May 8, 1945. D. A. CHRISTIAN ET AL 2,375,622

TELEPHONE OR LIKE SYSTEM

Filed May 13, 1943 2 Sheets-Sheet 1

FIG. 1

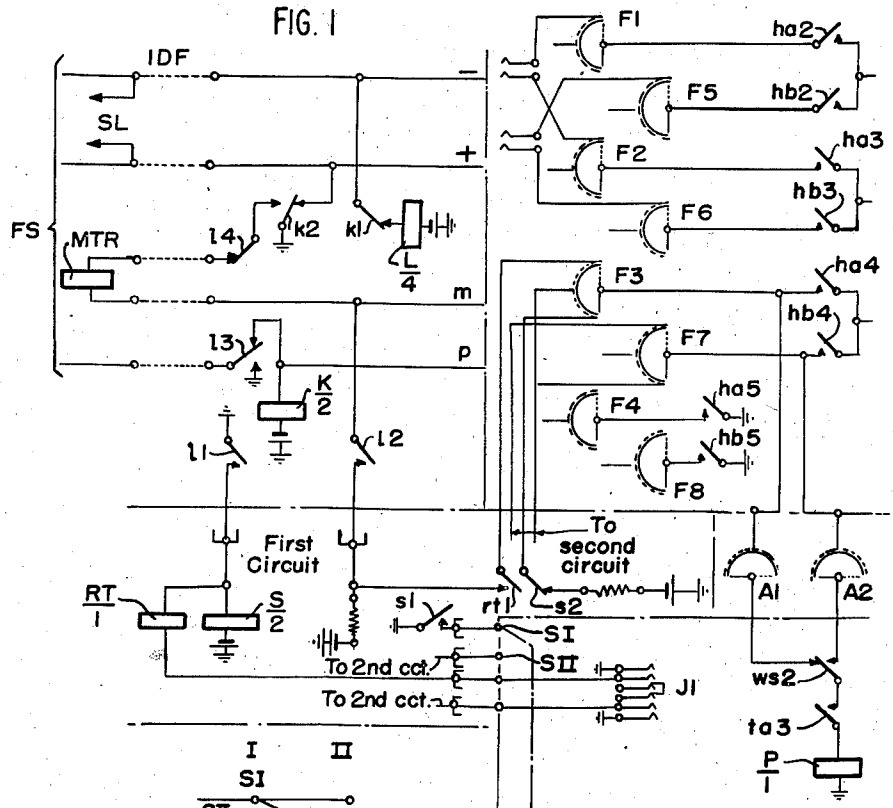


FIG. 2(a)

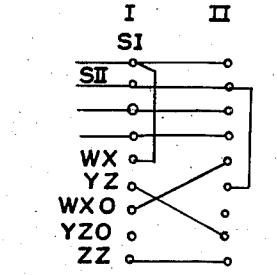
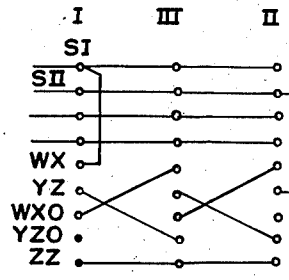


FIG. 2(b)



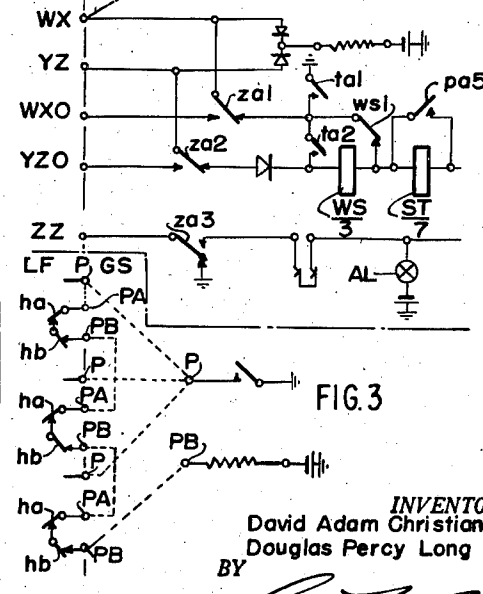


FIG. 3

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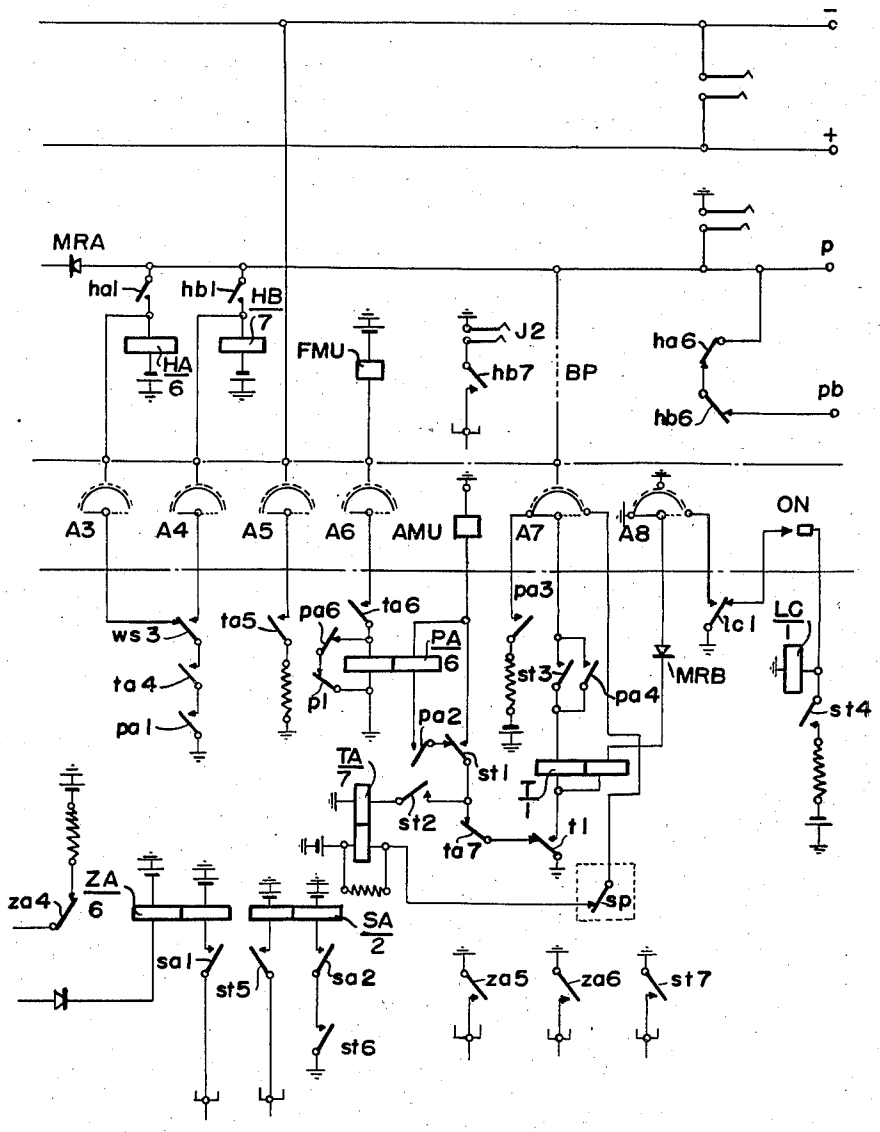
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TELEPHONE OR LIKE SYSTEM

Filed May 13, 1943 2 Sheets-Sheet 2

FIG. 1 continued



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Patented May 8, 1945

2,375,622

UNITED STATES PATENT OFFICE

2,375,622

TELEPHONE OR LIKE SYSTEM

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Application May 13, 1943, Serial No. 486,784
In Great Britain June 3, 1942

12 Claims. (Cl. 179—18)

This invention relates to telephone systems and more particularly to systems in which call finders are employed. Whilst it is of general application to arrangements in which call finders are assigned for use by allotters it is especially applicable to line finders concerned with the connection of incoming lines to common apparatus.

In an automatic telephone system employing finders it is usual to group the incoming lines and for each group of lines to provide a group of finders of appropriate size and one or more allotters to allot a free finder to deal with a call from an incoming line.

In the case of subscribers' lines it has been found convenient to group two hundred lines. The number of call finders necessary for such a group will vary with the calling rate. It may for example be 20, 23, 27 or 30. Two allotters would generally be provided for the group one to deal ordinarily with the even hundred group and the other with the odd hundred group and each to serve as a spare for the other in case of fault conditions.

The variable calling rates met with cause difficulty when the several groups of line finders and their associated allotters have to be assembled in racks since in manufacture it is desirable to have a standard size of rack which can be employed in any exchange.

It is common practice as regards automatic telephone exchange equipment to provide racks having a column of panels of ten switches. Accordingly one would have, for the finder groups mentioned, to utilise at least two and for the largest group mentioned three panels. Where groups of 23 or 27 come into question three panels could be used but there would be spare space or spare banks not in use.

As a compromise, panels, so far as wiring is concerned have been sub-divided so that one may form groups of multiples of five. In some cases wider racks have been employed such as would accommodate twelve switches when the calling rate indicates that round about 24 finders should constitute a group.

It is one object of the present invention to provide a disposition and connection of line finders and allotters on a rack such that it can be a stock rack which may be readily adapted to the requirements of an exchange.

To this end the conception of a group of lines, a group of call finders appertaining thereto and allotters as a unit is first disregarded and the matter approached from the point of view of a rack.

In the present invention all the banks of all allotters on the rack are multipled and outlets taken to all the line finders so that an allotter has access to every finder for control purposes. Since, however, an allotter eventually has only to deal with a particular group of line finders its testing-in circuit is so arranged that by strapping or by the cutting of a strap connection it is enabled to test into that group only. A convenient way of achieving this is to arrange that the test relay circuit of the allotter extends from the test wiper through a test relay to a marking bank wiper. The connection to earth of contacts in the marking bank would permit only the testing of line finders corresponding to the earthed contacts.

The number of allotters provided depends primarily on the number of groups of line finders appearing in the rack but for standardisation one may provide the banks, if not the mechanisms, on the basis of one for each ten line finders.

It may happen that the number of outlets from the allotters will exceed the number of line finders on the rack; for example, there may be seven panels of ten line finders each and the allotter is a hundred point switch. The 30 excess outlets could be used to serve line finders on another rack.

The rack is also adapted to be used in the following manner. Although the average calling rate for an exchange might dictate say 23 line finders for a group of 200 lines which represents a loss of space where panels of ten finders are standardised yet this average calling rate may be met so far as 600 lines are concerned by providing two groups of twenty line finders and one group of thirty line finders and assigning lines with lesser calling rates to the groups of twenty line finders and those with heavier calling rates to the group of thirty line finders. The strapping in the allotter already referred to provides the necessary association of allotters with the different sized groups.

It will be apparent that by abandoning the arrangement of allotters associated by wiring only with a particular group of line finders and by multiplying them to all finders groups of line finders of varying size can readily be arranged in any desired order on a rack or can even overlap onto an adjacent rack.

Of the line finders of a group some may be ungraded and others graded or some may be directly connected to a selecting switch whilst

others are connected to a secondary line finder which is directly connected to a selecting switch. In such cases the allotters may be arranged always to allot an ungraded or directly connected finder, if there is a free one, in preference to a graded or indirectly connected finder. If the selector with which a finder is connected is arranged to test free by reason of the absence of earth on the test wire and the allotter is arranged to test for the presence of battery potential a suitable source of potential may be provided, said potential being nullified when the line finder is seized and the usual busy earth is applied to the test wire.

Where secondary line finders are used, these may be mounted in panels and associated with allotters in a similar manner to that described. Relays for the control of primary finders may appear on the secondary finder rack.

The line finders and allotters may be high speed single motion switches driven by individual driving motors and the allotter may be arranged so that after one has been released from a call it preselects a line finder for use on the next call.

The nature of this invention will be clear from a consideration of a specific embodiment given by way of example and taken in conjunction with the accompanying drawings in which

Fig. 1 is a schematic diagram of a line finder and associated call allotter.

Figs. 2*a* and 2*b* show the strapping employed between terminals of different call allotters when two or three allotters, respectively, serve a common group of line finders.

Fig. 3 shows modifications required in Fig. 1 where the line finder is one of several graded finders which are connected to a single first selector.

At a telephone exchange the line finders are arranged in racks, each rack comprising a number of panels horizontally disposed in vertical tiers. For the purpose of the example a rack will be assumed to contain seven panels of line finders and a panel of allotters for their control. Furthermore, each panel of line finders will be assumed to contain 10 switches all the switches of a panel operating on the same multiple. Each line finder is provided with 200 outlets which form a group and a group of lines will usually need not less than 2 panels of line finders for its adequate service. Where two panels of line finders serve a single group of lines the line finder multiple will therefore extend over the two panels. If three panels of line finders are required to serve adequately a group of lines the line finder multiple will accordingly extend over the three panels. The allotters will be provided at a suitable rate. There will usually be at least two allotters for each group of line finders and there may be three. The allotters are connected to a common multiple and 70 outlets in the multiple are connected to the 70 line finders on the rack, one outlet to each line finder. The allotters are 100 outlet switches so there will be 30 outlets not connected to line finders on the rack. These may be connected to line finders on an adjacent rack. It is arranged that an allotter is available for use with any line finder of a group. Thus, if a group consists of 20 line finders accommodated on two panels and two allotters are assigned to the group each allotter may be permitted to control any of the 20 line finders of the group or the control exercised by the allotters may normally be restricted to one panel of line finders. It may happen that the line finders in a rack are not divisible into an exact number of groups but a group may comprise one or more panels of line finders on one rack and one or more panels of line finders on another rack. In order that all the finders of a group so divided may be controlled by their respective allotters use is made of the additional outlets. For example, a rack may have on it one panel of a three panel group, the other two panels of line finders being accommodated on an adjacent rack. As 70 outlets on the allotters are required for the 70 line finders on their own rack use is made of the 30 additional outlets for the control of the line finders of the same group accommodated on the adjacent rack. Similarly use is made of the additional outlets on the allotters on the adjacent rack for the control of that part of a group that is not accommodated on its own rack so that the rate of provision of allotters and their accessibility to whole groups may be maintained.

The rate of provision of line finders usually depends on the average calling rate per line of all the lines connected to the exchange. This may and in many instances would not be a number convenient to the efficient lay-out of line finders, that is it will not require a number of complete panels of line finders for adequate service. It may, for example require 23 line finders per group. If the rack is constructed to hold panels of 10 line finders obviously much space will be wasted and unnecessary provision of apparatus involved since the multiple will extend over the whole panel and the banks, at least, of the full number of line finders will be fitted and wired to the multiple. If recourse is had to half panels the advantages of a standard size of rack is lost. Accordingly, it is proposed to re-group the lines, allotting the more heavily loaded lines to one group and the more lightly loaded lines to another group and to provide line finders at the rate appropriate to the calling rates of the several groups. Thus two panels may serve each of two groups of lightly. loaded lines and three panels may serve a group of heavily loaded lines, the result being provision of line finders at the rate of 23 per group of 200 lines averaged over 3 groups. This provision of two groups of 20 line finders and one group of 30 may be repeated as often as necessary. In this particular example, it happens that the finders of the combined groups occupy a complete rack but it is not necessary that this should be so. For instance, the smaller groups could be together on one set of racks and the larger groups on another set.

It will now be explained, by reference to the accompanying drawings, how the association of the allotters and line finders is effected. In the drawings Fig. 1 shows circuit arrangements for a line finder and its allotter. Figs. 2*a* and 2*b* show the terminal connections for two and three allotters per group respectively and Fig. 3 shows modifications required in Fig. 1 where the line finder is one of a number of graded finders connected to a single first selector.

Reference will first be had to Fig. 1. The line finder is a 200 outlet single motion hunting switch driven by an individual electric motor the circuit of which is controlled by a latch magnet which, on operation closes the circuit for the motor and removes a latch from one of the gear wheels. The switch is furnished with 16 wipers and associated arcs of contacts, the wipers being paired and positioned so that when one wiper of a pair leaves the last contacts in its arc the other wiper steps on to the first contact in its associated arc.

The arcs are arranged in two sets of four pairs each set providing outlets for the positive, negative, test and metering and holding wires for 100 lines, there being 50 outlets in each arc. To one set are connected lines in the odd hundred and to the other set lines in the even hundred of a 200-line group. The pairs of wipers are designated F1 to F8 and are connected, as regards the positive, negative and test and metering wipers, over contacts of switching relays to similar wires incoming to a group selector, these wires marked +, — and *p* respectively, being shown at the right hand of the drawings. On the left of the drawings is shown a line circuit with its connections over a distributing frame designated IDF to a subscriber's line SL and to the terminals FS of this line in the final selector multiple. Below the line finder is shown the allotter which is of similar construction to the line finder but which has only 100 outlets from its 16 arcs of contacts. Its wipers which are also paired are designated A1 to A8. The relays shown in this part of the figure serve for the control of the allotter and line finder. To the left of the relays is shown a set of 9 terminals which provide for the starting of an allotter, the selection of the set of wipers on the line finder to be used and the extension of the start circuit to another finder should the one shown be faulty and for routine testing purposes.

The apparatus shown will now be referred to. In the line circuit is shown the line relay L, cut off relay K and meter MTR. Contacts of the line relays of one sub group of 100 lines are connected to a common start relay designated S, and similar contacts of the line relays of the other sub-group of 100 lines of the same 200 line group are to be assumed connected to another start relay. Only the starting arrangements relevant to the first sub-group are shown in detail, the arrangements of the other group being similar. They will be referred to where necessary as the description proceeds. There is also a relay RT for automatic routine testing purposes.

The line finder comprises the wipers and banks before referred to, the latch magnet FMU for controlling the driving motor, two switching relays HA and HB, one for each sub-group of lines and the metal rectifier MRA. The allotter circuit includes the allotter latch magnet AMU, start relay ST, wiper switching relay WS, allotter test relay T and its auxiliary relay TA, finder test relay P and its auxiliary PA, last contact relay LC, and off-normal contacts ON. There is also a pair of relays designated SA and ZA which are concerned with a timing circuit for extending the start wire if the allotter does not complete its task within a predetermined time. The outlets in the bank of the allotter are multipled over all the allotters on the panel, i. e. they are connected to all the finders on the rack and 30 outlets remain over for connection to finders on other racks if necessary as previously explained. The contacts in the arcs associated with the pair of wipers designated A8 are not multipled but contacts associated with outlets to all the finders of a group to which the allotter is assigned are commoned and connected to an earth terminal on the allotter. Wiper A8 is connected in the allotter test circuit so that test for a free line finder can only be made amongst those serving a particular group of lines as determined by the strapping and earthing of the contacts in the arc associated with the wiper. The off-normal contacts ON are only open when the allotter wipers are in their first contact position; in all other positions they are closed and relay LC if not operated is short-circuited. This arrangement is provided to allow the allotter to drive past the last contacts if search began at a contact other than the first so that all the available outlets can be searched yet the switch can be prevented from continuous driving if no free outlet is available to it. In the actual apparatus each arc comprises 52 contacts, the 52nd contacts being "last contacts" to which line finders are not connected, only 50 of the contacts being used for outlets. If a pair of arcs associated with a pair of wipers are considered as comprising contacts 1 to 52, represented by the full line semi-circle and contacts 53 to 104 represented by the dotted semi-circle, contact 1 in the arc of wiper A8 is directly earthed and contact 104 is earthed over contact *lc*1 when relay LC is operated. Contact 1 in the arc of wiper A7 is connected to battery over contact *pa*3 for a purpose which will be made clear later. Included in the allotter circuit is a contact designated *sp* for causing the allotter to execute a further search if after a search no line finder has been found free. Both the allotter and the line finders are high speed switches driven at the rate of about 200 steps a second. Jacks J are provided for testing purposes.

The operations involved in extending a call from a calling line to a group selector will now be described in detail.

The allotter normally stands on contacts connected to an outlet to a free finder-selector link, and if this link is free when the start circuit is closed it is seized for the call that gave rise to the starting condition. It will, however, for the purpose of description be assumed that the link on the outlets to which the allotter is resting is busy. When a subscriber initiates a call, line relay L operates in a circuit from earth over contact *k*2, the calling loop, contact *k*1, winding of the relay to battery. Contact *l*1 connects earth to the start wire common to the sub-group, which in the present case will be taken to be the sub-group having the common start relay S associated with it. Contact *l*2 connects battery over a suitable resistance to the contact in the arc of wipers F3 associated with the calling line and connected to wire *m*, contact *l*3 earths the test wire *p* in the final selector multiple and contact *l*4 opens a point in the meter circuit. Relay S operates over the start wire and contact *l*1. Contact *s*1 connects earth to terminal SI which is extended by strapping to terminal W and over contacts *za*1, *ws*1, relay ST, contact *za*4 to battery, and contact *s*2 disconnects battery from the first contact in the arc of wiper F3. This battery connection is provided in order to stop the line finder in that position should the calling condition be removed before search has been completed. Relay ST operates and closes the following circuit; earth over contacts *t*1, *ta*7, *st*1 magnet AMU to battery. In addition circuits are prepared as follows: at contact *st*2 for the upper winding of relay TA, at the moment short-circuited over contacts *ta*7 and *t*1; at contact *st*3 for test relay T; at contact *st*5 for the left-hand winding of relay SA; at contact *st*6 a locking circuit for relay SA over its right-hand winding and at contacts *st*7 a circuit for starting up the ringing current generator. As the outlet to which the allotter is connected is assumed to be busy, relay T will not operate as wire *p* will be earthed and magnet AMU will be energised to start the motor and the switch will commence to drive. When a free

finder in the group of finders to which the allotter is restricted in its search is found, relay T will operate to stop the allotter. The circuit for relay T is from earth over terminal E, the commoned contacts in the marking arc, wiper A8, rectifier MRB, both windings of relay T, contact *st3*, wiper A7, contacts *ha6* and *hb6*, wire *pb* to battery connected to this wire in the associated group selector. Relay T holds to this battery over its low resistance left-hand winding and earth over contact *t1*, thereby marking the finder selector link busy, disconnects the direct earth from magnet AMU and switches relay TA into circuit with magnet AMU. The resistance of the circuit including the winding of relay TA is too high to permit the magnet to remain operated and the magnet is de-energised and the switch brought to rest.

If the allotter fails to find a free finder in the group assigned to it before reaching the end of the bank, it will continue to drive over the whole of the bank so that any free finders connected in the multiple to contacts situated between contact 1 and the contact from which the search started may be seized. When the first contacts are reached contacts ON open and the short-circuit across relay LC is removed. Relay LC operates and at contact *lc1* connects earth to the last (104th) contact in the arcs of wiper A8 so that if drive continues until this position is again reached, relay T will operate from the earth over contact *lc1* to battery over the wiper A7, contact *sp* and the lower winding of relay TA. Contact *t1* opens to disconnect the circuit of magnet AMU and stop the switch. The two windings of relay TA are connected in opposition so that when both are energised as they will be in the event now under consideration, the relay will not be operated. Contact *sp* is opened every second by a suitable timing device and when it opens, relay T releases before relay TA can operate and the switch is driven off to make another search for a free outlet.

Continuing with the description of the normal operation of the circuits, it will be remembered that when a free finder was found by the allotter, relay T operated and connected relay TA in series with the alotter magnet AMU. Relay TA operates in series with the magnet winding and at contact *ta1* substantiates the starting earth holding relay ST operated. Contact *ta2* closes without effect in the present example and its purpose will be referred to later. Contact *ta3* prepares a circuit for the finder test relay P, contact *ta4* prepares a circuit for the finder switching relay, contact *ta5* applies earth to the negative wire to operate the impulse relay of the group selector which in turn operates the usual release relay for holding the connection by applying earth to wire *p*, contact *ta6* closes a circuit from earth over contacts *p1*, *pa6* and wiper A6 for magnet FMU and contact *ta7* opens the operating circuit for magnet AMU. In consequence of the application of earth in the group selector to wire *p* relay T is short-circuited and released but relay TA is guarded by the open contact *ta7*. Magnet FMU energises and brings about the driving of the line finder in search of the calling line. When this is found, relay P operates in a circuit from earth over the relay winding, contacts *ta3*, *ws2*, wiper A1, F3 wire *m*, contact *l2* to battery. Contact *p1* switches relay PA into the circuit of magnet FMU. The left-hand winding of relay PA is of high resistance and the relay operates over this winding but the magnet will not hold and the switch is therefore stopped. Contact *pa1* closes a circuit from earth over contacts *ta4*, *ws3*, wiper A3 for relay HA, contact *pa2* prepares a circuit for magnet AMU over the low resistance right-hand winding of relay PA, contact *pa3* connects battery to the first contact in the arc associated with wiper A7 for a purpose to be described. Contact *pa4* substantiates contact *st3*, contact *pa5* short-circuits relay ST to force its release should another call have been initiated and contact *pa6* opens a further point in the circuit for magnet FMU shunting the left-hand winding of relay PA. Relay HA operates and locks to wire *p* at contact *ha1*. Contacts *ha2*, *ha3*, *ha4* extend the negative, positive and test wires from the group selector back to the line circuit over wipers F1, F2 and F3, contact *ha5* applies earth to wiper F4 to operate cut-off relay K over wire *p* and contact *ha6* disconnects battery over wire *pb* from wire *p*. Relay K operates and disconnects the line relay L at contacts *k1* and *k2*. The cut-off relay remains held over wiper F4 to the earth on wire *p*. Relay L releases, removes the starting condition from the start wire so far as this call is concerned, connects up the meter and extends the earth applied in the group selector to wire *p* in the final selector multiple to maintain the busy marking on the line contact therein. Following the operation of relay PA, relay ST releases by reason of the short-circuit across it and relay P releases by reason of the short-circuit applied over contact *ha4*. Release of relay ST releases relay TA at contact *st2* and the holding earth for relay ST at contact *ta1* is removed. The following circuit is now closed: earth over contact *t1*, *ta7*, *st1*, *pa2*, low resistance right-hand winding of relay PA, magnet AMU to battery. The magnet operates and the switch drives until a free finder selector link is encountered, marked in the arc of wiper A7 by battery over contacts *ha6*, *hb6* and wire *pb*, whereupon relay T operates to stop the drive. This selection of a free link can only take place amongst finders of the group with which the allotter is concerned as determined by the strapping of the contacts in the arc associated with wiper A8. Relay TA will not operate as its circuit is open at contact *st2*. Consequent on the opening of the circuit of the alotter magnet, relay PA included in this circuit releases and opens the test circuit at contact *pa4* thereby leaving the allotter standing on the selected outlet without operating the finder thereof. When contact *pa5* opens, relay ST is freed for operation if another call is waiting or when a new start condition is applied. If the allotter is unable to preselect a finder in the group assigned to it, it continues in rotation until the first contacts are reached whereupon a test circuit will be completed and the switch stopped. This circuit extends from earth on contact 1 in the arc of wiper A8, the wiper rectifier MRB, both windings in series of relay T, contact *pa4*, wiper A7, first contact in its arc, contact *pa3* to battery and the allotter stays on those contacts until it is wanted for another call. Relay T is released when relay PA releases following the operation of contact *t1*.

When the allotter is first taken into use and relay ST is operated, contact *st5* connects the left-hand winding of relay SA to wire AS. Wires AS and AZ are connected momentarily to earth periodically by a timing device there being an interval of 6 seconds between the earthing of wire AS and that of wire AZ. When wire AS is earthed by the timing device, relay SA operates and locks up over its right-hand winding, con-

tacts *sa*2 and *st*6 and at contact *sa*1 connects relay ZA to wire AZ. If relay ST is still operated at the expiration of 6 seconds from the operation of relay SA, earth applied to wire AZ operates relay ZA and this relay locks up in the following circuit: earth over the contact in the other or one of the other allotters associated with the same group of lines and corresponding to contact *za*3, terminal ZZ, contact *za*3 of the allotter the operation of which is being described, left-hand winding of relay ZA to battery and in parallel therewith over lamp AL to battery. The lamp glows to indicate a condition of failure by the allotter to complete its task and contacts *za*1 and *za*2 of relay ZA transfer the starting circuit to the other or to a spare allotter. Contact *za*4 opens the start wire and releases relay ST and contacts *za*5 and *za*6 complete circuit for alarm and supervisory signals. It will be noted that if, before a calling line has been found, another call in the same sub-group of lines occurs, relay S will remain operated and the start condition will be maintained. However, consequent on the finding of a calling line by the finder, relays P and PA are operated and the latter by short-circuiting relay ST at contact *pa*5 ensures release of relay ST so that relay SA will be released at contacts *st*5 in readiness for a new time cycle.

If a line in the other hundred sub-group of the 200 line group calls, another start relay will be operated in the same manner and perform like functions to relay S. Its contact 1 will connect earth to terminal SII which will be connected in the second allotter of the group associated with the line group in question to the terminal YZ. If the allotter of Fig. 1 is now assumed to be one normally taken into use for calls in this other sub-group, the earth over terminal SII will be extended via terminal YZ, contact *za*2, relays WS and ST to battery. Relay ST will operate and if necessary start the allotters in search of a free outlet. Relay WS on operation changes the connections from wipers A1 and A3 to wipers A2 and A4 so that the calling line will be searched for over wipers F5—F8 the test circuit being in this instance over relay P, front contact *ws*2, wipers A2, F7 and wire *m*. When the line is found and relay PA is operated, switching relay HB is operated over wiper A4 and front contact *ws*3 and this relay performs functions similar to those performed by relay HA for calls in the other hundred sub-group. It will be noted that when relay TA is operated contact *ta*2 extends the earth over contact *ta*1 to hold relay WS as well as relay ST, the short-circuit across relay WS having been removed when the relay operated and opened contact *ws*1.

It may here be convenient to refer to Figs. 2*a* and 2*b*. Fig. 2*a* shows the terminal strapping employed when there are two allotters per group of lines. The terminals SI, SII and so on correspond to the terminals similarly designated in Fig. 1, those terminals in the column headed I being those of one allotter adapted normally for operation in response to calls signalled over terminal SI and those terminals in the column headed II being those of the other allotter for the same group of lines adapted normally for operation in response to calls signalled over terminal SII. It will be seen that for a call signalled over terminal SI the earth on that terminal is extended to terminal WX in allotter I and thence, by reference to Fig. 1, to relay ST. Similarly for a call signalled over terminal SII the earth on that terminal is extended to terminal YZ in allotter II and thence, by reference to Fig. 1, to relays WS and ST. The ZZ terminals on the two allotters are strapped together. If the allotter I should fail and relay ZA be operated, a call signalled over terminal SI is extended over terminal WX, contact *za*1 and terminal WXO in allotter I, the strapping, Fig. 2*a*, to terminal WX in allotter II and thence to the ST relay of that allotter. Similarly if allotter II should fail and its relay ZA be operated a call signalled over terminal SII is extended over terminal YZ (column II), contact *za*2 and terminal YZO in allotter II, the strapping, Fig. 2*a* to terminal YZ in allotter I and thence to relays WS and ST of that allotter. If there are three allotters per group of lines, the arrangements shown in Fig. 2*b* may be used. In this arrangement calls are normally dealt with by allotters I and II as before described but should one of these allotters fail the call will be dealt with by allotter III. The strapping shown in this figure will be seen to be between allotters I and III and between allotters II and III and the operation will be clear from the description of the strappings shown in Fig. 2*a*. The ZZ terminals of all three allotters are strapped together.

Returning to the line finder, it will be remembered that when the calling line was found it was extended by the switching relay, relay HA or HB as the case may be, to the group selector and the allotter was released. The group selector and subsequent selectors are set by impulses from the subscriber's dial and the wanted line tested and if free rung. When the called subscriber replies, a positive battery, the negative pole of which is earthed is connected at the feeding bridge circuit to wire *p* and the caller's meter is operated over wiper F3 or F7, wire *m*, the meter MTR, contacts *l*4 and *k*2 to earth. The cut-off relay K remains held over wire *p* and wiper F4 or F8 in an independent circuit over contact *ha*5 or *hb* 5. At the end of the conversion the caller clears, releases the impulse relay at the feeding bridge which in turn releases the slow-to-release release relay. This latter relay disconnects earth from wire *p* releasing the operated switching relay in the line finder and removing the busy marking from the contact in the arc of wiper A7. Release of the switching relay releases relay K which restores the connection of the line relay L to the line.

If the group selector is one arranged to connect battery potential to the test wire when it is free, the connection over contacts *ha*6 and *hb*6 and wire *pb* would be omitted and contacts *ha*6 and *hb*6 will be connected in series between the contact in the arc of wiper A7 and wire *p* at the place indicated by the broken wire BP. When calling line is found and the switching relay operated, the test circuit for relay T will be opened thus guarding the outlet against seizure by an allotter.

If the line finder is one of a number of graded finders, that is if a number of finders in different groups are connected to the same group selector, the test circuit for the allotter may be arranged as shown in Fig. 3. In this figure the terminals corresponding to P and PB in Fig. 1 are shown for three line finders LF and in addition a terminal PA is provided on each finder. All the terminals P of the graded line finders are commoned and connected to the selector test wire to which earth is adapted to be connected in the group selector GS and battery is connected in the group selector GS to terminal PB of one of the finders and extended over chain contacts of the

switching relays of all the graded finders to the finder test wire. The allotter test circuit extends over terminal P, the strap to terminal PA of the finder shown uppermost, the serially connected switching relay contacts of all the finders to the battery connection to terminal PB in the group selector. This chain circuit is opened by the operation of the switching relay in any one of the finders.

If some of the finders of a group are graded, the ungraded finders will be connected to earlier contacts in the allotter bank than the graded finders and only the outlets in the arc of wiper A8 corresponding to ungraded finders will be connected to earth. The outlets corresponding to graded finders will be connected to the last contact in the pair of arcs (the 104th) and contact *lc1*. Thus in searching for a free finder, all the ungraded finders must be tested before the graded finders as it is only after the switch has passed over its first contact position that the marking for graded finders will be connected up by the operation of relay LC.

The line finder shown in Fig. 1 is arranged for self-routining. If the upper springs of jack J1 are bridged by a plug, a start condition is simulated, relay RT operating in series with relay S from eart hconnected to the jack. The allotter will take into use a free line finder and, provided no other calling condition in the subgroup is present, the finder will rotate to a last contact position in which relay P will be operated over wipers A1 and F3, contact *rt1* to battery. The last contacts on the other line finder arcs, except the arc of wiper F1, are unconnected. Following the operation of relay PA and release of relay ST the allotter will advance to the next free outlet available to it and the line finder of this outlet will be rotated in like manner. When the allotter moves on after the line finder has been stopped on last contacts, the switching relay operated will be released as no earth will be present on wire *p*. In this manner all the line finders of the group may be tested automatically. If the jack J2 be plugged, an indication will be given by the closure of contact *hb1* that the set of wipers F5—F8 is in use. A similar test for lines in the other sub-group may be had by bridging the lower springs of jack J1.

We claim:

1. In a telephone system including a plurality of groups of incoming lines, a plurality of call finders for each of said groups having access to all of the lines in the group, a call allotter associated with each group of lines having circuit paths to all of said call finders, means responsive to the initiation of a call over one of said lines for starting the associated call allotter, and means causing said associated call allotter to allocate said call to a call finder in the group having access to said one line.

2. In a telephone system including a plurality of groups of incoming lines, a plurality of call finders for each of said groups having access to all of the lines in the group, a call allotter associated with each group of lines having circuit paths to all of said call finders, means responsive to the initiation of a call over one of said lines for starting the associated call allotter, and means preventing said associated call allotter from allocating said call to call finders which do not have access to said one line.

3. In a telephone system including a group of call allotters and a plurality of groups of call finders, connections therebetween capable of providing access to all of said call finders from each of said call allotters, and means causing each of said call allotters to allocate calls only to a particular group of said call finders.

4. In a telephone system including a rack containing a plurality of panels of call finders and a panel of call allotters, a series of first multiples each common to all of the call finders in one panel, a second multiple between some but not all of said first multiples, a third multiple common to all of said call allotters capable of providing access to all of said call finders from any one of said call allotters, and means causing any one of said call allotters to extend connections over said third multiple only to particular panels of call finders operating on common first multiples.

5. In a telephone system including a plurality of racks each containing a plurality of panels of call finders and a panel of call allotters, a series of first multiples each common to all of the call finders in one panel, a second multiple between some but not all of said first multiples in different racks, a third multiple common to all of the call allotters in one rack capable of providing access to all of the call finders in said one rack and also capable of providing access to all of the call finders in other racks which have their first multiples commoned to the first multiples of call finders in said one rack, and means causing any one of said call allotters in said one rack to extend connections over said third multiple only to particular panels of call finders operating on common first multiples.

6. A telephone system as claimed in claim 3 including a test circuit in each of said call allotters, and said means comprising a marking bank individual to each of said call allotters and included in the test circuit thereof.

7. In a telephone system as claimed in claim 3, circuit arrangements sub-dividing certain of said groups of call finders and causing the several subdivisions to normally be served by different call allotters, and means responsive to a failure of one of the call allotters causing another call allotter serving the same group of call finders to act as an alternative for said one call allotter.

8. In a telephone system as claimed in claim 3, circuit arrangements sub-dividing certain of said groups of call finders and causing the several sub-divisions to be served by different call allotters, a normally inactive call allotter associated with each such group, and means responsive to a failure of one of the call allotters serving a sub-division of a group to cause the said associated normally inactive call allotter to act as an alternative for said one call allotter.

9. A telephone system as claimed in claim 3 including means causing one of said call allotters to pre-select an idle call finder in the said particular group in which it is permitted to allocate calls.

10. In a telephone system as claimed in claim 3 in which one of said groups of call finders is subdivided into first choice and second choice finders, means preventing the call allotter serving said one group from allocating calls to said second choice finders while any one of said first choice finders is idle.

11. In a telephone system as claimed in claim 3 in which one of said groups of call finders is subdivided into first choice and second choice finders, a test circuit included in the call allotter

serving said one group, and means causing said call allotter to test all of the said first choice finders before testing any of the said second choice finders.

12. In a telephone system as claimed in claim 3 in which said means comprises a marking circuit for each call allotter including a number of terminals each corresponding to one of the call finders to which the associated call allotter is capable of allocating calls, and means for marking particular ones of said terminals to determine the group to which calls may be allocated.

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