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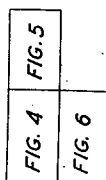
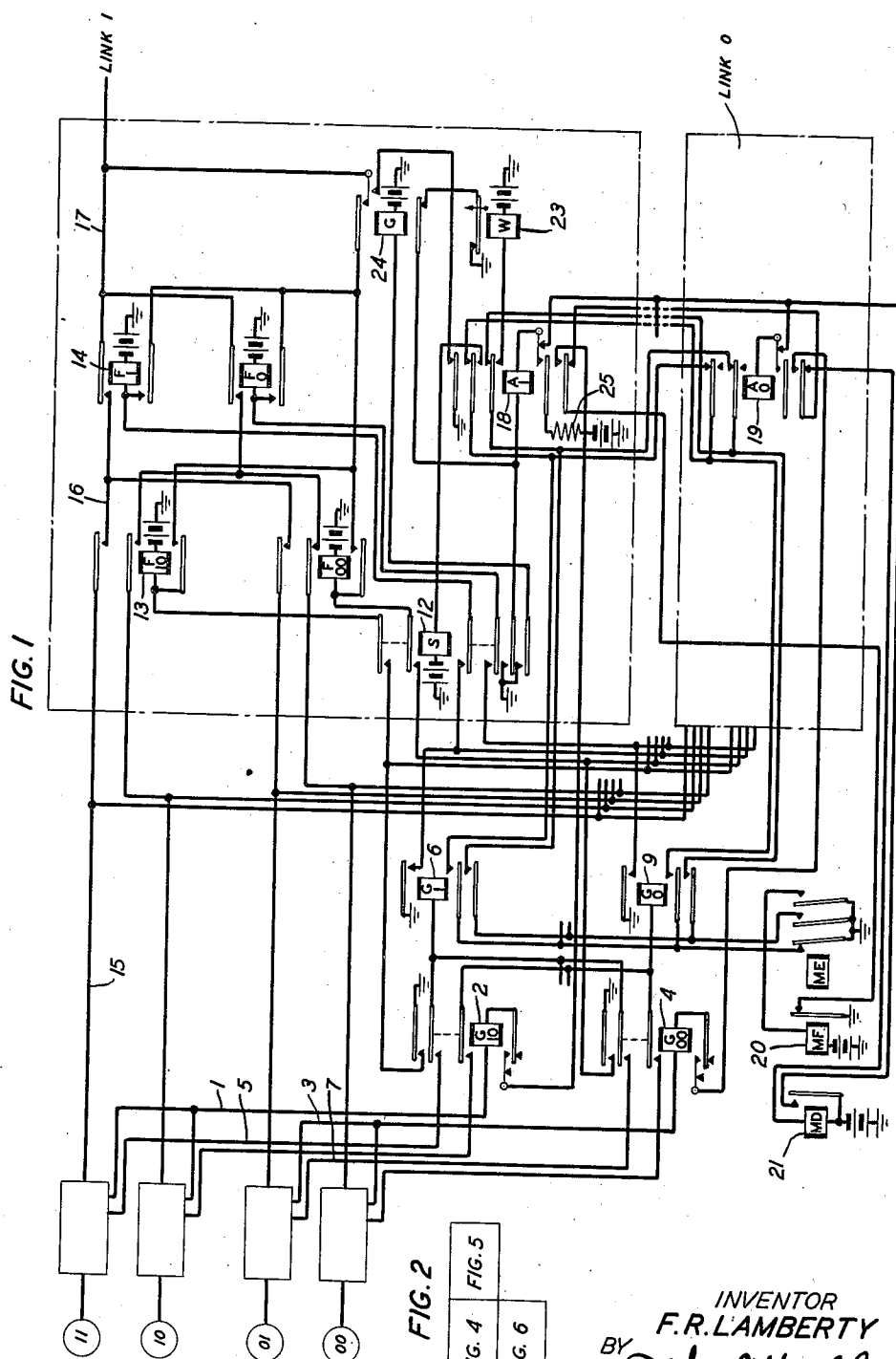
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2,286,142

GUARD CIRCUIT

Filed April 29, 1941

5 Sheets-Sheet 1



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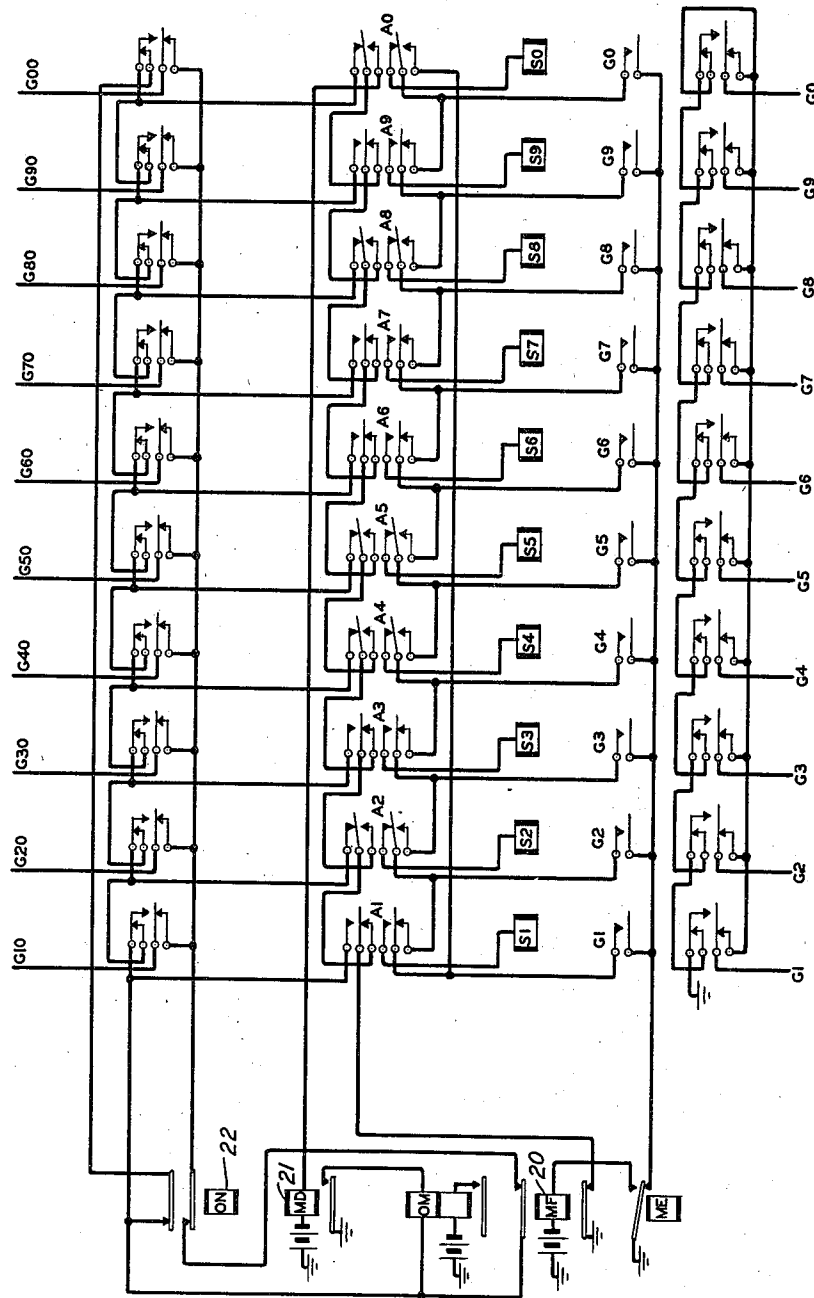
2,286,142

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FIG. 3



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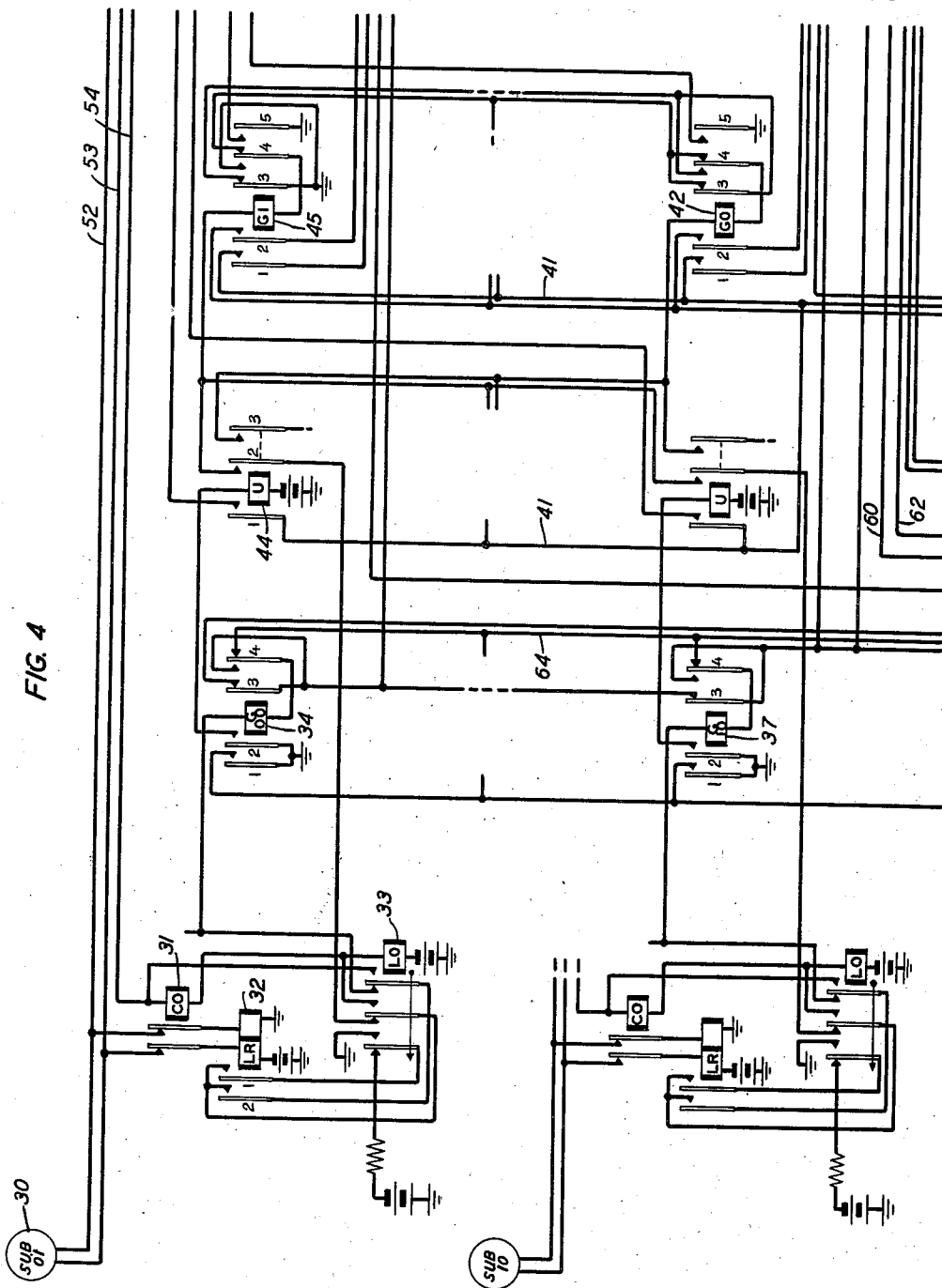
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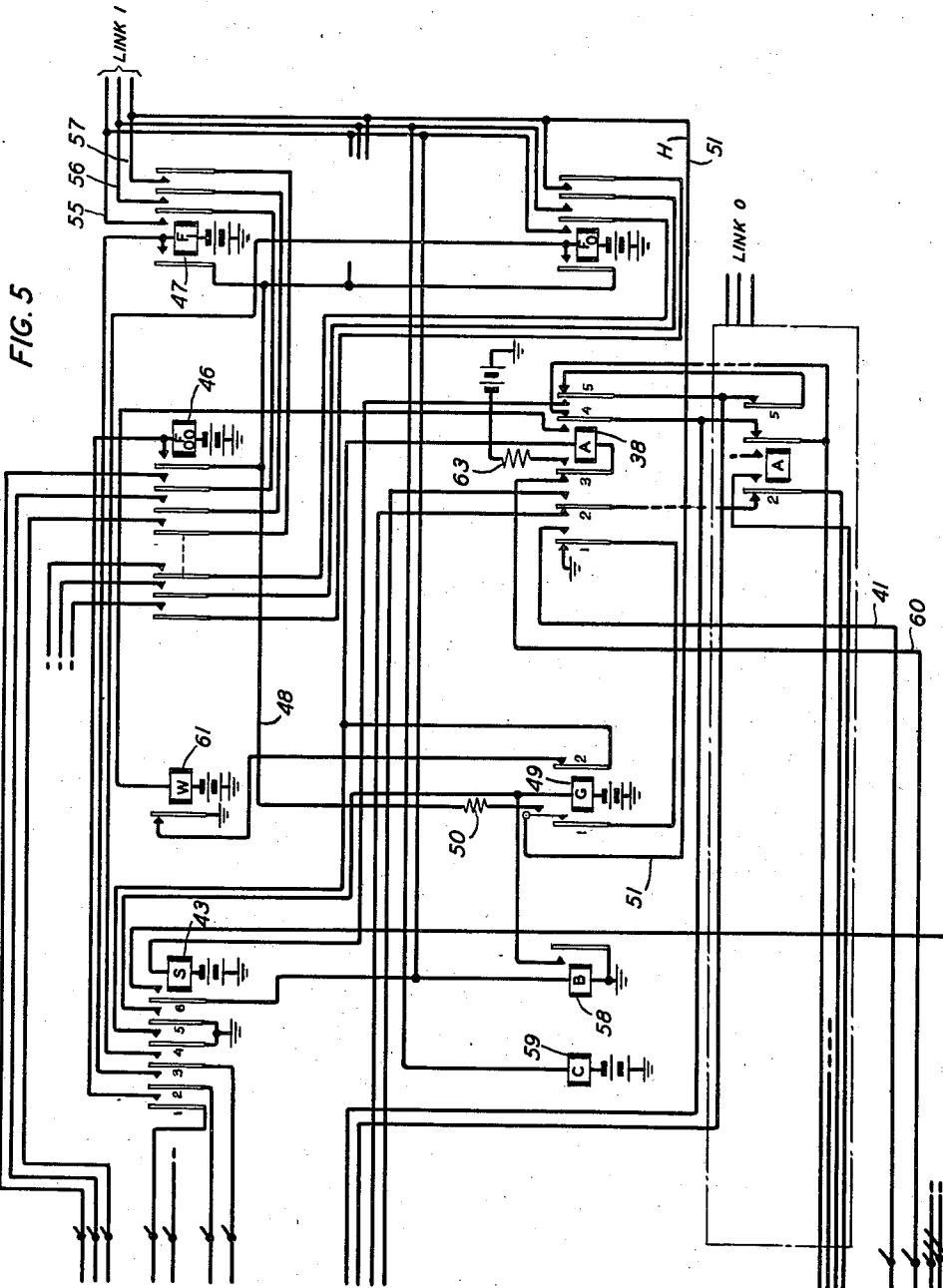
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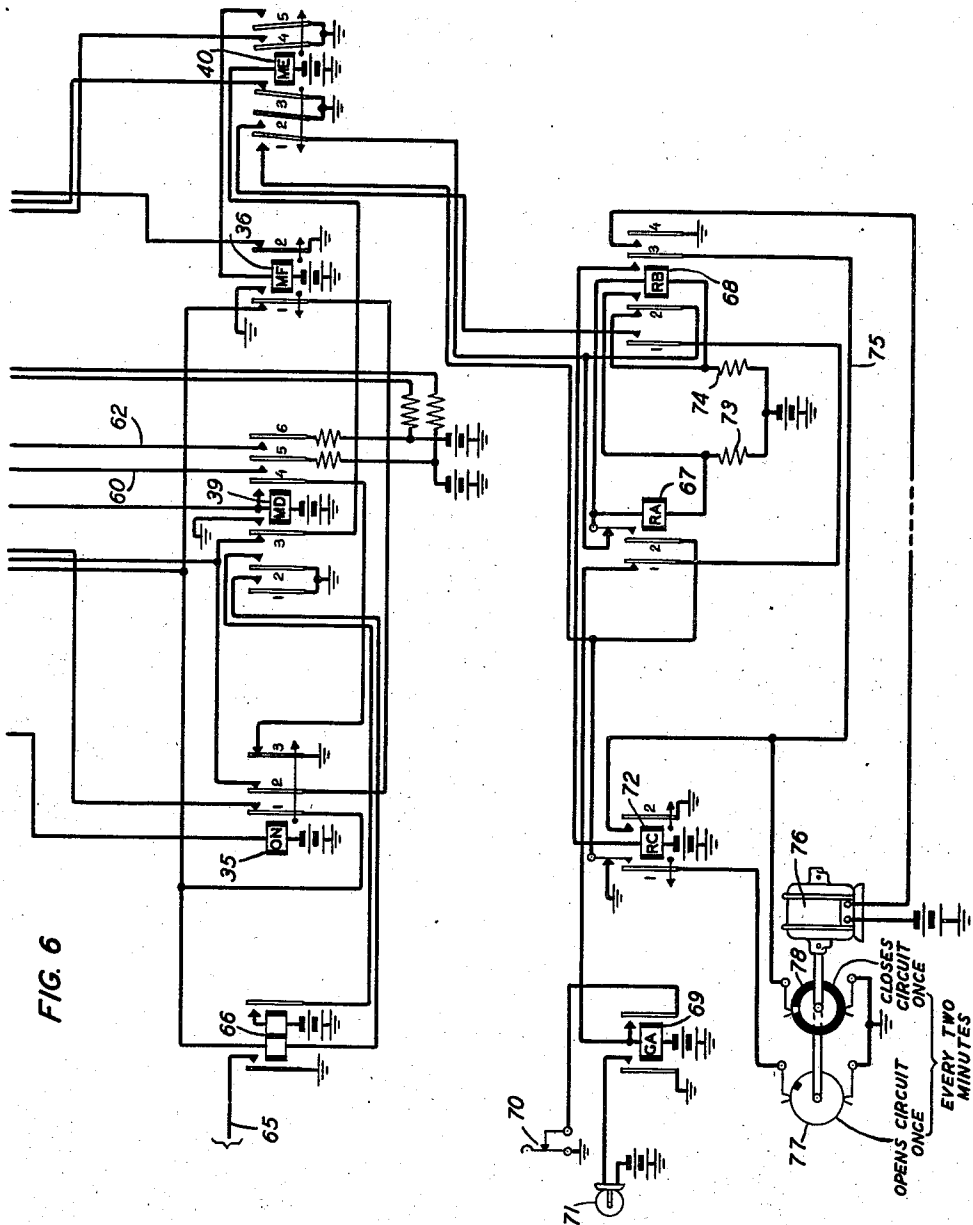
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GUARD CIRCUIT

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5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,286,142

GUARD CIRCUIT

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Application April 29, 1941, Serial No. 398,835

6 Claims. (Cl. 179—18)

This invention relates to communication systems and particularly to automatic switching arrangements.

The object of the invention is to provide automatic switching arrangements responsive to trouble conditions which will avoid misappropriation of switching facilities whereby service may not be seriously interrupted. This invention when applied to a telephone system will prevent a single defective line from appropriating the switching means for extending calling lines to link circuits to the exclusion of other calling lines.

Where calling lines are grouped and provided with a percentage link system by which they may be extended to directly operated switching facilities, the links are reached through the operation of an organization of relays controlled by a so-called guard circuit.

The function of this guard circuit is to insure that one calling line at a time is served and hence the guard circuit acts in a supervisory capacity and prevents confusion where more than one call appears simultaneously by locking out all other calls while a first is being forwarded. An allotting arrangement is used whereby calling lines in certain subgroups have precedence or preference over others. If the preference is fixed, the subgroups of lines beyond a given point are at a disadvantage if some line before that point unduly appropriates the guard circuit.

It is an object of the present invention to employ means for shifting the preference which will operate not only under normal conditions in a well-known manner but under extraordinary conditions in a novel manner. By an arrangement of this nature service may be maintained even though a trouble condition appears which heretofore would result in a serious interruption of such service.

The operation of the circuits of the present invention may be briefly described as follows: When a call is made, if the guard circuit is normal, extending operations are carried out to extend the call to the first idle link in accordance with the preference established at that time. The guard circuit goes off normal and prevents a second call from being extended until the operation with respect to the first call has been completed and the guard circuit returned to normal. Time is counted by slow relay action and normal operations will always be completed within the time limit set. These normal operations include what might be termed acceptance of the call by the selected link for it depends on a

signal from the link after the calling line has been extended thereto to dismiss the guard circuit. Heretofore any thing that interfered with the transmission of such signal resulted in failure to dismiss the guard circuit with the consequence that the timing-out operation was completed to produce a single retrial to establish a connection to a link after which the preference circuit remained off normal indefinitely until the trouble condition was remedied.

According to the present invention if a link is seized and the acceptance signal is not received within the time allotted the link is forcibly released, the preference is advanced, the guard circuit is returned to normal and the call causes another trial at the establishment of a connection to a link to be made. This time another link is used and this action will continue until a call is properly extended or the trouble is remedied. In the meantime, however, the idle links being used in rotation another call coming in is served in preference to the call caused by the defective line when this repeated trial advances the preference to the point where the said other call gains the preference. The invention, therefore, consists in the provision of means responsive to use of the guard circuit beyond a given time limit which will have the same ultimate result as the normal functioning of the guard circuit within such given time limit.

The invention also includes a novel signal circuit for noting the number of times no link has been available for a call. An all-links-busy condition prepares a circuit for operation as soon as a calling line, due to this condition, fails to receive immediate attention.

A feature of the invention is a supervisory circuit for temporary use which is dismissed within a given time limit under normal conditions and which functions to cause an automatic self-dismissal after such given time limit when normal operations fail to be completed within such time limit.

Another feature of the invention is a supervisory circuit including a preference advancing circuit which will automatically dismiss itself and advance the preference upon failure of the normal operations which such circuit is supervising to cause a normal dismissal thereof.

Still another feature of the invention is an overflow meter circuit in which an overflow relay remains normally short-circuited as long as there is a single link available but as soon as this condition ceases the relay is inserted in a circuit where it will respond to another incoming call

and at the same time will prevent any operation of the guard circuit.

Other features will appear in the following description.

The drawings consist of five sheets of circuit diagram containing six figures.

Fig. 1 is a schematic circuit diagram indicating the general arrangement by which calling lines are extended to outgoing links;

Fig. 3 is a schematic circuit arrangement indicating the preference arrangement; and

Figs. 4, 5 and 6, when arranged as indicated in Fig. 2, show the circuit arrangement of Fig. 1 in more detail. Fig. 4 shows the individual line circuits for each telephone line and the group relays in the guard circuit for identifying the calling line to the proper connecting relays in the link. Fig. 5 shows these connecting relays in the link together with certain of the control relays individual to the link. Fig. 6 shows the common controlling relays within the guard circuit.

Fig. 1 indicates, generally, a group of one hundred calling lines numbered for convenience from line 11 to line 00 and a group of outgoing links numbered for convenience from 1 to 0. The calling lines are grouped in accordance with the digits of their numbers. Thus the two upper lines numbered 11 and 10 belong in the major group whose tens digit is 1 and whose units digits are 1 to 0, inclusive. The two lower lines belong in the major group whose tens digit is 0 and whose units digits are from 1 to 0, inclusive. The rectangles into which these telephone lines extend represent the individual line circuits for such telephone lines and the conductors coming from the bottom of these rectangles extend to the group relays in the guard circuit. Thus it will be seen that a line 1 coming from the line circuits of lines 11 and 10 extends to the winding of a group relay 2, for convenience also designated G10. This group relay responds to all calling lines in the group of lines whose tens digit is 1. Similarly, a conductor 3 extends from each of the line circuits of the lines whose tens digit is 0 to the winding of a group relay 4, for convenience also designated G00. Another conductor 5 coming from the line circuit of line No. 11 extends through the contacts of group relay 2 to the winding of a group relay 6, for convenience also designated G1. Similarly, a conductor 7 coming from the line circuit of line No. 01 extends through the contacts of group relay 4 to the winding of group relay 6, so that it will be seen that each line whose units digit is 1 will cause the operation of group relay 6. In a similar manner it will also be noted that all lines whose units digit is 0 will operate the group relay 9, also designated for convenience as G0. Thus a calling line is identified by the operation of a tens group relay and a units group relay corresponding in number thereto. Assume at this time that the link No. 1, some of whose relays are shown in the upper broken line rectangle, is idle. Then if line No. 11 initiates a call, group relays 2 and 6 will operate and through the contacts of the S relay 12 will cause the operation of corresponding individual multicontact relays within the link circuit. Thus, through the operation of relay G10, relay 13, also designated for convenience as F10, will be operated. Through the operation of relay G1, relay 14, also designated for convenience as F1, will be operated so that a conductor 15 representing the line from telephone No. 11 may be traced

through the contacts of relay F10 to conductor 16, thence through the contacts of relay F1 to conductor 17 which represents the link No. 1.

In this manner the group relays of the guard circuit control the operation of the corresponding multicontact relays individual to the link circuit.

Each link circuit has an A relay. The A relay of the link circuit No. 1 is here designated 18 and the A relay of the link No. 0 is here designated 19. In the following description of Figs. 4 to 6 it will appear that the A relay when operated indicates that the link is idle and awaiting use. When the A relay is released it indicates either that the associated link is busy or that it has become idle after being used, and that the preference arrangement has not been recycled.

This may be understood more clearly from a contemplation of the schematic of Fig. 3. Here are shown ten groups of contacts. The upper group of contacts in each case belongs to the tens group relay in the guard circuit, the middle group of contacts belongs to the A relay of an associated link, and the lower group of contacts belongs to a units group relay in the guard circuit. Fig. 3 indicates the connections in a telephone system where there are ten group relays, such as relays 2 and 4, ten group relay such as relays 6 and 9, and ten outgoing links. Ten conductors coming from the top of this diagram extend from the winding of the corresponding group relay G10 to G00, inclusive, as indicated, and a conductor from each of these groups of contacts leads to a corresponding relay, here indicated as A1 to A9. It will be understood, of course, that this arrangement may be modified where there is a lesser number of group relays or a lesser number of outgoing links and though the method of operation will remain the same it will be somewhat easier to understand with the symmetrical arrangement shown.

It will appear in the following description that when the system is first put into operation and all of the A relays are in their released position that a circuit will extend from the lower armature and back contact of the MF relay 20 in a series circuit through contacts of all the A relays to the winding of the MD relay 21. The MD relay will operate and cause all of the A relays to operate (as indicated in Fig. 1). Since it is assumed now that all of the links are idle each A relay will become operated and locked in that position to indicate that the associated link is idle. As the links are taken for use the associated A relay will release so that in time a condition as indicated in Fig. 3 will be established. Thus the contacts of relays A1, A3, A6, A7 and A9 are in their unoperated position indicating that the associated links are either busy or have been used and are now idle awaiting the recycling operation. The contacts of relays A2, A4, A5, A8 and A0 are in their operated position indicating that the associated link is idle and awaiting use. As soon as the last idle link is taken for use and its A relay released, the above-described series circuit will be closed again and the A relays of those links which are now actually idle will again be operated. This is termed the recycling operation.

The manner of operation of the A relay is indicated in Fig. 1. A ground extends from the armature and back contact of relay 23 through the armature and back contact of relay 24 to the winding of A relay 18. The other side of this relay extends through the normal contacts of

one of its armatures to the front contact of the group relay 21 so that upon the operation of the MD relay battery will be supplied to all the A relays, and those whose associated relays 23 and 24 are in normal position will operate and lock through a resistance 25 to battery. When a call comes in to group relay G10 and the particular A relay 18 is operated, then a circuit will be extended from the G1 relay 6 through an armature and front contact of relay 18 to the winding of the S relay 12 which relay connects the contacts of the group relays of the guard circuit to the windings of the corresponding group relays in the link circuit. If the relay 18 were released, then the ground coming to the armature of relay 18 which would normally operate the S relay 12 will be extended over the back contact of this armature to a corresponding armature of another relay, here indicated by the broken lines extending to the upper armature of relay 19. If this relay were operated then it would cause the operation of the corresponding S relay for link 10.

Referring to Figs. 4, 5 and 6 where the circuits are shown in more detail, the operation of the guard circuit may be understood as follows. A subscriber's station 30 is indicated as extending to the subscriber's line circuit consisting of a cut-off relay 31, a line relay 32 and a lock-out relay 33. When the subscriber at station 30 removes his receiver from its hook he causes the operation of the line relay 32 in a well-known manner. Thereupon battery through the back contact and armature 1 of lock-out relay 33 is extended through armature 1 and front contact of line relay 32, front contact and armature 2 of the same relay, thence through armature 3 and back contact of lock-out relay 33 to the winding of group relay 34. The connection extends thence through armature 4 and back contact of group relay 34, back contact and armature 2 of off-normal relay 35, armature 1 and back contact of MF relay 36, to the front contact of armature 2 of the A relay of link 0. Let it be assumed, however, that the A relay 38 of link 1 is the only A relay operated now. Therefore, the connection will be traced through armature 3 and back contact of relay 37 and through the chain circuits of the other tens group relays until the front contact of armature 2 of relay 38 is reached and thence through the chain contacts of armature 2 and back contacts of the A relays of the other links to the back contact and armature 2 of MF relay 36 to ground. It should be noted at this point, also, that through a connection of this kind with some one of the A relays operated, this ground will also be extended back through the back contact and armature 3 of MD relay 39 to the winding of ME relay 40 so that relay 40 will be permanently energized for a purpose which will be described hereinafter.

The ME relay 40 is adjusted to be slow in releasing and will remain operated even though its energizing circuit has been opened throughout the normal operation of the guard circuit. If, however, the guard circuit is held for an undue length of time, the ME relay will release and dismiss any connection with which it may have been occupied. The purpose of this in dealing with trouble conditions will appear hereinafter.

If no other tens group relay, such as 34, is energized at this time, then relay 34 becomes energized and through its armature 1 operates the off-normal relay 35. This relay marks the fact that the guard circuit is in use and through its

armature 2 opens the circuit for the ME relay 40.

Relay 34 also through its armature 2 and front contact causes the operation of an auxiliary relay 44 and since relay 44 is always operated when relay 34 is operated, it acts to close a plurality of contacts which relay 34 would not be able to close in practice. This is merely an engineering expedient.

Through the operation of the line relay a circuit is also closed from battery, back contact and armature 1 of lockout relay 33, armature 1 and front contact of line relay 32, armature 2 and back contact of lock-out relay 33, armature 2 and front contact of relay 44 to the winding of group relay 45. A circuit from the winding of relay 45 may be traced through a chain of contacts on all of the units relays. Thus, it extends through armature 4 and back contact of relay 45 to the back contact and armature 3 of relay 42 and thence through the back contact and armature 3 of all the other units group relays to the back contact and armature 3 of relay 45 and thence to ground. If no other units relay is operated at this time, then relay 45 will become operated. There now being a tens group relay 34 and a units group relay 45 energized, the identification made by these two relays will be transferred to the multi-contact relays individual to the first idle link. Let it be assumed that link No. 1 shown in full in Fig. 5 is idle and selectable. This will be signaled by the fact that relay 38 is operated at this time. Therefore, a circuit will be established from ground, armature 3 and back contact of ME relay 40, conductor 41, front contact and armature 1 of relay 45, armature 5 and front contact of A relay 38, winding of S relay 43 to battery. Through the contacts of the S relay the multicontact relays of the link corresponding to the operated group relays of the guard circuit will be energized. Thus, a circuit may be traced from ground, armature 3 and back contact of ME relay 40, conductor 41, armature 1 and front contact of relay 44, armature 1 and front contact of relay 43 to the winding of multi-contact relay 46. Also, a circuit may be traced from ground, armature 5 and front contact of relay 45, armature 2 and front contact of relay 43 to the winding of relay 47. Relays 46 and 47 both lock to conductor 48. Through the operation of relay 43 relay 49 will become energized so that conductor 48 is extended through resistance 50 and the contacts of armature 1 of relay 49 to armature 1 of relay 38 which, due to the operated condition of relay 38, extends to ground on conductor 41. Conductor 48 also extends through resistance 50 to conductor 51.

Through the operation of multicontact relays 46 and 47, the tip, ring and sleeve conductors 52, 53 and 54 of the line may be traced through to the tip, ring and sleeve conductors 55, 56 and 57, respectively, of the link. Since conductor 51 is connected to conductor 57, the sleeve of the line will now be grounded and this will operate the cut-off relay 31 whereupon the line relay 32 will release and dismiss the guard circuit. This results in the release of relays 34, 44 and 45 as well as the off-normal relay 35. Thereupon the original energizing circuits for relays 46 and 47 will be opened and the S relay 43 allowed to release. Upon the release of relay 43, the A relay being held at this time through the front contact and armature 4 of relay 43 will be released, since relay 49 has also been operated. Through the action of armature 1

of relay 38 a ground is placed directly on armature 1 of relay 49.

It will be noted that there are two relays, 58 and 59, connected respectively to conductors 55 and 56. These relays supply battery to the calling line and if the subscriber is now on the line, both of these relays will operate. Relay 58 supplies a substitute holding ground for relay 49 so that the ground at the back contact and armature 1 of relay 38 now supplies a holding ground to conductor 48 as well as a ground to the sleeve conductor 57. The link No. 1 is now in use and is under the control of the calling subscriber at station 30.

In the broken line enclosure near the bottom of Fig. 5 certain elements of the last link are indicated. Thus, armatures 2, 4 and 5 of the A relay of that link are shown in the chain circuits associated with the other relays.

If all the A relays become deenergized, then a circuit will be established from battery, the winding of the MD relay 39, through the back contact and armature 2 of relay 38, and in series therewith the back contacts and armatures 2 of all the A relays, back contact and armature 2 of MF relay 36 to ground. Thereupon relay 39 operates and connects battery through its armature 5 and front contact, conductor 60, back contact and armature 3 and winding of the A relays of odd-numbered links, thence through armature 2 and back contact of relay 49, back contact and armature of relay 61 to ground. A similar circuit will be established through armature 6 and front contact of relay 39, a conductor 62 which extends through similar circuits of the A relays of even-numbered links. Since it was assumed that the link shown in full in Fig. 5 is in use at this time, the circuit just traced for this particular link will not be closed due to the operation of relay 49 but in all other links where the corresponding G relay is in its released position, the corresponding A relays will operate and lock through their associated resistance 63. Relay 39 locks through its armature 4 to the ground and at the back contact of armature 3 of relay 35. As soon as any one A relay operates, the chain circuit including the winding of relay 39 will be opened but relay 39 will not be returned to normal until some incoming call has caused the energization of the off-normal relay 35.

It should be noted that a relay 66 has its left-hand winding connected to the front contact of armature 1 of relay 39. If all of the links are busy, then ground will be connected to the left-hand winding of this relay. The other terminal of the left-hand winding of relay 66 extends to conductor 37 and under ordinary conditions will be grounded but when all of the A relays are operated the ground is removed from this conductor and hence the relay is subject to energization only if during this all-links-busy period another incoming call should appear. Under such condition, battery from a calling line extending through the windings of one of the tens group relays will be connected to conductor 64, thence through the back contact and armature 2 of off-normal relay 35, armature 1 and back contact of MF relay 36 to the upper terminal of the left-hand winding of relay 66. Relay 66 locks through its right-hand winding and its right-hand armature to the front contact and armature 2 of MD relay 39. Through its left-hand armature relay 66 grounds conductor 65 which extends to an over-flow meter to register the number of

times a call has come in while an all-links-busy condition existed. Since relay 66 locks to the ground on armature 2 of relay 39 the registration is of the number of times the overflow condition has been established rather than the possible number of calls that may have come in during a single establishment of the condition or a summation of the possible number of calls that may have come in during the total time the condition has been established.

In the lower part of Fig. 6 there is shown a circuit arrangement for giving the signal if the ME relay 40 becomes deenergized several times. A single deenergization of relay 40 will not be registered nor will a plurality of such operations be registered if they are separated by time intervals of a predetermined length. In this circuit there are two relays, 67 and 68, which constitute the well-known counting relay combination and these relays operate as follows: Upon the first deenergization of relay 40, relay 67 will become operated; upon the next energization of relay 40, relay 68 will become energized; upon a following deenergization of relay 40, relay 67 will become deenergized; and upon a following energization of relay 40, relay 68 will be released. This cycle will be continuously performed if relay 40 deenergizes and energizes a plurality of times in fairly quick succession. Thus, if relay 40 deenergizes once only for a short period, both relays 67 and 68 will be operated and a circuit for relay 69 extending through contacts of both the relays will still be maintained open now at relay 67 rather than at relay 68. If within a given time period thereafter relay 40 should again become deenergized, then the circuit for relay 69 will be closed at the contacts of both relays 67 and 68 to the back contact and armature 2 of relay 40 and thence to ground so that relay 69 will operate and lock through the releasing key 70 to cause the operation of the alarm signal 71. Thus, if the ME relay 40 should release and operate a plurality of times, the signal lamp 71 will indicate this fact. When the trouble is remedied, the releasing key 70 may be operated to unlock the relay 69.

The circuit for the operation of relay 67 upon the first release of relay 40 may be traced from ground, the normal contacts of armature 1 of relay 72, back contact and armature 1 of relay 40, normal contacts and armature 2 of relay 67, through the winding of relay 67, resistance 73 to battery. Relay 68, it will be noted, is short-circuited at this time through its armature 2 and back contact. Relay 67 operates and locks through its front contact and armature 2 to the ground at armature 1 of relay 72. When relay 40 again becomes operated, then the ground supplied for the original energization of relay 67 is removed and the short circuit about the winding of relay 68 is therefore opened so that relay 68 now operates through armature 2 and front contact of relay 67, winding of relay 68, resistance 74 to battery and ground. Through the operation of relay 68 a circuit is prepared through the front contact and armature 2 of relay 68 to short-circuit the winding of relay 67 when and if relay 40 again becomes deenergized. Assuming for a moment that this takes place, then relay 67 becomes deenergized and the circuit for relay 69 may be traced through the back contact and armature 1 of relay 67, the armature 1 and front contact of relay 68, the back contact and armature 2 of relay 40 to ground. Relay 69 locks up as hereinbefore described even though relay 40

may again immediately become energized and cause the deenergization of relay 68.

In case there is only a single deenergization of relay 40, then it is desired to dismiss relay 67 and this is done in the following manner. Upon the energization of relay 68 a circuit is established from ground, armature 4 and front contact of relay 68 to a motor start conductor 75 which will start motor 76 into operation. This motor operates a pair of interrupters. Interrupter 77 is arranged to open the circuit there-through leading to armature 1 of relay 72 momentarily once each two minutes. Interrupter 78 is designed to close the circuit there-through to the front contact and armature 2 of relay 72 once each two minutes. The closure of the circuit through interrupter 78 is arranged to be slightly after the opening of the circuit through interrupter 77. Thus, if relays 67 and 68 have been operated an undue length of time without another release of relay 40, then at a particular period, some time within two minutes, the ground through interrupter 78 will cause the energization of relay 72 whereupon the ground on the armature 1 of relay 72 will be removed and ground through interrupter 77 substituted therefor. Thereafter when through the movement of interrupter 77, this circuit is opened, relays 67 and 68 will become released without causing the operation of relay 69. Due to the release of relays 67 and 68, the relay 72 will be released, and the whole alarm circuit will be returned to normal. In this manner the timing circuit will be released if a single deenergization of relay 40 takes place.

Certain trouble conditions have been encountered in practice and the lock-out relay 33 is provided to take care of certain of these conditions. The following conditions under which the lock-out relay 33 is operated are well known and are mentioned here only for the sake of completeness in the disclosure. The station 30 may represent a number of substations on the line and hence interconnections between these stations may be established. These are known as revertive calls. By means which are not shown here a test is made when such a revertive connection is established which will result in the operation of the lock-out relay 33. The operation of this relay is accomplished by a momentary opening of the sleeve within the link circuit whereby the cut-off relay 31 deenergizes. The lock-out relay 33, however, is slow to release and remains operated during this momentary opening of the sleeve. At this time the subscribers, or at least one of them still being on the line, will cause the operation of the line relay 32. Thereupon ground will be extended through the front contact and armature 1 of lock-out relay 33, armature 1 and front contact of line relay 32, armature 2 and front contact of lock-out relay 33 to the winding of this relay to maintain it energized thereafter as long as line relay 32 is operated. Through the front contact and armature 2 of relay 32 and armature 3 and front contact of lock-out relay 33 ground is placed directly on sleeve 54 to mark the line as busy.

Another case in which the lock-out relay 33 may be operated is on what is known as a permanent signal, that is, when the subscriber on the line leaves his receiver off the hook or some other condition occurs which short-circuits the line or grounds the ring of the line. In any of these cases, when the trouble occurs, the connection will be extended to a link in the normal manner.

If the link is not used within a specified time, then a timing circuit in the link will cause the opening of the sleeve circuit 57 (by means not shown) which will result in the deenergization of the cut-off relay and the energization of the line relay in the same manner as hereinbefore described. Thus, a trouble condition of this nature will result in the operation of the lock-out relay 33 to hold the line out of service without interfering with the guard circuit. A third class of trouble may result from the calling subscriber forgetting to hang up after he has finished the conversation. In this case after the called subscriber hangs up the same timing operation in the link circuit will take place resulting finally in a momentary opening of the sleeve circuit, whereupon the cut-off relay 31 is allowed to deenergize and the line relay 32 is energized by the holding condition on the line with the same result as hereinbefore described.

There is another trouble condition which the present invention is designed to care for. If the sleeve wire 54 is open at any point so that when the link 1 is seized, as hereinbefore described, the cut-off and lock-out relays 31 and 33, respectively, fail to operate, then the operated group relays 34 and 45 will remain operated an undue length of time. Due to this lengthy operation of relays 34 and 45 and the off-normal relay 35, the ME relay 40 will finally release its armatures. Thereupon the relay 36 will be operated and the ground removed from the conductor leading through armature 2 of the A relays. Since the energization of the group relays depends on the continuous connection of ground to this conductor, the operation of relay 36 will immediately result in the deenergization of relays 34 and 45 and the restoration of the guard circuit to normal. As soon as the normal condition is reached and the call still existing at station 30, the same connection hereinbefore described will be set up, only this time another link will be used since the A relay 38 will now have been released. Under this condition the next available link will be seized but again if the cut-off relay fails to operate, the ME relay will in time forcibly return the guard circuit to normal so as to allow the calling line another trial.

If the open sleeve circuit had been due to some defect in the first link tried, then upon the seizure of a second link the call would be extended normally. If, however, the cause of failure of the cut-off relay to operate is at some point associated with the line circuit itself, the action of trying one link after another will continue indefinitely until the trouble condition is noted through the operation of signal lamp 71 and such condition remedied.

This action may be seen somewhat more clearly by consideration of the schematic of Fig. 3. Each of the lines coming from the top marked G10 to G00, inclusive, extends from the winding of a tens group relay. Each of the lines coming from the bottom of the drawing marked G1 to G0, inclusive, extends from a units group relay. The set of contacts into which the leads G10 to G00 extend represent armatures 3 and 4 of such relays as 34. These armatures are so adjusted that armature 4 will make contact with its front contact before armature 3 breaks contact with its back contact. The same effect is secured by a spring arrangement such as that shown in Fig. 3. Likewise armatures 3 and 4 of the units group relays are shown in a similar make-before-break arrangement as the bottom row of contacts. An-

other contact device representing armature 5 of the units group relays, such as relays 42 and 45 will extend a connection from a common conductor leading from a front contact of the ME relay into the group of contacts in the middle of this figure marked A1 to A0, inclusive. As hereinbefore stated, this figure represents a complete arrangement where there are ten tens group relays, ten units group relays and ten A relays representing ten links. According to this figure all lines having the same units digit have first choice over a particular link. Thus, for instance, all lines having a units digit 2 will, of course, operate the G2 relay and in Fig. 3 it will be seen how, with the A2 relay operated as indicated, a connection will immediately be established to the S2 relay which results in the No. 2 link being used.

If a call comes in on the G1 relay, then the S2 relay will be operated as the circuit to the S1 relay which is the normal preference for calls operating G1 relay is opened by the associated A1 relay as indicated in Fig. 3. The circuit from the contact of the G1 relay is also opened in the other direction at the contacts of the A0 relay.

If a call comes in on the G2 relay, then the S2 relay circuit will be closed through the operated contacts of relay A2. The circuit backward in the other direction will be chained through the contacts of relay A1 but will be opened at the contacts of relay A3.

If a call comes in on the G3 relay, then the S4 relay circuit will be operated since the A3 relay is in its normal position indicating either that the No. 3 link is busy or that it has been busy and may now be idle. The circuit from the G3 relay will be chained through the contacts of relay A3 and extended by the contacts of A4 to the S4 relay. The circuit in the other direction will be opened at the contacts of A2. It will be noted that a chain circuit extending from a ground at the make-before-break contacts of the G1 relay extends throughout the contacts of the higher numbered G relays to a common conductor so that if two calls should appear simultaneously, then the call on the units relay having the lower number will have the preference and the other call will be rejected. As soon, for instance, as the G2 relay operates its contacts the winding of the G2 relay will be chained through the contacts of the G1 relay to ground and the chain to higher numbered G relays will be opened so that none of these can be operated at this time.

With regard to the units group relays it will be noted that all of these are normally connected to a common conductor leading to an armature of the off-normal relay, thence through an armature of the MF relay to a chain circuit extending through the contacts of all the tens group relays and having ten branches extending to the contacts of the A relays. If any one A relay is operated, as for instance relay A2, then a ground will be supplied to this chain by a back contact of the MF relay. If the first connection through an A relay to this ground is of a lower number than the number of the tens group relay being used on an incoming call, then such tens group relay will be operated through this ground. If two calls should appear simultaneously, then the one using the tens group relay having the lower number will take the preference. If the first path to ground through the contacts of an A relay is between two tens relays, then the higher numbered tens relay will take the preference.

The above is important in the following respect—where a trouble call appears which will repeatedly operate the guard circuit the ME relay will repeatedly act to dismiss the guard circuit. Let us say that there is a trouble call on line 52 in the G50 group of lines, one which will repeatedly appear so that each time the off-normal relay restores the guard circuit to normal a new calling operation will take place. Line No. 52 will cause the operation of relay G2 if the G50 relay can be operated. With the preference circuit as shown in Fig. 3, the S2 relay will first be operated and link 2 will be seized. Since this is a trouble call, the connection will be rejected in the manner hereinbefore explained and the guard circuit will then be returned to normal. Thereupon relay G50 will again operate allowing G2 to follow and now since A2 has returned to normal, the ground through the contacts of G2 will extend through the contacts of A2, A3 and A4 to operate S4. On the next trial S5 will be operated; on the following trial S8 will be operated; and finally SO will be operated. Thereupon the series circuit from the MD relay will be closed and all of the A relays associated with idle trunks will become operated. Thereupon another trial for a connection will be made and this time either relay S2 or the next higher numbered S relay associated with an idle trunk will be operated. This automatic action will be repeated continuously until the trouble is remedied, each idle link being tried in turn.

If now a genuine call should appear, let us say in the G90 group, the call in the G50 group will have the preference until at least relays A1 to A5, inclusive, have been all returned to normal, whereupon the call in the G90 group will take preference and since this is a genuine call, a link will be properly seized and such genuine call completed. Since the automatic trial of one link after another is a rapid operation, the delay to which the genuine call is subjected will not be noticed by the calling subscriber. In other words, a calling subscriber in one tens group will not be denied service through a trouble condition in another tens group.

Should a genuine call appear on another line in the same tens group, as for instance on line 57, then upon the operation of relay G50 both relays G2 and G7 will operate simultaneously. Through the operation of the chain contacts on the G1 and G0 relays, the G2 relay will take the preference and the call operating the higher numbered units group relay will fail. However, if the order is reversed and the trouble call involves a higher numbered units group relay, the genuine call will be successful so that in the case of a trouble call genuine calls on only a small percentage of the lines may be adversely affected, or put in another way, by means of the present invention it is possible to provide service for the great majority of the lines even where a trouble condition appears which will repeatedly engage and operate the guard circuit.

What is claimed is:

1. In a communication system, a plurality of lines, each having a line and cut-off relay, a plurality of links, a guard circuit for supervising the connection of a calling one of said lines to one of said links, said guard circuit including a preference arrangement for changing the order of accessibility of said links by said lines, means responsive to the operation of said cut-off relay of a line upon the extension of one of said lines to a link for dismissing said guard circuit and

advancing the said preference, and means repeatedly responsive to the failure of said cut-off relay to operate for automatically dismissing said guard circuit and for advancing the said preference.

2. In a communication system, a plurality of lines, a plurality of links, a guard circuit for supervising the connection of a calling one of said lines to one of said links, said guard circuit including a preference arrangement for changing the order of accessibility of said links by said lines, means responsive to the successful extension of a line to a link for dismissing said guard circuit and advancing the said preference and means responsive to a call characterized by a given trouble condition preventing the successful extension of a line to a link for repeatedly and automatically dismissing said guard circuit and for advancing the said preference whereby a call coexisting with the said call characterized by said given trouble condition originally beyond said call characterized by said given trouble condition in preference will through the said repeated advance in preference become reversed in relation thereto and through thus gaining the preference be successfully extended.

3. In a communication system, a plurality of lines arranged in groups, a plurality of links, a guard circuit common to said lines and said links for supervising the connection of a calling one of said lines to one of said links and preventing the establishment of similar connections until said first connection has been completed, said guard circuit including a shifting preference arrangement for changing the order of accessibility of said links by said lines, means responsive to the successful extension of a line to a link for dismissing said guard circuit and advancing the said preference and means responsive to a call characterized by a given trouble condition on a line in a first of said groups preventing the successful extension of said line to a link for automatically dismissing said guard circuit and for advancing the said preference, means responsive to the repeated dismissal of said guard circuit and the continued advance of the said preference for eventually reversing the preference between the said line in said first of said groups and a line in another of said groups whereby a line in said other of said groups will be successfully extended to a link regardless of the said repeated trial to extend said line in said first of said groups to a link.

4. In a communication system, a plurality of

lines, a plurality of links, a guard circuit for supervising the connection of a calling one of said lines to one of said links, said guard circuit including a preference arrangement for changing the order of accessibility of said links by said lines, means responsive to the successful extension of a line to a link for dismissing said guard circuit and advancing the said preference, additional means responsive to the unsuccessful extension of a line to a link for dismissing said guard circuit and advancing the said preference, and means responsive to an all-links-busy condition for preventing the response of said guard circuit to a calling condition on one of said lines.

5. In a communication system, a plurality of lines, a plurality of links, a guard circuit for supervising the connection of a calling one of said lines to one of said links, said guard circuit including a preference arrangement for changing the order of accessibility of said links by said lines, means responsive to the successful extension of a line to a link for dismissing said guard circuit and advancing the said preference, additional means responsive to the unsuccessful extension of a line to a link for dismissing said guard circuit and advancing the said preference, means responsive to an all-links-busy condition on one of said lines, and an over-flow meter for recording the number of occurrences of the said all-links-busy condition responsive to said last means.

6. In a communication system, a plurality of lines, a plurality of links, a guard circuit for supervising the connection of a calling one of said lines to one of said links, said guard circuit including a preference arrangement for changing the order of accessibility of said links by said lines, means responsive to the successful extension of a line to a link for dismissing said guard circuit and advancing the said preference, additional means responsive to the unsuccessful extension of a line to a link for dismissing said guard circuit and advancing the said preference, a high resistance relay normally rendered inoperative by said preference arrangement, means responsive to an all-links-busy condition for inserting said high resistance relay in said guard circuit to prevent the response of said guard circuit to a calling condition on one of said lines, said high resistance relay thereafter responding to a said calling condition on one of said lines, and an over-flow meter responsive to said high resistance relay.

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