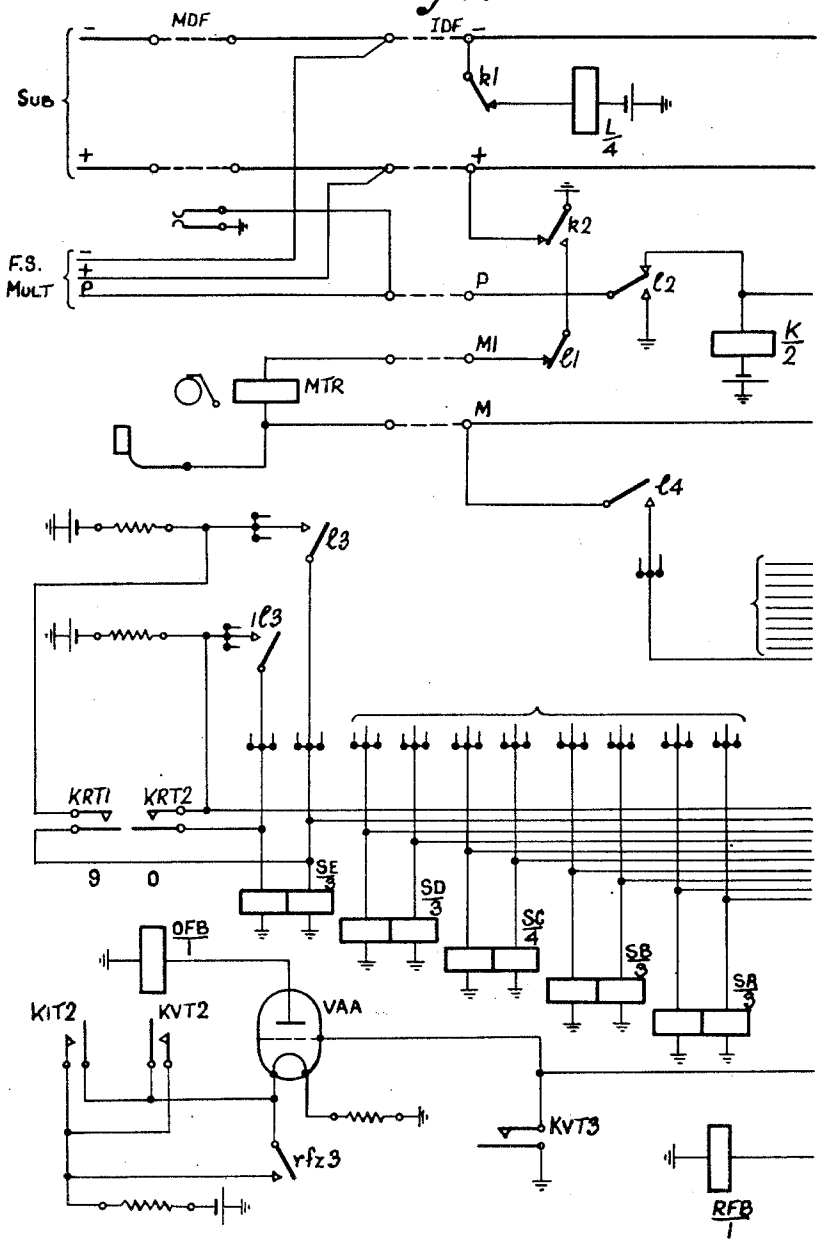
Aug. 15, 1939. R. TAYLOR ET AL 2,169,302

TELEPHONE SYSTEM

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Fig. 1.



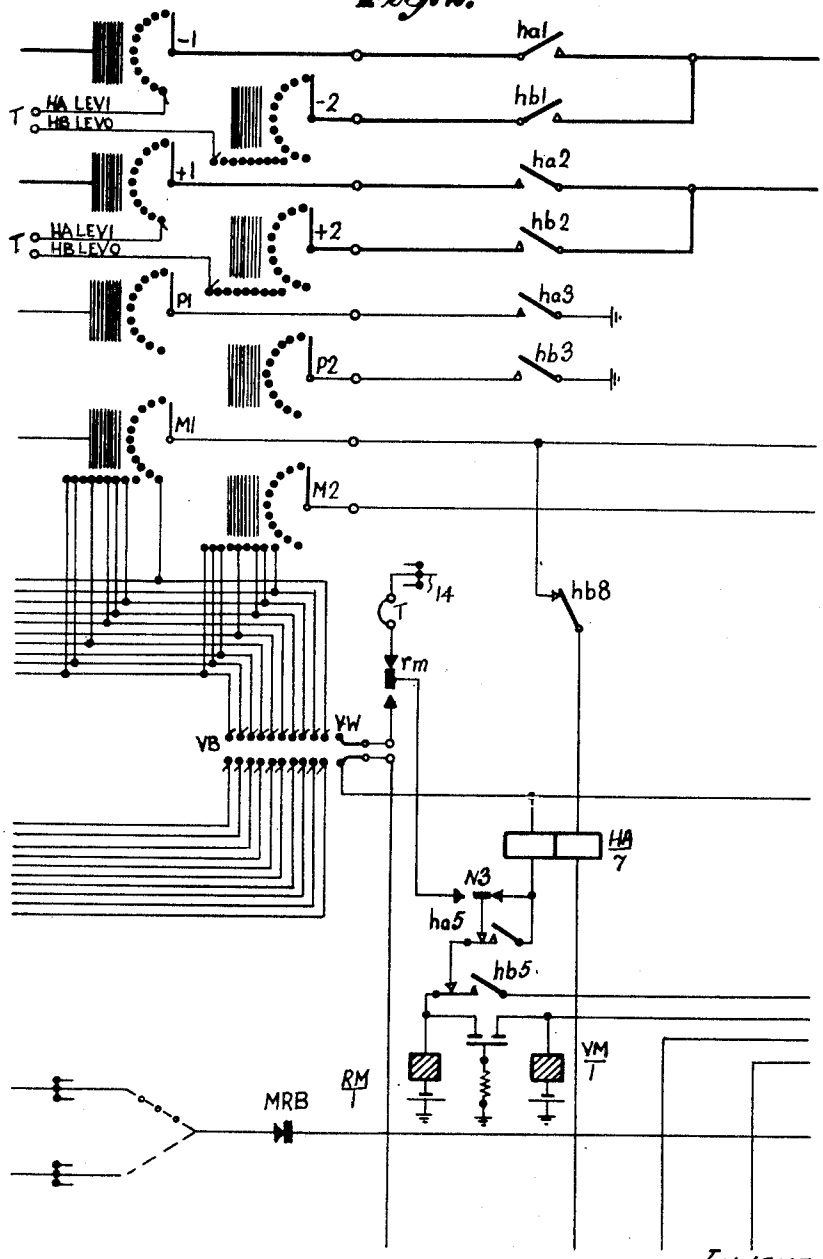
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TELEPHONE SYSTEM

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Fig. 2.



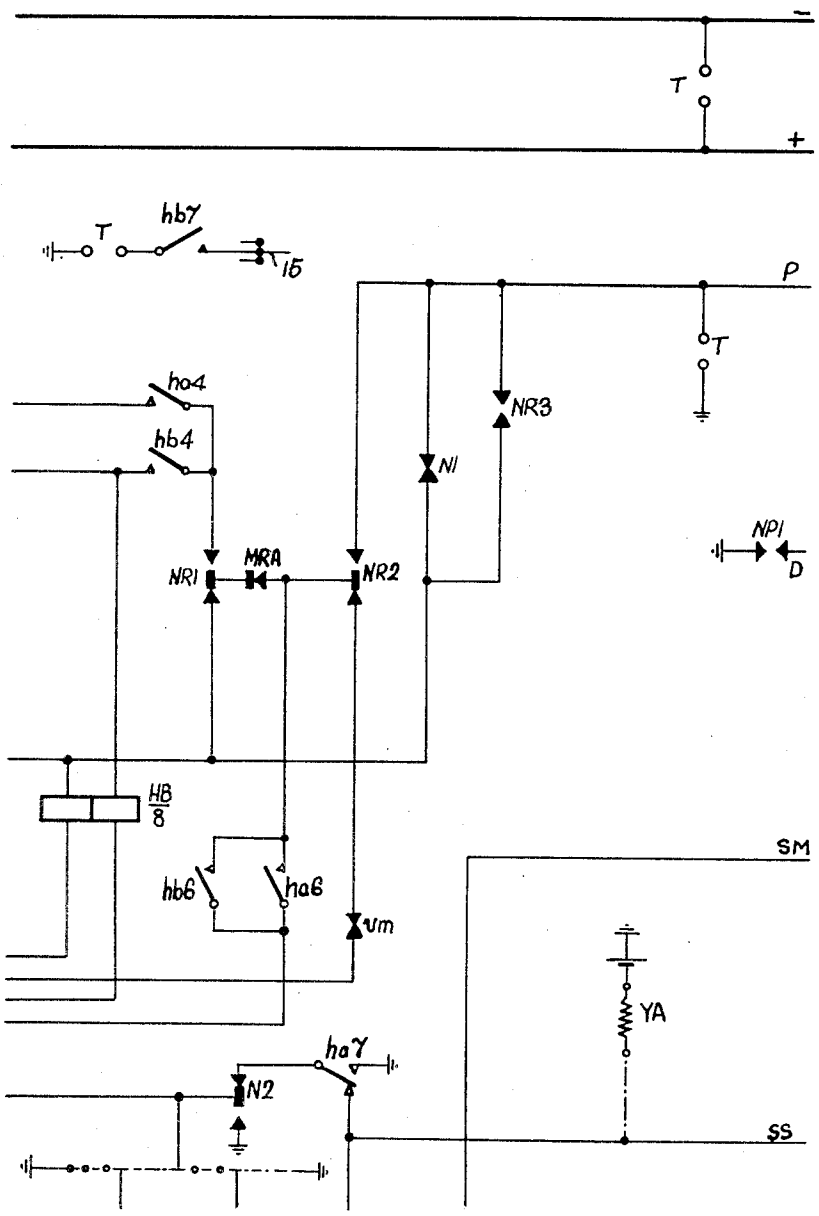
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TELEPHONE SYSTEM

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Fig. 3.



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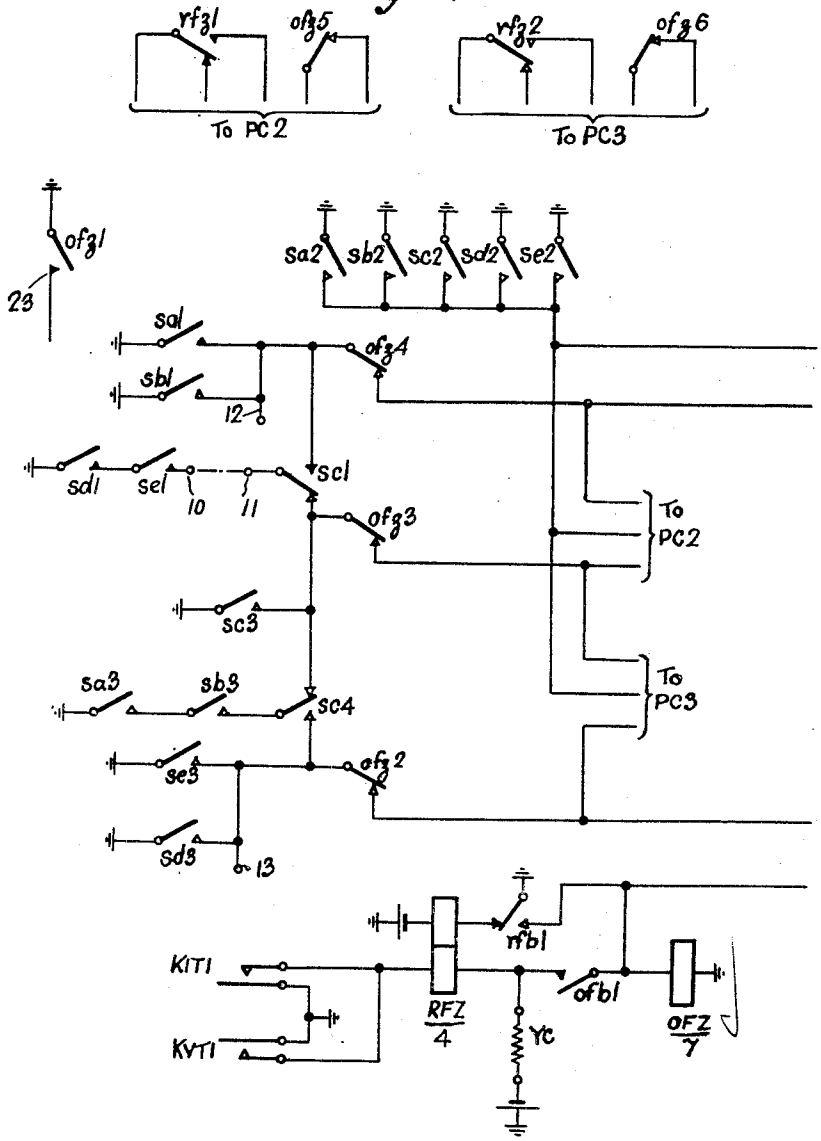
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TELEPHONE SYSTEM

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Fig. 4.



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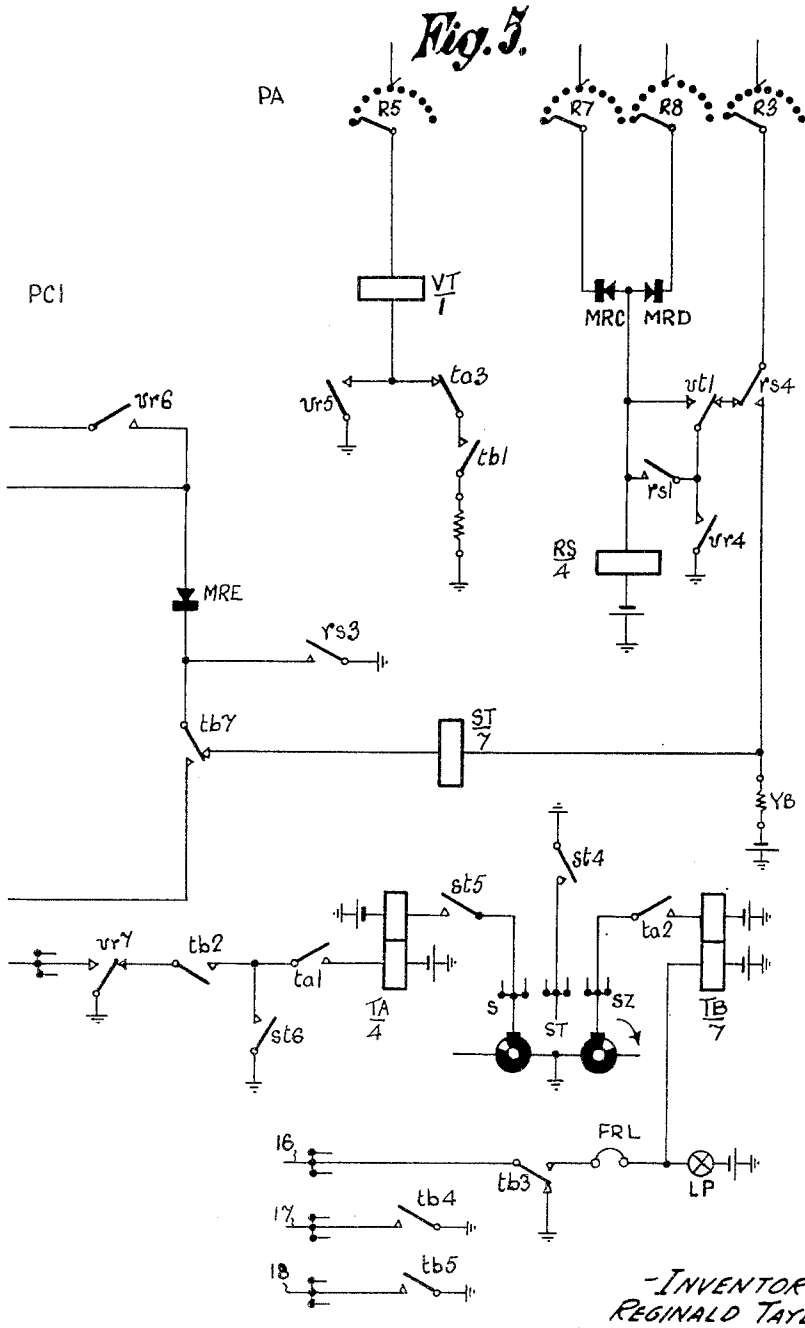
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TELEPHONE SYSTEM

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Fig. 5.



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Fig. 6.

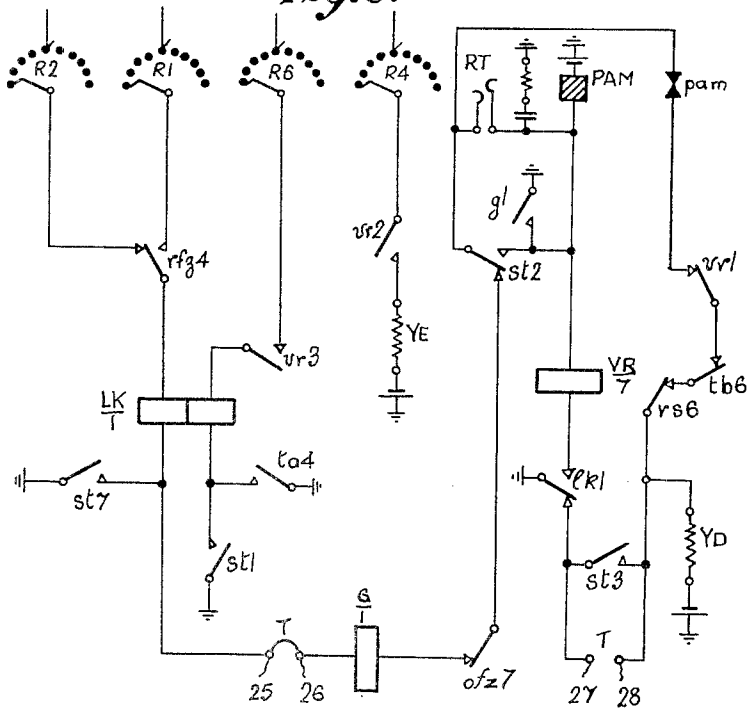


Fig. 9.

1	2	3	7
4	5	6	8

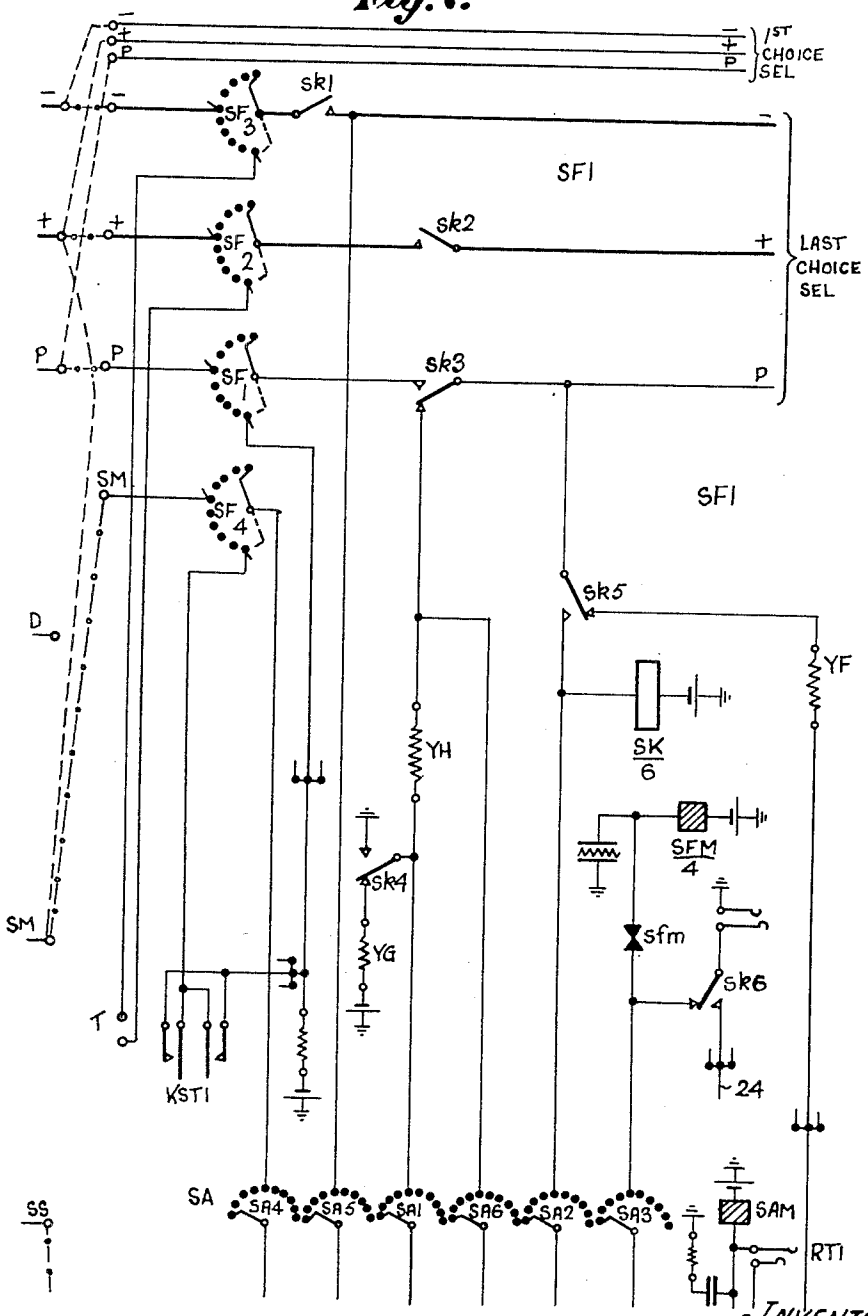
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TELEPHONE SYSTEM

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Fig. 7.



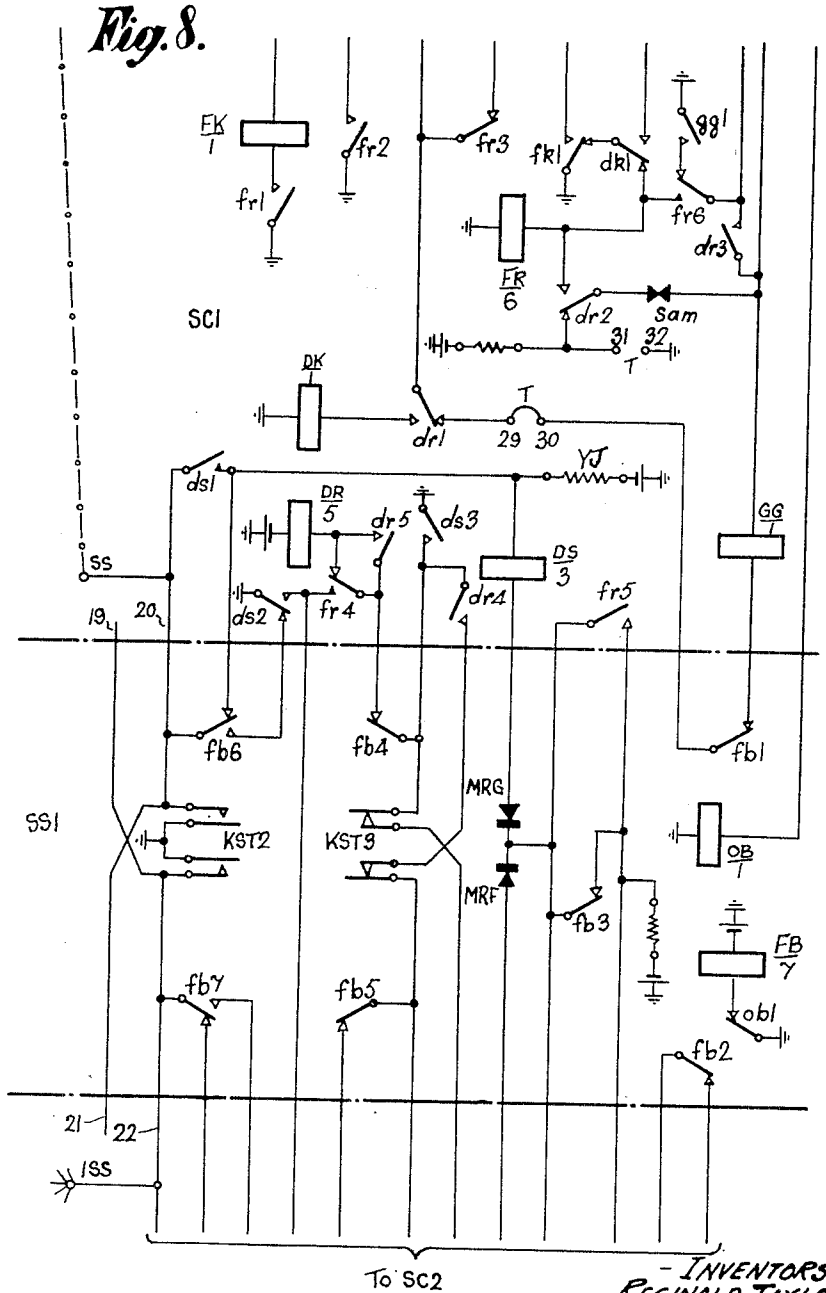
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TELEPHONE SYSTEM

Filed April 25, 1936 8 Sheets-Sheet 8

Fig. 8.



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Patented Aug. 15, 1939

2,169,302

UNITED STATES PATENT OFFICE

2,169,302

TELEPHONE SYSTEM

Reginald Taylor and George Thomas Baker, Liverpool, England, assignors to Associated Telephone and Telegraph Company, Chicago, Ill., a corporation of Delaware

Application April 25, 1936, Serial No. 76,322
In Great Britain May 13, 1935

18 Claims. (Cl. 179—18)

The present invention relates to telephone systems and has for its object the provision of an improved finder switch arrangement for connecting a calling subscriber's line to a first numerical switch. The invention may be considered as an improvement on the arrangement disclosed in our Patent No. 2,091,127, granted August 24, 1937, in which primary line finders are arranged so that those first taken into use are directly connected to first group selectors, while those last taken into use are arranged to be connected to first group selectors in a common group over secondary finders.

Since switches of this type are required to operate at high speed it is important that they shall be reliably stopped when the wipers encounter the calling line, and according to one feature of the invention this is secured by shunting the interrupter contacts so that the driving magnet is held energised.

According to another feature of the invention the test for a free last choice finder and its associated secondary group is made simultaneously so that under all traffic conditions dual or lost connections are avoided.

According to a further feature of the invention if the secondary group seized by a last choice primary finder cannot complete the call, for example due to all secondary finders in the group being busy, or to a fault, the primary finder will be released and another connected to a different secondary group will be taken into use.

A still further feature of the invention which is concerned with the routing of last choice finders is that should all such finders become engaged due to incident traffic, further calls are routed to the first choice finders and the group is not closed until all first and last choice finders are engaged. As in the prior arrangement the primary finder switches in connection with which the present invention will be described are of the two-directional type adapted to operate in both directions of motion in a self-interrupted circuit. No release magnet is provided and the restoration of the switches to normal is effected by the intermittent operation of the secondary magnet, so that the switch wipers in the complete setting and restoration operation perform a so-called rectangular movement. Control of the primary and secondary finder switches is by means of common sets of apparatus associated with the switches over rotary allotter switches as in the prior arrangement.

The invention will be better understood from the following detailed description of one method of carrying it into effect, reference being had to the accompanying drawings comprising Figs. 1 to 8 which should be arranged as shown in Fig. 9 to form a complete circuit.

Referring first to the individual figures, Fig. 1 shows a subscriber's line circuit, primary control start relays which are associated with each 200-line group of subscribers, a thermionic valve VAA and relays RFB and OFB which together form a group busy detecting device for both first and last choice finders. Fig. 4 comprises the start relay set which has the function of starting up the control sets either separately or together depending upon the calling conditions. Three primary control sets PC1, PC2 and PC3 are assumed to be fitted, full details of PC1 being disclosed in Figs. 5 and 6. The strapping shown in Fig. 4 between terminals 10 and 11 allows for three primary control sets and their associated allotters which may be simultaneously started up if there are three or more simultaneous calls in the group but if only two control sets PC1 and PC2 are provided the strapping between terminals 10 and 11 is omitted and instead terminal 10 is strapped to terminal 12 and terminal 11 to terminal 13. Figs. 2 and 3 show full details of a line finder and the proper number of such finders required for each subscribers' group are connected to the banks of the primary allotters such as PA. The finders are divided up into first choice and last choice finders and the arrangements are such that the last choice finders are not taken into use until all the first choice finders become busy. The necessary changes of connection according to the conditions under which the finders are to be used are made at the I. D. F. and there are also certain strapping changes to be made on the finders internally. Thus the chain-dotted connections shown are suitable for first choice finders which are directly connected to first selectors while the circle and dash connections apply to last choice finders which are connected with first selectors by way of secondary finders. Fig. 8 covers details of a secondary finder control set SC1 in conjunction with a secondary start set SS1 which can start up two control sets SC1 and SC2 while Fig. 7 gives details of the secondary allotter SA which has access to a group of secondary finders such as SF1. The secondary finders have access over the I. D. F. to last choice primary finders.

It will be understood that the secondary start and control groups are accessible in common from primary allotters serving different groups of lines and are provided in numbers sufficient

to cater for the maximum traffic on these groups of lines. It is also arranged that adjacent contacts in the banks of the primary allotters extend to different secondary control groups in order to increase the possible availability although it is conceivable that the same secondary control group may make more than one appearance in the banks of a primary allotter but only on contacts which are widely spaced apart. In the case of first choice finders the negative, positive and P wires are connected directly over the I. D. F. to a selector as shown in Fig. 7. The SS lead is not required and the SM lead is strapped over the I. D. F. to the positive lead. The D lead when required is strapped through to the first selector and is utilised when a group of finders is arranged for serving mixed coin-box and ordinary subscribers. Normal post springs NP1 are fitted in such a case and are arranged to operate on the level upon which the coin-box subscribers are accommodated; this lead is only wired on first choice finders. The negative, positive, P and SM leads of last choice finders are connected over the I. D. F. to the bank multiple of the secondary finders while the SS lead is connected across to the secondary start relay sets.

For the purpose of description it will first be assumed that the finder shown is one of a first choice group and only the chain dotted connections shown therefore will apply.

Referring now to Fig. 1, when the subscriber whose line circuit is shown removes his receiver, the loop placed across the incoming speaking leads operates relay L. Thereupon armature *l4* marks the position of the calling line in the rotary bank multiple of the finder, armature *l3* extends a marking battery to the finder vertical bank multiple and operates the level start relay SE and armature *l2* disconnects the winding of relay K from the P lead extending to the final selector multiple and applies earth thereto in order to busy the line to incoming calls.

Assuming for convenience of description that start relay SA is energised rather than relay SE, a circuit is completed from armature *sa1*, Fig. 4, to operate the start relay ST, Fig. 5, in the primary control set PC1 by way of rectifier MRE in the conductive direction. It should be explained that the primary allotter PA is arranged to be preselecting so that under conditions of light traffic its wipers will already be standing in engagement with a free finder. Assuming this to be the case, armatures *st4*, *st5* and *st6* prepare a circuit for a delayed alarm change-over device to be described later while armature *st7* completes a circuit from earth, left-hand winding of relay LK, armature *rfz4*, wiper R2 of primary allotter PA, chain-dotted connection, off-normal springs N2, armature *ha7*, chain-dotted connection, idle marking resistance YA in the primary finder to battery. Relay LK on operating in this circuit at armature *lk1* opens the circuit of the allotter magnet PAM before it has had time to operate and completes a circuit for relay VR in series with the magnet which does not operate in these circumstances. Due to the low resistance of relay LK an immediate guard earth is extended to the finder seized. Relay VR upon operating completes a circuit from earth, armature *vr5*, (Fig. 5) winding of relay VT, wiper R5, vertical wiper VW in normal position, left-hand winding of relay HA, off-normal springs N3, armatures *ha5* and *hb5*, finder rotary magnet RM to battery; relay HA operates in this circuit but relay VT and magnet RM are non-operative. Armature *vr2* extends battery by way of resistance YE and wiper R4 to the SM lead which is cross-connected at the I. D. F. to the positive conductor of the first selector, the A and B relays of which then operate to return a holding earth over the P conductor.

Relay HA upon operating, at armature *ha5* locks independently of the off-normal springs N3 and at armature *ha6* completes a self-interrupted driving circuit for the finder vertical magnet VM from earth, (Fig. 5) armatures *vr4*, *vt1* and *rs4*, wiper R3, armature *ha6*, rotary off-normal springs NR2, vertical magnet interrupter springs *vm*, magnet VM to battery. At armature *ha7* earth is applied by way of springs N2 to wiper R2 to further guard the finder against seizure by any other searching allotter. This earth shunts the left-hand winding of relay LK which however remains operated by way of its right-hand winding over wiper R6 to battery over the idle marking resistance YA.

By the operation of the magnet VM the finder is stepped vertically until the vertical wiper VW encounters battery on the marked contact in the vertical bank VB whereupon relay VT quickly operates and opens the vertical magnet driving circuit at armature *vt1* and also energises relay RS. Owing to the low resistance of relay VT the level is guarded against seizure by any other finder in the group. Relay RS in the control set operates and locks by way of armatures *vr4* and *rs1* and completes a holding circuit for relay ST at armatures *rs3* independent of the start earth. Armature *vt1* also opens the holding circuit of relay HA which thereupon releases, but the finder remains guarded by the earth extended from off-normal springs N2 which operate as soon as the switch steps vertically. On the release of relay HA the vertical magnet circuit is further disconnected at armature *ha6* and at armature *ha5* a circuit is completed from earth on lead *l4* by way of equipment which gives an alarm should the magnet remain energised for more than a predetermined period, test link T, rotary magnet interrupter springs *rm*, off-normal springs N3, armatures *ha5* and *hb5*, magnet RM to battery and accordingly the wipers are rotated in search of the calling line.

When this is reached a circuit is completed to hold the finder rotary magnet in the operated position and thus arrest the motion. Assuming the marking is on the M1 bank, this extends as follows: earth, armatures *vr4* and *vt1*, rectifier MRC in the conductive direction, wiper R1, low resistance right-hand winding of relay HA, armature *hb3*, wiper M1, armature *l4* in the calling line circuit, vertical bank VB and wiper VW, rotary magnet interrupter springs *rm* in the operated position, off-normal springs N3, armatures *ha5* and *hb5*, rotary magnet RM to battery. If the marking had been on the M2 bank, the jamming circuit would have been completed by way of rectifier MRD in the control set, wiper R3 and the right-hand low resistance winding of relay HB.

Assuming that the marking is on the M1 bank, relay HA operates in series with the magnet. Armatures *ha1* and *ha2* extend the negative and positive conductors through to the first selector, armature *ha3* extends an earth over the finder P1 wiper to operate relay K in the calling line circuit, armature *ha4* extends the meter lead M1 through to the outgoing P lead by way of the rotary off-normal springs NR1 and NR2 and

rectifier MRA, armature *ha5* opens the magnet jamming circuit and completes a holding circuit for relay HA by way of rotary off-normal springs NR3 to the P conductor which is earthed from the selector while at armature *ha6* this earth is extended over springs NR2, armature *ha6*, wiper R3 and armature *rs4* to short-circuit and release relay ST in the control set. In the line circuit relay K upon operating disconnects relay L which thereupon releases and removes the vertical and rotary bank markings while at armatures *l1* and *k2* earth is connected to the subscriber's meter MTR in preparation for metering.

The start relay concerned which is assumed to be SA releases when relay L falls away assuming there are no further calls for lines connected to levels 1 and 2 and the armatures *sa1* and *sa2* remove the start and hold earths from the primary control set. Relay ST releases due to short-circuiting of its winding and at armature *st1* opens the holding circuit of relay LK which falls away and in turn releases relay VR. The holding circuit of relay RS is now opened at armature *vr4* while relay VT was previously released when relay L removed the vertical marking battery. The allotter PA now preselects a free finder in a manner to be described later and the control set becomes available for handling further calls.

It will be appreciated that if the calling party had been connected to the M2 bank, relay HB would have operated to switch through the second set of wipers. Relay HB in addition to performing functions similar to those performed by relay HA, at armature *hb1* prepares a circuit for the common test buzzer connected to lead 15 so that by inserting a link into the test jack point T an attendant may readily determine which set of wipers is in use. Should two calling lines be encountered in the same position, relay HB has preference over relay HA since it opens the circuit of relay HA at armature *hb8*.

It may be explained here that in ordinary operation all switches are self-driven to decrease the hunting time. The drive is disconnected by a high speed low resistance relay switching to marking battery through a non-inductive resistance except in the case of the line finder rotary motion where magnet jamming is employed. Relays VT, Fig. 5, LK, Fig. 6, FK and DK, Fig. 8, come under this heading and are designed to operate in a minimum time to reduce the possibility of dual connections. Two such relays will not operate together in parallel to one marking battery and should one be already operated it will effectively guard the outlet seized against another relay switching thereto.

Under normal light traffic conditions as soon as a control set is restored to normal it preselects a free finder under control of relay G. Earth from the operated springs N2 of the finder just set is extended by way of the chain-dotted connection, wiper R2, armature *rfz4*, left hand winding of relay LK, test link T, winding of relay G, armatures *ofz1* and *st2*, allotter magnet interrupter springs *pam*, armatures *vr1*, *tb6* and *rs2*, resistance YD to battery. Relay LK does not operate in this circuit but relay G operates and at armature *g1* energises the magnet PAM which opens the interrupter springs *pam*. Relay G thereupon releases and disconnects the magnet which then advances the wipers one step and again closes the interrupter springs. Should the allotter wipers now encounter an engaged finder, earth will again be extended over wiper R2 to re-operate relay G and the interaction will continue until a free finder is preselected. Should a further call originate before the completion of preselection, relay ST will re-operate and to reduce the finding time a circuit is completed at armatures *st2* and *st3* to self-drive the allotter in search of a free finder. As soon as the allotter encounters a free finder, relay LK operates to disconnect the drive and the circuit operation proceeds as described before.

As soon as all first choice finders in the group are taken into use, the idle marking battery which is normally extended from each free finder in the group through resistance YA, Fig. 3, chain-dotted connections, armature *ha7*, off-normal springs N2, rectifier MRB and chain-dotted connection to relay RFB which it is common to the group is removed. Relay RFB thereupon releases and at armature *rfb1*, Fig. 4, operates relay RFZ over its upper winding. Armatures *rfz1*, *rfz2* and *rfz4* change over the test leads in the various primary control sets to wiper R1 in order to prepare for testing last choice finders while armature *rfz3* completes the filament circuit of the valve VAA in preparation for testing last choice finders. It will be understood that the rectifier MRB provided in each finder is connected up in such a sense as to prevent earth connected to the right-hand side of the rectifier from shunting the idle marking battery of other finders connected in common to relay RFB or valve VAA.

After completion of the setting of the last free first choice finder, the primary control set preselects a free last choice finder in conjunction with a free secondary control set SC1, Fig. 8. Should either the finder or its associated secondary control set be engaged an earth will be fed back on to the bank of wiper R1 to operate relay G which causes the allotter to step on until it encounters a free outlet.

When a further call is originated, relay ST operates and relay LK is then energised from earth, armature *st1*, left-hand winding of relay LK, armature *rfz4*, wiper R1, circle and dash connection, off-normal contacts N2, armature *ha7*, lead SS, IDF cross connection to Fig. 8, armature *fb6* in the secondary start relay set SS1, winding of relay DS, rectifier MRG, armature *fb3*, to battery in parallel with a resistance marking battery YJ. Relay LK operates in this circuit and at armature *lk1* disconnects the allotter magnet circuit and operates relay VR which initiates the vertical hunting of the line finder. At armature *vr2* a marking battery is extended over wiper R4 to the SM lead and by the cross connection over the I. D. F. marks this finder in the secondary finder bank multiple, while armature *vr3* connects the right-hand low resistance winding of relay LK by way of wiper R6 to the SS lead extending to the secondary control set thus holding relay LK over this winding after relay HA is operated in the finder. From this point the operation of the last choice primary finder proceeds as described for the first choice finder and when the calling line is located either relay HA or relay HB is operated.

Relay DS in the secondary control set operates in series with relay LK and at armature *ds1* locks up to the SS lead and at armature *ds3* completes a circuit to operate relay DR which at armature *dr4* completes an operating circuit for a similar relay DR in control set SC2 (not shown). The operation of the two relays DR causes both the secondary finder SF1 and a similar one controlled by the control set SC2 to be set in operation to

search for the marked last choice primary finder. Should the primary finder find the calling line before the secondary finder completes its finding operation, the primary control set will remain held until a signal is received from the secondary finder. The primary and secondary finders hunt simultaneously but since the secondary finders have no normal position and since two are set in operation together, one of the secondary finders will almost always find the primary finder before the latter has found the calling line.

As regards the detailed circuit operation, when relay DR operates, at armature *dr1* it connects relay DK to the secondary allotter wiper SA1 while at armatures *dr2* and *dr3* a self-interrupted driving circuit is completed for the secondary allotter magnet SAM. Since the allotter is preselecting by the interaction of relay GG and the magnet SAM, under light traffic conditions its wipers will already be standing in engagement with a free secondary finder and relay DK will operate immediately over wiper SA1 to the idle marking battery through resistance YG in the secondary finder SF1. Due to its low resistance relay DK provides an immediate guard on the finder seized. Armature *dk1* disconnects the driving circuit of the allotter and removes the short-circuit from relay FR which then operates in series with the magnet SAM which cannot now and also completes the circuit of the driving magnet SFM of the secondary finder seized. Relay FR thereupon locks up at armature *fr6*, at armature *fr4* locks relay DR, at armature *fr1* extends earth by way of relay FK over wiper SA4 to wiper SF4 of the secondary finder and at armature *fr2* extends earth over wiper SA5 to the negative conductor of the secondary finder in order to operate the A relay in the selector connected to the secondary finder. This relay then operates relay B which returns an earth over the P conductor.

The driving magnet SFM of the secondary finder operates in a self-interrupted circuit to rotate the wipers in search of the primary line finder which is marked over the SM lead from the primary control set by battery through resistance YE. When this is found, relay FK in the secondary control set operates and at armature *fk1* disconnects the magnet drive circuit and extends earth over wiper SA2 to operate relay SK in the secondary finder. Due to its low resistance the winding of relay FK provides an immediate guard on the primary finder seized. Thereupon armatures *sk1*, *sk2* and *sk3* extend the negative, positive and P leads from the secondary finder wipers through to the selector, armature *sk4* connects a further guard earth to wiper SA1 in order to short-circuit relay DK, armature *sk5* locks relay SK to the earthed P conductor while armature *sk6* connects up a test buzzer over common lead 24 to a routine test jack. Relay DK now releases and prepares a circuit for shunting down relay FR.

If the primary finder reaches the calling line before the secondary finder completes its finding operation, there will be no hold earth extended over the P conductor to hold relay HA or relay HB operated in the normal manner and relay HA is therefore held operated in series with relay ST in the circuit: earth, armatures *rs3* and *tb1*, winding of relay ST, armature *rs4*, wiper R3, armature *ha6* or *hb6*, springs NR2 and NR3, left-hand winding of relay HA or HB, armature *ha5* or *hb5* rotary magnet RM to battery. Relay ST is not yet short-circuited and the primary control set is therefore held until the secondary finder has completed its operation. As soon as the secondary finder finds the marked primary finder, earth will be extended over the P lead to maintain relay HA or HB in the primary finder and to short-circuit and release relay ST in the primary control set. On the release of relay ST the primay contol set becomes available for further common use and the primary allotter preselects another free last choice finder.

As regards the associated secondary apparatus, when relay VR in the primary control set releases after the release of relays ST and LK, the resistance marking battery is disconnected from the SM lead at armature *vr2* and relay FK in the control set SC1 is released. The start earth is already removed from the SS lead and relays DS and DR release. Relay FK on releasing at armature *fk1* short-circuits relay FR and during the release time of relay FR an earth is extended over armatures *fk1*, *dk1* and *fr6* to energise the allotter magnet SAM so that when relay FR releases the allotter wipers are stepped to the next secondary finder. Should this finder be engaged earth will be extended over wiper SA1 to operate relay GG which will interact with the magnet SAM to preselect a free secondary finder. Should the control group be again seized during this hunting operation, relays DS and DR will operate again and the relay drive for the magnet SAM will be changed to self drive to reduce the finding time to a minimum.

When the complete train of automatic switches is set up and the called subscriber replies, a booster battery metering impulse is applied to the P conductor and is extended over rotary off-normal spring NR2, rectifier MRA in the conductive direction, springs NR1, armature *ha4*, wiper M1, meter MTR, and armatures *l1* and *k2* to earth so as to operate the meter in the calling subscriber's line circuit in the well-known manner. The rectifier MRA prevents relay HA or HB and the meter from holding operated in series when subsequently earth is removed from the P conductor when the calling subscriber restores his receiver. It will be noticed that there are two terminals provided at the I. D. F. for connection to the meter MTR and also that the necessity for inserting a separate rectifier in each individual meter circuit has been overcome by the arrangement according to the invention which only requires one in the line finder circuit. With the circuits shown by a simple alteration of jumpering at the I. D. F. the switch can be adapted to work in with any existing system of metering which may for example utilise booster battery operated meters each connected to earth by way of a rectifier; meters connected to battery with no rectifier in series which are operative only when booster potential is applied or meters operated over a fourth wire by the application of negative battery or by the application of earth potential. If therefore a line finder system of this type is installed in an existing exchange, no replacement of subscribers meters will be necessary and this represents a substantial economy.

At the end of the call when the calling subscriber replaces his receiver, earth is removed from the P conductor and in the primary finder relay HA or HB according to which has been operated is released and in turn releases relay K in the line circuit. At armature *ha5* or *hb5* the operating circuit for the finder rotary magnet is again completed and the switch thereupon rotates to the 12th position in which the wipers

are clear of the bank. In this position the supporting means for the wiper carriage are no longer operative and it falls by gravity assisted by a spring and then rotates to the normal position and thereupon the off-normal springs N3 open and disconnect the rotary magnet. The guarding earth extended from the operated springs N2 to the allotter bank during release is then removed and the finder becomes available for further use. Preferably while the switch wipers are falling and rotating back to normal the rotary magnet interrupter springs are mechanically prevented from opening so that the magnet remains energised and does not chatter.

If the call is completed through a secondary finder, when the earth is removed from the P conductor relay SK will also release and at armature *sk*4 restores the idle marking battery to mark the secondary finder free in the banks of the allotter. The wipers of the secondary finder remain in the position in which they were last used.

Should the calling subscriber restore his receiver before the finder has completed its vertical movement the level marking battery on the finder vertical and rotary bank multiples and the start earth to the primary control set would be removed. Relays ST, LK and VR in the control set therefore release and armature *vr*4 disconnects the finder vertical magnet circuit and at the same time opens the holding circuit of relay HA in the finder. Relay HA upon releasing completes a self driving circuit for the rotary magnet RM and the finder will therefore cut in on the level it has reached and rotate to the 12th position and then release If it had already commenced its rotary movement relays RS and VT in addition will be released and the switch will rotate clear of the bank and restore to normal as previously described.

Should the finder fail to find the vertical marking it will step to the 10th level and relay VT will be operated by the marking battery permanently connected to the 10th vertical bank contact. The wipers will then cut in, rotate to the 12th position and release. Since the start signal is maintained another finder will then be selected by the primary allotter and a search for the calling line will commence again.

As soon as the last idle last choice finder in the group is taken into use, battery which is extended normally from resistance YJ, Fig. 8, armature *fb*6, SS lead, armature *ha*7, off-normal springs N2, rectifier MRB, circle and dash connection to the grid of the valve VAA is removed. The grid then becomes positive with respect to the filament which it will be remembered was heated when relay RFZ operated due to all first choice finders being busy The increase of anode current due to the positive potential on the grid results in the operation of relay OFB which at armature *ofb*1 completes a circuit for relay OFZ which then operates in series with resistance YC as soon as relay VR releases after the final last choice finder has been fully set. Armature *ofz*1 applies earth to lead 23 extending to the congestion meter, armatures *ofz*2, *ofz*3 and *ofz*4 disconnect the start leads to the primary control sets while armatures *ofz*5, *ofz*6 and *ofz*7 disconnect the circuits of relays G in the various primary control sets in order to prevent unnecessary hunting of allotters.

When a last choice finder again becomes free the grid of the valve VAA again becomes negative and relays OFB and OFZ release to open up access to the primary control sets. Similarly in case a first choice finder becomes free relay RFB re-operates and at armature *rfb*1 short circuits relay OFZ and disconnects relay RFZ to open up the primary control sets for access to first choice finders.

If all the first and last choice finders cannot be accommodated on the banks of one allotting switch, an auxiliary allotter may be provided giving access to last choice finders and in these circumstances relay RFZ upon operating when all first choice finders are busy is arranged to transfer the wiper connections from the regular allotter to the auxiliary allotter. The transfer is delayed until the primary control set has completed the setting of the first choice finder last taken into use by arranging that the change-over relay required will not operate until relay VR is released and relay RFZ is operated. It is thus insured that there will be no interference with a finder which is in the process of being set.

If all secondary finders operated from a secondary control set become busy, the idle marking battery normally fed out from each finder in the group by way of resistances YF' to a common lead extending to relay OB in the secondary start relay set is disconnected at armature *sk*5 in the last secondary finder to be set. Relay OB thereupon releases and at armature *ob*1 operates relay FB which at armatures *fb*6 and *fb*7 applies earth to mark the access points SS and ISS busy and at the same time disconnect the start relays DS in the secondary control sets SC1 and SC2. Should a secondary finder be hunting at the time relay FB operates, relay FR will be already operated and at armature *fr*5 will maintain a circuit for relay DS until the call is switched through. Continuous rotation of the secondary allotters is prevented by disconnecting relay GG at armature *fb*1.

If the secondary group is seized over both routes of access when only one secondary finder is available, one of the callers will be unsuccessful as regards completing the connection over this secondary group, but as soon as the successful caller is switched through to the group selector, relay FR releases and at armature *fr*5 disconnects battery feed from relay DS since relay FB will now be operated. Consequently the primary finder of the unsuccessful caller is caused to release after which another primary finder connected to a different secondary group will be taken into use and the call completed thereover.

In case a condition should arise when all secondary finders in the exchange are in use at the same time, the battery will be removed from all access points SS so that all valves VAA in the exchange operate their respective relays to connect up the congestion meters and prevent access to the last choice finders.

When a primary control set is taken into use, relay ST operates and as previously mentioned starts a delayed change-over set to give an alarm should the control set be held beyond the predetermined time; this is effected by armature *st*4 which applies earth to lead ST extending to the delayed alarm set and this starts the machine which drives cams associated with the S and Z leads. After a short period earth is applied to the S lead from the machine and relay TA will operate over its upper winding from this lead and subsequently lock over its lower winding by way of armatures *ta*1 and *st*6. If the

control set is not released within the predetermined period, earth is connected to the Z lead to operate relay TB. This relay then locks to earth supplied to common lead 16 from the unoperated armature *tb3* of the TB relays in other primary control sets of the same group which are not faulty. The primary control set supervisory lamp LP is lit to indicate the fault condition while armatures *tb4* and *tb5* extend earth over common leads 17 and 18 to give general and classified alarms. Armature *tb1* switches the control set out of service, releases relay ST and transfers the start circuit to another control set in the same group while armature *tb2* maintains a locking circuit for relay TA if relay VR is not operated and armature *tb6* disconnects relay G to prevent rotation of the allotter.

If the control set is faulty and has failed to associate itself with a free primary finder, relay VR will not be operated. Relays TA and TB will therefore remain locked up until the fault release link FRL is momentarily removed when the fault is cleared by an attendant. If the primary control set has functioned properly and has become associated with a faulty finder relay LK will be already operated and hence when relay TA operates relay LK will be locked up at armature *ta4*. If the finder has failed to step vertically, armature *vr5* will maintain relay HA operated and thus busy the faulty finder at armature *ha1*. When relay TB operates, relay ST is released which then releases relay TA. This relay opens the holding circuit of relay LK at armature *ta4* and relay LK in turn releases relay VR. Armatures *tb1* and *ta3* thereupon maintain the circuit for relay HA over the allotter wiper R5. Should the finder step vertically but fail to rotate, relays LK, VR and RS will be disconnected when relays ST and TA release, while the faulty finder will be busied by way of the operated off-normal springs N2.

If the first group selector associated with a first choice finder is artificially busied for test purposes by the connection of earth to the release trunk conductor P, this earth will extend over off normal springs N1 to operate relay HA. A busying earth will then be extended by way of armature *ha1*, off-normal springs N2 and the chain-dotted connection to the R2 bank, and assuming that an allotter is standing on this finder the earth will be effective over wiper R2 to operate relay G and cause the allotter to preselect another finder. The rectifier MRA is non-conductive in this instance and prevents the earth on the P conductor from extending to the finder vertical magnet.

If the first selector associated with a secondary finder is artificially busied for test purposes by connection of earth to the P conductor, this earth will extend by way of armature *sk5* and high resistance YF to relay OB. It will be appreciated that owing to the presence of resistance YF relay OB will remain held from idle marking battery through resistance YF of other idle secondary finders of the same group. The busying earth is also extended through armature *sk3* to bank SA6 to busy the secondary finder. Should any secondary allotter be standing on the finder the earth will be extended to operate relay GG and cause the allotter to preselect another free finder. Resistance YH is provided to prevent the full earth being applied to the low resistance YG and causing over-heating.

Keys are provided for routining first and last choice finders and secondary finders when desired. To enable first choice finders to be routined, double-throw keys KRT (Fig. 1) are provided one for each two levels and they simulate the start signal from any desired level. For example if the routine key for level 9 is thrown, that is key KRT shown is operated to the left, marking battery is extended over springs KRT1 to the 9th contact of the vertical bank VB and a finder is caused to hunt vertically until it encounters the marking battery when it will cut in on level 9 and rotate until it reaches the 11th position. The 11th position on the various levels is strapped in such a way that for example, on the first level a circuit will be completed over the M1 wiper to operate relay HA, on the second level there is a circuit for relay HB over the M2 wiper while on the third level there is a circuit for both relays HA and HB. Hence by operating the various routine keys KRT the operation of all the various circuits can be observed. When relay HA or HB operates the rotary magnet is held, the control set is released and since there is no circuit to hold either relay, the relay releases also. The finder will then step to the 12th position and restore to normal. The control set operates as usual to preselect another free finder and since the start signal is maintained the next free finder will be routined. All the first choice finders in the group will therefore be routined in progression and the operation will continue as described unless all first choice finders become engaged due to incident traffic in which case the last choice finders will be brought into the test.

Should it be desired to routine last choice finders only, key KIT is thrown also. Key contacts KIT1 operate relay RFZ to transfer the test leads on the control sets to last choice finders while key contacts KIT2 complete the valve filament circuit. If under these conditions all last choice finders become busy due to incident traffic, relay OFB associated with the valve VAA operates and serves to short-circuit relay RFZ. Further calls are therefore routed to first choice finders and the group is not closed until all first and last choice finders are engaged.

A routine test of the valve VAA can be made by the use of the routine test key KVT which when thrown operates relay RFZ at springs KVT1, completes the valve filament circuit at springs KVT2 and connects earth to the grid of the valve at springs KVT3 thus causing relay OFB to operate if the valve is functioning correctly.

In order to routine secondary finders one double-throw key KST is provided per secondary start relay set. When the key is thrown either way contacts KST1 mark the last outlet in the secondary finder bank multiple which is reserved for routine purposes, and if for example, it is thrown upwards, contacts KST2 extend a start earth to the upper secondary control set while contacts KST3 disconnect the circuit normally used for setting the secondary finder in operation from the control set SC2 on an ordinary call. When the key is thrown downwards the control of the finders by the lower secondary control set can be routined. A lead is extended from each side of the key KST2 in the secondary start set SS1 to the opposite control set. These leads are terminated at the shelf jack points 19 and 20 and should a control set be removed, jack points 19 and 20 and 21 and 22 are arranged to make contact. Hence if the control set SC2 is removed for example, a start signal over lead 188

will be extended through jack points 21 and 22 in contact to control set SC1.

Rectifiers MRF and MRG in the secondary start set allow the use of one resistance battery feed for both the start relays in the two control sets SC1 and SC2 so that a start signal received over the SS lead to the set SC1 will not effect the DS relay in the SC2 set and vice versa.

To test the stepping operation of the allotters for maintenance purposes the test link T is removed from the test points 25 and 26 (Fig. 6) and inserted between the test points 27 and 28 thereby disconnecting the preselecting circuit and enabling a self-interrupted driving circuit for the allotter magnet PAM to be completed by short-circuiting the test jack springs RT on the allotter in question. Similarly by the transfer of the test link T from jack points 29 and 30 to jack points 31 and 32 the secondary allotter may be operated from the test jack RT1.

We claim:

1. In a telephone system, lines, a plurality of finder switches, a common equipment controlling the operation of any one of said finder switches to find a line when a call is initiated from said line, a driving magnet for each finder switch for operating it to seize said line, and means including a circuit extending into said common equipment for holding the magnet of a finder switch energized when the finder connects with the calling line.

2. In a telephone system, lines, a plurality of finder switches, a common equipment for controlling the operation of said finder switches to seize a line when that line is calling, means associated with each line when a call is initiated therefrom for marking that line for seizure by a finder switch by means of a potential, and a circuit partially included in said common equipment for supplying said potential to mark said line as calling.

3. In a telephone system, lines, primary finders for connecting with said lines, groups of secondary finders associated with said primary finders, each group for connecting with certain of said primary finders, means responsive to a call on one of said lines for operating one of said primary finders to hunt for and find the calling line and for taking one of said secondary finders in the associated corresponding group into use, means for releasing both the operated primary finder and the associated secondary finder taken into use in case said secondary finder is unable to complete a connection, and means for taking another primary finder associated with a different secondary finder group into use to complete the call.

4. In a telephone system, lines, primary finders for connecting with said lines, groups of secondary finders, each such group having access to certain of said primary finders, and means responsive to a call on one of said lines for taking a primary finder into use only in case a simultaneous test indicates an idle primary finder and an available secondary finder in the group having access to such idle primary finder.

5. In a telephone system, lines, a group of finders for connecting with calling lines, said finders arranged in normally used first choice finders and last choice finders used only in case all the first choice finders are in use, means for enabling a routine test of said last choice finders to be made by making said first choice finders artificially busy, and means responsive to all said last choice finders becoming busy for automatically rendering said artificially busied first choice finders available for handling calls initiated by said lines.

6. In a telephone system, lines, a plurality of finder switches each having primary and secondary movements to connect with a calling line, a common equipment for controlling the operation of said finder switches to seize a line when calling, means associated with each line when a call is initiated therefrom for marking that line for seizure by a finder switch by means of a potential, and a circuit partially included in said common equipment completed only after the primary movement of a finder switch for supplying said potential.

7. In a telephone system, lines, a plurality of finder switches having vertical and rotary movements to find a calling line, a vertical test wiper in each finder switch, a common equipment for controlling the operation of said finder switches to find and seize a line when calling, means associated with each line when a call is initiated thereover for marking that line for seizure by a finder switch by means of a potential, and a circuit partially included in said common equipment completed over the vertical test wiper of a finder switch for supplying said potential.

8. In a telephone system, lines, a plurality of finder switches having primary and secondary movements to find a calling line, primary and secondary motor magnets in each finder switch for operating said switches in their primary and secondary movements, means responsive to the initiation of a call on one of said lines for preparing a circuit to mark said line as calling, means also responsive to the initiation of said call for operating the magnets of one of said finder switches to hunt for and connect with the calling line, and means for completing said prepared marking circuit by connecting a potential through the winding of the secondary motor magnet of said finder switch in response to the operation of said finder switch.

9. In a telephone system, lines, a plurality of finder switches having primary and secondary movements to find a calling line, primary and secondary motor magnets in each switch for operating said switches in their primary and secondary movements, means responsive to a call on one of said lines for operating the magnets of one of said switches to hunt for and find the calling line, a marking circuit individual to said line prepared in response to a call on said line, means for connecting a potential through the winding of the secondary motor magnet of said finder switch to said prepared marking circuit to mark said line as calling, and contacts on said secondary motor magnet for maintaining said magnet energized in response to said switch finding said calling line by connection with said marking circuit.

10. In a telephone system, lines, a plurality of finders having primary and secondary movements to find a calling line, primary and secondary motor magnets in each finder for operating said finders in their primary and secondary movements, means responsive to a call on one of said lines for operating the magnets of one of said finders to hunt for and find the calling line, contacts on said secondary motor magnet included in a circuit for maintaining said magnet energized in response to said finder finding the calling line, and a switching relay in said finder operated in response to said finder finding the

calling line for opening said maintaining circuit to release said secondary magnet.

11. In a telephone system, lines, primary finders for connecting with said lines, groups of secondary finders, a secondary control equipment for each secondary finder group for allotting idle secondary finders for use in completing calls when taken into use, each secondary control equipment associated with only certain of said primary finders, primary control equipment operated in response to a call on one of said lines for operating one of said primary finders to find the calling line, a start lead for each secondary control equipment, a potential normally connected to each start lead, a relay in said primary control equipment operated by the potential on the start lead when the associated secondary control equipment is taken into use in response to the call by the calling line, means for disconnecting said potential from said start lead to release said relay in case said associated secondary control equipment is unable to complete the call, and means responsive to the release of said relay for reoperating said primary control equipment to release said operated primary finder and to take another primary finder associated with a different secondary control equipment into use to complete said call.

12. In a telephone system, lines, primary finders for connecting with said lines, groups of secondary finders, each such group having access to certain of said primary finders, a test circuit for selecting an idle primary finder, a series of contacts included in said test circuit indicating that the primary finder is idle and that a secondary finder having access to such idle primary finder is available, and means responsive to a call on one of said lines for taking into use an idle primary finder over said test circuit only in case a secondary finder is available.

13. In a telephone system, lines, a group of finders for connecting with calling lines, said finders arranged in normally used first choice finders and last choice finders used only in case all the first choice finders are in use, a relay, means for energizing said relay to make said first choice finders artificially busy to enable a routine test to be made of said last choice finders, means responsive to all said last choice finders becoming busy for short-circuiting said relay to release the same, and means responsive to the release of said relay for rendering said first choice finders available for handling calls initiated by said lines.

14. In a telephone system, lines, a plurality of finders for connection with calling ones of said lines, a booster battery circuit in each finder, a rectifier in each finder, means for including said rectifier in said circuit in response to the connection of the finder with a calling line, said rectifier preventing an improper operation of said finder during the operation of said finder.

15. In a telephone system, lines, a test contact and a cut-off relay for each line, a group of finders having access to said lines, means responsive to a call on one of said lines for operating one of said finders and for applying a marking potential to the calling line's test contact independent of the calling line's cut-off relay to enable such finder to find the calling line, a wiper on said finder, and means responsive to the connection of said finder to said line for operating said cut-off relay over said wiper.

16. In a telephone system, lines, a plurality of finders having access to said lines, means responsive to a call on one of said lines for operating one of said finders to hunt for and find the calling line, means associated with each line for preparing a marking circuit to mark such line as calling in response to the initiation of a call, means responsive to the operation of said finder for completing said marking circuit by connecting a potential to said prepared circuit to mark said line as calling, and means responsive to said finder finding said connected potential on said completed marking circuit for connecting said finder to the calling line.

17. In a telephone system, lines, primary finders for connecting with said lines, groups of secondary finders, allotting means for each secondary finder group for allotting idle secondary finders for use in completing calls when taken into use, each allotting means associated with only certain of said primary finders, means responsive to a call on one of said lines for operating one of said primary finders to find the calling line and for taking into use the associated secondary allotting means, means for releasing the operated primary finder in case said secondary allotting means is unable to complete a connection, and means for taking another primary finder associated with a different secondary allotting means into use to complete the call.

18. In a telephone system, lines, a plurality of finder switches for connecting with calling ones of said lines, a numerical switch directly associated with each finder switch and connected thereby to a calling line, means for artificially busying a numerical switch for test purposes, a rectifier in each finder switch, said rectifier preventing operation of said finder switch whenever the switch associated therewith is made artficially busy.

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