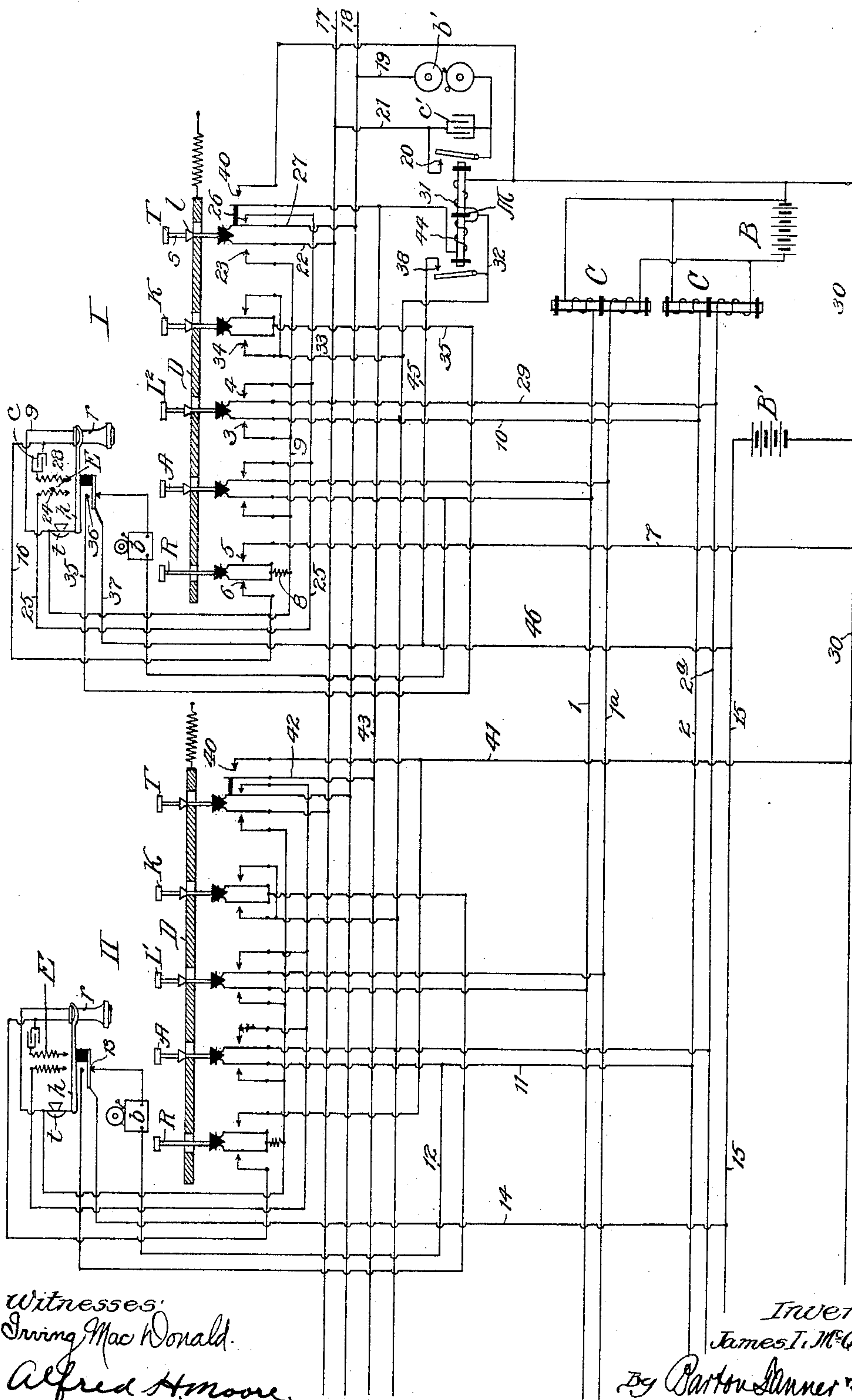


J. L. McQUARRIE.
PRIVATE BRANCH INTERCOMMUNICATING TELEPHONE SYSTEM.
APPLICATION FILED NOV. 23, 1907.

931,138.

Patented Aug. 17, 1909.



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UNITED STATES PATENT OFFICE.

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PRIVATE BRANCH INTERCOMMUNICATING TELEPHONE SYSTEM.

No. 931,138.

Specification of Letters Patent.

Patented Aug. 17, 1909.

Application filed November 23, 1907. Serial No. 403,511.

To all whom it may concern:

Be it known that I, JAMES L. McQUARRIE, citizen of the United States, residing at Oak Park, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Private Branch Intercommunicating Telephone Systems, of which the following is a full, clear, concise, and exact description.

My invention relates to a private branch exchange telephone system, embodying an intercommunicating system, and also providing for outside connections with the central office exchange.

My invention relates more particularly to an arrangement whereby a call over a trunk line may be answered at any one of several stations in the private exchange, and whereby the telephone used for answering an outside call may be utilized for communicating with another local station without causing a disconnect signal at the central office during the interval of such use.

The object of my invention is to provide a simple and efficient arrangement of circuits and apparatus for effecting these operations.

My invention provides means at two or more stations of an intercommunicating system for maintaining the circuit continuity of a trunk line leading to said intercommunicating system from the central office exchange, said means being in addition to and in substitution of the telephone set at said stations. By such arrangement, means are provided for holding a calling line while the telephone set which was used in answering the call is being utilized for communicating with another local station. Likewise, my invention provides means whereby said call may be transferred to another station without the act of transferring causing a disconnect signal at the central office. Likewise, my invention also provides means for holding a trunk line while the station at which the call is received has communication with another local station, without the central office operator hearing the conversation.

In a co-pending application, Serial No. 403,510, filed November 23, 1907, I have shown an arrangement of circuits and apparatus for accomplishing the results above mentioned.

The present invention consists of an arrangement of circuits and apparatus whereby a call received over a trunk line may be

answered at any one of two or more stations of an intercommunicating system and whereby a path in substitute of the telephone set may be closed to maintain the continuity of the trunk line, while the telephone with which the call was answered is used for communicating with another of said stations, and whereby, in turn, the telephone at either of said stations may be substituted for said substitute path by merely operating a key to connect the telephone set of that station with the trunk line.

One feature of the invention consists in the means of controlling the continuity of the aforementioned substitute path, said means consisting of a relay, the winding of which does not receive current from the trunk line, and which is not affected, therefore, when the trunk line current may be interrupted, but is under the sole control of the stations of the intercommunicating system. The source of current for this controlling relay may be a battery located at the private branch exchange, but I do not limit myself to such source of current.

Other features of this invention relate to the particular structure and arrangement of the switch keys at the stations of the intercommunicating system, and also to the circuits controlled by said keys.

These and other features of my present invention may be more readily understood by reference to the accompanying drawing, which is a diagram of circuits and apparatus which may be employed.

For sake of clearness, only two stations of the intercommunicating system and one trunk line terminating therein, are shown, it being obvious that as many trunk lines may be employed as may be deemed necessary, and that the stations of the system may be duplicated within the usual limits. Each station is provided with local keys associated with the local lines of every other station, those at station I being designated L^2 , and those at station II L^1 . Each station is also provided with an answering key A associated with its own local line. Each station is further provided with a ringing key R for applying ringing current to the line selected by the operation of the local key. At each station is the usual call bell b , the circuit through which is closed at the switch contacts when the receiver is on its hook. The battery B^1 furnishes the source

of ringing current. In addition to said local answering and ringing keys, which provide for local intercommunication only, each of said stations is provided with a trunk key T and a transfer key K, the function and operation of which will hereinafter be more fully referred to. It will be noted that with the exception of the ringing key R, all the keys at a station are held locked down when depressed by means of a plate D, and the depression of one key releases any key already locked down. The manipulation of key R, however, has no effect on any other key, and said key is not adapted to be locked down by the plate D.

Considering first merely the intercommunicating features of the system illustrated in the drawings, each local station, as shown, for example, at station I and station II, is equipped with the usual telephone set comprising a transmitter *t* receiver *r*, and induction coil E. Corresponding with each station is a local line 1, 1^a, and 2, 2^a, respectively, connected with a common battery B through the usual retardation coils C.

The manner in which a subscriber at one station may call up another station is obvious. For example, if the subscriber at station I desires to communicate with station II he will remove his receiver *r* from its switch hook *h*, and depress key L², thus closing contacts 3, 4, and connecting his telephone set with local line 2, 2^a. He will then depress his ringing key R, thereby closing contacts 5 and 6, whereupon, if the called line is not in use, current will flow from battery B¹ through conductor 7, contact 5, resistance 8, conductor 9, contact 3 of key L², conductors 10, 2, 11, 12, bell *b*, contact 13, conductors 14, 15, back to battery B¹. The subscriber at station II will respond by depressing his answering key A and by removing his receiver *r* from its hook. Stations I and II are now connected for telephonic communication, the telephone sets thereof being connected to local line 2, 2^a, through local key L² of station I and answering key A of station II. Bridged across conductors 2, 2^a, as before stated, is the retardation coil C through which current from battery B is supplied for local communication.

It will be observed that the drawings show a standard substation equipment of the telephone set. A circuit is closed at station I, for example, from the conductor 2, through conductor 10, contact 3, conductor 9, transmitter *t* switch hook *h*, winding 24 of induction coil E, conductor 25, contact 4, conductor 29 to conductor 2^a. The receiver *r* and condenser *c* are in shunt on transmitter *t*, and a circuit may be traced from transmitter *t*, through switch hook *h*, winding 28 of induction coil E, condenser *c*, receiver *r*, conductor 9, back to transmitter *t*.

The arrangement in connection with the signaling circuit described, provides means whereby the calling party is informed whether or not the station called is busy. At the time the party at station I depressed his ringing key R, current was supplied for ringing the bell *b* at station II, said current flowing through resistance 8. One terminal of the receiver *r* is connected through conductor 9, to one side of said resistance, and the other terminal of the receiver is connected to the other side of said resistance through conductor 16 and the closed contact 6 of the key R. The ringing of the bell *b* at station II causes a buzz in the receiver *r*, due to the difference in potential across the terminals of resistance 8, this resistance being in series with the bell at station II. The current flowing through resistance 8 is intermittent, owing to the opening and closing of the circuit in the usual manner in the contact of the bell *b*. The buzz denotes to the party at station I that the telephone at station II is not in use, since if it were, contact 13 would be open, the bell *b* at station II would not ring, and the party at station I would not hear a buzz in his receiver.

It will be observed that the arrangement thus far described in detail provides what is commonly designated as an intercommunicating system. I will now describe the circuits and arrangement whereby such a system may be connected to a central office exchange to provide for outside communication, and means permitting transferring of calls and preventing the display of a disconnect signal during the interval of transfer.

Conductors 17, 18 constitute a trunk line extending from the central office exchange to the intercommunicating system. Said trunk line is multiplied, as shown, with each station of the intercommunicating system. A signal bell *b*¹ is associated with the trunk line in a manner to give a signal at the stations at which it is desired to answer calls received over the trunk line. The bell *b*¹ may be located, for example, at some point where it can be heard from any station. As hereinbefore stated, each of the stations with which the trunk line is multiplied is provided with a trunk key T and a transfer key K, associated with the trunk line. The trunk key, when depressed, closes a pair of contacts adapted to connect the telephone set of that station to the trunk line. The function of the transfer key K is to establish conditions to maintain the continuity of the trunk line in substitution of the telephone set, thus enabling that station to call up and communicate with any other station without giving a disconnect signal at the central office. As shown in the drawing, such continuity of the trunk line is maintained over a bridge of the line extending from conductor 18 to conductor 17 through conductor

19, including the bell b^1 , contact 20 of a differential relay M, and conductor 21, said bridge being normally open at contact 20. The depression of the transfer key K serves
 5 to energize one winding of the relay M and thus to close its contact 20 and to maintain the continuity of the trunk line over the bridge, the circuit for the relay M being thereafter maintained through contact 38 in
 10 substitution of key K.

Associated with each trunk key T is a way-down contact 40 which is closed when said key is completely depressed by the operator, but which is not closed when the key
 15 is merely held down in its usual locked position by the plate D. The stem s of key T is of such length that said key may be depressed sufficiently to close the way-down contact 40. When the pressure is removed
 20 from said key, the key rises in the usual manner until the collar l thereof engages with the underside of the plate D, said plate holding the key locked in this latter position with the pair of contacts which connects
 25 the telephone set with the trunk line closed but with the way-down contact open. The closing of said way-down contact performs no function unless the relay M is already energized by the prior operation of a transfer key, in the manner hereinbefore described, at which time it may close the circuit of a neutralizing winding on relay M. When a transfer key at any station has been
 30 operated so as to energize the relay M, the subsequent operation of a trunk key, in connecting the telephone set at any of the stations to the trunk line, closes a circuit through the other winding of the differential relay, which differential windings thus
 35 neutralize the magnetizing effect of each other. The resultant deenergization of relay M opens contact 20 in the bridge across the trunk line. In the drawings, the battery B^1 is shown as the source of current for the
 40 differential relay M.

It is apparent that a call over the trunk line may be answered at any station with which the trunk line is multiplied, and the answering station may thereafter secretly
 50 communicate with any other station without giving a disconnect signal at the central office. Furthermore, the answering station may then either renew the conversation with the calling party, or request the called party
 55 to answer over the trunk line.

The operation of the system as a whole is as follows: Assume that a call is received over the trunk line, and is answered at station I. The party at said station removes
 60 his receiver from its hook and depresses trunk key T. Current then flows from the central office over conductor 17 of the trunk line, through conductor 22, contact 23 of the key T, conductor 9, transmitter t , switch
 65 hook h , winding 24 of induction coil E, con-

ductor 25, contact 26 of key T, conductor 27, and conductor 18 of the trunk line to central office. This completes the circuit continuity of the trunk line and establishes conditions at the central office which show, 70 in the usual manner, that the call has been answered. As hereinbefore mentioned, a standard telephone set is employed, and hence a further description thereof is unnecessary. Station I is now so connected to 75 the trunk line that conversation can take place between the private branch exchange party and the calling party, connected through the central exchange, the party at station I controlling the central office sig- 80 nals in the usual manner, that is, by means of his switch hook. If the party at station I now wishes to call up any other station of the intercommunicating system for any purpose, as, for example, to receive instructions, 85 or to transfer the call, he presses down the transfer key K, which key is then held down by the plate D. By depressing key K, the key T is released, and the beforementioned bridge is placed across the trunk line con- 90 ductors 17, 18, thus maintaining the continuity of the signaling circuit of that line, and leaving the party at station I at liberty to use his telephone for calling up any other station of the private branch exchange. 95

The circuit conditions brought about by depressing transfer key K are as follows: Current flows from battery B^1 , through conductor 30, winding 31 of relay M, conductors 32, 33, contact 34 of key K, conductor 35, 100 contact 36, conductors 37, 46, 15, back to battery B^1 . The closure of this circuit causes relay M to become energized, closing contacts 20, 38, thereof. The relay M is now locked up through the closed contact 38. The clo- 105 sure of contact 20 short-circuits the condenser c^1 and provides a path for direct current across the trunk line, as hereinbefore described. The act of depressing key K has released the key T, thereby disconnecting 110 the telephone set of station I from the trunk line. It will be seen, therefore, that by operating key K the party at station I substitutes another bridge than the telephone set across the trunk line, said bridge including 115 contact 20 of the relay M. The party at station I is now free to communicate with any other local station in the manner hereinbefore described, and in the meantime a disconnect signal at the central office is not displayed. In depressing the key L^2 to call up station II, for example, the key K at station I is released, opening the contact 34, but not deenergizing relay M, since said relay, as before stated, is locked up through its own 125 contact 38. Assuming the party at station I has communicated with the party at station II, either may then connect with the trunk line by depressing the trunk key T at that station, the conditions brought about being 130

the same in either case. Let us assume, however, that the party at station I desires to transfer the call to station II. After calling up station II in the usual manner, he instructs the party at that station to answer over the trunk line. The party at station II then depresses his trunk key T, and in so doing releases his answering key, leaving his telephone set connected only with the trunk line. The party at station II is now in position to talk with the outside calling party. The circuits established through the connections of station II are substantially the same as those hereinbefore traced from the trunk line through station I and may be readily followed without further description.

When the party at station II answers over the trunk line by completely depressing the key T, the contact 40 is closed. Current then flows from battery B¹ through conductor 30, conductor 41, contact 40, conductors 42, 43, winding 44 of relay M, conductor 32, contact 38 of relay R, conductors 45, 46 and 15, back to battery B¹. The opposing currents in windings 44 and 31 of relay M will each neutralize the magnetizing effect of the other, and hence relay M will be demagnetized. The bridge across the trunk line is now open at contact 20 of relay M. The circuit continuity of the trunk line is maintained, however, through the telephone set at station II. The contact 40 of key T remains closed only so long as the party at station II keeps said key completely depressed. Upon removal of the finger from key T said key moves upward a sufficient distance to open contact 40, but is held locked down by plate D to maintain the other contacts of said key in their closed position. Upon the party at station II hanging up his receiver, the continuity of the circuit of the trunk line is destroyed at the contacts of the switch hook, and the usual disconnect signal is given at the central office exchange. It will be observed that substantially the same conditions apply whether a call received over the trunk line is actually transferred from the station answering the call to another one of the local stations or whether the answering station, without losing connection with the trunk line, merely talks with another station, as for example, for the purpose of obtaining information. Hence it will be understood the terms "transfer" and "transfer-key", in their broad sense, are applicable to both of the above-mentioned conditions.

I claim:

1. In a telephone system, the combination with a plurality of subscribers' stations, of a trunk line multiplied with said stations, a telephone set at each station adapted to be connected to the trunk line, a bridge of the trunk line, in substitute of the telephone set, for maintaining the circuit continuity of the

trunk line, a holding relay controlling said bridge, a circuit for said relay having a source of current independent of the current over said trunk line, and switching mechanism at each of said stations for connecting the telephone set of that station to the trunk line and for controlling the magnetization or demagnetization of said holding relay.

2. In a telephone system, the combination with a plurality of subscribers' stations, of a trunk line multiplied with said stations, a trunk key at each of said stations having contacts controlling the connection of the telephone set of that station to the trunk line, a bridge of the trunk line, in substitute of the telephone set, for maintaining the circuit continuity of the trunk line, a holding relay controlling said bridge, a circuit for said relay having a source of current independent of the current over said trunk line, and a transfer key at each of said stations for closing a circuit through said holding relay.

3. In a telephone system, the combination with a plurality of subscribers' stations, of a trunk line multiplied with said stations, a trunk key at each of said stations having contacts controlling the connection of the telephone set of that station to the trunk line, a bridge of the trunk line, in substitute of the telephone set, for maintaining the circuit continuity of the trunk line, a holding relay controlling said bridge, a circuit for said relay having a source of current independent of the current over said trunk line, a transfer key at each of said stations for closing a circuit through said holding relay, and a locking circuit for said relay closed upon the energization thereof.

4. In a telephone system, the combination with a plurality of subscribers' stations, of a trunk line multiplied with said stations, a trunk key at each of said stations having contacts controlling the connection of the telephone set of that station to the trunk line, a bridge of the trunk line, in substitute of the telephone set, for maintaining the circuit continuity of the trunk line, a holding relay controlling said bridge, a circuit for said relay having a source of current independent of the current over said trunk line, a transfer key at each of said stations for closing a circuit through said holding relay, a locking circuit for said relay closed upon the energization thereof, and a circuit under the control of the trunk key at each of said stations for effecting the deenergization of said holding relay.

5. In a telephone system, the combination with a plurality of subscribers' stations, of a trunk line multiplied with said stations, a telephone set at each station adapted to be connected to the trunk line, a bridge of the trunk line, in substitute of the telephone set, for maintaining the circuit continuity of the

trunk line, a differential relay controlling said bridge, a circuit for said relay having a source of current independent of the current over said trunk line, and switching mechanism at each of said stations for connecting the telephone set of that station to the trunk line and for controlling the magnetization or demagnetization of said differential relay.

6. In a telephone system, the combination with a plurality of subscribers' stations, of a trunk line multiplied with said stations, a trunk key at each of said stations having contacts controlling the connection of the telephone set of that station to the trunk line, a bridge of the trunk line, in substitute of the telephone set, for maintaining the circuit continuity of the trunk line, a differential relay controlling said bridge, a transfer key at each of said stations for closing a circuit through one of the windings of said relay, and a contact adapted when closed by the subsequent operation of a trunk key at any of said stations to also close a circuit through the other winding of said relay.

7. In a telephone system, the combination with a plurality of subscribers' stations, of a trunk line multiplied with said stations, a trunk key at each of said stations having contacts controlling the connection of the telephone set of that station to the trunk line, a bridge of the trunk line, in substitute of the telephone set, for maintaining the circuit continuity of the trunk line, a differential relay controlling said bridge, a transfer key at each of said stations for closing a circuit through one of the windings of said relay, a locking circuit for said winding closed upon the energization of said relay, and a contact adapted when closed by the subsequent operation of a trunk key at any of said stations to also close a circuit through the other winding of said relay.

8. In a telephone system, the combination with a plurality of subscribers' stations, of a trunk line multiplied with said stations, a trunk key at each of said stations having contacts controlling the connection of the telephone set of that station to the trunk line, a bridge of the trunk line, in substitute of the telephone set, for maintaining the circuit continuity of the trunk line, a differential relay controlling said bridge, a transfer key at each of said stations for

closing a circuit through one of the windings of said relay, and a way-down contact at each of said stations associated with the trunk keys and adapted when closed by the subsequent operation of a trunk key at any of said stations to also close a circuit through the other winding of said relay.

9. In a telephone system, the combination with a plurality of subscribers' stations, of a trunk line multiplied with said stations, a trunk key at each of said stations having contacts controlling the connection of the telephone set of that station to the trunk line, a bridge of the trunk line, in substitute of the telephone set, for maintaining the circuit continuity of the trunk line, a differential relay controlling said bridge, a transfer key at each of said stations for closing a circuit through one of the windings of said relay, a locking circuit for said winding closed upon the energization of said relay, and a way-down contact at each of said stations associated with the trunk keys and adapted when closed by the subsequent operation of a trunk key at any of said stations to also close a circuit through the other winding of said relay.

10. In a telephone system, the combination with a plurality of subscribers' stations, of a trunk line multiplied with said stations, a telephone set at each station adapted to be connected to the trunk line, a bridge for holding said trunk line in substitution of a telephone set, a differential relay controlling such substitution, and means for controlling the magnetization and demagnetization of said relay.

11. In a telephone system, the combination with a plurality of subscribers' stations, of a trunk line multiplied with said stations, a telephone set at each station adapted to be connected to the trunk line, a bridge for holding said trunk line in substitution of a telephone set, a differential relay controlling such substitution, a source of current for said relay independent of the current over said trunk line, and means for energizing one or both of the coils of said relay.

In witness whereof, I, hereunto subscribe my name this ninth day of November A. D., 1907.

JAMES L. McQUARRIE.

Witnesses:

WILLIAM MCA. SMITH,
EDWARD B. CRAFT.