Oct. 23, 1928. 1,688,651

W. O. PASSMORE

TELEPHONE SYSTEM

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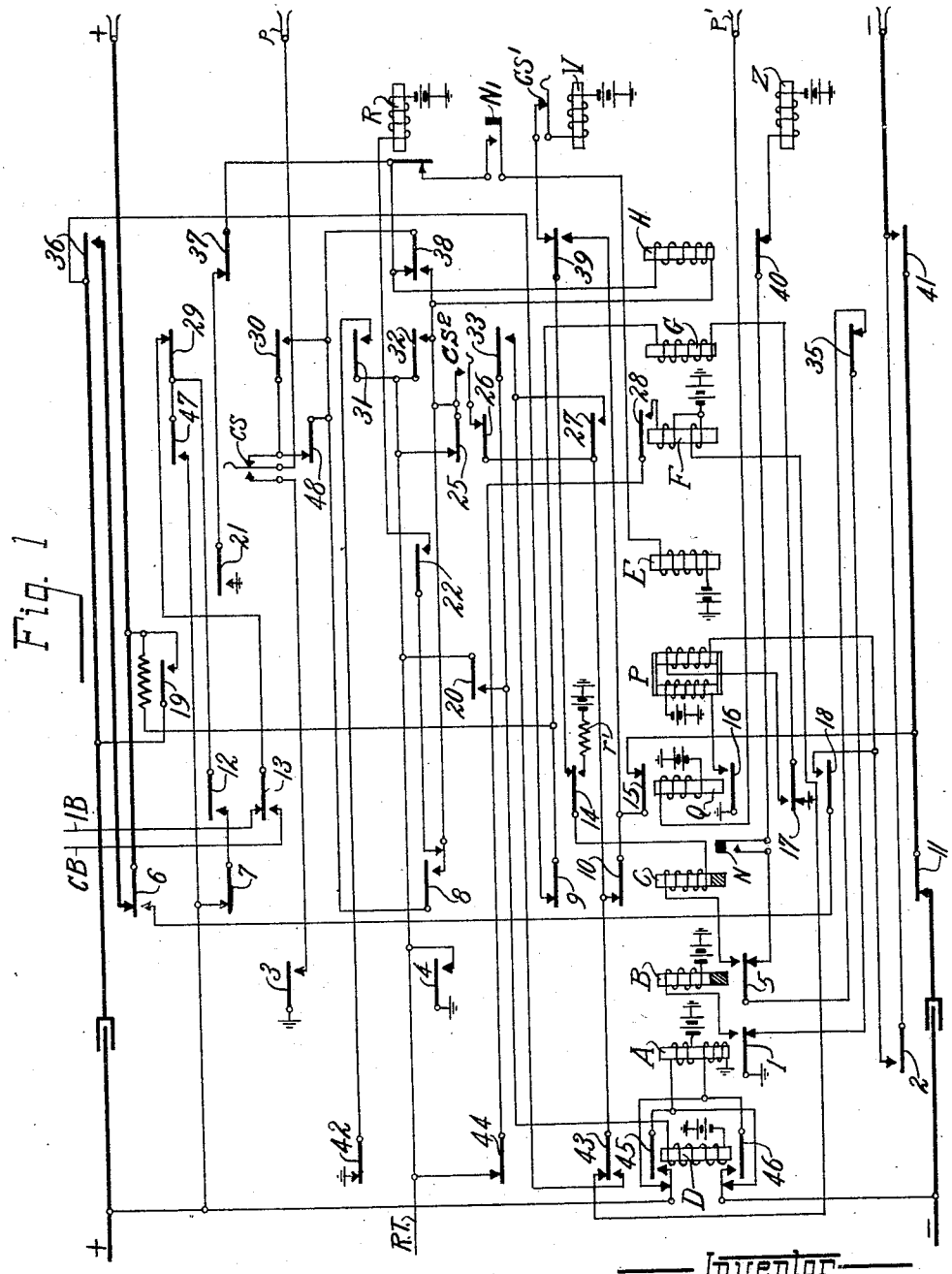


Fig. 1

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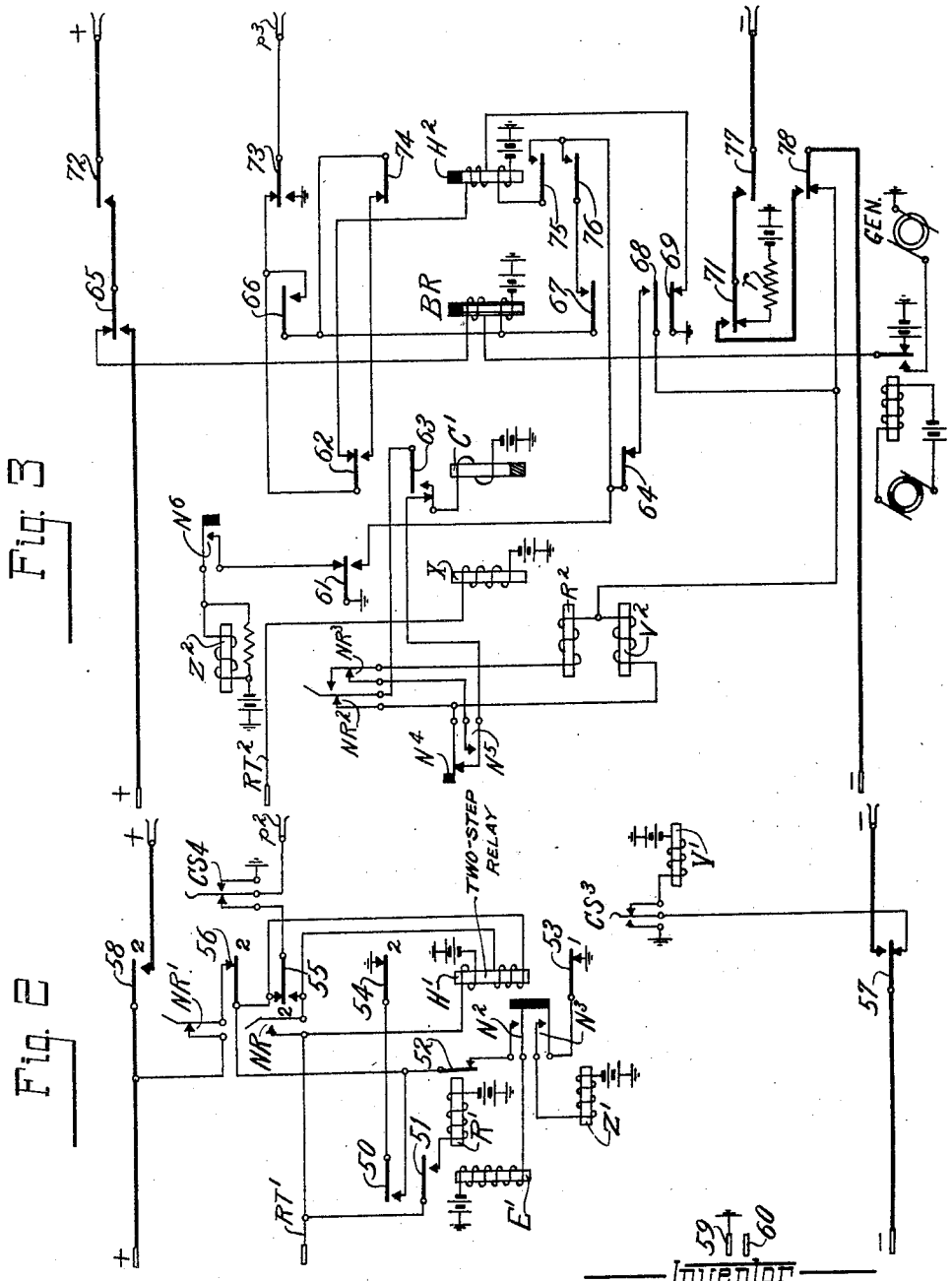


Fig. 3

Fig. 2

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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

Application filed July 6, 1926, Serial No. 120,735, and in Great Britain July 20, 1925.

This invention relates to automatic or semi-automatic telephone systems and is particularly concerned with such systems in which talking current is supplied from the trunking switch (selector) rather than from a final selector (connector) and one object of the invention is the production of new and improved circuit arrangements for such selectors, intermediate selectors and connectors whereby the number of relays in these switches may be considerably reduced.

A further object of the present invention concerns the provision of new and improved circuit arrangements for transmitting busy signalling currents and metering currents in a system of the above character.

Referring now to the drawings comprising Figs. 1–3, they show by means of usual circuit diagrams so much of the equipment in a telephone system embodying the features of the invention as is necessary for the invention to be understood. Specifically, Fig. 1 shows a first selector repeater; Fig. 2 shows an intermediate selector accessible to the first selector repeater of Fig. 1; and Fig. 3 shows a connector accessible to the intermediate selector of Fig. 2.

According to the present invention a group of relays associated with a first selector switch is arranged to feed talking current to both the calling and called subscribers, guarding potential being fed forward to hold up all local switches taken into use. On all connections the battery feed selector is arranged to function as a selector repeater. The impulsing circuit of this battery feed selector is arranged so that the relay which responds to impulses generated by a calling party repeats the first series directly to the magnet of the first selector, while subsequent impulses for setting local switches are controlled over one speaking conductor and subsequent impulses for controlling switches in distant exchanges are transmitted over both sides of a two-wire junction in series. After each series of impulses to local switches the relay group is arranged to exert a controlling effect over the other speaking conductor for the hunting magnets of the series. The change over from the one wire impulsing circuit to the two wire circuit is brought about by a device which is energized when the selector is set to a level having access to junction lines. Preferably the device is energized over an additional wiper, the bank contacts engaged by this wiper being earthed on any one or a number of levels as desired. Instead of earthing the bank contacts engaged by the additional wiper at the first selector they may be earthed at a second or subsequent selector. By this means great flexibility is attained as it is possible to have outgoing trunks on any level or levels of the first or intermediate selectors. Where this flexibility is not required the additional wiper may be eliminated by operating the device on a certain level or levels of the first selector by normal post or level springs. The second and intermediate selectors are considerably simplified by having only two relays, one serving to control switching and release functions and the other the automatic hunting operation. The impulse relay in the battery feed selector transmits impulses direct to the operating magnets of the intermediate local selectors over the negative speaking conductor and the relay in the battery feed selector which de-energizes at the end of each series of impulses controls the hunting operation of the intermediate selectors over the positive speaking conductor. The combined switching and release relay of the intermediate selectors is arranged to be partially energized over the release trunk conductor by guarding potential fed forward from the battery feed selector and to disconnect the release magnet of the intermediate selectors.

In the connector switch only four relays are required a release relay energized by guarding potential fed forward over the release trunk conductor, a change over relay energized in turn in series with the vertical and rotary magnets, a combined busy and ring-cut off relay and a switching relay. The impulses for operating the vertical and rotary magnets of the connector are transmitted over one speaking conductor from the battery feed selector. In order to take care of certain supervisory arrangements, the battery feed selector is provided with a busy relay, a high impedance relay and a polarized relay. The high impedance relay is arranged to be normally connected between earth and the positive speaking conductor so that it can be energized by connecting battery to the positive speaking conductor for example at an operator's position. The energization of the high impedance relay under these conditions is arranged to place the release of the switches under the control of the operator's position

since when the high impedance relay is energized alone the guarding potential for holding up all the switches is controlled by this relay. The busy relay in the battery feed selector is normally connected between battery and the negative speaking conductor so that the high impedance relay and the busy relay may be operated over both speaking conductors in series to control the calling party's meter, the meter being actuated either by a reversal or booster battery as desired. This busy relay may also be operated alone by connecting earth to the negative speaking conductor. When the busy relay is energized alone it is arranged to connect a busy signalling conductor to the positive speaking conductor of the calling line. This busy signalling conductor is connected to a busy tone current and battery and a busy tone current and earth alternately.

When the battery feed selector is set to a level having access to junction lines, a relay is operated which changes the connections of the high impedance relay so that it is now connected in series with a polarized relay and across the speaking conductors. This change over relay also disconnects the busy relay. The circuit for transmitting the busy flash or/and tone current is now controlled by the high impedance relay over the outgoing loop circuit. Metering over junction lines is effected by the polarized relay which responds to a reversal of current over the junction line.

Should all the lines accessible through the called level of the battery feed selector be busy, the wipers will be stepped on to the 11th contact whereup 11th step cam springs will operate and connect guarding potential to the release trunk, disconnect the vertical magnet in order to prevent further operation of the switch should the calling party continue to dial, complete a local circuit for the busy relay which thereupon operates and connects busy tone and battery to the calling party's line, the switch being released by the calling party hanging up his receiver and bringing about the release of the line relay.

Should all the trunks accessible to an intermediate selector be engaged, the 11th step cam springs disconnect the vertical magnet and connect earth to the negative speaking conductor which completes a circuit for the busy relay. The busy relay also removes guarding potential from the release trunk thereby allowing a marginally adjusted switching relay in the second selector to de-energize and complete a circuit for the release magnet and thus restore the second selector to normal. It should be understood that while the foregoing description contemplates operating the driving magnets of the local selectors and connectors direct from the battery feed selector over one of the speaking conductors that an impulse relay may be inserted to control the driving magnets locally if desired.

A description will first be given of the manner in which a local call is set up. Assuming that the battery feed selector repeater, Fig. 1, is taken into use by a calling party, the impulsing relay A energizes over the positive and negative leads and completes a circuit at armature 1 for the slow release relay B. Relay B upon energizing earths the release trunk RT at armature 4; at armature 5 prepares the impulsing circuit for the vertical magnet V. Relay A responds to impulses dialled by the calling party and repeats them to the vertical magnet over the following circuit: earth, 1, 35, 5, C, 14, 39, CS′, V, battery. Relay C energizes in series with the vertical magnet V and operates its armatures 6, 7, 8, 9, 10 and 11 and being slow to release remains energized throughout the series of impulses. The vertical magnet responds to the series of impulses and raises its wipers to a level in accordance with the impulses transmitted. Upon the first vertical step, the off normal springs N and N′ close. The closure of off normal springs N′ with relay C in operated position completes a circuit for stepping relay E: battery, E, N′, contacts of R, 38, 8, 25, 4, earth. Relay E upon energizing establishes a locking circuit for itself at armature 21 and at armature 22 prepares the circuit for the rotary magnet R.

At the end of the series of impulses, relay C de-energizes and at the normally closed contacts controlled by armature 8 completes the following circuit for the rotary magnet R: battery, R, 22, contacts controlled by 8, 25, 4, earth. The rotary magnet upon energizing advances its wipers into engagement with the first set of bank contacts in the selected level and at its interrupter contacts 42, breaks the locking circuit for stepping relay E, which accordingly de-energizes.

If the first trunk in the selected level is busy, test wiper *p* will be earthed and relay E will be energized over the following circuit: battery, E, N′, 42, 38, 48, CS, *p*, to complete the circuit again for the rotary magnet. This alternate operation of stepping relay E and rotary magnet R will continue until an idle line is found. Should all the lines in the selected level of the battery feed selector be engaged, the switch wipers will be automatically stepped on to the 11th contact when the following circuit will be complete by the operation of the 11th step cam springs CS, CS′ and CS².

By the operation of cam springs CS earth at armature 3 is connected to test wiper *p* in order to operate an overflow meter (not shown) which indicates the number of times all the lines of a group are busy. By the operation of springs CS′ the vertical magnet V is disconnected to prevent the operation of

the calling party's impulse sender from actuating the switch, and by the operation of cam springs CS^2, the following circuit is completed for slow relay F: battery, lower winding of relay F, 43, 26, CS^2, 25, 4, earth. Relay F upon energizing completes the following circuit for itself at armature 28: battery, upper winding of relay F, 28, 44, 4, earth: and at armature 47 connects the combined intermittent busy tone and busy flash conductor IB to the calling party's positive speaking conductor as follows: IB, 13, 29, 47, positive speaking conductor. The battery feed selector is held in this busy condition until the calling party hangs up and releases the impulsing relay A to release the switch by operating the release magnet Z.

When an idle trunk is found, no earth will be present on the test conductor p and relay H will not be short circuited and will now energize in series with relay E. Relay E will not energize however in series with the high resistance relay H. Relay H upon energizing operates its armatures, 36, 37, 38, 39, 40 and 41 and at armature 36 connects the positive wiper to the positive line of the second selector, Fig. 2, this line being used for the first automatic rotary step of the intermediate selectors; at armature 41 connects the negative wiper to the negative line of the second selector, this line being used for transmitting impulses for the vertical operation of the switches, and at armature 38 connects the test wiper p to the release trunk conductor RT, earth being fed forward over this conductor from the battery feed selector, Fig. 1 to guard the switches and control their release; at armature 37, relay H opens a point in the initial locking circuit of relay E; at armature 39 disconnects the vertical magnet V and at armature 40 disconnects the release magnet Z.

In the second or intermediate selector, Fig. 2, the earth on test wiper p completes a circuit for the upper winding of switching relay H′ which however only operates its armature 53 to open a point in the circuit of the release magnet Z′. When the calling party dials the next series of impulses, relay A in the battery feed selector repeats them to the vertical magnet V′ over the following circuit: earth, 1, 35, 5, C, 14, 39, 15, 41, negative speaking conductor 57, CS^3, V′ and battery. The vertical magnet V′ raises the wipers of the intermediate selector to the desired level and upon the first vertical step, the vertical off normal springs N^2 and N^3 close. The springs N^2 prepare a circuit for stepping relay E′ and the springs N^3 prepare a circuit for the release magnet Z′.

At the end of the series of impulses, relay C in the battery feed selector de-energizes and completes the following circuit for stepping relay E′ in the intermediate selector: earth, at armature 17 of relay Q, G, 9, 36, 6, positive wiper, positive speaking conductor of the intermediate selector, Fig. 2, rotary off normal springs NR′, 56, 52, vertical off normal springs N^2, switching relay E′, battery. Relay E′ completes a locking circuit for itself at armature 50 and at armature 51 connects the rotary magnet R′ to the release trunk conductor RT′. The rotary magnet energizes and steps the wipers on to the first set of contacts in the selected level. When the rotary magnet has fully energized, the rotary interrupter springs 52 open, breaking a circuit of relay E′ which de-energizes. The rotary off normal springs NR′ are opened and the rotary off normal springs NR are closed; the springs NR′ prevent further control of relay E′ over the positive speaking conductor while the off normal springs NR connect up the lower winding of the switching relay H′. Should the selected trunk be busy, relay E′ will be energized over the following circuit: earth, on test wiper p^2, 11th step cam springs CS^4, 55, 52, N^2, E′ and battery. The stepping relay E′ again operates and closes a circuit of the rotary magnet R′ which steps the wipers on to the next set of bank contacts. When an idle trunk is found, switching relay H′ energizes over its lower winding in series with stepping relay E′ and switches the speaking conductors through to the next switch, earth being fed forward over the test wiper p^2.

Should all the trunks in the selected level be busy the wipers will be rotated to 11th contact position and operate the cam springs CS^3 and CS^4 on the 11th rotary step, whereupon the following circuit will be completed: earth will be connected to wiper p^2 by the operation of the cam springs CS^4, to operate an overflow meter (not shown). Springs CS^3 will disconnect the vertical magnet V′ and connect earth to the negative speaking conductor. The connection of earth to the negative speaking conductor by the cam springs CS^3 will operate the relay F in the battery feed selector over the following circuit: earth, CS^3, 57, negative speaking conductor, negative wiper, 41, 15, 10, 43, lower winding of relay F to battery. Relay F upon energizing completes a locking circuit for itself and connects up the busy tone and busy flash conductor IB in the manner previously described in order to transmit a busy tone or busy flash to the calling party. The busy relay F also disconnects at armature 25 earth from the test wiper p thereby removing earth from the release trunk conductor RT of the second selector, Fig. 2, whereupon the switching relay H′ which was partially operated now restores and closes the following circuit for release magnet Z′: battery, Z′, N^3, 53, earth. From the above it will be seen that in the event of an intermediate selector finding all lines busy that the intermediate selectors are automatically released and the busy tone or flash trans-

mitted to the calling party from the battery feed selector.

Assuming now that the intermediate selector Fig. 2, finds an idle line: Under these conditions there will be no earth on test wiper p^2 and switching relay H′ will operate over its lower winding in series with relay E′ and switch through to the final selector, Fig. 3. By the operation of armature 55 of relay H′ earth on release trunk conductor RT′ is fed forward over the wiper p^2 to the release trunk conductor RT^2 and operates relay X. Relay X upon operating opens a point in the circuit of release magnet Z^2 and prepares a holding circuit for the final selector. When the calling party dials the next series of impulses, relay A of the battery feed selector repeats the impulses over the negative speaking conductor and the first vertical impulse is transmitted to the vertical magnet V^2 of the final selector F^3 over the following circuit: earth, 1, 35, 5, C, 14, 39, 15, 41, negative wiper, negative speaking conductor, 57, negative wiper, negative speaking conductor, 78, V^2, N^4, N^5, normally closed contacts controlled by 63, relay C′ to battery. Upon the first vertical step the off normal springs N^4, N^5 open and N^5 makes contact with its working contact and subsequent impulses are transmitted to the vertical magnet V^2 over the following circuit: negative speaking conductor, 78, V^2, rotary off normal springs NR^2, 63, C′, battery. The vertical magnet V^2 sets the switch wipers opposite to the desired level and at the end of the series of impulses relays C, in the battery feed selector and C′ in the final selector de-energize. The de-energization of relay C will have no effect at this time but the de-energization of relay C′ will prepare the impulsing circuit for the rotary magnet R^2.

When the calling party dials the last digit of the wanted number the first impulse is transmitted to the rotary magnet R^2 over the folowing circuit: negative speaking conductor, 78, R^2, NR^3 and its resting contact NR^5, and its working contact, normally closed contacts controlled by armature 63, relay C′ to battery. The rotary magnet now steps the wipers on to the first set of bank contacts in the selected level whereupon the rotary off normal springs NR^2, NR^3, operate and the circuit for subsequent impulses to the rotary magnet is as follows: negative speaking conductor, 78, R^2, NR^3, NR^2, armatures 63, relay C to battery. Responsive to the impulses transmitted to the rotary magnet the wipers are rotated on to the desired level of contacts and at the end of this series of impulses, relay C and C′ de-energize. Relay C′ upon de-energizing opens the impulsing circuit thereby preventing any further impulses dialled by the calling party from becoming effective. Should the wanted party be engaged there will be an earth potential on test wiper p^3 and under these conditions, the following circuit will be completed for the lower winding of the combined busy and ring cut off relay BR: earth, wiper p^3, 73, 62, 74, lower winding of relay BR to battery. Relay BR being slow to release will remain operated for an interval after the relay C′ falls back and during this interval earth potential will be connected to the negative speaking conductor as follows: earth, 61, 64, 68, 78, negative speaking conductor. This earth also operates the busy relay F in the battery feed selector which locks up and connects up the busy tone and busy flash to the incoming positive speaking conductor as previously described. Relay F also removes earth from the release trunk conductors RT′ and RT^2 thereby releasing the train of switches. When earth is removed from RT^2, relay X de-energizes and completes the following circuit for release magnet Z^2: earth, 61, N^6, Z^2 battery.

If the called partly is free when a connection is established, relay H^2 will operate over its upper winding in series with the switching relay of the wanted party's line switch and complete a locking circuit at armature 75 over its lower winding. Switching relay H^2 also connects earth to the test wiper p^3 at armature 73 to busy the called party's line and at armatures 72 and 77 connects up ringing current from the ringing machine GEN to the negative and positive speaking conductors as follows: positive wiper, 72, 65, upper winding of BR to interrupter ringing current and from the negative wiper, 77, resistance r to battery.

When the called party answers, relay BR operates and locks up at armature 67 and at armatures 65 and 71 connects up the positive and negative speaking conductors to the wanted line, battery being fed to the calling party's line through windings of the A relay in the battery feed selector, Fig. 1, and to the called party as follows: earth, at armature 17 of relay Q, winding of relay G, 9, 36, 6, positive speaking conductor, and battery is connected to the negative speaking conductor from battery, lower winding of relay F, 43, 10, 15, 41, negative speaking conductor. Relays F and G operate over the called party's loop, but the busy circuit will not be completed since relay G is quicker to pull up than relay F and relay G opens the busy circuit at 29 before armature 47 of relay F operates.

Relays G and F also complete the following circuit for reversing relay D: battery, D, 33, 27, 10, 15, 41, negative wiper, called party's loop, positive wiper, 6, 36, 9, G, 17, earth. It will thus be seen that relay D is connected in parallel with the lower winding of relay F. Relay D upon energizing disconnects the lower winding of relay F at armature 43 and maintains its circuit through 33, 43, 10, 15, 41 to the negative wiper. Bat-

tery for talking purposes is now fed to the called party through the winding of relay D to the negative line and earth to the positive line through relay G. Relay D also reverses the direction of current to the calling line to operate a meter or other supervisory device.

It may be mentioned here that a bank contact such as 60 is engaged by the wiper p' on all levels having access to local switches, the bank contact such as 59 which is connected to earth being engaged only on the levels having access to trunk lines leading to other exchanges. Consequently since bank contact 60 is left dead, relay Q will not operate on local connections.

A description will now be given of the operation of the battery feed selector, Fig. 1, in extending calls to a distant exchange. The battery feed selector operates in the manner previously described for the first digit but on the level or levels having access to inter-exchange trunks, the relay Q is operated over wiper p'. Relay Q upon operating connects at armature 17 the high impedance relay G and the right hand winding of the polarized relay P across the outgoing positive and negative speaking conductors, the circuit being as follows: negative speaking conductor, 2, right hand winding of polarized winding p, 17, G, 9, 36, 6, positive speaking conductor. Relay G at armature 18 closes a circuit so that relay A will transmit loop impulses to the distant exchange, the circuit being: negative speaking conductor 2, 18, 6, positive speaking conductor. The springs 2 of relay A control the loop circuit across the positive and negative speaking conductors. Relay Q at armature 14 disconnects relay C from the vertical magnet V and connects it to battery through the resistance r' and at armature 12 prepares a circuit for transmitting the busy flash and tone to the incoming positive speaking conductor.

At the end of the impulse transmission, relay C will de-energize and the switches in the distant exchange will be held over relay G and the right hand winding of relay P. Relay Q is also arranged to change over the connection from the intermittent busy lead IB to a continuous busy lead CB since relay Q is operated over the test wiper p' and a bank contact in the second selector bank. It will be readily understood that trunks leading to distant exchanges may be taken from the levels of any subsequent selectors the particular place at which they extend to distant exchanges being determined by earthing the bank contact engaged by the wiper p' at that particular switch.

If the called party is busy when inter-exchange connections are set up, the high impedance relay G will be released and operated by the busy conditions at the distant incoming selector and will connect up a busy tone or busy flash signalling current at the battery feed selector, Fig. 1 to the calling subscriber or operator as the case may be. The contacts 29 of relay G will repeat the busy tone and busy flash over the following circuit: continuous busy tone and flash leads CB, 13, 29, 12, 7, positive speaking conductor. When the called party answers, battery is reversed at the distant office over the outgoing speaking conductors and the polarized relay P operates and completes an energizing circuit for relay D at armature 20. Relay D upon energizing reverses the direction of current over the incoming speaking conductors for metering or supervisory purposes, battery being fed to the calling party from relay A and to the called partly from the distant exchange.

The release of the connection is under the control of the calling party since relay A controls relay G at armature 2 and relay G in turn controls relay H, the release magnet circuit being as follows: battery, release magnet Z, 40, N, 5, 35, 1, earth.

What I claim is:—

1. In a telephone system in which connections are set up through a first selector having a directed group-selecting movement and a free trunk-hunting movement to select an idle trunk in the selected group and an intermediate selector having similar movements, primary magnets in said switches, respectively, for effecting the group-selecting movements, a line relay in the first selector arranged to repeat impulses directly to the associated primary magnet and to repeat impulses over a talking conductor directly to the primary magnet of the intermediate selector after such selector has been taken into use, and means associated with said first selector for exercising a control over the other talking conductor at the end of the group of impulses transmitted to the intermediate selector so as to cause said intermediate selector to initiate its free hunting operation.

2. In an automatic system in which connections are set up through trains of switches each containing a selector having a directed group-hunting movement and a free trunk hunting movement, said movements being controlled by a primary magnet and a hunting magnet, respectively, circuit arrangements for transmitting impulses directly to the primary magnet of an intermediate switch over one talking conductor of a connection established thereto, and separate circuit arrangements for exercising a control over the other talking conductor so as to cause said intermediate selector to initiate its trunk-hunting movement at the end of the group-selecting movement.

3. In a telephone system in which a connection set up from a calling line to a called line includes a first selector repeater and a plurality of other switches, means in the first

selector repeater effective when one of the other switches finds all trunks in a selected group busy or finds the called line busy for releasing the other operated switches in the train and for transmitting a busy signal to the calling line, said means being controlled over a circuit path including one talking conductor of the established connections and excluding the other.

4. In a multi-exchange telephone system in which connections are set up through a plurality of selectors in serial relation, means associated with the first selector of a train and effective in local connections for repeating impulses to the succeeding switches involved in the connection over a circuit including one talking conductor and excluding the other, and circuit arrangements automatically effective in case the connection is extended to a distant exchange for modifying the control circuit so that impulses are transmitted to the distant exchange over the two talking conductors in series.

5. In a telephone system in which connections are set up through a first selector repeater and through a plurality of other switches in serial relation, means associated with the first selector repeater for causing it to repeat to the other switches impulses different in one case from the impulses repeated in another case, and controlling means governed in accordance with the value of the series of impulses controlling the operation of the first selector repeater for determining the nature of the impulses repeated by the first selector repeater.

6. In a telephone system as claimed in claim 1, means effective in the event of a switch being set on a busy line, or in correspondence to a busy group of lines for transmitting busy signalling current back to the originating end of the connection over the talking conductor used for setting the switches.

7. In a telephone system as claimed in claim 5, circuit arrangements such that the means which controls the nature of the impulses to be retransmitted is in turn controlled in accordance with the position in which the first selector repeater is set.

8. In a multi-exchange telephone system, means including a train of automatic switches for setting up a connection from a calling line in one exchange to a called line in the same exchange and including the first switch of the train for setting up a connection from said calling line to a called line in another exchange, circuit arrangements associated with the said first switch for supplying talking current to the calling line in each case, and for supplying talking current to the called line only in case the called line is a local line, a supervisory-control device associated with said selector repeater operated in response to the flow of transmitter current when a local connection is set up, and means for operating said device responsive to a reversal in the flow of current when the called subscriber responds in an inter-exchange connection.

In testimony whereof I have signed my name at Liverpool, England, this 24th day of June, 1926.

WILLIAM OGLESBY PASSMORE.