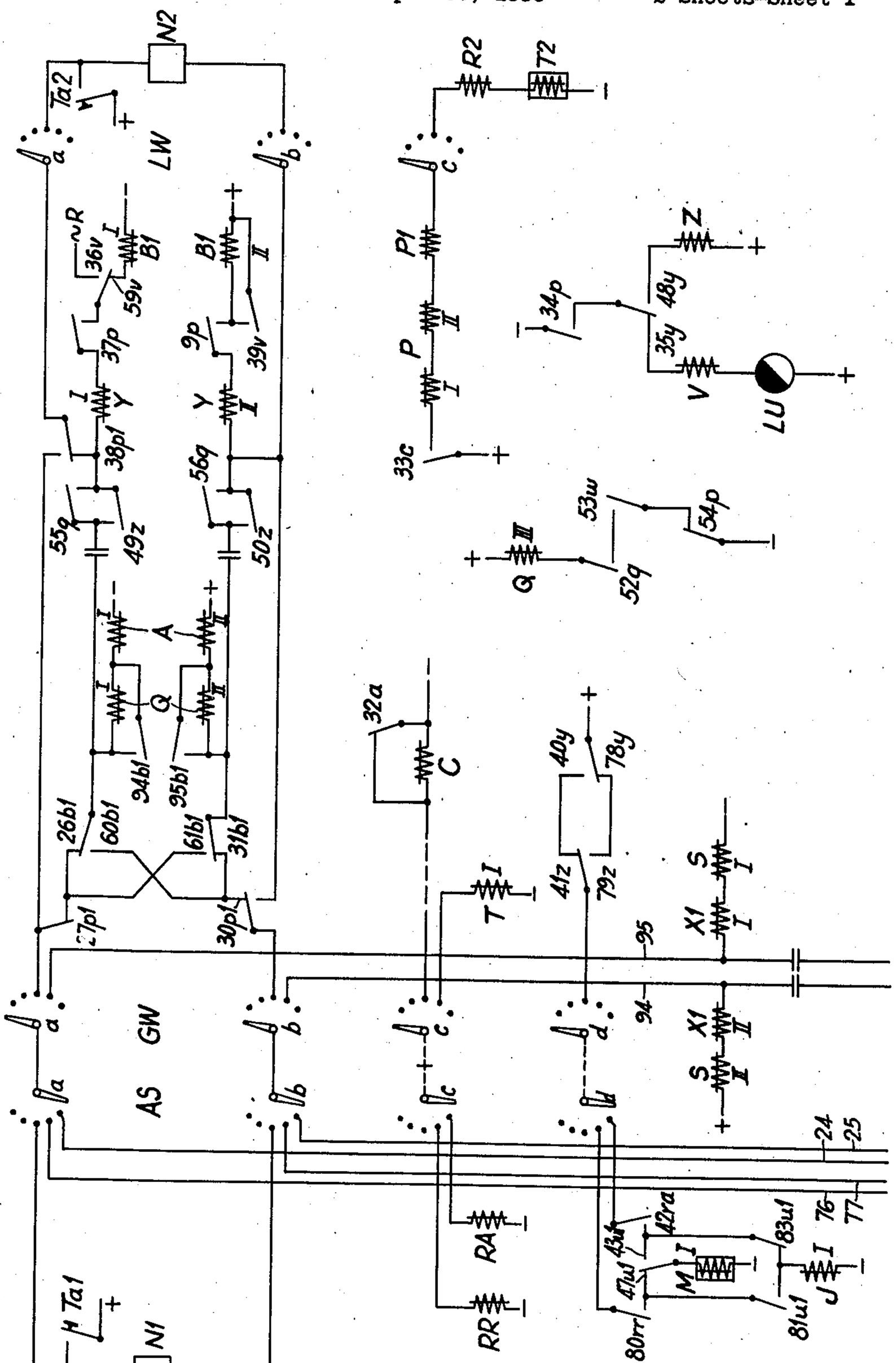
Dec. 19, 1939. F. SIMON 2,183,848

TELEPHONE SYSTEM

Filed Sept. 30, 1936 2 Sheets-Sheet 1

FIG. 1



INVENTOR.
FRANZ SIMON

BY Chas. Fr. Candy

ATTORNEY.

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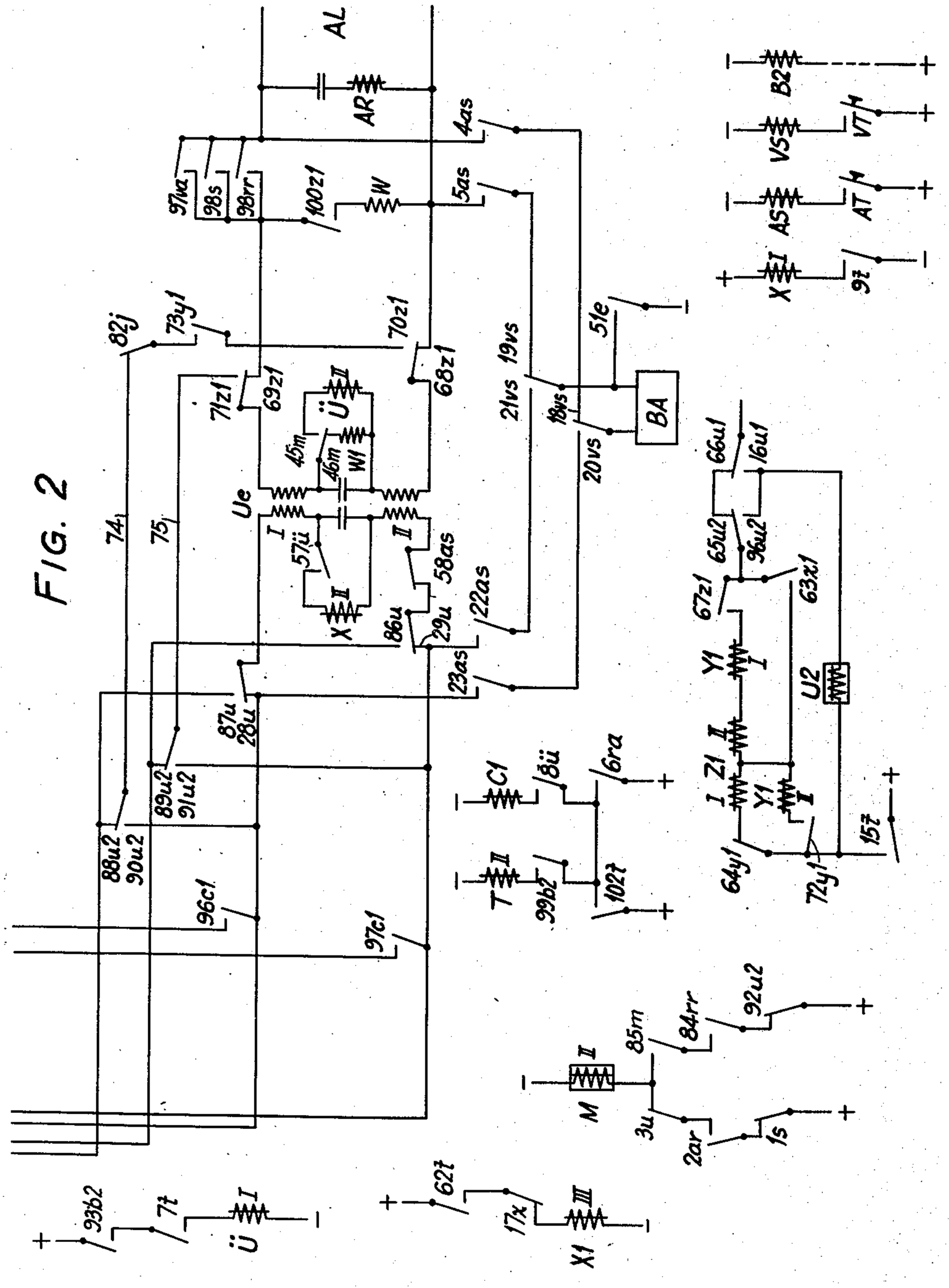
FIG. 2



INVENTOR.
FRANZ SIMON.

BY

ATTORNEY.

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UNITED STATES PATENT OFFICE

2,183,848

TELEPHONE SYSTEM

Franz Simon, Berlin-Friedenau, Germany, assignor to Siemens & Halske Aktiengesellschaft, Siemensstadt, near Berlin, Germany

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In Germany October 1, 1935

15 Claims. (Cl. 179—27)

The invention relates to a circuit arrangement for telephone systems in which the subscribers have the facility for establishing inquiry calls and for establishing connections to engaged subscribers. If in such systems inquiry switching operations are promoted by causing a differential relay to receive the impulses for establishing and releasing inquiry calls in response to the depression of a key and if switching on to an engaged line is also promoted by a differential relay the differential relay can also be influenced for the purpose of switching on to an engaged line by subscribers' stations possessing an earthing key. Since, however, only privileged stations are to establish connection to engaged lines while inquiry calls on the other hand can be promoted by some or all of the other subscribers who are not entitled to the former facility, separate connecting paths must be provided for those subscribers entitled to establish connection to engaged lines, and those not so entitled. This, however, is uneconomical. The invention obviates these conditions in that the initiating impulses for inquiry switching and for switching on to connected subscribers' lines are transmitted by different potentials operating upon differential relays and that the differential relay influenced by the potential applied only promotes the switching operations corresponding to the impulse received.

One embodiment of the invention is shown in the drawings comprising Figs. 1 and 2, in which Fig. 1 shows a call finder AS, a group selector GW, a final selector LW, and subscribers' stations N1 and N2 in a private branch exchange; and Fig. 2 shows a trunk line AL from a public exchange terminating in an operator's position BA located in the private branch exchange. In a telephone private branch exchange system of the type disclosed in the drawings the transitory connecting impulse transmitted from a station (operator) is only maintained, by a differential relay arranged in the feeding circuit, when a station entitled to switch on to engaged line applies negative-potential to the speaking line and accordingly one particular winding of the differential relay in the feeding circuit of the calling station receives current. In this case a local winding of this relay is connected up. This winding is connected in the same sense as the winding operative in the feeding circuit so that the impulse promoting the switching on to an engaged line is maintained.

Subscribers N1 and N2 are provided with earthing keys at their stations by means of which impulses for promoting inquiry switching and for switching over to the devices of the exchange are transmitted. These subscribers who are not entitled to switching on to engaged calls can indeed influence the differential relay Q effecting the switching on operation by depressing their keys, but the winding III connected in the opposite sense to the operative winding I renders the impulse inoperative and thus prevents any connection taking place.

The switching operations will be described in detail as follows:

Internal calls

If the subscriber of station N1 wishes to converse with subscriber of station N2 he removes his receiver. The call-finder AS is thereby set on the line of the calling station in the known way. A free final selector is seized over the group selector GW. When such a final selector LW is found relay A energizes in the following feeding circuit: negative, winding I of relay A, winding I of relay Q, contacts 26*b*1 and 27*p*1, wiper *s* of the group selector GW, wiper *a* of the call-finder AS, the loop of the station N1, wiper *b* of the call-finder AS, wiper *b* of the group selector GW, contacts 30*p*1, 31*b*1, winding II of relay Q, winding II of relay A and positive. Relay A opens contact 32*a*. The short-circuit for relay C is removed and this relay energizes.

Through the transmission of impulses the final selector LW is set on the line of the desired station in the known manner (not represented). If the station N2 is free relay P is energized over: positive, contact 33*c*, windings I and II of relay P, relay P1, wiper *c*, relay R2, relay T2, and negative. Relay P closes the following circuit for relay V: negative, contacts 34*p*, 35*y*, relay V, slow interrupter LU, and positive. Ringing current is applied to the line at definite intervals of time. The ringing circuit passes from the source R of ringing current over contacts 36*v*, 37*p*, winding I of relay Y, contact 38*p*1, wiper *a* of the final selector LW, over the bell of the station N2, wiper *b* of the final selector LW, winding II of relay Y, contacts 9*p* and 39*v*, and positive. When the subscriber replies by removing his receiver relay Y energizes. At contact 35*y*, relay Y opens the circuit for relay V. Relay Z energizes over contact 48*y* and the switching through takes place at 49*z* and 50*z*.

If the subscriber is engaged and the calling party receives the busy signal in the known way he can try to switch on to the engaged subscriber by depressing the key T*a*1. The differential relay Q is energized in his feeding circuit since

winding I of relay Q is subjected to current over positive, key Ta1, wiper *a* of the call-finder AS, wiper *a* of the group selector GW, contacts 27*p*1, 26*b*1, winding I of relay Q, winding I of relay A and negative.

Winding II of relay Q is short-circuited. Over positive, winding III of relay Q, contact 529, rotary off-normal contact 53*w*, contact 54*p* and negative, winding III of relay Q is operated. This winding is, however, arranged in opposition to winding I of relay Q so that relay Q returns its contacts to normal. A repeated energizing and deenergizing of relay Q can take place as long as the subscriber depresses the key. During the depression of the key the speaking equipment of the station is short-circuited. When the subscriber releases the key relay Q releases and subscriber N1 is forced to bring about the release of the connection.

The arrangement can also be so constructed so that relay Q only brings about the connection to an engaged line if the impulse for initiating such a connection is transmitted from the calling station within a strictly predetermined time, for example during the testing period of the selector. Thus if the subscriber succeeds in connecting up earth at this particular time relay Q is energized but the opposing winding is switched on. Relay Q releases and the final selector is caused to release at the end of the testing period. The subscriber then receives the busy signal from the preceding connecting devices (for example over devices which are associated with the subscriber's line).

Incoming public exchange calls

When a call is received over the public exchange line AL relay AR is energized by the ringing current. In the case of calls over the public exchange line AL relay B2 is energized and remains so until the public exchange line is released. Relay AR closes the following circuit for relay M: positive, contact 1*s*, 2*ar*, 3*u*, winding II of relay M and negative. A call indicating lamp for the private branch exchange operator is switched on by relay AR in the known manner (not shown). The operator operates key AT and accordingly energizes relay AS. Relay AS closes contacts 4*as* and 5*as* so that the operator's equipment BA is connected to the calling public exchange line AL.

When the operator has been told which subscriber is wanted she operates the key VT. Relay VS is energized. Relay VS opens contacts 18*vs* and 19*vs* and closes contacts 20*vs* and 21*vs*. The equipment of the operator BA is accordingly connected over contacts 22*as* and 23*as* to the connecting side of the public exchange line AL. A calling circuit is closed over the loop of the operator's position BA in the known manner and the call-finder AS is caused to be set on line 24/25. Thereupon the relay RA energized over wiper *c* of the call finder AS.

By means of relay RA relay T is energized over positive, contacts 6*ra* and 99*b*2, winding II of relay T and negative. Relay T causes relay U to energize over positive, contacts 10*t*, 11*ü*, 12*m*, 13*u*1, and winding II of relay U. Relay U closes contact 14*u* and thereby prepares the circuit for relay U1. Relay T closes contact 7*t*. A circuit is completed for relay Ü over positive, contact 99*b*2, 7*t*, winding I of relay Ü and negative. Relay Ü opens contact 11*ü* and thereby removes the short-circuit over relays U and U1. The following circuit is completed: positive, contacts 10*t*, 14*u*, winding I of relay U, winding I of relay U1, winding II of relay U and negative. Relay U1 energizes, opens contact 13*u*1 and closes contact 101*u*1. Relays U and U1 are now held energized over positive, contacts 10*t* and 14*u*, winding I of relay U, winding I of relay U1, contact 101*u*1, winding II of relay U1 and negative. The following circuit is established for relay U2; positive, contact 15*t*, relay U2, contact 16*u*1 and negative.

Relay M is caused to release by the opening of contact 3*u*. Relay X is energized over positive, winding I of relay X, contact 9*t* and negative, by relay T. Relay X by opening contacts 17*x*, prevents relay X1 from energizing. The operator transmits an impulse train and thereby sets the group selector GW on a free final selector LW. When this has been done the following feeding circuit is established: negative, winding I of relay A, winding I of relay Q, contacts 26*b*1 and 27*p*1, wiper *a* of the group selector GW, wiper *a* of the call finder AS, lead 24, contacts 23*as* and 20*vs*, the loop at the operator's position BA, contacts 21*vs*, 22*as*, lead 25, wiper *b* of the call-finder AS, wiper *b* of the group selector GW, contacts 30*p*1 and 31*b*1, winding II of relay Q, winding II of relay A and negative. Only relay A energizes in the feeding circuit. Relay Q does not operate its contact since it is arranged as a differential relay. Relay A opens contact 32*a* and removes the short-circuit over relay C. Relay C energizes.

Impulse trains are transmitted from the operator's position BA for setting the final selector LW. The setting of the final selector takes place in the known manner and is not represented.

If when the setting of the final selector on the station N2 required by the exchange is completed this station is found to be free relay P energizes in the testing circuit of the selector LW, over positive, contact 33*c*, windings I and II of relay P, relay P1, wiper *c* of the final selector LW, relay R2, relay T2 and negative. By means of relay P, relay V is connected up in a circuit influenced by the slow interrupter LU over negative, contacts 34*p* and 35*y*, relay V, slow interrupter LU and positive. Ringing current is applied to the line to be signalled at definite intervals of time by means of relay V. The ringing circuit passes from the source R of ringing current over contacts 36*v* and 37*p*, winding I of relay Y, contacts 38*p*1, wiper *a* of the final selector LW, over the bell at station N2, wiper *b* of the final selector LW, winding II of relay Y, contacts 9*p*, contact 39*v* and positive.

When the called subscriber replies relay Y energizes, relay Y at contact 35*y* breaks the circuit for relay V. The station N2 receives feeding current over the following circuit: negative, winding I of relay B1, contacts 59*v* and 37*p*, winding I of relay Y, contact 38*p*1, wiper *a* of the final selector LW, over the loop at station N2, wiper *b* of the final selector LW, winding II of relay Y, contact 9*p*, winding II of relay B1 and positive. The relay B1 arranged in the feeding circuit is a differential relay which when connected in the foregoing circuit does not operate its contacts. Relay Y causes the following circuit to be established: positive, contacts 40*y* and 41*z*, wiper *d* of the group selector GW, wiper *d* of the call-finder AS, contacts 42*ra* and 43*u*1, winding I of relay M and negative. Relay M energizes. Over contacts 11*ü* and 12*m*, winding I of relay U and winding I of relay U1 are short-circuited. Relay U opens contacts 14*u*.

Relay Y at contact 48*y*, completes a circuit for relay Z. The circuit is completed over negative,

contacts 34*p* and 48*y*, relay Z and positive. Relay Z switches through at contacts 49*z* and 50*z*. Contact 41*z* breaks the circuit for relay M. The latter releases and at contacts 12*m* breaks the circuit for relay U1. Relay U1 by opening contact 16*u*1 returns relay U2 to normal.

Thus the connection to the desired subscriber is established and the operator can switch off from the connection. Relays AS and VS thereupon deenergize and restore their contacts to normal. The feeding bridge relay A is now held energized over the following circuit: negative, winding I of relay A, winding I of relay Q, contacts 26*b*1, 27*p*1, wiper *a* of the group selector GW, wiper *a* of the call-finder AS, lead 24, contacts 28*u*, winding I of repeater Ue, contact 58*ü*, winding II of relay X, winding II of repeater Ue, contacts 58*as* and 29*u*, lead 25, wiper *b* of the call-finder AS, wiper *b* of the group selector GW, contacts 30*p*1 and 31*b*1, winding II of relay Q, winding II of relay A and positive. In this circuit winding II of relay X is connected in the same sense as winding I so that relay X remains energized.

If the station N2 is engaged relay P cannot energize in the testing circuit of the final selector.

The operator can now transitorily apply battery to the line 24/25 in any desired way.

The contact 51*e* may be the contact of a key which is operated by the operator after the transmission of a busy signal, or it can be automatically closed after each impulse train when the operator, who is entitled to switch on to engaged lines, operates the impulse sender so that the potential for causing connection to the engaged line is only applied during a particular period. The connection of battery need not take place at the station itself, but can take place in the exchange by using transmitting means.

The transitory connection of battery causes the following circuit to be set up: negative, contacts 51*e*, 21*vs*, 22*as*, lead 25, wiper *b* of the call-finder AS, wiper *b* of the group selector GW, contacts 30*p*1 and 31*b*1, winding II of relay Q, winding II of relay A and positive. The differential relay Q closes the following circuit over winding III of relay Q: positive, winding III of relay Q, contact 52*q*, rotary off-normal contact 53*w*, contact 54*p* and negative. Winding III of relay Q is arranged in the same sense as winding II so that the relay remains energized after the transitory impulse and at contacts 55*q* and 56*q* effects the switching through in the final selector LW, independent of contacts 49*z* and 50*z*. The operator is thus connected to the engaged subscriber N2 and can ask the latter to terminate his call.

When the subscriber at station N2 finishes his call and the connection established is released the guarding is removed in the known way and the testing relay P in the final selector LW can energize. The subscriber is rung in the known way. When he replies relay Y energizes and effects the switching operations already described (transmission of the reply impulse to the devices of the public exchange line). In addition switching through is caused in the manner described at contacts 49*z* and 50*z*. When relay P energizes contact 54*p* is opened and the locking circuit for relay Q over winding III is disconnected. Relay Q releases.

The subscriber of station N2 is thus connected with the calling public exchange line AL.

While a public exchange call is in progress the subscriber can establish an inquiry call. The initiating impulse for establishing this inquiry call is given by the subscriber N2 by transitorily depressing his earthing key. By operating the key T*a*2 the differential relay B1 in the feeding circuit of the call station N2 is energized. By the closing of contacts 94*b*1 and 95*b*1 any influencing of the differential relay Q is prevented. Relay B1 opens contacts 26*b*1 and 31*b*1, and closes contacts 60*b*1 and 61*b*1. The circuit described for relay A is thereby switched over in such a way that winding II of relay X receives current in the opposite direction and acordingly causes relay X to release. Relay X completes a circuit for relay X1 over positive, contacts 62*t* and 17*x*, winding III of relay X1 and negative. Relay X1 closes contact 63*x*1. The following circuit is established: positive, contacts 15*t* and 64*y*1, winding I of relay Z1, contacts 63*x*1, 65*u*2 and 66*u*1, and negative. Relay Z1 energizes and at contact 67*z*1 prepares a circuit for relay Y1. Relay Z1 opens contacts 68*z*1 and 69*z*1, and closes contacts 70*z*1 and 71*z*1. The public exchange connection is held over contact 100*z*1.

When the subscriber at station N2 releases the key T*a*2, the differential relay B1 in the feeding circuit releases and contacts 60*b*1 and 61*b*1 are opened and contacts 26*b*1 and 31*b*1 are closed. Winding II of relay X receives current in the same direction as winding I of relay X. Relay X energizes. On account of the operation of relay X, relay X1 deenergizes. Contact 63*x*1 is opened and thus the short-circuit over winding II of relay Z1 and over winding I for relay Y1 is removed. The following circuit is established for relays Z1 and Y1: positive, contacts 15*t* and 64*y*1, windings I and II of relay Z1, winding I of relay Y1, contacts 67*z*1, 65*u*2 and 66*u*1 and negative. Relay Y1 closes contact 72*y*1 and opens contact 64*y*1. The following circuit is set up for relays Z1 and Y1: positive, contacts 15*t* and 72*y*1, winding II of relay Y1, winding II of relay Z1, winding I of relay Y1, contacts 67*z*1, 65*u*2, and 66*u*1 and negative. At contact 73*y*1 relay Y1 switches the inquiry line 74/75 through. Through the closing of contact 73*y*1 a calling circuit is closed in the known way and a free call-finder is set on the line 76/77. After the call finder has been set a circuit is established for relay RR over wiper *c*.

The impulses transmitted from the station N2 for setting the switches of the inquiry path are received by relay Y and transmitted to relay J by contact 78*y*. The circuit for relay J is as follows: positive, contacts 78*y* and 79*z*, wiper *d* of group selector GW, wiper *d* of call-finder AS, contacts 42*ra*, and 83*u*1, winding I of relay J and negative. At contact 82*j* relay J breaks the loop of the inquiry line in correspondence with the impulse trains sent out so that the impulses are transmitted to the receiving devices of the inquiry line. The group-selector and final selector are set in the same way as has been described with reference to the group selector GW and the final selector LW which are shown. When the subscriber replies, the relay impulse is transmitted to winding I of relay M from the final selector set by the inquiry call over wiper *d* of the group selector and call finder of the inquiry line, contacts 80*rr* and 47*u*1, winding I of relay M and negative. Relay M is transitorily energized and locks up over positive contacts 92*u*2, 84*rr*, 85*m* and winding II of relay M and negative. Relay M closes contacts 45*m* and opens 46*m*. Winding II of relay Ü is connected in the bridge of the inquiry line thus winding II of

relay Ü is arranged in the same sense as winding I of relay Ü so that relay Ü remains up.

If the subscriber called in the inquiry call is to take over the public exchange call he operates his earthing key transitorily and thereby energizes the differential relay (see corresponding relay B1) arranged in his feeding circuit. The differential relay effects a switching-over operation whereby the direction of the current in winding II of relay Ü in the public exchange line is reversed. Relay Ü is accordingly deenergized and relay U is energized over positive, contacts 10*t*, 11*ü*, 12*m* and 13*u*1, winding II of relay U and negative. Relay U operates and opens contacts 28*u* and 29*u* and closes contacts 86*u* and 87*u*. The loop over the line 24/25 is accordingly broken and the connecting path which was set up from the operator to the desired station N2 is released.

Relay U closes contact 14*u*. When the subscriber called in the inquiry call releases the key the direction of the current through winding II of relay Ü is reversed again. Relay Ü energizes again and opens contact 11*ü*. The following circuit is established: positive, contacts 10*t* and 14*u*, winding I of relay U, winding I of relay U1, contact 13*u*1, winding II of relay U and negative. Relay U1 opens contact 13*u*1 and closes contact 101*u*1. The following circuit now exists for relays U and U1; positive, contacts 10*t* and 14*u*, winding I of relay U, winding I of relay U1, contact 101*u*1, winding II of relay U1 and negative. Relay U1 on energizing opens contact 66*u*1 and thus breaks the locking circuit for relays Z1 and Y. Relays Z and Y1 return their contacts to normal. Relay U2 is energized over contacts 16*u*1. Relay U2 opens contacts 88*u*2, 89*u*2, and closes contacts 90*u*2 and 91*u*2. Relay U2 opens contact 92*u*2. The locking circuit for relay M is broken so that this likewise returns its contacts to normal. The subscriber called in the inquiry call is now connected to the repeater Ue over line 76/77 and contacts 87*u* and 86*u*, and thus to the public exchange line AL.

Establishment of an outgoing public exchange call

If a subscriber for example at station N1 desires an outgoing public exchange call, then after removing the receiver and setting the call-finder AS, he has to set the group selector on a particular contact level in which a free public exchange line can be reached. If the group-selector GW is set on line 94/95 relay T energizes over wiper *c* of the group selector GW. The following feeding circuit is established for the calling period: negative, winding I of relay S, winding I of relay X1, lead 95, wiper *a* of group-selector GW, wiper *a* of call-finder AS, a loop at station N1, wiper *b* of call-finder AS, wiper *b* of group selector GW, lead 94, winding II of relay X1, contacts II of relay S and positive. In this feeding circuit only relay S energizes. Relay X1 is differential relay and does not operate its contacts. On seizure the busy relay B2 of the public exchange line is energized in any desired manner. The following circuit is set up for relay Ü: positive, contacts 93*b*2 and 7*t*, winding I of relay Ü and negative. Relay Ü effects the energizing of relay C1 over positive, contacts 102*t* and 8*ü*, relay C1 and negative. Relay X is energized over: negative, contact 9*t*, winding I of relay X and positive. Relay C1 connects the calling subscriber to the repeater Ue of the public exchange line by way of contacts 96*c*1 and 97*c*1.

Relay S switches through at contacts 98*s*. The subscriber can now transmit impulses over the public exchange line. The impulses are received by relay S and repeated to the public exchange line AL at contact 98*s*.

If a subscriber who has set up an outgoing public exchange call desires to establish an inquiry call he transitorily depresses the earth key T*a*1 and thereby energizes the differential relay X1 in his feeding circuit. Relay X1 influences relays Z1 and Y1 in the manner already described. The line is switched over onto the inquiry line 74/75. The switching operations subsequently occurring are exactly the same as already described.

The subscriber called in the inquiry call can likewise take over the public exchange call. For this purpose he depresses his earthing key and thereby changes the direction of the current flowing in winding II of relay Ü which then in the manner already described causes the public exchange connection to be switched over onto the subscriber called in the inquiry call.

What is claimed is:

1. In a telephone system, automatic switches, subscribers' stations and lines therefor, means controlled by a subscriber at any one of said stations for extending a connection to any other one of said stations, an operator's position, an incoming trunk line terminating at said position, means controlled by the operator at said position for controlling said switches to extend a call received over said trunk line to any one of said stations, means controlled from said operator's position for controlling said switches to cut-in on a line of a station engaged in conversation and for enabling said switches to signal the station so engaged after the conversation has been terminated, means at the called station for temporarily holding the trunk line call and for extending a connection to any one of said subscribers' stations, and means controlled at said other station for disconnecting said called station from said trunk line and for connecting said other station thereto.

2. In a telephone system, automatic switches, subscribers' stations and lines therefor, an operator's position, an incoming trunk line, means controlled by the operator at said position for controlling said switches to extend a call received over said trunk line to any one of said stations, a first differential relay, means at said operator's position for energizing said differential relay to control said switches to cut-in on a line engaged in conversation, a second differential relay, and means at the called subscriber's station for controlling said second differential relay to enable said called subscriber to hold said trunk call while he extends an inquiry call to another one of said stations.

3. In a telephone system, automatic switches, subscribers' stations and lines therefor, an operator's position, an incoming trunk line, means controlled by the operator at said position for controlling said switches to extend a call received over said trunk line to any one of said stations, a first differential relay, means at said operator's position for energizing said differential relay to control said switches to cut-in on a line engaged in conversation, a second differential relay, means at the called subscriber's station for controlling said second differential relay to enable said called subscriber to hold said trunk call while he extends an inquiry call to another one of said stations, a third differential relay, and means at the subscriber's station to which said inquiry call has

been extended for energizing said third differential relay to disconnect the first of said called subscribers' stations from said inquiry call and from said trunk call and for connecting said trunk call to the subscriber's station to which the inquiry call has been extended.

4. A telephone system as claimed in claim 3, in which the second and third differential relays are energized from a ground potential applied by means of a key at the subscribers' stations and the first of said differential relays is energized from a negative potential applied from said operator's position.

5. A telephone system as claimed in claim 3, in which said differential relays are connected to the talking conductors of the extended connections.

6. In a telephone system, a first subscriber's station, other subscriber's stations, a trunk line, automatic switches controllable from said first station to extend a connection over said trunk line, other automatic switches, means controlled from said first station for holding the connection extended over said trunk line and for enabling the subscriber at said first station to control said other switches to extend a connection to one of said other stations, and means controlled from said second station for disconnecting said first station from the connection extended therefrom to said second station and to said trunk line and for completing a connection between said second station and said trunk line.

7. In a telephone system, automatic switches, subscribers' stations, an outgoing trunk line, means at any one of said stations for causing certain of said switches to be connected serially in a train to extend a call from said one station to any other station or for causing certain of said switches to be connected serially in a train to extend an outgoing call from said one station over said trunk line, means controllable at said one station if an outgoing call has been extended over said trunk line for causing said outgoing call to be held while said trunk line is disconnected from the established connection and for causing said established connection to be extended to any other desired station over a train of said switches identical to said first train.

8. In a telephone system such as claimed in claim 7, means controllable at said last station for disconnecting said last station from said one station and for connecting said last station to said trunk line to take over said outgoing call.

9. In a telephone system, automatic switches, subscribers' stations, an incoming trunk line, means for causing certain of said switches to be connected serially in a train to extend a call incoming over said trunk line to any of said stations, means at the called station for causing a local extension to replace said trunk line in the established connection and for causing said incoming call to be held while said trunk line is disconnected from said established connection, means at said called station for directing said local extension through a train of switches identical to said first train to any other one of said stations.

10. In a telephone system such as claimed in claim 9, means controllable at said other station for disconnecting said other station from said called station and for connecting said other station to said trunk line to take over said incoming call.

11. In a telephone system, automatic switches, subscribers' stations, means at any one of said stations for causing certain of said switches to be connected serially in a train to extend a call from said one station to any other desired station, an incoming trunk line, an operator's position, means at said position for causing certain of said switches to be connected serially in a train to extend a call incoming over said trunk line to any of said stations, means at said position for causing the switches of said last connection to cut-in upon the connection of a station engaged in conversation and for causing said switches of said last connection to signal the station so engaged after said conversation has been terminated, means at the called station for causing a local extension to replace said trunk line in said last connection and for causing said incoming call to be held while said trunk line is disconnected from said last connection, means at said called station for causing said local extension to be directed through a train of switches identical to said first train to any other desired one of said stations.

12. In a telephone system, local lines, an incoming trunk line, automatic switches, a repeater in said trunk line, means for extending a call incoming to the trunk-line side of said repeater through said repeater and a train of said switches to any desired local line, means controllable over the called line for disconnecting said trunk line from said trunk-line side of said repeater and for holding said incoming call while said trunk line is so disconnected, means controllable over said called line for extending a local call from said trunk-line side of said repeater to any desired other one of said local lines over a train of said switches identical to said first train.

13. In a telephone system, a local exchange, local subscribers' stations, a trunk line extending to a distant exchange, means in said local exchange for establishing a voice transmission circuit between any one of said stations and said trunk line, a device in said local exchange for conductively isolating the trunk portion of said circuit from the local portion of said circuit, means controllable at said one station for disconnecting the trunk line from the trunk side of said device and for placing a holding bridge across said trunk line, means controllable at said one station for extending a local voice transmission circuit to any other one of said stations from said trunk side of said device, means controllable at said other station for causing the circuit to said one station to be disconnected from the local side of said device, for causing the circuit to said other station to be disconnected from the trunk side of said device and connected to said local side of said device, and for causing said trunk line to be disconnected from said holding bridge and reconnected to said trunk side of said device.

14. In a telephone system, subscribers' stations and lines therefor, an incoming trunk line, an operator's position, automatic switches, said switches effective at times to extend a local call from any one of said stations to any other station under control of a subscriber at said one station and effective at other times to extend a call incoming over said trunk line to any one of said stations under control of the operator at said position, a differential relay in one of said switches connected in the line circuit of the called station during said local and incoming calls, said relay effective responsive to potential applied to the line at said called station when said called station is engaged in an incoming call

to enable said called station to hold said incoming call and extend a local call to another station.

15. In a telephone system such as claimed in claim 14, another differential relay in one of said switches connected in the line circuit of the calling station in local calls and in the line circuit of said position in incoming calls, means at said position for applying a potential different from said first potential to said line circuit of said position, said relay effective responsive only to said last potential to cause said switches both to cut-in upon the line of a station engaged in another call and to signal the station so engaged when said other call is terminated.

FRANZ SIMON.