Dec. 4, 1928. 1,693,599

C. GILLINGS

TELEPHONE SYSTEM

Filed Feb. 10, 1925 2 Sheets-Sheet 1

Fig. 1

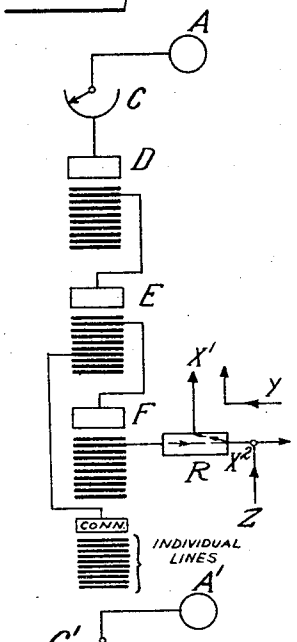


Fig. 2

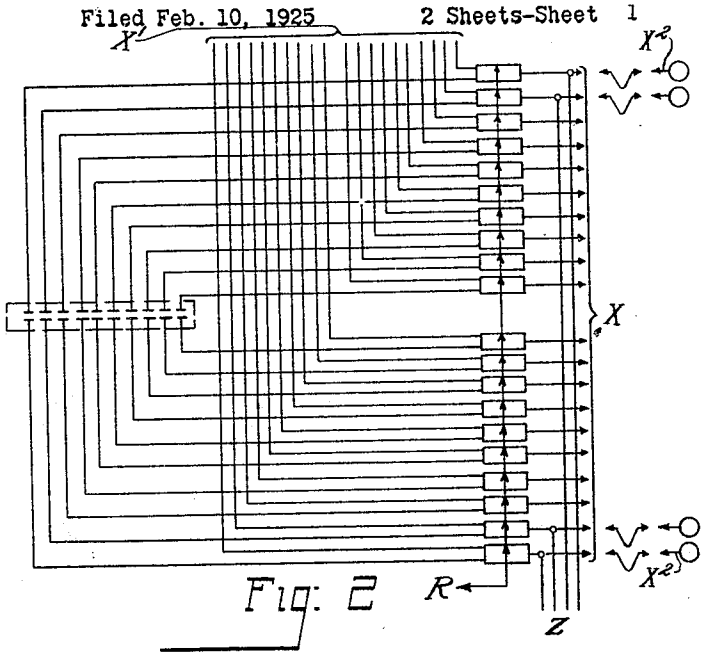


Fig. 3

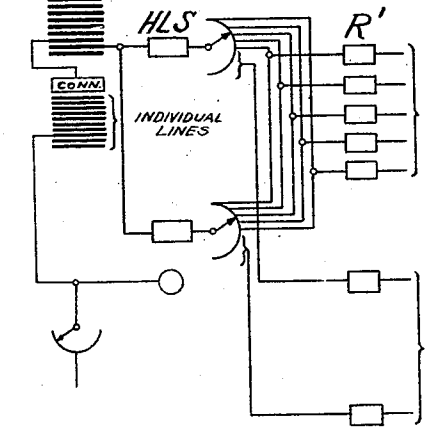
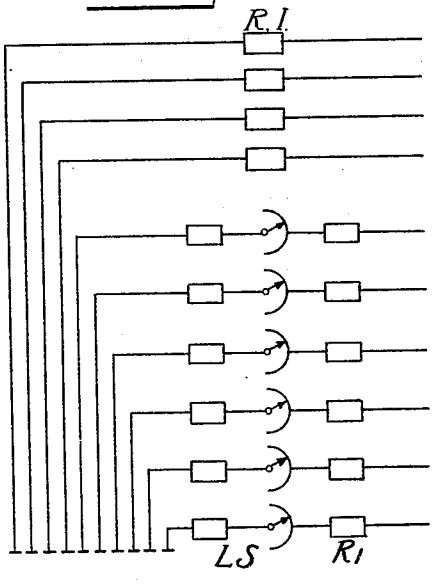


Fig. 4



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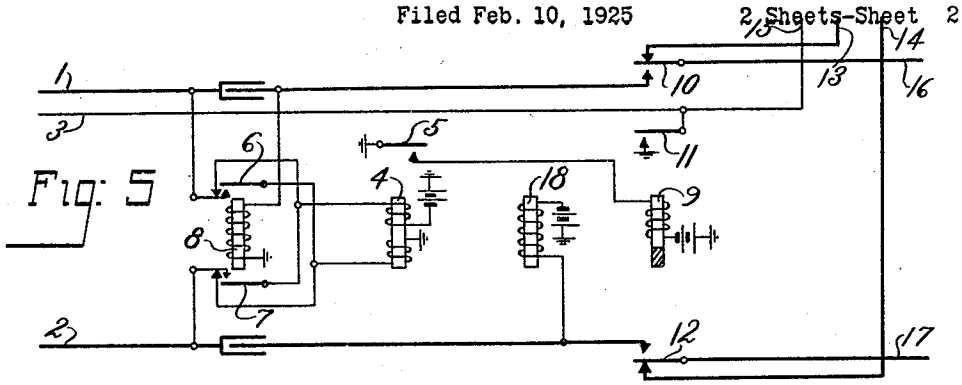


Fig. 5

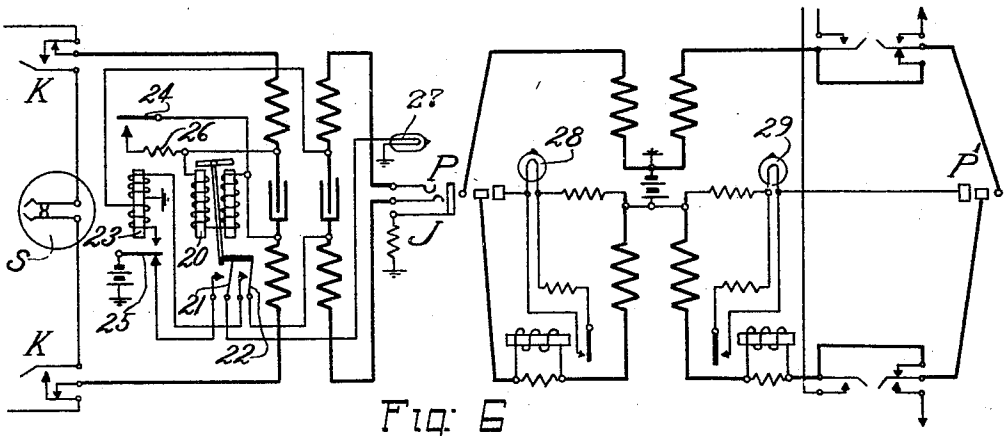


Fig. 6

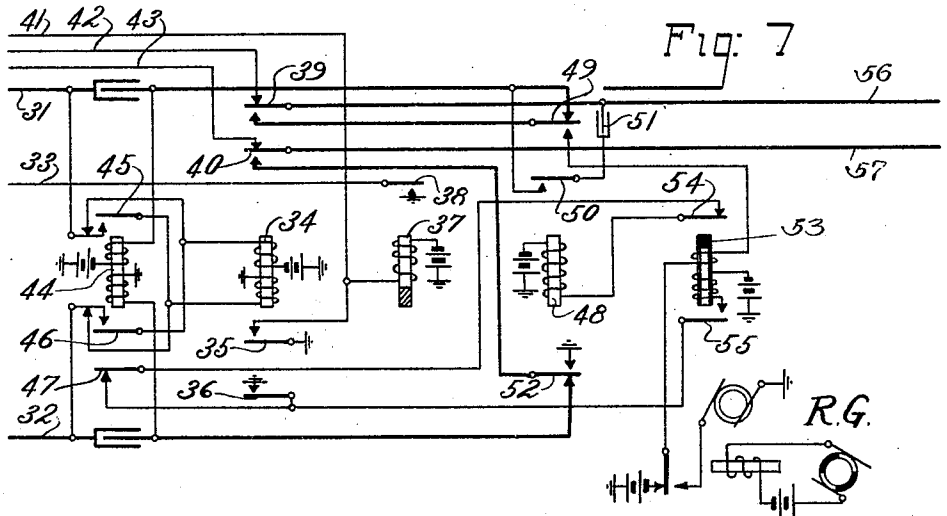


Fig. 7

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Patented Dec. 4, 1928. 1,693,599

UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

Application filed February 10, 1925, Serial No. 8,271, and in Great Britain February 15, 1924.

The present invention relates to improved trunking arrangements for use in automatic or semi-automatic telephone systems with a view to reducing the cost of providing what are known as private branch exchange line facilities, that is to say, groups of lines leading to the same subscriber and provided in the directory with a single telephone number. Various ways of dealing with this problem have been proposed, one arrangement being to provide special connector switches with automatic movement over the lines of each private branch exchange group. If the number of lines were greater than 10, it was arranged that automatic movement should take place in both directions of motion after a certain digit had been dialled. These special switches have usually been segregated into groups separate from the regular connector switches; moreover they have generally been of the connector type, having means for ringing the called subscriber and for supplying feed current to both calling and called parties. They are accordingly expensive and as a large number have to be provided in connection with a large group of lines, the cost of providing service to such P. B. X. subscribers may be very heavy.

This objection may be largely overcome according to one feature of the invention by employing outgoing secondary hunting switches for selecting an idle private branch exchange line, these switches having the same controlling means as the switches used in the regular trunking with special repeaters individual to the private branch exchange lines for effecting the signalling of the private branch exchange. These repeaters may be individual to each line or may be associated with the hunting switches.

According to another feature of the invention connections are extended to private branch exchanges having a large number of lines with the same numerical designation over non-numerical secondary switches reached over fewer switching stages than are employed for connecting with individual subscribers' lines.

A further feature of the invention is that private branch exchange lines when in large groups are adapted to be selected direct or through the intermediary of secondary hunting switches only from the banks of group selector switches, signalling means being provided beyond the selector switches so that no modification whatever is required of the selector switches used for traffic to both private branch exchange lines and individual lines.

Still another feature of the invention is that some of the lines from a private branch exchange terminate in repeaters including battery feed and supervisory arrangements so as to permit of traffic in both directions while others are equipped for traffic in one direction only.

These features will be more fully understood from the following description taken in conjunction with the accompanying drawings which show by way of example several embodiments of the invention. It will be understood however that various modifications of the arrangements shown might be employed without exceeding the scope of the invention.

Figure 1 shows diagrammatically one arrangement according to the invention and Figure 2 shows in more detail the bank wiring used for the third selector of Fig. 1. Figure 3 shows an alternative arrangement for rather larger groups a modification of the bank wiring being indicated in Fig. 4. Figs. 5 and 6 show the actual circuits of the repeaters used and the connecting arrangements at the private branch exchange, while Fig. 7 shows an alternative arrangement which could be used for instance with a cordless local switch board.

In Figure 1, it is assumed that the private branch exchange in question has less than 20 but more than 10 lines and that the subscriber at substation A wishes to extend a connection to it. He therefore removes his receiver and takes into use the first selector D by way of his line switch C, and selector D when operated seizes the second selector E. The particular level of E to which the switch is now operated does not extend to connector switches, as is usual assuming a 10,000 line exchange, but to third selectors such as F. These selectors are of the so called large capacity type having two sets of wipers and corresponding contact banks and arranged for simultaneous hunting over both banks. Switches of this type are described for instance in British Patents Nos. 170,385 and

186,037. Access may thus be had to as many as 20 lines X, each of which leads to a repeater R such as shown in Fig. 5 or Fig. 7. This repeater is adapted to control the ringing or other signalling and supervision to supply feed current to both parties and to include the necessary switching circuits for permitting outgoing calls to be established.

Generally speaking the operator in charge of the P. B. X. switch board is on duty only during the daytime and if the building is not entirely deserted at night it is usual to connect through night service lines to one or more telephones located at selected points in the installation. It is then clearly necessary for these lines to be first choice to the automatic switches, otherwise it would be impossible to establish connection with them at night. Thus in Figs. 1 and 2 assuming four night service lines X^2 are provided these will be connected to the first and second contacts in each bank. In order, however, that a calling party may be able to gain access to a particular night service line, it is also arranged that they are also accessible from ordinary straight line connectors as indicated at Z. Thus if the caller does not know the night service number of the particular line he requires he may dial the regular P. B. X. number and will then obtain connection with one of the night service lines unless they are all already in use. He may then enquire for the number of the particular line wanted and if he dials this he will obtain connection over the ordinary connectors and one of the lines Z. The night service number need bear no relation to the ordinary P. B. X. number. If the calling party knows the night service number of the particular line he wants, he will of course dial it in the first place, but he is not denied service in case he does not know it. Clearly also access may be obtained to the night service lines over the regular connectors in the daytime though as these lines are first choice they will probably generally be busy.

In Figs. 1 and 2, the lines X^1 extending from the repeaters R lead to line switches and are used for establishing outgoing connections in the manner described in connection with Figs. 5, 6 and 7. The lines Y in Fig. 1 are used only for outgoing connections, it being assumed in this case that the outgoing traffic is somewhat heavier than the incoming traffic; there is thus a saving on these lines as no repeaters have to be provided. Obviously these lines equipped for outgoing traffic only will be taken into use by the operator in preference to the lines equipped for both way working.

Figs. 3 and 4 show alternative arrangements for rather larger groups of lines, the maximum number allowed for being 205 in Fig. 3 including 5 night service lines and 154 in Fig. 4 including 4 night service lines. Suppose that subscriber A' takes into use first selector D' and second selector E' by way of his line switch C' and then operates selector E' to the particular level corresponding to the P. B. X. In the case shown in Fig. 3, each contact in this level instead of leading to a connector switch as it would for individual subscribers' lines, extends to a line switch HLS having access for instance to 25 lines so that a double hunting operation is obtained. This switch is of the homing type, that is to say it returns to a normal position after use and the wiring is so arranged that the five night service lines are connected to its first five contacts so as to be first choice. These five contacts are multipled between the line switches connected to each of the ten contacts of the selector level, but the remaining twenty contacts in each case are connected to a different group of lines; hence with this arrangement a maximum of 205 lines is obtained. Each of these lines will as in the previous case have a repeater R^1 associated with it to provide battery feed and permit of both way working.

The arrangement shown in Fig. 4 obviates the necessity for homing type line switches in that the night service lines are directly connected to the first few contacts of the selector level. The remaining contacts are connected as before to line switches LS which in this case may be of the type in which the wipers remain on the contacts last used and each contact of each switch accessible from any one level may extend to a separate P. B. X. line. Repeaters R^1 individual to the lines are again employed and the night service lines are preferably accessible also from ordinary connectors as before.

The actual repeater circuits shown in Figs. 5, 6 and 7 will now be briefly described. When the repeater in Fig. 5 is taken into use, leads 1 and 2 will be connected over the calling loop and a circuit will therefore be completed by way of the normally closed contacts controlled by armatures 6 and 7 for line relay 4. Relay 4 upon operating, at armature 5 completes a circuit for change over relay 9. The latter on operating, at armature 11 connects earth to release trunk conductor 3, and at armatures 10 and 12 disconnects the outgoing conductors 16 and 17 from the winding of the line relay of the line switch and earth respectively and completes the following circuit: battery, retardation coil 18, front contact and armature 12, lead 17, normally closed springs controlled by dialling key K, lower left hand winding of repeating coil, windings of polarized relay 20, upper left hand winding of the repeating coil, normally closed springs of key K, lead 16, armature 10 and its front contact, winding of relay 8 to earth. Relay 8 cannot operate in this circuit owing to the high resistance of polarized relay 20, but the latter operates and completes a circuit as follows:

battery, armature 25 and its back contact, springs 21, call lamp 27 to earth. Lamp 27 therefore lights and the operator on noting this inserts the answering plug of an idle cord circuit, for instance plug P, into the jack J. A circuit is thereupon completed over the sleeve of the jack for lighting the supervisory lamp 28 and a circuit is also completed from battery, lower left hand winding of the repeating coil in the cord circuit, supervisory relay, ring of plug, ring of jack, lower right hand winding of the repeating coil in the trunk circuit, springs 22, upper winding of relay 23 to earth. Relay 23 is now operated and at armature 25 completes a locking circuit through its lower winding at the same time extinguishing lamp 27 and at armature 24 places a shunt including resistance 26 across the windings of polarized relay 20. This shunt is not sufficient to de-energize relay 20 but allows enough current to pass to energize relay 8. Relay 8 which now operates, at armatures 6 and 7 reverses the current back over the calling line for metering, supervision or similar purposes. The operator may now complete the connection locally with the calling plug P^1 of the cord circuit, supervision from this side being by means of the lamp 29 as usual.

When the conversation is finished both parties will replace their receivers. When the receiver is hung up at the called substation, the supervisory relay will de-energize and lamp 29 will light. When the calling party hangs up, line relay 4 will de-energize and by releasing armature 5 cause relay 9 to de-energize also. Relay 20 is thus again placed across conductors 13 and 14 and the current flow from the line relay of the line switch is not in the right direction, to maintain relay 20 operated. Relay 20 upon de-energizing opens at springs 22 the circuit through the upper winding of relay 23 and the supervisory relay in the answering portion of the cord circuit so that lamp 28 lights. The operator then removes both plugs and all the apparatus is restored to normal. It will be understood of course, that the line relay of the line switch connected to conductor 13 is unable to energize in series with relay 20 owing to the high resistance of the latter.

For outgoing calls the operator will insert a calling plug, for instance the plug P′ of the cord circuit shown into the jack J and will then throw the dialling key K. When this occurs, the line switch is able to operate in the usual manner, the connection of earth to lead 15 which then ensues serving to busy the repeater to incoming calls. The operation of the dial S sets the automatic switches in known manner and when the called party replies the reversal of current over the line operates polarized relay 20 to give the P. B. X. operator answering supervision. The whole connection is released when the operator withdraws the plugs after both subscribers have hung up.

Referring now to Fig. 7, the arrangement there shown is suitable for use where the signaling devices at the P. B. X. respond to ringing current. In this case when the repeater is taken into use a circuit is completed over leads 31 and 32 and the normally closed springs controlled by armatures 45 and 46 for line relay 34. Relay 34 upon energizing, at armatures 39 and 40 disconnects conductors 42 and 43 extending to the associated line switch and prepares the ringing circuit, at armature 35 completes a circuit for relay 37 and at armature 36 completes a circuit for relay 48. Relay 37 energizes when its circuit is completed and at armature 38 connects earth to release trunk conductor 33. Relay 48, upon energizing, at armatures 49 and 52 completes the ringing circuit from the ringing generator RG by way of the upper winding of the ringing trip relay 53 and at armature 50 gives the calling party ringing induction by way of the small condenser 51.

When the attendant at the P. B. X. replies, relay 53 is operated by direct current and at armature 55 completes a locking circuit for itself and at armature 54 opens the circuit of relay 48. The latter therefore de-energizes and at armatures 49 and 52 completes the speaking circuit, battery being fed from the windings of back bridge relay 44. This therefore operates, at armature 47 opens a further point in the circuit of relay 48 and at armatures 45 and 46 reverses current back over the calling loop so as to give supervision in the usual manner. The release of the connection takes place as usual when the calling party hangs up, the ensuing de-energization of relay 34 bringing down relays 44, 37 and 53.

Outgoing connections are completed over conductors 56 and 57, armatures 39 and 40 and their back contacts and conductors 42 and 43 in the usual manner. The earth fed back on conductor 41 by the operation of the line switch serves to energize relay 37 and this by operating armature 38 busies the repeater to incoming calls in known manner.

What I claim is:

1. In a telephone system, regular subscribers' lines, selector switches, a group of private branch exchange lines, means for operating one of said selectors to extend a connection toward one of said regular subscribers' lines or to complete a connection to an idle one of said private branch exchange lines, a special repeater individual to each of said private branch exchange lines, and means included in said repeaters for signalling over the private branch exchange lines.

2. In a telephone system, individual lines, selector switches, connector switches, means for operating said selector switches and said

connectors to connect with said individual lines, means in said connector for signalling said individual lines, a group of private branch exchange lines, non-numerical hunting switches, means for selecting an idle line in said group through the intermediary of said hunting switches only from the banks of said selector switches, and signalling means provided beyond said selectors for signalling said private branch exchange lines.

3. In a telephone system, a main exchange, a branch exchange, trunk lines interconnecting said exchanges all of which are adapted to handle branch to main exchange calls, and individual ringing repeaters provided for some of said trunk lines to enable such trunk lines to be used for main to branch exchange calls also.

4. In a telephone system, main and branch exchanges, trunk lines for handling day calls from the main exchange to the branch exchange, a small group of other trunk lines for handling night calls from the main exchange to the branch exchange, the said night lines being accessible to connectors in the main exchange, and selectors in the main exchange having access to all said trunk lines, the trunk lines being so connected to the selector banks, however, that the night lines are first choice.

5. In a telephone system, a main exchange, a branch exchange, a trunk line connecting said exchanges, means including an automatic hunting switch in the main exchange for extending a calling line to said trunk line, a repeater in the main exchange included in said trunk line, and means including a line relay in said repeater energized responsive to the seizure of the trunk line for transmitting signalling current over the trunk line.

6. In a telephone system, a main exchange, a branch exchange, groups of hunting switches in the main exchange, groups of day service trunks accessible to said groups of switches, respectively, a common group of night service trunks accessible to the switches of all said groups, the said night service trunks being so connected in the banks of said switches that they are first choice, and terminals for all said trunks at the branch exchange.

7. A telephone system as claimed in claim 6 in which selectors are inserted ahead of the hunting switches and in which the night service trunks are directly accessible to the selectors as first choice.

8. In a telephone system, a trunk line divided into two sections normally disconnected from each other, a ringing repeater at the junction of said sections, a line relay in said repeater responsive to the seizure of said trunk line for connecting the sections of said trunk line together, and a ringing relay in said repeater responsive to the initial operation of said line relay for applying signalling current to said trunk line.

9. In a telephone system, a trunk line divided into two sections normally disconnected from each other, a ringing repeater at the junction of said sections, a line relay in said repeater responsive to the seizure of said trunk line for connecting the sections of said trunk line together, a ringing relay in said repeater responsive to the initial operation of said line relay for applying signalling current to said trunk line, and a ring cut-off relay included in said repeater and operated over said trunk line for disconnecting said current from said trunk line.

10. In a telephone system, a trunk line divided into two normally disconnected sections, a ringing repeater at the junction of said sections, a line relay in said repeater responsive to the seizure of said trunk line for connecting together said normally disconnected sections, a ringing relay in said repeater responsive to the initial operation of said line relay for applying ringing current to said trunk line, a ring-cut-off relay in said repeater, subscriber controlled means for operating said ring-cut-off relay, and means controlled by said ring-cut-off relay for disconnecting said ringing current.

11. In a telephone system, main and branch exchanges, a group of private branch exchange lines connecting the main and branch exchanges, selector switches in the main exchange, and means whereby said selectors have direct access to certain lines of said group while the remaining lines of said group are accessible to said selectors only through non-numerical hunting switches.

12. In a telephone system, main and branch exchanges, a group of private branch exchange lines connecting the main and branch exchanges, selector switches in the main exchange, means whereby said selectors have direct access to certain lines of said group while the remaining lines of said group are accessible to said selectors only through non-numerical hunting switches, and an individual ringing repeater provided for each of the lines of said group for signalling said lines.

13. In a telephone system, main and branch exchanges, trunk lines for handling day calls from the main exchange to the branch exchange, a small group of other thrunk lines for handling night calls from the main exchange to the branch exchange, and selectors in the main exchange having access to all said trunk lines, the night lines being directly connected to the selector banks as first choice and the day lines being connected to the selector banks only through non-numerical switches.

14. In a telephone system, a main exchange, a branch exchange, groups of hunting switches in the main exchange, groups of day service trunks accessible to said groups of switches, respectively, a group of night ser-

vice trunks, selector switches having direct access to said hunting switches and said night service trunks, the said night service trunks being so connected in the banks of said selectors that they are first choice, and terminals for all said trunks at the branch exchange.

15. In a telephone system, a group of private branch exchange lines, and a repeater individual to each of said lines for use by such lines when calling and for transmitting ringing current and feeding talking battery to said lines when called.

In testimony whereof I affix my signature.

CHARLES GILLINGS.