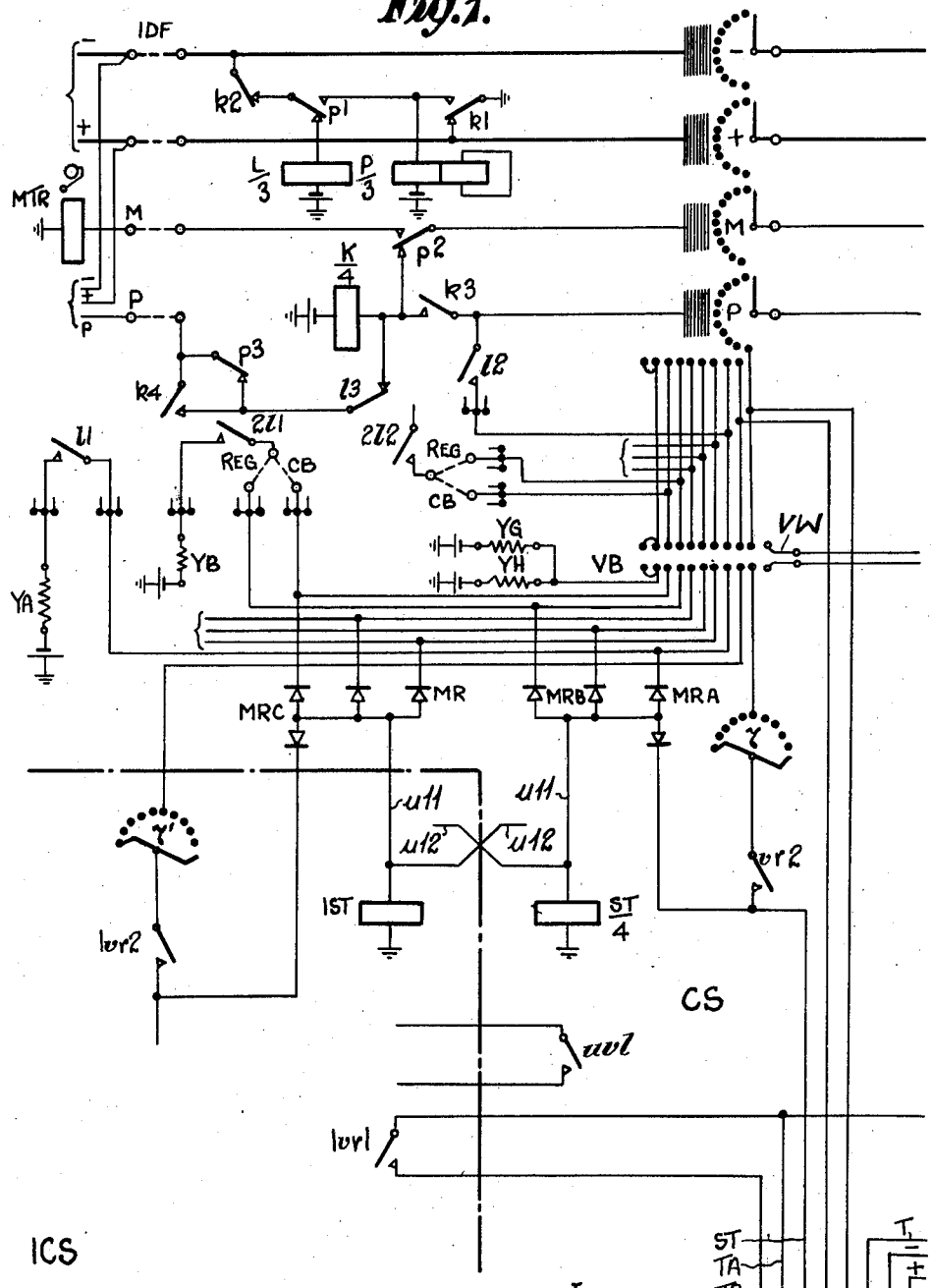
Oct. 18, 1938. G. T. BAKER ET AL 2,133,415

TELEPHONE SYSTEM

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Fig. 1.



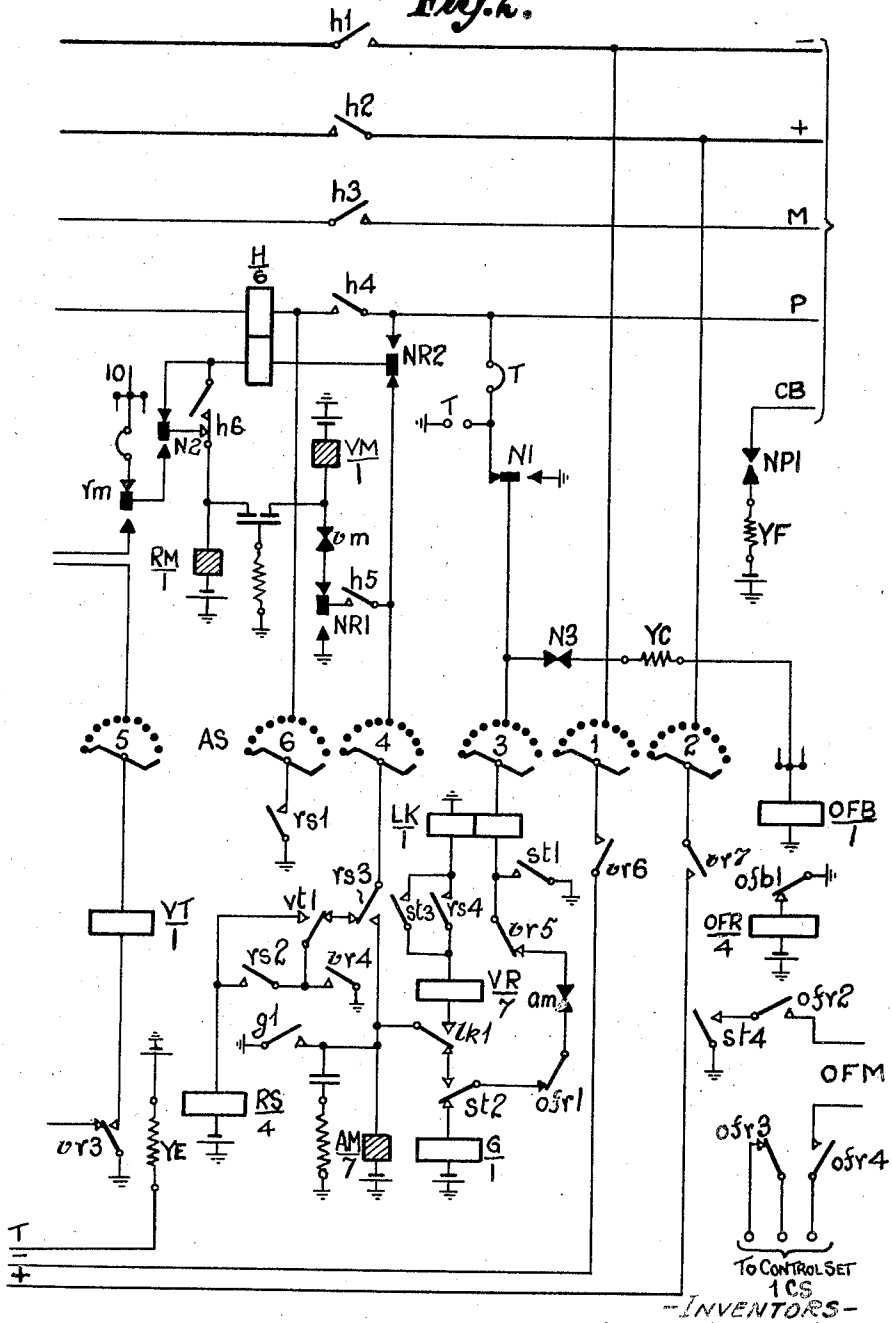
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TELEPHONE SYSTEM

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Fig. 2.



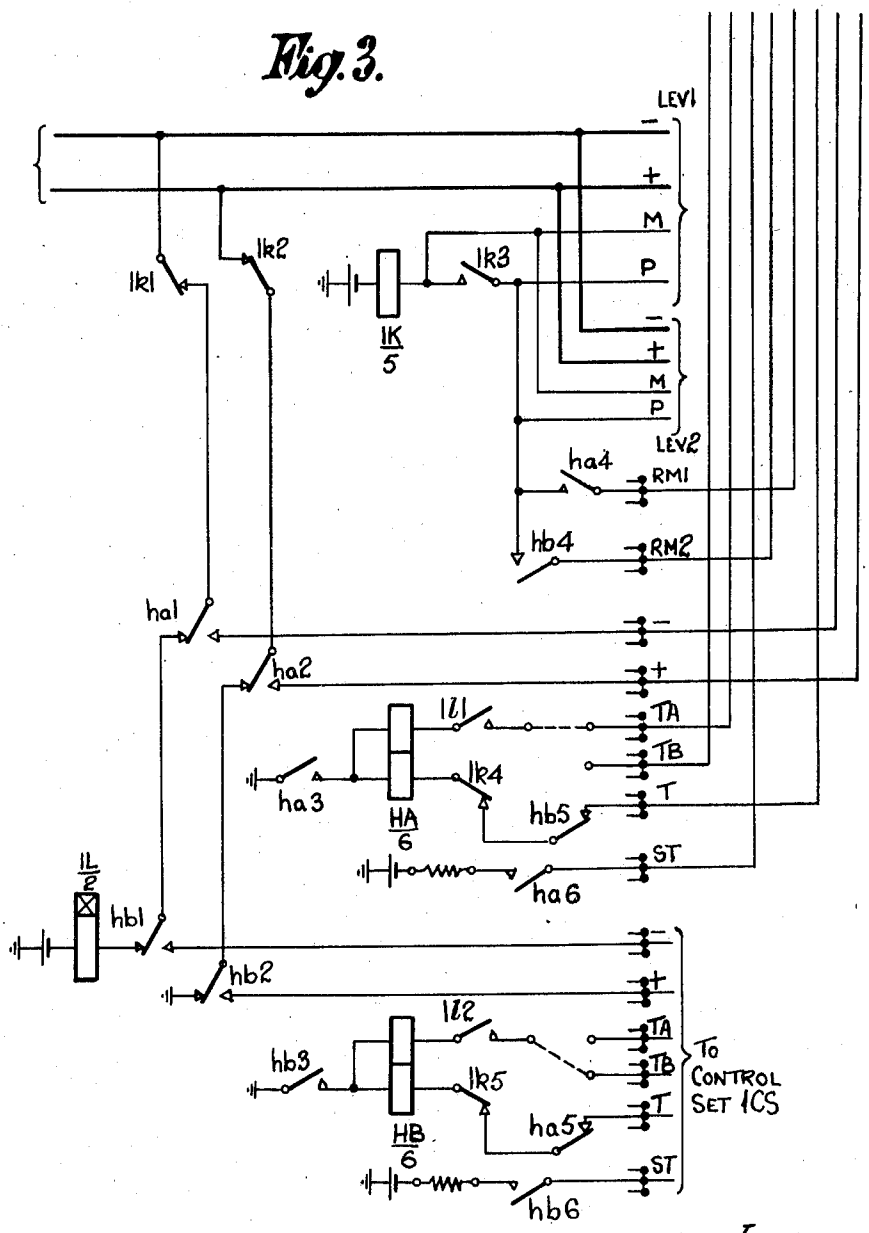
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Fig. 3.



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2,133,415

TELEPHONE SYSTEM

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15 Claims. (Cl. 179—18)

The present invention relates to telephone systems and is more particularly concerned with line finder systems employing an arrangement suitable for use in a small exchange whereby junction lines as well as subscribers' lines appear in the banks of the finder switches. If the finders are of the large capacity type, difficulties may arise in known arrangements in obtaining sufficiently speedy operation in the case of junction connections where only the inter-digital pause is available and there is no question of waiting for dial tone as when a subscriber is calling. The chief object of the invention is to provide an improved arrangement for enabling impulses to be successfully received over a junction before the finder has completed its operation. It will be understood that the term "junction" refers to a trunk line from a distant exchange.

According to one feature of the invention in a telephone system employing finder switches for connecting calling lines to numerical switches, during the operation of a finder the calling line is connected to the associated numerical switch independently of the wipers of the finder, the marking in the finder bank corresponding to the calling line being characteristic of the finder employed so that in the event of simultaneous calls the finders used will connect with the proper lines.

According to another feature of the invention in a telephone system employing finder switches to the banks of which are connected both subscribers' lines and junctions from another exchange, during the operation of a finder due to a call incoming over a junction the junction is connected to a numerical switch independently of the wipers of the finder to enable dialled impulses to be received over the junction.

A further feature of the invention is that in a telephone system employing two-directional finder switches to the banks of which are connected both subscribers' lines and junctions from another exchange, the junctions are each connected to a plurality of levels of the finders, the number of such levels corresponding to the number of finders, having access to a particular group of lines, which are adapted to hunt simultaneously.

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, 2 and 3 which should be arranged with Fig. 2 to the right of and Fig. 3 below Fig. 1. Figs. 1 and 2 show a subscriber's line circuit in association with a line finder connected to a common control set CS by way of a single motion allotter AS, while Fig. 3 shows the line circuit associated with a junction. The line finder switch is assumed to be of the two-directional type which performs a so-called rectangular movement in operation and uses one of the setting magnets to restore it to normal. Levels 1 and 2 of the line finder shown accommodate the junction line circuits each of which appears in both levels, levels 3 to 6 accommodate ordinary subscribers' line circuits while levels 7 and 8 may accommodate either coin box or ordinary subscribers, discrimination being made by a strapping change in the line circuit concerned. Level 9 is used for routine purposes and no line circuits are accommodated on this level. Two control sets and two allotters are provided per group of lines accessible to a finder switch, the arrangements being such that each control set serves half the group in normal circumstances.

Referring to Figs. 1 and 2, a circuit description of a call originated by an ordinary subscriber will first be given, the particular line terminating in level 3 of the finder bank. When the receiver is removed the loop extended over the incoming negative and positive conductors operates relay L which thereupon at armature *l1* extends a level marking battery by way of resistance YA to the finder vertical bank multiple and at the same time operates the start relay ST in the control set CS by way of the upper half of rectifier MRA. Armature *l2* marks the position of the calling line in the finder P bank multiple and armature *l3* disconnects the winding of relay K from the P lead of the final selector multiple in order to busy the line to incoming calls.

Relay ST upon operating, at armature *st1* completes a circuit for relay LK from earth over its right-hand low resistance winding, wiper 3, finder off-normal springs N1, link T, P lead to idle marking battery in the associated selector (not shown). Relay LK operates in this circuit and the low resistance of its right-hand winding provides an immediate guard on the outlet seized. It should be mentioned that in the absence of calls free finders are preselected by the allotter as will be described later. Armature *lk1* thereupon disconnects a possible operating circuit for the allotter magnet AM and completes a locking circuit for relay LK in series with relay VR and magnet AM which is non-operative in this condition. Relay VR operates and energizes re-

lay H from earth, armatures *vr*4, *vt*1 and *rs*3, wiper 4, finder rotary off-normal springs NR2, lower winding of relay H, off-normal springs N2, armature *h*6, rotary magnet RM to battery. Relay H upon operating, at armature *h*6 locks up independently of the off-normal contacts N2 and at armature *h*5 completes a self-interrupted driving circuit from the same earth for the vertical magnet VM which causes the finder to hunt vertically for the marked level. The off-normal springs N1 and N2 operate on the first vertical step and at springs N1 extend a further guard earth to wiper 3.

As soon as the marked level is encountered, the fast operating relay VT in the control set is energized over wiper 5, vertical wiper VW and bank VB to the level marking battery by way of resistance YA. In this case the low resistance earth through the winding of relay VT immediately guards the level against seizure by another finder. Armature *vt*1 disconnects the vertical magnet driving circuit, releases relay H and completes an operating circuit for relay RS. As a result of the release of relay H a self-interrupted driving circuit is completed for the rotary magnet RM from earth on common lead 10 by way of delayed release alarm equipment, rotary magnet interrupter springs *rm*, off-normal springs N2, armature *h*6 and rotary magnet RM to battery and accordingly the wipers are rotated in search of the calling line. At the commencement of rotary motion the rotary off-normal springs NR1 and NR2 operate.

When the calling line is encountered a circuit is completed to jam the rotary magnet from earth, armature *rs*1, wiper 6, upper low resistance winding of relay H, P wiper, armature *l*2, vertical bank VB and wiper VW, interrupter springs *rm*, off-normal springs N2 and armature *h*6 to hold operated the rotary magnet RM and thus prevent further rotation. Relay H operates in this circuit and at armatures *h*1, *h*2, *h*3 and *h*4 extends the negative, positive, M and P leads through to the selector while armature *h*6 opens the magnet jamming circuit and completes a holding circuit for relay H by way of its lower winding, springs NR2 and armature *h*4. Earth by way of springs NR1 and armature *h*5 is now extended over wiper 4 to energize magnet AM and to short-circuit relays LK and VR in order to free the control set for further use.

In response to the extension of the calling loop through to the selector, the line relay therein is operated and operates the release relay which returns a guard earth over the P conductor to hold relay H after the control set is released. Earth is also returned over the M conductor to operate relay K which thereupon operates and at armature *k*3 locks in series with the upper winding of relay H to the earthed P lead and at armature *k*1 operates relay P which extends the M lead through to the subscribers meter MTR which operates when subsequently the called subscriber answers. Armatures *k*1 and *k*2 at the same time open the circuit of relay L which releases and removes the level marking battery at armature *l*1 in order to release relay ST in the control set. Dial tone is now returned to the calling subscriber over the line conductors to inform him that the circuit is ready to respond to the dialled impulses. Relays LK and VR in the control set now release due to the short-circuiting effect of armature *h*5 and in turn release relay RS. Armature *rs*3 opens the circuit of the magnet AM which de-energizes and steps the allotter wipers on to the next contact in readiness for a further call.

Under normal light traffic conditions it may be assumed that no further call will be originated for a short period and in the meantime the control set is arranged to preselect a free finder and associated selector under control of relay G. Should the finder on to which the allotter has been stepped be engaged, an earth from the operated off-normal springs N1 in this finder will be extended over wiper 3 to operate relay G in series with relay LK which however will not operate in this instance. Armature *g*1 energizes the magnet AM which opens its interrupter springs *am* and opens the circuit of relay G. This relay thereupon releases and disconnects the magnet which again advances the wipers one step and closes its interrupter springs. Should the allotter wipers again encounter an engaged finder, the same operation will occur and interaction between relay G and the magnet will continue until a free finder is reached. If, however, a further call originates before the completion of preselection, relay ST will be operated and armatures *st*1 and *st*2 change over the relay magnet drive to a self-interrupted drive in order to reduce the allotter hunting time. As soon as the allotter encounters a free finder, relay LK will operate to the idle marking battery in the associated selector and disconnect the drive and the circuit operation then proceeds as already described.

In the case of faults known as P. G.'s which result in the simulation of a calling condition, it is arranged that the selector institutes forced release conditions a predetermined time after seizure if no impulses have been received. These conditions result in the removal of earth from the P conductor which restores relay H in the finder and relay K in the line circuit. Relay P, which is made slow releasing by a short-circuited winding, will remain operated during the release transit time of relay K and subsequently its operating circuit will be maintained from the fault over the subscriber's loop and armatures *k*2 and *p*1. This condition obtains until the fault is cleared and the line is thus isolated from the exchange equipment. If desired an alarm may be given by the continued operation of relay P with relay K de-energized. The finder is restored to normal on the release of relay H as described later.

In order to effect economy in selectors it is arranged that they are shared by both subscribers and incoming junctions, the latter being connected to the finder bank levels 1 and 2 by way of a relay set such as that shown in Fig. 3. This includes line and cut-off relays 1L and 1K and also two additional testing relays HA and HB, the function of which is to route the call to a particular one of the two control sets. To even up the load it is arranged by a simple strapping connection between the switching relays HA and HB and conductors TA and TB that odd numbered junctions have preference for the first control set and even numbered junctions have preference for the second, but in either case connection is made with the other control set if the preferred one is already engaged.

When a call arrives over the junction, the loop extended to the incoming negative and positive conductors operates relay 1L which at armatures *1l*1 and *1l*2 prepares operating circuits for relays HA and HB. Assuming now that the first control set CS which is first choice for this junc-

tion is free, earth is extended from armature *vr*3 therein, conductor TA, armature *l*1, windings of relay HA in series, armature *l*k4 and *hb*5, conductor T, to battery through resistance YE in the control set CS. Relay HA operates and at armature *ha*3 short-circuits its upper high resistance winding thereby extending a low resistance guarding and holding potential on to conductor T to prevent another relay corresponding to relay HA from switching thereto. Relay HA also at armature *ha*6 extends a resistance marking battery on to the start lead ST, at armature *ha*5 disconnects the circuit of relay HB, at armature *ha*4 supplies a marking to the finder P bank over conductor RM1 and at armatures *ha*1 and *ha*2 switches the incoming negative and positive leads through to the control set.

If however the first control set was in use, relay VR would be operated and there would be no earth on conductor TA for operating relay HA. In case the second control set ICS was free the operation of relay VR in the first control set CS would result in the connection of earth over armature *vr*1 to conductor TB associated with the second set and therefore a circuit would be completed to enable relay HB to operate over this conductor and function in a like manner to relay HA except that the incoming leads are switched through to the second control set ICS and marking is applied to conductor RM2 instead of RM1.

As a result of the operation of relay HA, the resistance battery applied to the conductor ST causes relay ST in the control set CS to operate and relays LK and VR therefore immediately energize to switch the control set through to a preselected finder. The finder therefore commences its hunting operation as for an ordinary subscriber's call but in these circumstances armatures *vr*6 and *vr*7 extend the incoming junction negative and positive leads direct over the allotter wipers 1 and 2 to the selector associated with the finder taken into use and therefore it is able to respond to any incoming impulses at once. The finder now commences to hunt vertically and it will be noticed that armature *vr*2 extends the level marking battery over wiper 7 to vertical bank contact 1 while the rotary jamming circuit is completed over conductor RM1 and armature *ha*4 in Fig. 3. In case the second control set had been taken into use, relay HB would have operated and similar operations would have been performed except that armature *lvr*2 marks vertical bank contact 2 and armature *hb*4 (Fig. 3) completes the rotary jamming circuit by way of level 2 and conductor RM2. Corresponding contacts of levels 1 and 2 are multipled together so that each junction makes an appearance in both these levels.

In the case of simultaneous calls one junction relay set will switch by way of conductor TA to control set CS and the other relay set will switch by way of conductor TB to control set ICS or vice-versa thus causing the finders taken into use to hunt over different levels. It will be appreciated that the drive stopping circuits are divided at the vertical bank so that there is no possibility of a finder becoming associated with a different junction line from that which is linked to the associated selector through the allotter over wipers 1 and 2.

When the finder has found the calling junction and switched through, the negative, positive, M and P leads are connected straight through to the selector and the temporary by-path dialling circuit through the allotter is disconnected with the release of that equipment. Upon the operation of relay IK in Fig. 3 the switching relay which was previously operated is released.

The junction relay set, Fig. 3, may readily be arranged to return busy tone to the subscriber in case further dialling occurs before a selector can be connected to the junction; this condition would arise if both the control sets were already in use at the moment a call arrived over the junction.

Referring again to Figs. 1 and 2, it is arranged that a maximum of ten line circuits may serve either coin box or ordinary subscribers; these line circuits appear in both levels 7 and 8 corresponding contacts of which are multipled together. Contacts 2*l*1 and 2*l*2 shown in Fig. 1 are assumed to be carried by a line relay 2L of a line circuit in this group. If for example five of these line circuits serve ordinary subscribers, the level and rotary markings will be extended by way of suitable jumpering to level 7 while the remaining five which serve coin box subscribers will be marked on level 8. On calls originated by the five ordinary subscribers therefore the finder will hunt over level 7 until it encounters the rotary marking extended by way of the "regular" strapping and on calls originated by coin box subscribers the finder will hunt over level 8. Due to the separation of the stopping circuits as in the case of the junction lines, there is no possibility of hunting over an incorrect level, this being important since it is desirable to give a discriminating signal when a coin box subscriber originates a call. Normal post springs NP1 are arranged to operate on the 8th level and a discriminating battery by way of resistance YF is therefore connected to the CB conductor extending to the selector to inform the operator of the class of the subscriber originating the call where it is routed to the manual board.

At the conclusion of conversation, when the calling subscriber replaces his receiver, earth is removed from the P conductor. Relay K in the line circuit releases and releases relay P while relay H in the finder is also released. At armature *h*6 a self-interrupted driving circuit for the 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 back to the normal position whereupon the off-normal springs N2 open and disconnect the rotary magnet. The guarding earth extended by springs N1 to the allotter bank 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 prevented from opening so that the magnet remains energized and does not chatter.

Should the calling subscriber restore his receiver during the finding operation, the marking battery on the vertical and rotary bank multiple will be removed and relay ST in the control set will be released thus releasing relays LK and VR at armature *st*3 if the finder has not completed its vertical movement. In this case armature *vr*4 will disconnect the vertical magnet circuit and open the circuit of relay H. Armature *h*6 thereupon completes a self-interrupted circuit for the rotary magnet and the finder will cut in on the particular level at which it stopped and

rotate to the 12th position and then release. If it has already commenced rotary movement when the subscriber hangs up, relays LK, VR and RS remain operated until the switch rotates to the 11th position where a magnet jamming circuit is completed and relay H in the finder operates over its upper low resistance winding. Armature *h*6 disconnects the magnet jamming circuit and armature *h*5 extends earth over wiper 4 to energize the magnet AM and short-circuit and release relays LK and VR. Relay VR upon releasing releases relay RS which opens the circuit of the allotter magnet AM which then steps the wipers 1 to 7, of the switch AS, to the next contact in readiness for a further call.

Armature *rs*1 opens the holding circuit of relay H which then releases and causes the finder rotary magnet to step the switch to the 12th position whereupon it restores to normal.

Should the finder fail to find a vertical marking, it will step to the ninth level and relay VT will be operated by the marking battery permanently connected to this level by way of spools YG and YH. The wipers will then cut in, rotate to the 12th position and release. Since the start signal is maintained, as soon as another finder is selected by the allotter the hunting operation will be repeated.

In case all finders become busy, all the idle marking batteries normally extended over the various selector P leads by way of off-normal springs N1 and N3 and high resistance YC to the common lead extending to relay OFB will be disconnected at the finder off-normal springs. Relay OFB will therefore release and operate its relief relay OFR which opens the driving circuits of both allotters at armatures *ofr*1 and *ofr*3 to prevent useless hunting, while armatures *ofr*2 and *ofr*4 prepare circuits for the overflow meters associated with the control sets so that further calls originated during this period are recorded.

In case a control set is removed during maintenance, shelf jack points U11 and U12 in the control set concerned are arranged to make contact so that the start relay ST in the remaining control set can serve all the subscribers in the group.

Rectifiers MRA to MRC are inserted in the start leads to prevent marking battery from feeding back to other vertical bank contacts and thus causing a finder to stop at an incorrect level.

We claim:—

1. In a telephone system, calling lines, finder switches having bank contacts terminating said lines, wipers on said finder switches for connecting with said lines by way of said contacts, a numerical switch associated with each of said finder switches, means responsive to calls on said lines for marking the finder bank contacts corresponding to the lines calling and for taking said finder switches into use one for each call, each of said markings being individual to the particular finder switch taken into use by one call to enable said finder switches in case of simultaneous calls to find and connect with the proper lines, and means for connecting the calling lines independently of the finder switch wipers to the numerical switches associated with the particular finder switches taken into use during the operation of such finder switches in search of the calling line.

2. In a telephone system, finder switches having wipers and bank contacts accessible thereto, lines of a first class and lines of a second class terminating in said bank contacts, means responsive to a call on any one of said lines for operating the wipers of one of said finders to find and connect with the calling line by way of said bank contacts, a numerical switch associated with each of said finder switches, and means operative only in case said call is of the second class for connecting the line independently of the finder switch wipers to the associated numerical switch to enable dialled impulses to be received over said line prior to the connection of said finder switch with said line.

3. In a telephone system, two-directional finder switches having wipers and levels of bank contacts accessible thereto, subscribers' lines and trunk lines terminating in said bank contacts, each trunk line being multiplied to the bank contacts in a plurality of trunk line levels, and the number of multiplied trunk line levels corresponding to the number of finder switches which may be simultaneously operated to find the lines calling.

4. In a telephone system as claimed in claim 1 including an allotter for taking an idle one of said finders into use and for applying said marking individual to the finder taken into use.

5. In a telephone system as claimed in claim 2 including an allotter for taking an idle one of said finders into use, and wipers on said allotter for connecting said trunk line to said numerical switch independent of the finder wipers.

6. In a telephone system as claimed in claim 2 including a plurality of allotters each having access to all the finder switches for allotting idle ones of said finder switches for use, each allotter being first choice to certain of said trunk lines, and all allotters being simultaneously operable to take into use a plurality of said finder switches.

7. In a telephone system, two-directional finder switches each having levels of bank contacts accessible thereto, trunk lines terminating in said bank contacts, a plurality of allotters for allotting idle ones of said finders for use, each allotter being first choice to certain of said trunk lines and normally allotting a finder for use thereby, each trunk line being multipled in a plurality of levels in the bank contacts of each finder, means responsive to a call on any one of said lines for operating the allotted finder switch in search of the calling line, and means also responsive to said call for marking the calling line in a certain one of said levels in case the corresponding first choice allotter is available or for marking the calling line in another one of said levels in case said first choice allotter is unavailable.

8. In a telephone system, two-directional finder switches having levels of bank contacts, subscribers' lines and trunk lines terminating in different levels in said bank contacts, a vertical bank contact for each level of bank contacts in each finder switch, an allotter for allotting an idle one of said finder switches for use, means responsive to a call on any one of said subscribers' lines or said trunk lines for operating the allotted finder in search of the calling line, individual subscriber controlled means responsive to a call on one of said subscriber's lines for directly marking the vertical bank contact corresponding to the level terminating said calling subscriber's line, and means including a wiper on said allotter for marking the vertical bank contact corresponding to the level terminating the calling trunk line in response to a call on one of said trunk lines.

9. In a telephone system as claimed in claim 8 including a start lead individual to each level for applying said marking potential to said vertical

bank, a start relay in said allotter, a connection connecting each start lead to said relay, and a rectifier in each said connection for individualizing each start lead.

10. In a telephone system as claimed in claim 2 including normal post springs in each of said finder switches, and means for operating said normal post springs to transmit a signal in case said finder switches are operated to connect with certain of said lines when calling.

11. In a telephone system as claimed in claim 8 wherein certain of said subscribers' lines are divided into two different classes, said certain lines being multipled in a plurality of levels of bank contacts, means for causing the finder to search over one of said levels for lines of one class and over another of said levels for lines of a different class whereby the lines of one of said classes may be readily changed to lines of the other class.

12. In a telephone system, calling lines, finder switches having bank contacts terminating said lines, wipers on said finder switches for connecting with said lines by way of said contacts, a numerical switch associated with each of said finder switches, means responsive to the initiation of a call on one of said lines for taking any one of said finder switches into use and for marking only the bank contacts of said one finder switch, said marking corresponding to the calling line.

13. A telephone system as in claim 12 including means for connecting the calling line to the numerical switch associated with said one finder switch independently of the finder switch wipers.

14. In a telephone system, calling lines, a group of finder switches having bank contacts terminating said lines, wipers on said finder switches for connecting with said lines by way of said contacts, a numerical switch associated with each of said finder switches, means responsive to the initiation of a plurality of simultaneous calls on said lines for simultaneously taking into use a finder switch for each of said calls, means for connecting each calling line to one of said numerical switches independently of the finder switch wipers and means for causing the wipers of each finder switch to engage only the bank contacts terminating the line to which the numerical switch associated with said finder switch is connected.

15. In a telephone system, calling lines, a group of finder-selector links having finder bank contacts terminating said lines, finder switch wipers for connecting with said lines by way of said contacts, means responsive to the initiation of a plurality of simultaneous calls on said lines for simultaneously taking into use one of said links for each of said calls, means for connecting each calling line to one of said links independently of said finder switch wipers, and means for setting the finder switch wipers of each link on only the finder bank contacts terminating the line to which the link is connected.

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