relays to operate from the battery of the original calling lines.

The battery supply relay associated with each transmission path will release when the telephones of two connected extensions have been replaced on the switch hooks and, upon releasing, cannot be reoperated except by subsequent operation of the attendant's listening key. This feature, which is, in effect, an instantaneous disconnect, is introduced here to prevent the battery supply relay from reoperating after the original connection has been released at the path connecting relay. If the battery supply relay were allowed to reoperate, then the next extension called by the attendant would be connected with the original calling line in error. Although the path connecting relays associated with two connected extensions are grounded at their respective extension ringing key, the proper relay will operate since it will be the only one to have battery on the battery side of its winding.

What is claimed is:

1. In a private branch exchange comprising a plurality of subscribers' extensions, a plurality of transmission circuits for interconnecting said extensions, switching means associated with each transmission circuit at each extension for connecting a calling extension and transmission circuit, a ringing key for each extension, and means responsive to the operation of a ringing key at a called extension for connecting such extension with a calling extension.

2. In a private branch exchange comprising a plurality of subscribers' extensions, a plurality of transmission circuits for interconnecting said extensions, switching means associated with each transmission circuit and serially associated with each other for connecting calling extensions with said transmission circuits, a ringing key for each extension, and means responsive to the operation of said ringing key for automatically connecting the called extension to the transmission circuit connected with a calling extension.

3. In a telephone system comprising a main central office and branch exchange, a

plurality of subscribers' extensions at the branch exchange, a plurality of trunk lines for interconnecting the subscribers' extensions and main central office, a plurality of
5 transmission circuits local to the branch exchange for interconnecting the subscribers' extensions, keys associated with said trunk lines and transmission circuits in serial relation with each other for connecting the call-
10 ing extensions with the trunk lines and transmission circuits, means associated with said extensions for impressing ringing current on a called extension, means associated

with the transmission circuit at the called extension responsive to the operation of the last 15 mentioned means for connecting the called extension with the transmission line of the calling extension, and signaling means associated with the keys of said trunk lines at the called extension operable during the 20 period of such connection.

In testimony whereof, I have signed my name to this specification this 9th day of November, 1923.

RAND S. BAILEY.