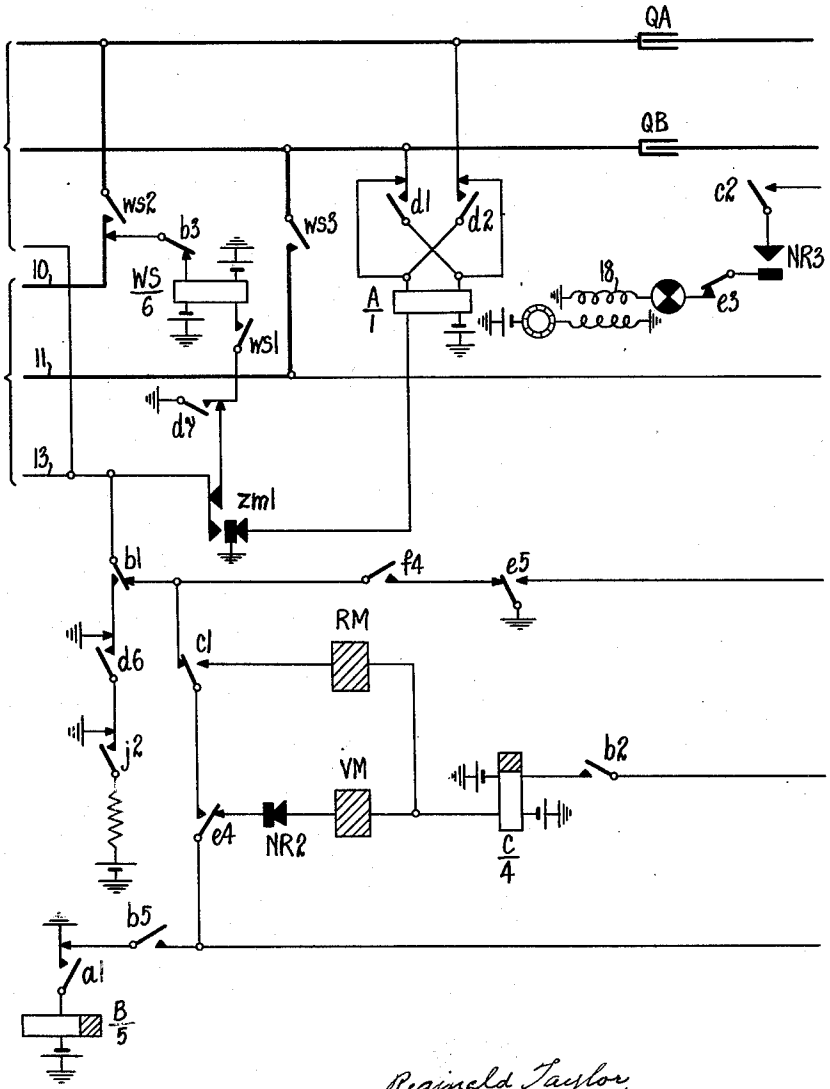
Feb. 12, 1935. R. TAYLOR ET AL 1,990,677

TELEPHONE SYSTEM

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Fig. 1.



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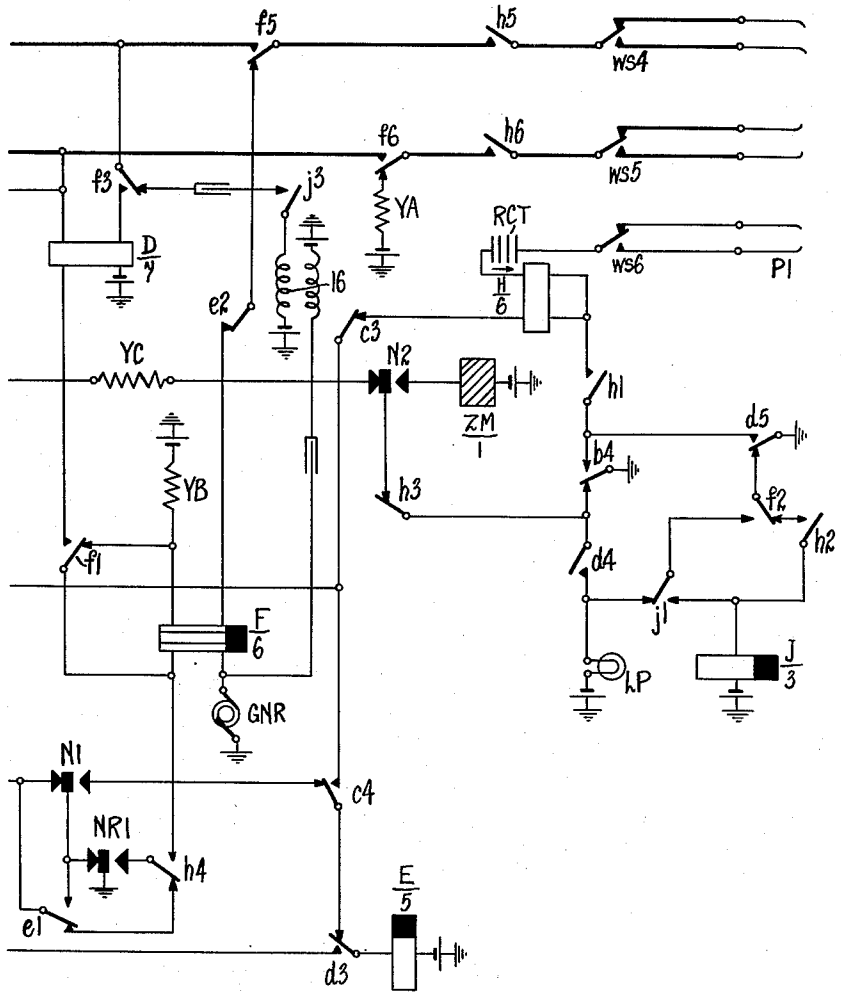
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TELEPHONE SYSTEM

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Fig. 2.



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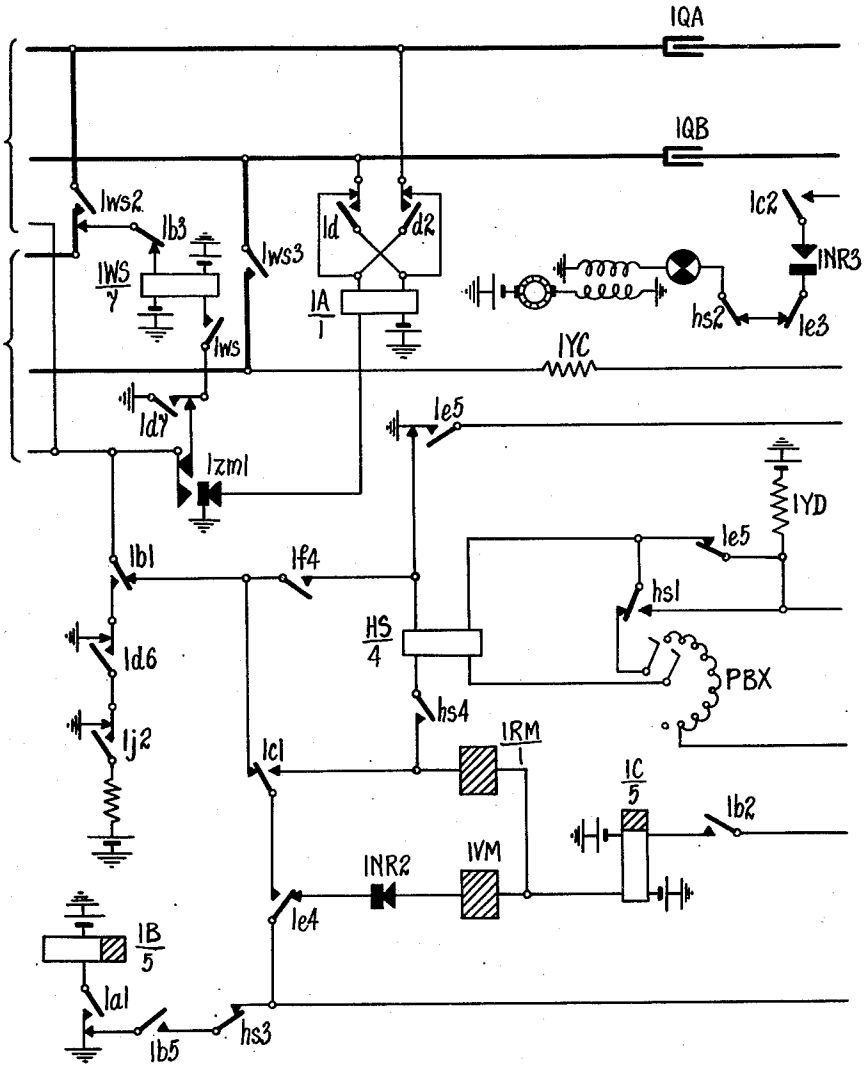
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TELEPHONE SYSTEM

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Fig. 3.



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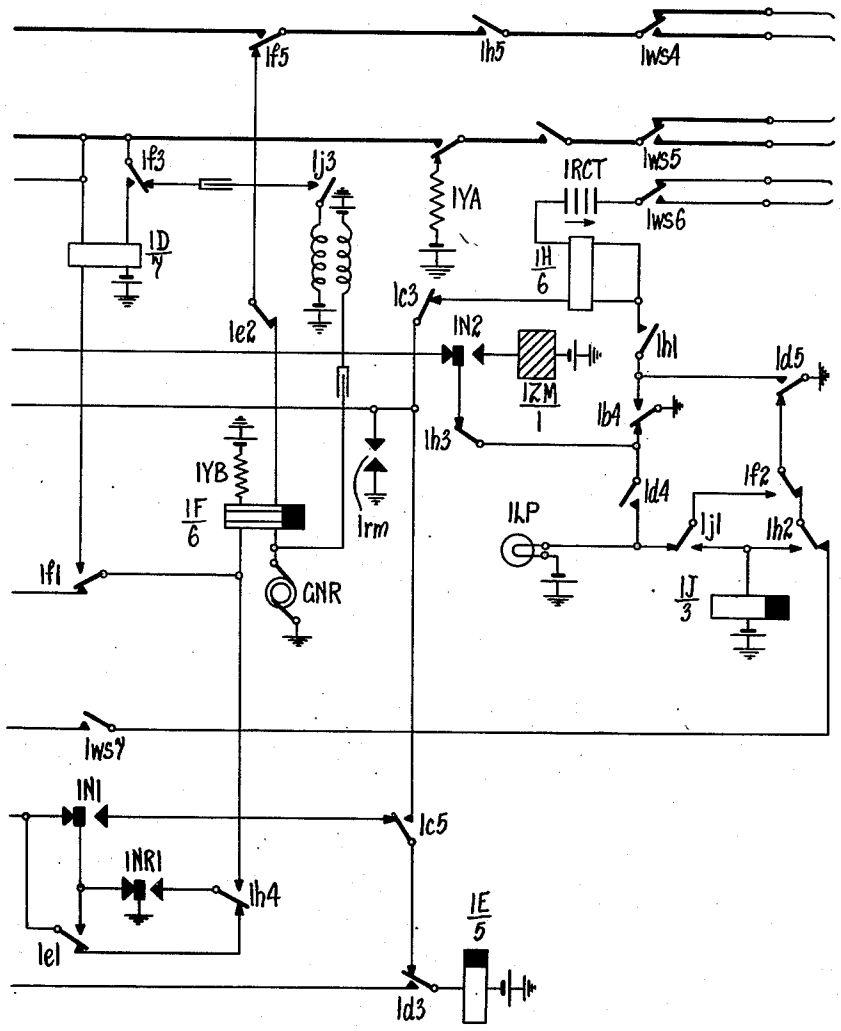
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TELEPHONE SYSTEM

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Fig. 4.



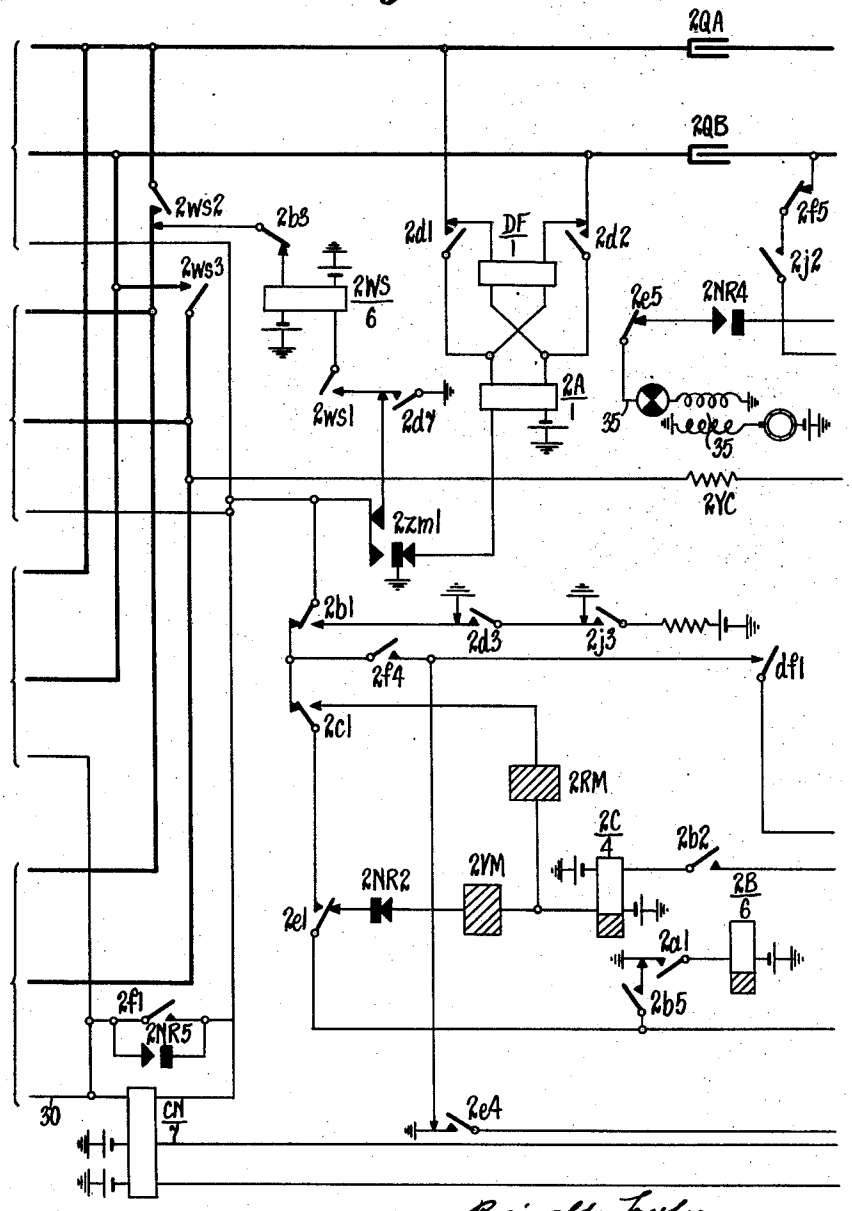
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Fig. 5.



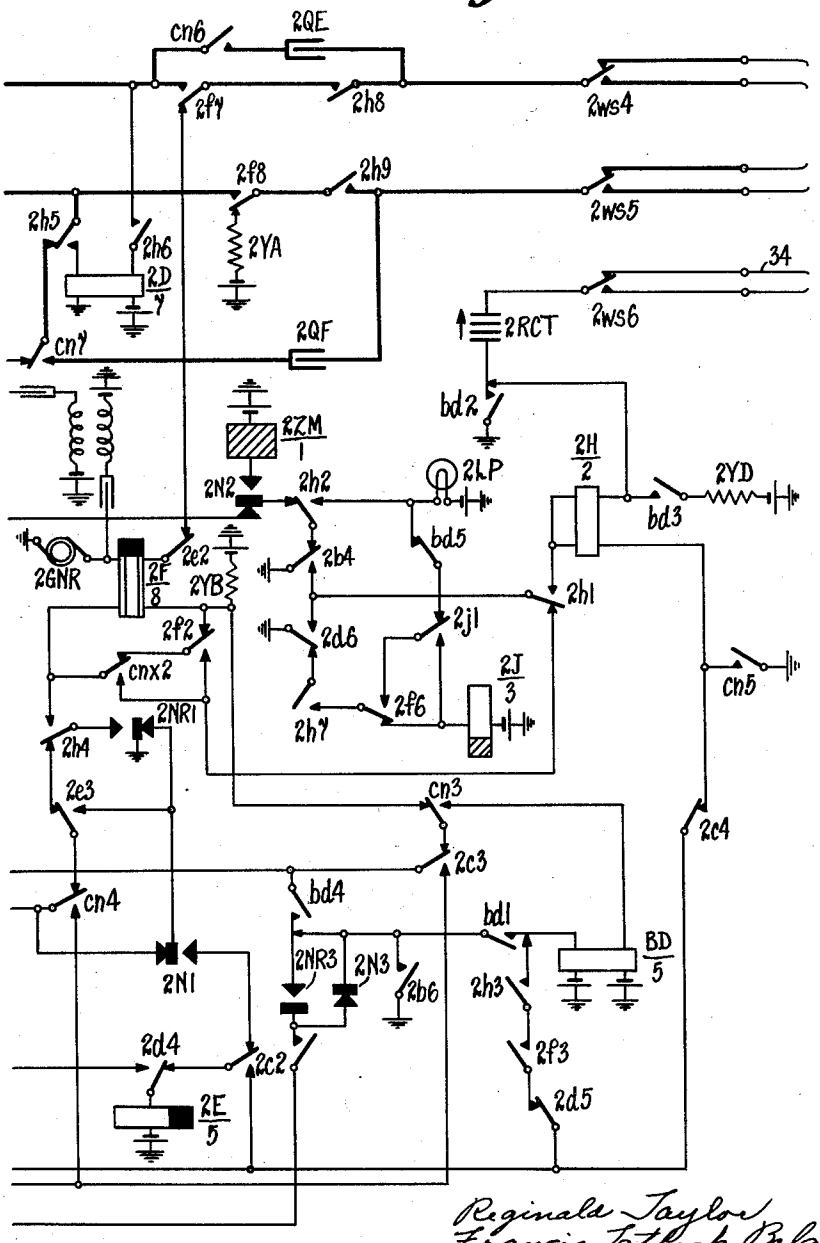
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TELEPHONE SYSTEM

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Fig. 6



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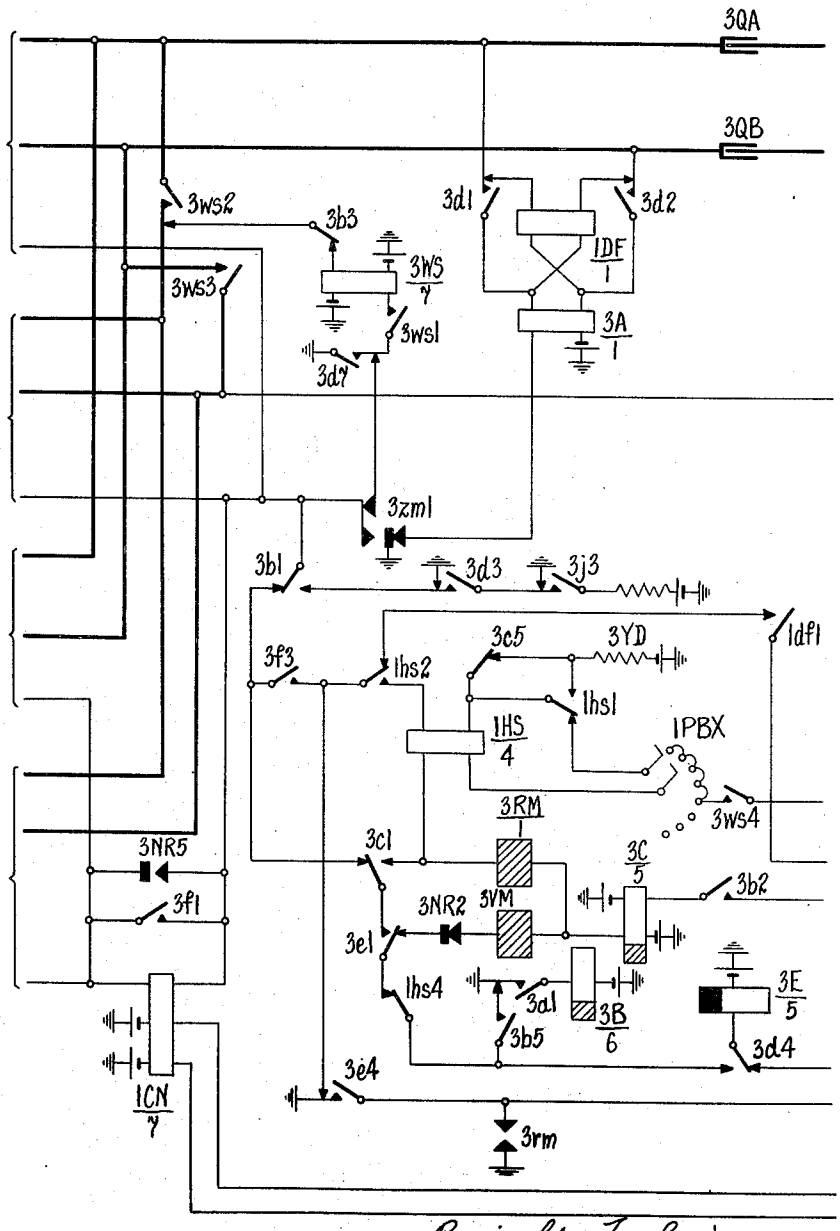
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Fig. 7.



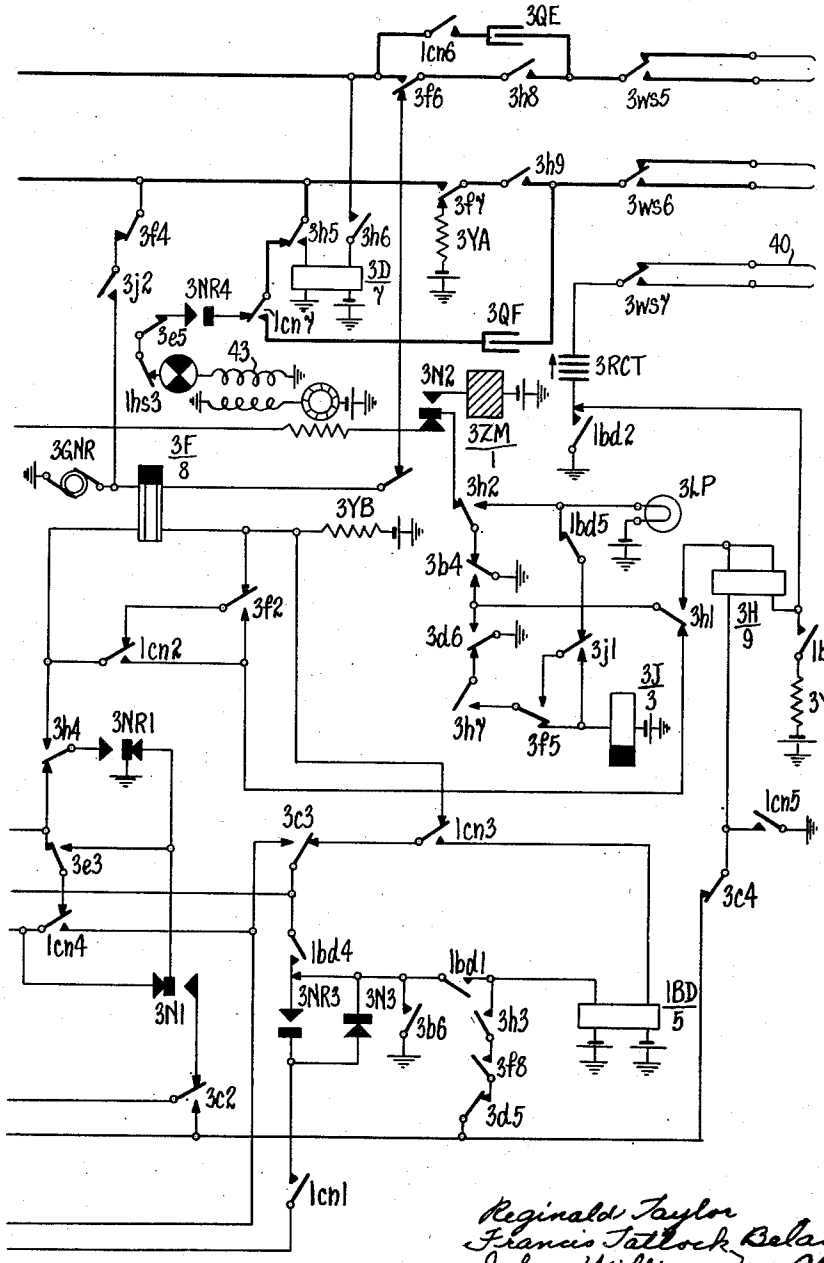
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TELEPHONE SYSTEM

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Fig. 8.



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Patented Feb. 12, 1935 1,990,677

UNITED STATES PATENT OFFICE

1,990,677

TELEPHONE SYSTEM

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Application March 21, 1932, Serial No. 600,272
In Great Britain March 23, 1931

11 Claims. (Cl. 179—18)

The present invention relates to telephone systems and is more particularly concerned with improved final selector switches for use in such systems.

According to one feature of the invention a two-directional final selector switch has associated therewith a relay adapted to be maintained energized during the primary movement of the switch and to de-energize at the end of said movement and a second relay adapted to energize in response to the de-energization of the fist relay to control the change-over of the impulsing circuit from the primary magnet to the secondary magnet and to control the re-energization of the first relay.

According to another feature of the invention in a two-directional final selector switch having associated therewith a relay adapted to be maintained energized during the primary movement of the switch and to de-energize at the end of said movement and a second relay adapted to energize in response to the de-energization of the first relay to control the change-over of the impulsing circuit from the primary magnet to the secondary magnet in which the second relay is adapted to control a circuit for testing the selected line at the end of the secondary movement of the switch.

According to a further feature of the invention in a two-directional final selector switch having associated therewith a relay adapted to be maintained energized during the primary movement of the switch and to de-energize at the end of said movement and a second relay adapted to energize in response to the de-energization of the first relay to control the change-over of the impulsing circuit from the primary magnet to the secondary magnet in which the second relay is adapted to interact with the secondary magnet to control the selection of an idle line in a selected group.

The invention will be better understood from the following description of one method of carrying it into effect, reference being had to the accompanying drawings comprising Figs. 1 to 8.

Figs. 1 and 2 show a final selector for use by regular subscribers and provided with two sets of wipers.

Figs. 3 and 4 show a final selector for use by regular subscribers which is provided with two sets of wipers and arranged to select an idle one of a group of lines when a particular set of wipers are connected up.

Figs. 5 and 6 show a final selector switch for use by both regular subscribers and toll operators and provided with two sets of wipers.

Figs. 7 and 8 show a final selector switch for use by both regular subscribers and toll operators which is provided with two sets of wipers and arranged to select an idle one of a group of lines when a particular set of wipers is connected up.

The switches shown in Figs. 5 and 6, 7 and 8 are arranged when controlled by a toll operator to extend the speaking connection to a line already engaged on a local connection and are further arranged under the control of the operator to disconnect the wanted subscriber from the local connection.

Referring now to Figs. 1 and 2, it will be seen that the final selector shown may be taken into use over two sets of conductors extending from the preceding switch the particular set taken into use depending upon the destination of the call. When the switch is taken into use over the upper set of wipers will be connected up so as to establish connection with the first hundreds group of lines. When the switch is taken into use over the lower set of conductors relay WS is operated prior to the setting operation of the switch to connect up the lower set of wipers so that connection may be established in the second hundreds group.

Assuming now for the purposes of this description that the switch is taken into use over the lower set of conductors 10 and 11, relay WS will be operated over the circuit: earth at armature *b*4, armature *h*3, off-normal springs N2, resistance YC, conductor 11, calling loop by way of the preceding switches and subscriber's instrument, conductor 10, armatures *ws*2 and *b*3, left-hand winding of relay WS to battery. Relay WS in operating, at its light armature *ws*1 completes a locking circuit for itself over its right-hand winding to earth which is momentarily extended over the release trunk conductor 13 from the preceding switch. At armatures *ws*2 and *ws*3 the calling circuit is transferred to relay A and at armatures *ws*4, *ws*5 and *ws*6 the lower set of wipers is connected up. Relay A is operated over the calling loop and at armature *a*1 operates relay B which at armature *b*1 connects a guarding and holding earth to the release trunk conductor to replace the momentary forward earth from the preceding switch, at armature *b*2 preoperates relay C on its upper winding from earth over conductor 14 by way of the resting springs N1 and NR1. The operation of relay C is without function until the reception of the next series of impulses, whereupon relay A will be operated in synchronism and

at each de-energization will complete the following circuit for energizing the vertical magnet VM and relay C over its lower winding in series: earth at the resting springs of armature *a1*, armatures *b5* and *c4*, normal rotary springs NR2, winding of vertical magnet VM and relay C to battery. In this manner the vertical magnet is energized to raise the shaft and wipers to the desired level corresponding to the number of impulses in the series and although the initial energizing circuit to the upper winding of relay C is opened during the first step of the switch, it remains held during the continuance of the impulsing owing to the intermittent energization of its lower winding and the copper slug surrounding its core. In a somewhat similar manner relay B is held operated during the impulsing period. At the conclusion of the first vertical step the off-normal springs are operated, whereupon at springs N1 the initial energizing circuit is opened to relay C and prepared to relay E, and at springs N2 the circuit is prepared to the release magnet ZM. At the end of the train of impulses the wipers will be standing opposite the required level and as relay A is now held operated for an extended period, relay C will release after a short interval to operate relay E over the circuit: earth at the normal rotary springs NR1, operated off-normal springs N1, armatures *c4* and *d3*, winding of relay E to battery. Relay E in operating, at armature *e1* re-operates relay C over its upper winding and at armature *e4* transfers the impulsing circuit by way of the operated armature *c1* to the rotary magnet RM in readiness for the reception of the units series of impulses. It will be noticed that upon the re-operation of relay C the initial energizing circuit to relay E is opened at armature *c4*, but the relay remains held from earth applied by its own armature *e5*. Upon the reception of the units series of impulses relay A is again operated in synchronism and the rotary magnet RM is intermittently energized to rotate the wipers of the switch into engagement with the desired set of bank contacts. At the conclusion of the first rotary step, the normal rotary springs are operated whereupon at springs NR1 the initial energizing circuit to relay C is opened but the relay remains held during the continuance of the impulsing over its lower winding which is energized in circuit with the rotary magnet RM. At the normal rotary springs NR2 the energizing circuit is opened to the vertical magnet VM and at springs NR3 a point is prepared in the busy tone circuit. At the end of the units series of impulses the wipers will be standing in engagement with the desired line and if this is free, the lower test wiper P1 will encounter battery by way of the cut-off relay in the called subscriber's line equipment. Consequently upon the release of relay C and during the slow releasing period of relay E an operating circuit for the switching relay H may be traced as follows: earth at armature *e5*, armature *c3*, both wndings of relay H in series, metal rectifier, RCT, armature *ws6*, wiper P1 to battery in the called subscriber's line equipment. It should be explained that the metal rectifier RCT is included in the circuit of relay H to guard against the false operation of this relay from current in a reversed direction in case the wiper P1 should encounter booster battery potential during the metering condition of another circuit. Relay H in operating, at its armature *h1* prepares a holding circuit for itself over its low resistance upper winding, at armature *h2* operates relay J to prepare the metering circuit, at armature *h3* opens a point in the release magnet circuit, at armature *h4* connects up the left-hand winding of relay F which is normally short-circuited, and at armatures *h5* and *h6* prepares for the extension of ringing current to the wanted subscriber.

Upon the release of relay E after its slow period ringing current is extended to the wanted subscribers' instrument over the circuit: ringing generator GNR, right-hand winding of relay F, armatures *e2*, *f5*, *h5* and *ws4*, wiper and bank contact of the switch, calling subscriber's instrument circuit, bank contact and wiper of the switch, armatures *ws5*, *h6* and *f6* to the ring return circuit, comprising the resistance YA connected to battery. In order that the calling subscriber may be informed that the call is proceeding, ringing tone is extended to his instrument by way of the ringing tone transformer 16, armatures *j3* and *f3* to the upper speaking conductor. It should be explained that relay F is insensitive to the ringing current, but when the calling subscriber replies by removing his receiver from the switchhook, the direct current circuit produced will bring about the operation of relay F from battery, superimposed upon the ringing circuit, and the relay at its armature *f1* removes the short circuit from its left-hand winding so that it may lock for the remainder of the call from earth connected up by the normal rotary springs NR1 and the operated armature *h4*. At armature *f2* the locking circuit for relay J is transferred to the control of its own armature *j1* and at armatures *f5* and *f6* the speaking circuit is completed between the calling and called subscribers.

Relay D thereupon operates over both its windings in series over the called loop and at armature *d1* and *d2* reverses the direction of current to the calling side of the circuit for supervisory purposes in case the call has been extended by way of an operator, at armature *d5* completes a locking circuit to relay H, alternative to that provided by armature *b4* at the same time opening the holding circuit to relay J, at armature *d6* connects booster battery to the release trunk conductor 13 in place of earth, and at armature *d7* completes a locking circuit for relay WS. During the slow releasing period of relay J booster battery is connected to the release trunk conductor to effect the operation of the calling subscriber's meter, and later after the slow period of this relay has elapsed the booster battery is replaced by earth to maintain the guarding and holding conditions.

At the conclusion of the conversation in case the calling party should clear first, relay A restores and during the slow period of relay B, relay E is re-operated over conductor 17 and consequently when relay B restores, relay E will remain operated for a short period owing to its slug to hold earth from the release trunk conductor for a period sufficiently long to ensure the release of the preceding switches. Later when relay E restores, earth is re-applied at armature *e5* to the release trunk to guard the switch until the called subscriber clears. Moreover since relay B is now restored the supervisory lamp LP will be lighted to provide supervision of the holding condition. In case the called party should restore first, relay H will remain held from earth at armature *b4*, relay D releases however and the supervisory lamp LP is lighted over armatures *d5*, *f2* and *j1*. When both subscribers have restored, relays B and D will release and as there is now no circuit for relay H it releases and completes an energizing circuit to the release magnet ZM which restores the shaft and wipers to nor-

mal. The release magnet ZM is equipped with springs *zm*1 which serve to disconnect the circuit of relays A and WS to ensure their release and connects earth to the release trunk conductor to guard the switch until the wipers arrive at their normal position where the off-normal springs will again operate to open the release magnet circuit.

Returning now to the completion of the units digit and assuming that the called subscriber is engaged, test wiper P1 will under these circumstances encounter earth on the associated bank contact, and therefore relay H is not operated and upon the release of relay E busy tone will be extended to the calling subscriber over the following circuit: busy tone feed 18, armature *e*3, normal rotary springs NR3, armature *c*2 to the lower speaking conductor thereby informing the calling subscriber that the desired number is unavailable.

Assuming now that the called subscriber is required for a toll connection, the calling party in the local connection may if desired be forcibly disconnected by the application of full earth to the private bank multiple of the called subscriber over the wipers of a special switch which is taken into use by the toll operator. The effect of this arrangement is to short-circuit the upper holding winding of relay H so that it releases and opens the local speaking circuit and moreover at armature *h*4 relay C is again operated over its upper winding, and at armature *c*2 extends busy tone to the calling party of the local connection as long as he holds the final selector.

The circuit shown in Figs. 3 and 4 is similar to that shown in Figs. 1 and 2 except that it provides for the automatic selection of an idle line in a P.B.X. group of from two to ten lines located in the even hundred group. The general functioning of the switch is substantially the same as that already described and consequently the description which follows will be directed more particularly to the P. B. X. hunting facility. For this latter purpose it should be explained that the switch is provided with a bank arc designated PBX comprising a substantially semi-circular plate into which rows of contact pins are screwed to provide contact points which are wiped over by wipers carried by the main switch shaft. Two wipers of the trailing type are employed arranged to establish individual connection with adjacent contacts in the same level at the same instant. In the drawings only one level has been shown and the circuit arrangements are such that all contacts of the P. B. X. level are connected together except the last contact which is unwired.

Assuming now that the calling party dials the first line of a P. B. X. group and that this line is already engaged, the test wiper will encounter earth which prevents the operation of the switching relay 1H but relay HS is operated over the following circuit: earth at armature 1*d*5, armatures 1*f*2, 1*h*2 and 1*ws*7, conductor 20, bank commoning and first wiper of the bank P. B. X. right-hand winding of relay HS, armature 1*c*5 to battery by way of the resistance 1YD. Relay HS in operating, at armature *hs*1 locks in a circuit independent of armature 1*c*5, at armature *hs*2 opens a point in the busy tone circuit, at armature *hs*3 opens the normal impulsing circuit, and at armature *hs*4 prepares a circuit for re-energizing the rotary magnet 1RM in series with relay 1C when relay 1E releases. Upon the release of relay 1E at armature 1*e*5 earth will be extended by way of the low resistance left-hand winding of relay HS to energize the rotary magnet in series with relay 1C which is re-operated. In this manner the line wipers of the switch are advanced into engagement with the next set of contacts in the P. B. X. group and it should be explained as the wipers of the P. B. X. bank arc are passing between contacts relay HS remains held over its low resistance left-hand winding. At the conclusion of the magnet stroke the associated springs 1*rm* will close thereby re-operating relay 1E which locks up at armature 1*e*5 and opens the magnet circuit. Upon the release of relay 1C and during the slow releasing period of relay 1E the testing circuit for relay 1H is again completed and in case this second outlet in the P. B. X. group is also busy, relay 1H will fail to operate and when relay 1E eventually restores after its slow period, the driving circuit is again completed to the rotary magnet in order that the wipers shall make a further step. This sequence of operations will be repeated until an idle line is encountered or the wipers reach the last line in the group. Since the last contact point on the P. B. X. arc is unwired relay HS is released when the wipers encounter this position to terminate the automatic hunting operation and in the event of the last line proving busy, relay 1H will fail to operate and upon the release of relay 1E relay 1C is re-operated over its upper winding to connect busy tone to the calling subscriber.

When a free line is encountered relay 1H is operated in series with the cut-off relay in the associated line equipment, and from this point the extension of ringing current to the desired subscriber's line and the metering of the connection against the calling party when the called party replies is substantially identical with that already described in the foregoing pages. In the case of night service calls when it is usual to have only one line in the P.B.X. group connected through, calling subscribers are instructed to dial a special number other than the first in the group and since under these circumstances both wipers will engage the P.B.X. arc before relay 1C releases, relay HS is short-circuited to prevent its operation. Consequently in case the night service line selected grows busy, automatic rotation cannot take place owing to the non-operation of relay HS and when relay 1E releases relay 1C is re-operated to extend the busy signal to the calling subscriber.

The switch shown in Figs. 5 and 6 is in many respects similar to those shown in Figs. 1 and 2 and Figs. 3 and 4 in that it is provided with an upper and lower set of wipers the required set being taken into use in accordance with the route over which the switch is seized. In addition, however, the switch is arranged to be taken into use by both regular subscribers and toll operators and for this purpose four sets of incoming conductors are provided. The upper two sets of bracketed conductors extend from the bank multiple of the regular subscribers' switches, while the lower two sets of bracketed conductors extend from the bank multiple of the toll operator's switches. Switching over from the upper to the lower set of wipers is effected by the relay 2WS connected in circuit with the negative conductor of the even trunk group, and in order that the operation of the switch may be different according as to whether it is engaged by a regular subscriber or a toll operator, a relay CN is included in the release trunk conductor extending from the operator's train of switches and when operated effects the necessary circuit changes to pro-

vide for automatic cut-in on busy lines and also extends the control of the ringing circuit to the operator's position. Since the general functioning of the circuit is the same as that already described in connection with Figs. 1 and 2 the description which follows will be directed more particularly to the operations which take place when the switch is taken into use by a toll operator.

Assuming now that the toll operator desired to extend a call to a subscriber in the odd hundreds group the switch shown will be taken into use over the third set of bracketed conductors and the line relay 2A is operated in series with a differentially wound relay DF which is not operated at this time. Relay 2A in operating, at armature 2*a*1 operates relay 2B which at armature 2*b*1 connects earth to the release trunk conductor 30 in series with the upper low resistance winding of relay CN. Moreover at armature 2*b*2, relay 2C is pre-operated over its upper winding in the following circuit: earth at springs 2NR1, springs 2N1, armature 2*b*2, upper winding of relay 2C to battery. Upon the release of the guarding relay in the preceding switch, relay CN becomes operated over its upper winding in series with the switching relay therein, and at its light armature *cn*1 completes a locking circuit for its lower winding to earth at armature 2*b*6 over springs 2N3 and at armature *cn*2 pre-operates relay 2F over the following circuit: earth at armature 2*b*4, armatures 2*h*1 and *cn*2, lower winding of relay 2F to battery by way of the resistance 2YB. Relay 2F in operating at armature 2*f*1 short-circuits the upper winding of relay CN so that a full earth shall be extended to the release trunk conductor 30 for guarding and holding purposes and at armatures 2*f*7 and 2*f*8 disconnects the ringing circuit so that ringing current may be withheld from the line selected at the discretion of the toll operator. No further circuit changes will take place until the reception of the next series of impulses, whereupon relay 2A operates in synchronism and at armature 2*a*1 repeats the impulses to the vertical magnet 2VM in series with relay 2C over the following circuit: earth at armature 2*a*1, armatures 2*b*5 and 2*e*1, off-normal rotary springs 2NR2, vertical magnet 2VM to battery via the lower low resistance winding of relay 2C. In this manner the vertical magnet is energized to raise the shaft and wipers to the desired level corresponding to the number of impulses in the series and although the initial energizing circuit to relay 2C is opened at the conclusion of the first vertical step by the off-normal springs 2N1, the relay remains held during the continuance of the impulsing over its lower winding and by reason of the copper slug surrounding its core. Relay 2B is similarly slugged in order that it shall hold continuously during the impulsing period.

When the off-normal springs are operated, at the conclusion of the first vertical step springs 2N2 prepare a circuit to the release magnet 2ZM, and springs 2N3 open the holding circuit to relay CN which releases. At the end of the train of impulses the wipers will be standing opposite the required level and as relay 2A is now held operated for an extended period relay 2C will release after a short interval, and at armature 2*c*2 operates relay 2E from earth at the springs 2NR1, springs 2N1, armature 2*c*2, armature 2*d*4, winding of relay 2E to battery. Relay 2E in operating at armature 2*e*1 transfers the impulsing circuit to the rotary magnet 2RM at armature 2*e*3 re-operates relay 2C over its upper winding by connecting earth over armature *cn*4, and at armature 2*e*4 provides an alternative locking circuit for itself over conductor 33 which is effective when relay 2C re-operates. Upon the reception of the next train of impulses, corresponding to the units digit, relay 2A is again operated in synchronism and owing to the transference of the impulsing circuit by way of armature 2*e*1 and 2*c*1, the impulses are transmitted to the rotary magnet 2RM to advance the wipers into engagement with the desired line. During the first rotary step the rotary off-normal springs are operated thereby at springs 2NR1 opening the energizing circuit to relay 2C which is, however, maintained during the impulsing owing to the energization of its lower winding in the magnet circuit, at springs 2NR2 a point is opened in the circuit of the vertical magnet 2VM, and at springs 2NR5 the upper winding of relay 2CN is short-circuited in order to maintain a full earth on the release trunk conductor after the release of relay 2F which will shortly take place. At the conclusion of impulsing, relay 2A will again be held energized and relay 2C therefore releases after a short interval and at armature 2*c*2 opens the circuit to relay 2E and at armature 2*c*4 prepares the switching circuit to relay 2H.

Assuming now for the purpose of the description that the line selected is idle, the test wiper 34 will encounter battery by way of the cut-off relay in the associated line equipment and during the slow release period of relay 2E, switching relay H will be operated over the following circuit: earth at armature 2*e*4, armature 2*c*4, windings of relay 2H in series, armature *bd*2, metal rectifier 2RCT, armature 2*ws*6, wiper 34 and bank contact to battery in the line equipment. Relay 2H in operating, at armature 2*h*1 completes a holding circuit for itself over the upper winding, at armature 2*h*4 completes a further holding circuit to relay 2F alternative to that which was opened at armature 2*h*1, at armatures 2*h*5 and 2*h*6 connects relay 2D to the speaking conductors, and at armatures 2*h*8 and 2*h*9 extends the speaking circuit by way of the wipers and bank contacts of the switch to the line selected. Absence of busy tone indicates to the calling operator that the line selected is idle, but ringing current is with-held until the subscriber who originated the toll call again takes up the connection.

When the toll operator has again established connection with the calling subscriber, she may then set up the ringing condition in the switch in question by operating a control key in her cord circuit, which has the effect of connecting earth to the negative line which is the upper one of the third bracketed set taken into use thereby short-circuiting one winding of relay 2A so that it then holds over the other winding in series with one winding of differentially wound relay DF. Under these circumstances relay DF is operated and is effective in releasing relay 2F by connecting earth by way of its armature *df*1 over armatures 2*c*3 and *cn*3, to the resistance 2YD feeding battery to relay 2F. In consequence of this connection the lower winding of relay 2F is short-circuited so that it releases and at armatures 2*f*7 and 2*f*8 completes the ringing circuit over the line selected to the wanted subscriber's instrument. Moreover at armature 2*f*6 relay 2J is operated to prepare a metering circuit which is without effect on toll calls, and at armature 2*f*2 causes ringing tone to be connected to the

lower speaking conductor to the calling subscriber to inform him that the call is proceeding.

When the called subscriber answers by removing his telephone from the switchhook, a direct current circuit is produced which brings about the operation of relay 2F on its upper winding from battery which is superimposed upon the ringing circuit, and upon the operation of its armature 2*f*2 and assuming that the toll operator has by this time restored the control key the relay then locks over its lower winding for the remainder of the call, and at armatures 2*f*7 and 2*f*8 completes the transmission circuit between the calling and called subscribers. Owing to the presence of the called subscriber's instrument circuit relay 2D is operated over the line conductors, and at armatures 2*d*1 and 2*d*2 reverses the direction of current flow over the calling circuit to provide supervision for the toll operator and at the same time disconnects the differentially wound relay DF during the conversation period.

In case the toll operator should call a subscriber who is already engaged in conversation, the test wiper 34 will encounter guarding earth instead of the idle marking battery potential so that relay 2H will not be operated, and upon the release of relay 2E after its slow period, busy tone will be extended to the toll operator over the following circuit: busy tone feed 35, armature 2*e*5, springs 2NR4, armatures *cn*7 and 2*h*5 to the lower speaking conductor and from thence to the toll operator's instrument.

A circuit is also completed for re-operating relay 2C and this may be traced from earth at springs 2NR1, armatures 2*h*4, 2*e*3, *cn*4 and 2*b*2, upper winding of relay 2C to battery. Relay 2C in operating prepares the circuit for re-operating relay CN under the control of the toll operator.

In order that the toll operator may cut in on the busy connection she will operate the control key in her cord circuit which brings about the operation of the differentially wound relay DF, and as relay 2C is operated at this time, a circuit is completed for re-operating relay CN over its middle winding and armatures 2*c*3, *df*1 and 2*e*4 so that the relay then locks over its lower winding to earth at armature 2*b*6. Relay CN in operating, at armature *dn*4 transfers the holding circuit for relay 2C to the control of relay DF and at armatures *cn*6 and *cn*7 extends the operator's speaking circuit by way of the condensers QE and QF to the busy connection. The operator may now offer the call to the wanted subscriber and in case he is engaged on an incoming call, it may become necessary to force the disconnection of the local call, and this is effected by a further operation of the control key.

Considering now the circuit operations involved it will be seen that upon the release of the key from its previous operation relay 2C will restore and upon the re-operation of the key the earth from armature *df*1 will be extended over armatures 2*c*3 and *cn*3 to operate relay BD over its right-hand winding so that the relay then locks over its left-hand winding and armature *bd*1 to earth at armature 2*b*6. Relay BD moreover at armature *bd*2 connects a direct earth to the test wiper 34 to short-circuit the switching relay of the connector engaged in the local conversation so that the connection will be immediately released in the manner described for Fig. 1, at armature *bd*3 relay 2H is operated on both its windings in series to earth at armature *cn*5, at armature *bd*4 the holding circuit for the lower winding of relay CN is transferred to the control of relay DF and at armature *bd*5 the circuit is held open to the supervisory lamp 2LP. In case the wanted subscriber should be engaged on an outgoing local call, relay BD in operating will extend earth forward on to the private normal conductor which shunts down the odd or even switching relay in the finder to disconnect the negative, positive and private lines, so that the wanted subscriber is then held and the trunk is busied by the connection of full earth on to the private conductor. It will be appreciated when a subscriber is already engaged on a toll call, it is impossible for another toll operator to break down the connection since the switch relay 2H is under these circumstances locked operated in a local circuit.

Returning now to the operation of the switching relay 2H, at armature 2*h*1 the relay is locked in a local circuit thereby opening the original energizing circuit of relay 2F but owing to the operation of armature 2*h*4 the latter relay will remain held to complete the speaking connections. In case the wanted subscriber should replace his receiver meanwhile, it will then be necessary for the toll operator to re-ring him and this is effected by a still further operation of the control key. The circuit operations involved for this feature are somewhat similar to those described in connection with the normal ringing operation in that relay DF in operating extends earth to the right-hand side of the lower winding of relay 2F which is thereupon short-circuited and released, and at armature 2*f*7 and 2*f*8 re-connects the ringing circuit to the line conductors.

The circuit shown in Figs. 7 and 8 offers identical facilities to that shown in Figs. 5 and 6 in that it may be taken into use by regular subscribers or toll operators, and in addition provides for the automatic selection of an idle line in a P. B. X. group of from 2–10 lines located in the even hundred multiple. From the knowledge of the previous circuits a detailed description of the additional facility concerning P. B. X. hunting will make the understanding of the circuit in Figs. 7 and 8 quite clear.

Assuming then for the purposes of this description that the calling party, either a subscriber or a toll operator, dials the first line of a P. B. X. group and that this line is engaged, then the test wiper 40 will encounter guarding earth instead of battery, so that relay 3H is not operated and consequently the hunting start relay 1HS will be operated over the following circuit; earth at the operated off-normal springs 3NR1, armatures 3*h*4 and 3*ws*4, bank commoning and leading wiper of the bank arc 1PBX, right-hand winding of relay 1HS, armature 3*c*5 to battery by way of the resistance 3YD. Relay 1HS in operating, at armature 1*hs*1 locks in an alternative circuit, at armature 1*hs*2 prepares the circuit for energizing the rotary magnet 3RM, at armature 1*hs*3 opens a point in the busy tone circuit and at armature 1*hs*4 opens the normal impulsing circuit to the rotary magnet. Upon the release of the relay 3E, at armature 3*e*4, earth will be extended over the circuit prepared by the operation of armature 1*hs*2 for energizing the rotary magnet 3RM in series with the low resistance winding of relays 1HS and 3C. The magnet and relay 3C are therefore operated so that the wipers are moved into engagement with the next set of blank contacts and relay 1HS is retained operated over its low resistance wind-

ing while the wipers of the bank are 1PBX are passing between contacts. At the conclusion of the magnet stroke the springs 3*rm* will close and complete a circuit for re-operating relay 3E which at armature 3*e*4 opens the rotary magnet circuit and prepares the circuit to the switching relay 3H.

Assuming now that the wipers are in engagement with a free line, wiper 40 will encounter battery by way of the cut-off relay in the line equipment and upon the release of relay 3C after its slow period relay 3H will be operated over the following circuit: earth at armature 3*e*4, armature 3*c*4, windings of relay 3H in series, resting springs of armature 1*bd*2, metal rectifier 3RCT, armature 3*ws*7, wiper 40 and bank contact to battery by way of the cut-off relay in the line equipment. Relay 3H in operating locks at its armature 3*h*1, at armature 3*h*4 opens the circuit to relay 1HS which releases to terminate the rotary movement and at armatures 3*h*8 and 3*h*9 completes a ringing circuit over the line selected in the well-known manner. It should be explained in regard to the bank arc 1PBX that all contacts in the P. B. X. group are connected together except the last which is unwired, and consequently in case all the lines in the group should prove busy, the leading wiper will be moved into engagement with the unwired contact so that relay 1HS releases and as the switching relay 3H will also fail to operate owing to the presence of earth encountered by wiper 40, upon the release of relay 3E busy tone will be extended to the calling party over the following circuit; busy tone feed 43, armatures 1*hs*3, and 3*e*5, springs 3NR4, armatures 1*cn*7 and 3*h*5 to the lower speaking conductor and from thence to the calling subscriber to inform him that the desired line is busy. Moreover upon the release of relay 3E during the busy condition a circuit is completed for re-operating relay 3C over its upper winding, in order to prepare for the cut-in feature as previously explained in case the call has been originated by a toll operator.

In the case of night service calls when it is usual to have only one line in the P. B. X. group connected through, calling subscribers are instructed to dial a special number other than the first in the group and since under these circumstances both wipers will engage the bank arc 1PBX before relay 3C releases, it will be seen that relay HS under these circumstances is short-circuited to prevent its operation, and in case the particular line should prove busy, automatic rotation of the switch will not take place and busy tone is immediately delivered to the calling subscriber. The circuit is arranged for last party release and in case the called party should hold the connection after the calling party has restored, the train of switches set up as far as the final selector in question are released and later the trunk is rebusied in order to prevent further selection of the final selector until the called party has restored. In the case of either party holding the connection after the other has restored, supervision is provided by the lamp 3LP.

What we claim is:

1. In a telephone system, a two-motion connector switch, a relay maintained energized during the primary movement and deenergized at the end thereof, a second relay energized responsive to the deenergization of said first relay to change over to the secondary movement, means for reenergizing and maintaining said first relay energized during the secondary movement and for deenergizing the same at the end thereof, a circuit controlled by the first relay during the secondary movement for maintaining the second relay energized, and means for again energizing said first relay in the event that the line selected in the secondary movement fails to test idle.

2. In a telephone system, a connector switch having primary and secondary movements, a relay maintained energized during the primary movement of the switch and deenergized at the end of such movement, a second relay energized responsive to the deenergization of said first relay, means for changing over to the secondary movement under control of said secondary relay, and a circuit controlled by said second relay for testing the selected line at the end of the secondary movement.

3. In a telephone system, a connector switch having primary and secondary movements, a relay maintained energized during the primary movement of the switch and deenergized at the end of such movement, a second relay energized responsive to the deenergization of said first relay, means for changing over to the secondary movement under control of said second relay, a secondary magnet, and means for causing said second relay to interact with said secondary magnet to step the switch in its secondary movement.

4. In a telephone system, a combined local and toll connector switch, said switch having a plurality of sets of wipers, means for seizing said switch over any one of a plurality of paths, means controlled in accordance with the path used for determining whether the switch will operate as a local connector or as a toll connector, and means controlled in accordance with the path used for determining which set of wipers will be used.

5. In a telephone system, a combined local and toll connector, a relay which controls the continuity of the talking conductors in said switch, means for holding said relay energized over the test wiper of said switch in local calls, and means independent of the test wiper for holding said relay energized on toll calls.

6. A connector switch as claimed in claim 1, in which the first relay is provided with means to control the connection of a busy signal to the calling line when the said relay is energized the third time.

7. A connector switch as claimed in claim 1, in which a third relay is provided which is controlled by a toll operator to extend a connection to a busy line, and in which a circuit is prepared for said third relay by said first relay when the same is energized the third time.

8. A final selector switch as claimed in claim 4, including a wiper switching relay arranged to be operated when the switch is seized over a particular path and arranged to connect the line relay to that path.

9. A final selector switch as claimed in claim 4, including a relay adapted to convert the switch for toll operation and to be operated over a test conductor connected to all the paths accessible to toll operators.

10. In a telephone system, a two-motion connector switch, a relay maintained energized during the primary movement and deenergized at the end thereof, a second relay energized responsive to the deenergization of said first relay to change over to the secondary movement, means for reenergizing and maintaining said first relay energized during the secondary movement and

for deenergizing the same at the end thereof, a circuit controlled by the first relay during the secondary movement for maintaining the second relay energized, means for again energizing said first relay in the event that the line selected in the secondary movement fails to test idle, a third relay controlled by a toll operator to extend a connection to a busy line, a circuit prepared for said third relay by the first relay when energized the third time, said first relay deenergized when the connection is extended to the busy line, said switch having a further relay controlled by the toll operator to release the previous connection to the busy line, and a circuit for the last mentioned relay prepared by the said first relay.

11. In a telephone system, a combined local and toll connector switch, said switch having a plurality of sets of wipers, means for seizing said switch over any one of a plurality of paths, means controlled in accordance with the path used for determining whether the switch will operate as a local connector or as a toll connector, means controlled in accordance with the path used for determining which set of wipers will be used, a relay, said relay having means for converting the switch for toll operation and operated over a test conductor connected to all paths accessible to toll operators, said relay having means for completing an auxiliary talking circuit through the switch.

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Disclaimer

1,990,677.—*Reginald Taylor*, *Francis Tatlock Belas*, and *John William McClew*, Liverpool, England. TELEPHONE SYSTEM. Patent dated Feb. 12, 1935. Disclaimer filed Sept. 8, 1950, by the assignee, *Automatic Electric Laboratories, Inc.*

Hereby enters this disclaimer to claims 2 and 3 of said patent.

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