

Feb. 9, 1943.

W. H. T. HOLDEN
COMMUNICATION SYSTEM

2,310,634

Filed Oct. 15, 1941

3 Sheets-Sheet 1.

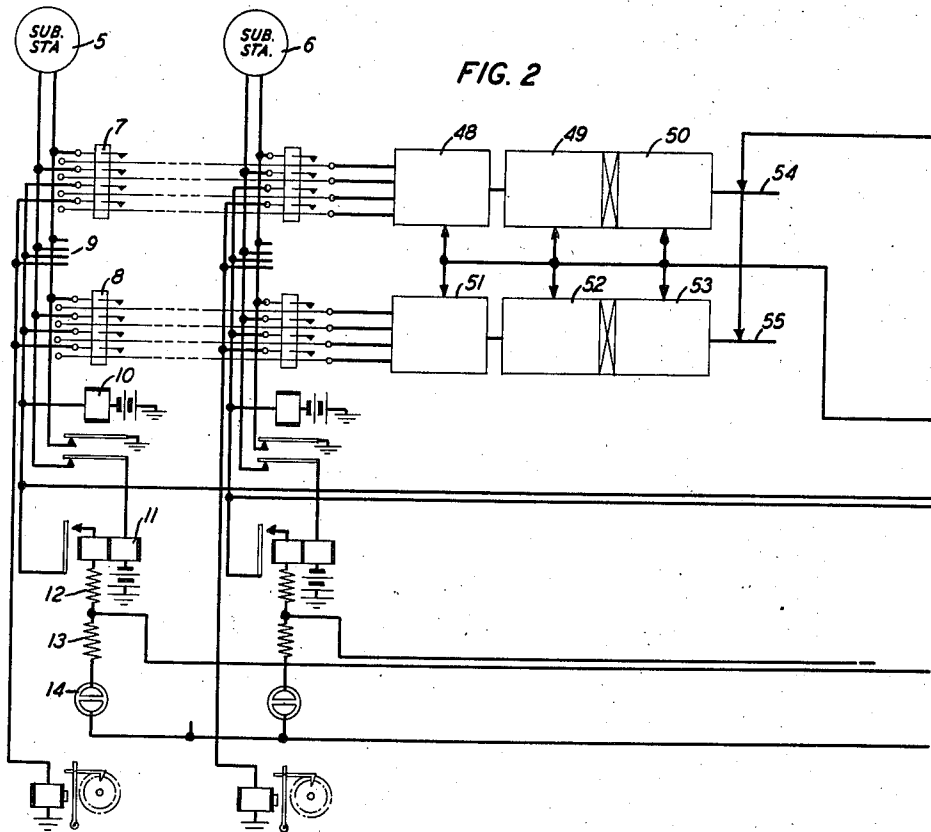


FIG. 5

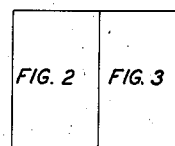
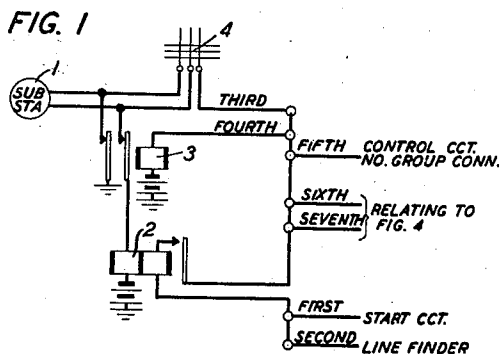
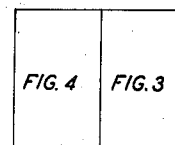


FIG. 6



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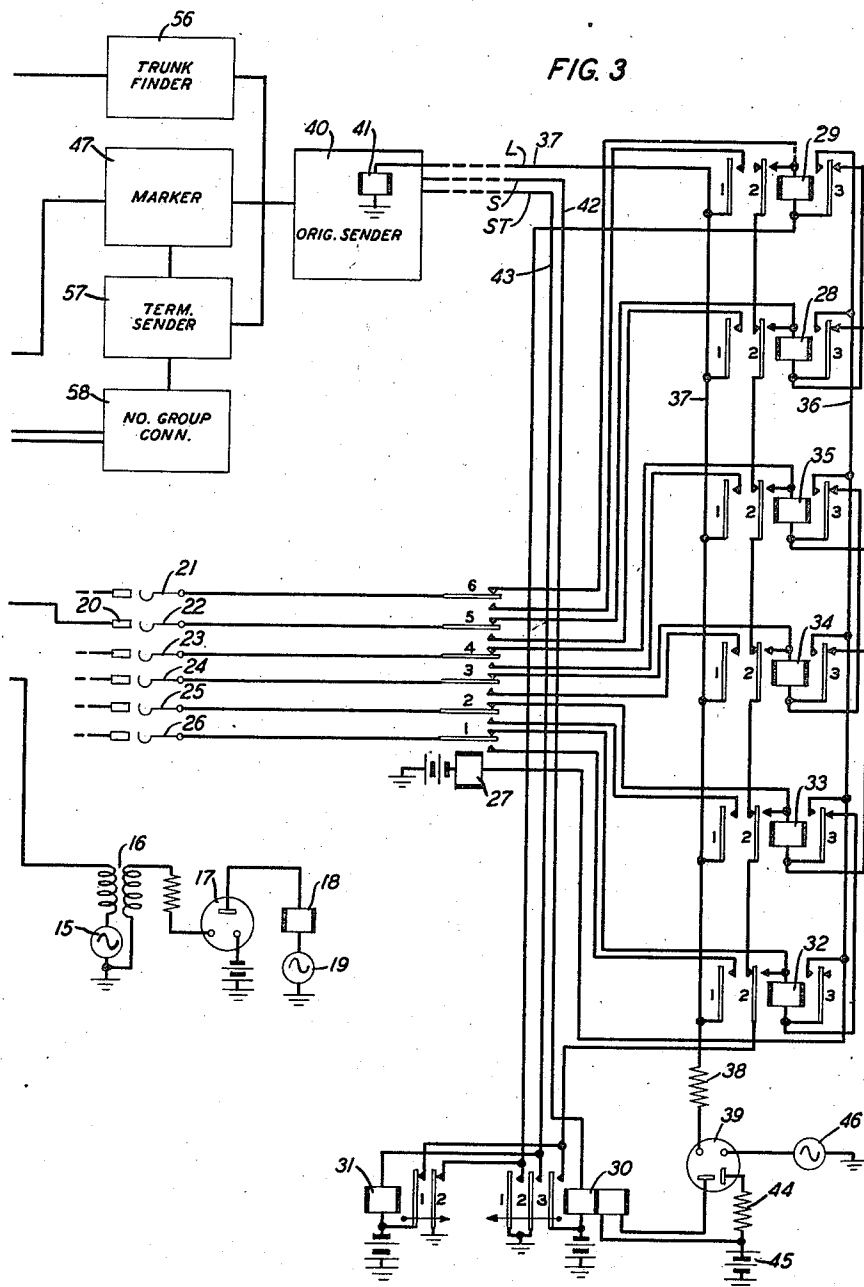
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Filed Oct. 15, 1941

3 Sheets-Sheet 2



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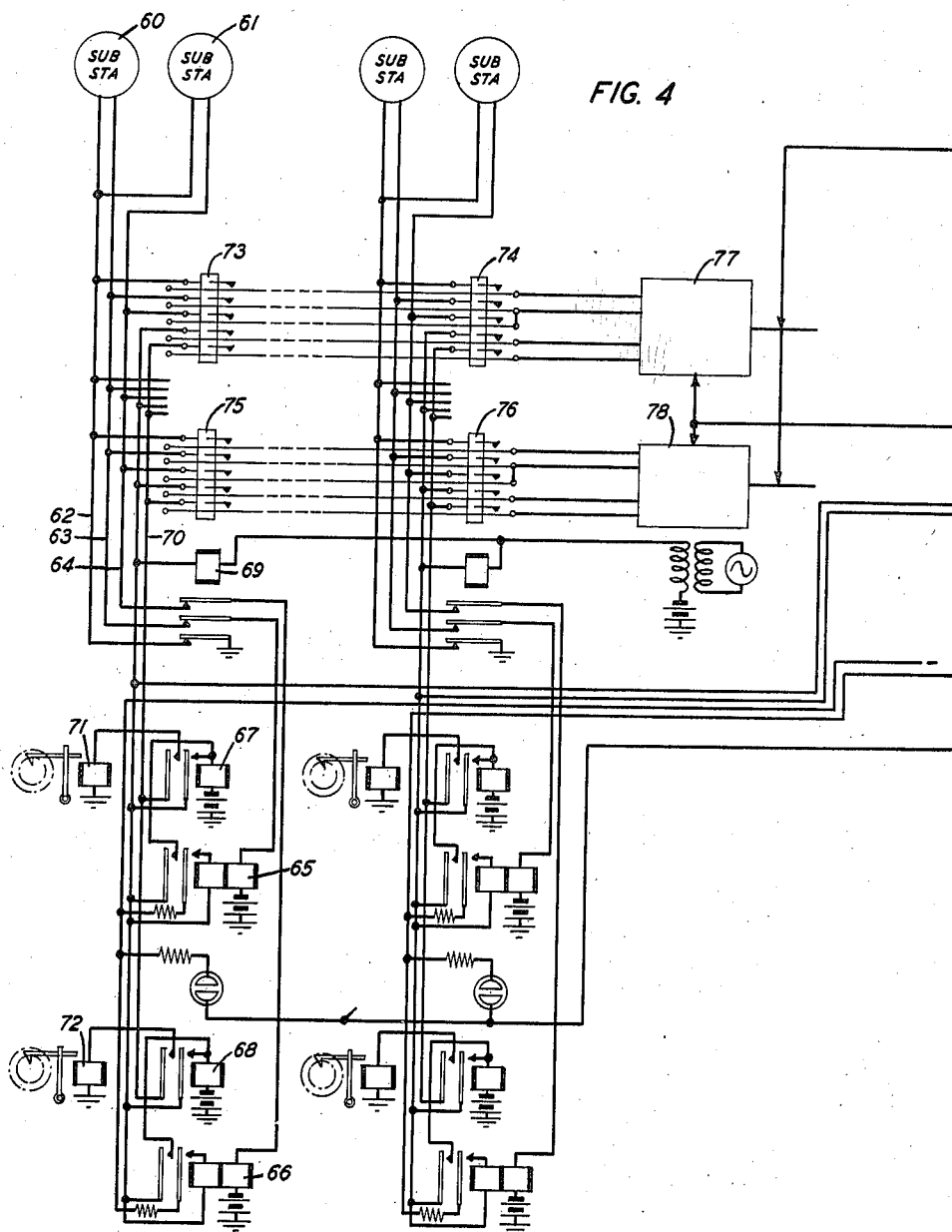
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COMMUNICATION SYSTEM

Filed Oct. 15, 1941

3 Sheets-Sheet 3



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2,310,634

COMMUNICATION SYSTEM

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Application October 15, 1941, Serial No. 414,991

14 Claims. (Cl. 179—18)

This invention relates to communication systems and particularly to machine switching systems for extending a communication channel serially through a multistage connection.

The object of the invention is to produce an economical and simple switching system. Each subscriber's line is provided at the central office with a simple relay which responds to switch-hook and dial operation on the line and which controls the complete establishment of the serial multistage connection. Each subscriber's line is effectively divided at the central office end into a single conductor signaling path and a two-conductor communication channel. The signaling path is extended by a line-finder arrangement into a sender which responds to the line relay to record the complete designation of the desired communication channel. Thereafter, such communication channel is established under sender control by an entirely separate train of switches. Effectively, therefore, one train of switches is used for signaling purposes and another train is used for communication purposes. A magnet individual to the line and individual to one of said communication channel switches is used as a cut-off relay for said line relay.

The line relay is a high speed sensitive relay controlling only a single make contact. This relay controls a circuit having two branches, a first branch controlling a start circuit for a line finder and a second branch appearing in and extensible by said line finder. The first branch contains an electronic circuit closing tube which responds to a switchhook operation on the line to close the start circuit of the line finder. When the calling line appearing in its second branch circuit in the line finder is found, the said electronic circuit closing tube in the first branch is quenched and thereafter maintains the start circuit open. The line relay thereafter responds to dial operation and pulses the complete designation of the desired communication channel over the said second branch via said line finder into a sender. It should be noted that while a sender is a preferred arrangement, this may nevertheless be replaced by a train of step-by-step switches which will set up a by-path to the desired termination which will thereupon control the establishment over a separate path of a parallel communication channel in accordance with well-known principles.

A feature of the invention is a single line relay which controls over a single path both a start circuit for, and a signaling circuit through a line finder.

Another feature is the use of a line relay controlled circuit having two branches one of which includes an electronic circuit closing tube responsive to an initial operation of the line relay and rendered ineffective thereafter during signaling by subsequent operations of said line relay over a second branch thereof.

Another feature of the invention is a line circuit for a communication channel comprising a line relay and a cut-off relay therefor comprising a magnet of a switch which is operated only after the complete designation of the desired connection for the extension of the communication channel has been repeated by the line relay.

Another feature of the invention is a system utilizing a single conductor signaling path from each line extensible to a sender or other signal responsive means by a line finder having a plurality of brushes and a like plurality of contacts for each selective position thereof, the said single conductor signaling path occupying only one of said contacts whereby the capacity of the said line finder is the product of the number of brushes times the number of selective positions thereof.

Still another feature of the invention is the use of a line finder serving a plurality of lines at each selective position thereof with means for simultaneously testing all lines appearing at each selective position thereof and for extending a detected calling one thereof.

Another feature of the invention is a line circuit for a communication channel, comprising a switch for extending the said channel, a magnet of said switch individual to the said channel, a line relay individual to said channel and cut-off contacts for said line relay operated by said magnet. The line relay when operated completes a circuit having a plurality of branches. A first branch of said circuit leads to a start circuit for a line finder. A second branch of said circuit constitutes an appearance in said line finder which may be extended by the line finder to a sender or other pulse responsive circuit. A third branch of said circuit is an appearance in said switch under control of said magnet and constitutes a means whereby said magnet may be held energized during the maintenance of a connection. A fourth branch of said circuit leads to the said magnet. A fifth branch of said circuit leads to a means under control of a sender which functions to test said circuit for a busy condition and to cause the original energization of said magnet. And last,

a secondary winding of said line relay is included in series with said circuit so that when the line finder has extended the signaling circuit to a sender, dial tone returned from there will be transmitted to the calling subscriber through the coupling of the two windings of the line relay.

Other features will appear in the following description.

The drawings consist of three sheets having six figures, as follows:

Fig. 1 is a schematic circuit diagram showing the essential elements of the present invention;

Fig. 2 is a circuit diagram showing the details of the line circuit and a schematic representation of switching means for extending the communication channel to and from a line;

Fig. 3 is a circuit diagram of certain circuit arrangements in a line finder with a schematic representation of controlling circuits whereby the signal circuit from the line circuit is extended through the line finder to affect control over the switches which extend the communication channel;

Fig. 4 is an alternative to Fig. 2 and shows certain arrangements for two party lines;

Fig. 5 shows how Figs. 2 and 3 may be combined to form a circuit diagram of one form of the invention; and

Fig. 6 shows how Figs. 4 and 3 may be combined to form a circuit diagram of another form of the invention.

The invention is shown schematically in Fig. 1. A telephone substation 1 is extended by a pair of wires to a central office line circuit represented by the remainder of the diagram. A line relay 2 is connected through the contacts of a magnet 3 to the line wires. The device 4 represents a switch for extending a communication channel to and from the line to substation 1. The line relay 2 is responsive to both switchhook and dial control over the line. When a call is made, relay 2 responds. Thereupon relay 2 closes a signal circuit between one portion having a third, fourth and fifth branch and including in series therewith the right-hand winding of relay 2. The first effect is to connect the battery potential of the magnet 3 to the first and second branches of the signal circuit. The first branch extends to a start circuit for line finders which seek this battery potential over the second branch of the signal circuit. When a line finder finds this second branch circuit the first branch is rendered thereafter ineffective, and the second branch is extended to a sender which has a relay therein responsive to the battery of magnet 3 but of high enough resistance so that magnet 3 is not operated. Thereafter dial tone is connected to the second branch in the sender and through the coupling of the two windings of the line relay 2 is transmitted to the calling line. The subscriber now dials the complete designation of the called line and relay 2 responds thereto and thus operates the sender. Thereafter the sender affects the second branch circuit to cause the operation of the magnet 3. As the communication channel is extended over the switch 4 a ground is returned over the sleeve conductor connected to the third branch of the signal circuit to maintain the magnet 3 operated. At the called line the number group connector grounds the fifth branch of the signal circuit individual to the called line to operate the magnet 3 thereof and to thus operate the switch 4 thereof. The magnet 3 is individual to the line to sta-

tion 1 and individual to the switch 4. Preferably, the magnet 3 is a hold magnet of a crossbar switch represented by the device 4. Upon the operation of magnet 3 the line relay 2 is cut off and the line finder and sender are released.

In more detail, and with reference to Fig. 2, two stations 5 and 6 of a plurality served by one crossbar switch are illustrated. The line from station 5 is individual to a vertical row of contact sets of which two, numbered 7 and 8, are shown and others are indicated by the multiple terminals 9. The hold magnet 10 is individual to this vertical row of contact sets and when it operates will render that one of the sets effective which has been selected by a select magnet in the well-known manner.

When the station 5 is operated the line relay 11 is operated, whereupon the potential of the battery connected to the hold magnet 10 through the armature, front contact and left-hand winding of line relay 11, resistance 12, resistance 13 to one terminal of the cold cathode glow lamp 14. This lamp will break down and allow alternating current from the source 15 to flow through the winding of transformer 16 whereupon the starting anode of tube 17 is energized with the result that current will flow from battery through the working anode and the cathode of tube 17, group start relay 18 and a source of alternating current 19. The group start relay 18 is well known and by its operation will cause a step-by-step line finder represented by the brushes 21 to 26, inclusive, to operate. These six brushes are of well-known design and operate to traverse one hundred sets of contacts arranged in ten rows of ten sets each. Each contact of each set has a line connected thereto leading from a line circuit such as contact 20 leading from the junction of resistances 12 and 13 in the line circuit individual to the line associated with station 5.

When brush 22 meets terminal 20, the second branch of the signaling conductor of the said line circuit will be extended over armature 5 and back contacts of relay 27, winding of relay 28, armature 3 and back contact of relay 29, armature 2 and back contact of relay 31 to ground. Relay 28 will respond in series with the winding of hold magnet 10 but is of resistance high enough to prevent the operation of the hold magnet. A circuit is now established from battery, armature 1 and back contact of relay 31, thence in a chain through armature 2 and back contacts of relays 32 to 35, inclusive, armature 2 and front contact of relay 28 and thence over the circuit previously traced to ground on the armature 2 of relay 31. This will hold relay 28 energized. The ground on armature 2 of relay 31 is now extended over armature 3 and back contact of relay 29, armature 3 and front contact of relay 28 to conductor 36, leading to the winding of relay 27. Relay 27 responds and connects the second branch of the signaling conductor connected to terminal 20 over brush 22, armature 5 and front contact of relay 27, front contact and armature 1 of relay 28 to conductor 37 leading through resistance 38 to the starting cathode of tube 39.

Due to the potential of the battery connected to the hold magnet 10, a discharge through the tube 39 from the cathode connected to the resistance 38 will take place to the anode connected to resistance 44 and thence to the positive battery 45. This discharge in the tube 39 will

so activate it that during one-half cycle of each cycle of the alternating current from source 46, current will flow through the right-hand winding of relay 30. This relay is slow releasing so it will respond to this periodic energization and remain operated as long as the potential from the hold magnet is maintained on the resistance 38. In the meantime ground will be returned over the sleeve wire 42 from the sender to energize relay 30 through its left-hand winding.

It will be noted that the start wire 43 from the front contact of armature 2 of relay 30, the sleeve wire 42 connected to the left-hand winding of relay 30 and the second branch of the signaling conductor 37 extend by dotted lines to the originating sender 49 where the second branch of the signaling conductor is connected through the winding of a pulsing relay 41 therein. The dotted lines are to represent schematically other switching arrangements of usual type, the point being that the second branch of the signaling circuit 37 as a single conductor is eventually connected to a pulsing relay in the sender which will respond to pulses sent by the line relay 11. Relay 41 responds in series with the hold magnet but does not cause the operation of such hold magnet.

The subscriber at station 5 now dials the complete designation of the wanted line. The line relay 11 follows the dial pulses and repeats them to the pulsing relay 41 in the sender. It is to be especially noted that the sender is thus set over a single conductor path by dial pulses repeated by the line relay. In all other respects this sender is of conventional design, and will operate to cause the establishment of a communication channel between the calling and the called subscriber over switching facilities of the crossbar type. For a detailed description of such means, reference is made to the following patents: 2,089,921 and 2,093,117, W. W. Carpenter, August 10, 1937, and September 14, 1937.

The crossbar switching facilities are here indicated in a highly schematic manner. The originating sender controls a marker 47 which in turn controls certain switches 48 to 53 to extend the calling line to an outgoing trunk 54 or 55. When the marker 47 has properly set these switches, the second branch of the signaling circuit 37 extending into the sender 40 is connected to a lower resistance ground or to a positive battery to cause the operation of the hold magnet 10 which is thereafter held operated from the usual sleeve path through the switches, here shown as the third branch of the signaling circuit. Thereupon the line relay is cut off and the first and second branches severed from the third, fourth and fifth branches of the signaling circuit.

At the distant end where the channels 54 and 55 may represent incoming trunks, a trunk finder 56 will connect such trunks to a terminating sender 57 and that part of the designation of the called line relating to such distant end will be "spilled" into such terminating sender. The terminating sender now through the agency of the number group connector will make a test of the called line over the fifth branch of the signaling circuit and if the line is idle the terminating sender will thereupon control a marker 47 to operate the switching facilities in known manner to complete the connection to the called line.

The marker 47 is here shown as operating both from the originating sender 40 and the terminating sender 57 but it will be understood that

this showing is schematic and is merely intended to indicate in a general way the manner in which the communication channel is established by crossbar switches. Details will be found in the above-noted Carpenter patents.

Fig. 4 shows an arrangement for a two-party message rate line circuit employing the features of the present invention. Each two-party line leaves the exchange and extends over separate loops to the two subscriber's stations such as 60 and 61. At the exchange, however, the two loops are combined into a three-wire line with a common tip conductor 62 but with separate ring conductors 63 and 64, respectively. A line relay 65 responds over ring conductor 63 to station 60 and a line relay 66 responds over ring conductor 64 to station 61. The signaling circuit with its various branches shown in Fig. 1 operates in exactly the same manner under the control of the two line relays, the only material difference in the circuit being the two auxiliary line relays 67 and 68 which under control of their associated line relays 65 and 66, respectively, operate and lock into the signaling conductor over what might be termed the sixth and seventh branches thereof. The auxiliary relays will remain operated under control of the signaling circuit after the hold magnet 69 has been operated to connect the message register conductor 70 to the message register 71 or 72.

The two separate ring conductors will be connected together upon the operation of the primary line switch represented by the contact sets 73 to 76, inclusive. In this showing the switching facilities 77 and 78 are equivalent to the switching facilities 49 to 53 of Fig. 2. In all other respects the circuits are the same and their operation may be readily followed by following the description of the arrangement indicated in Fig. 5.

What is claimed is:

1. In a communication system, a plurality of subscribers' lines, each said line having a relay connected thereto responsive to switchhook and dial operation on said line, a line finder, a first branch circuit controlled by said relay for starting said line finder, said first branch circuit including an electronic circuit closing tube fired by said relay, a second branch circuit in parallel with said first branch circuit appearing in said line finder for marking said line as calling in said line finder, and means responsive to the extension of said second branch circuit by said line finder for quenching said tube for opening said first branch circuit.

2. In a communication system, a plurality of subscribers' lines, each said line having a relay connected thereto responsive to switchhook and dial operation on said line, a line finder, a sender accessible to said lines via said line finder, a first branch circuit responsive to said relay for starting said line finder, a second branch circuit in parallel with said first branch circuit appearing in said line finder for marking said line as calling in said line finder, means responsive to the extension of said second branch circuit by said line finder to said sender for rendering said first branch circuit ineffective, and means in said sender responsive to said relay via said extended second branch circuit.

3. In a communication system, a plurality of subscribers' lines, each said line having a relay connected thereto responsive to switchhook and dial operation on said line, a line finder, a sender accessible to said lines via said line finder, a first branch circuit responsive to said relay for start-

ing said line finder, a second branch circuit in parallel with said first branch circuit appearing in said line finder for marking said line as calling in said line finder, means responsive to the extension of said second branch circuit by said line finder to said sender for rendering said first branch circuit ineffective, means in said sender responsive to said relay via said extended second branch circuit, and means controlled by said sender for cutting off said relay.

4. In a communication system, a plurality of subscribers' lines, each said line having a relay connected thereto responsive to switchhook and dial operation on said line, each said line constituting a communication channel, a signaling path for each said line controlled by said relay, a line finder, a sender accessible to said signaling paths via said line finder, a first branch circuit of said signaling path responsive to said relay for starting said line finder, a second branch circuit of said signaling path in parallel with said first branch circuit appearing in said line finder for marking said line as calling in said line finder, means responsive to the extension of said second branch circuit by said line finder to said sender for rendering said first branch circuit ineffective, means in said sender responsive to said relay via said extended second branch circuit, switching means controlled by said sender for extending said communication channel, and means controlled by said sender for cutting off said relay.

5. In a communication system, a plurality of subscribers' lines, each said line having a relay connected thereto responsive to switchhook and dial operation on said line, each said line constituting a two-conductor communication channel, a single conductor signaling path for each said line controlled by said relay, a line finder, a sender accessible to said signaling paths via said line finder, a first branch circuit of said signaling path responsive to said relay for starting said line finder, a second branch circuit of said signaling path in parallel with said first branch circuit appearing in said line finder for marking said line as calling in said line finder, means responsive to the extension of said second branch circuit by said line finder to said sender for rendering said first branch circuit ineffective, means in said sender responsive to said relay via said extended second branch circuit, switching means controlled by said sender for extending said communication channel, and means controlled by said sender for cutting off said relay.

6. In a communication system, a plurality of subscribers' lines, each said line having a relay connected thereto responsive to switchhook and dial operation on said line, each said line constituting a two-conductor communication channel, a single conductor signaling path for each said line controlled by said relay, a line finder comprising a step-by-step switch having a plurality of brushes and a like plurality of contacts for each selective position of said brushes, a second branch circuit for a different line being connected to each of said contacts whereby said line finder has a capacity equal to the number of brushes times the number of selective positions thereof, a sender accessible to said signaling paths via said line finder, a first branch circuit of said signaling path responsive to said relay for starting said line finder, said second branch circuit of said signaling path in parallel with said first branch circuit appearing in said line finder for marking said line as calling in said line finder, means responsive to the extension of said second

branch circuit by said line finder to said sender for rendering said first branch circuit ineffective, means in said sender responsive to said relay via said extended second branch circuit, switching means controlled by said sender for extending said communication channel, and means controlled by said sender for cutting off said relay.

7. In a communication system, a plurality of subscribers' lines, each said line having a relay connected thereto responsive to switchhook and dial operation on said line, each said line constituting a two-conductor communication channel, a single conductor signaling path for each said line controlled by said relay, a line finder comprising a step-by-step switch having a plurality of brushes and a like plurality of contacts for each selective position of said brushes, a second branch circuit for a different line being connected to each of said contacts whereby said line finder has a capacity equal to the number of brushes times the number of selective positions thereof, means for simultaneously testing said second branch circuits temporarily connected to said brushes in each selective position thereof to determine which one, if any, of said second branch circuits is in a calling condition, a sender accessible to said signaling paths via said line finder, a first branch circuit of said signaling path responsive to said relay for starting said line finder, said second branch circuit of said signaling path in parallel with said first branch circuit appearing in said line finder for marking said line as calling in said line finder, means responsive to the extension of said second branch circuit by said line finder to said sender for rendering said first branch circuit ineffective, means in said sender responsive to said relay via said extended second branch circuit, switching means controlled by said sender for extending said communication channel, and means controlled by said sender for cutting off said relay.

8. In a communication system, a plurality of subscribers' lines, each said line having a relay connected thereto responsive to switchhook and dial operation on said line, each said line constituting a two-conductor communication channel, a crossbar switch for extending said communication channel, a hold magnet of said crossbar switch individual to said line, said hold magnet having contacts to cut off said line relay, a single conductor signaling path for each said line controlled by said relay, a line finder, said single conductor signaling path appearing in and extensible by said line finder, a sender operable by a said single conductor signaling path extended by said line finder, said sender controlling said crossbar switch to extend said communication channel.

9. In a communication system, a plurality of subscribers' lines, each said line having a relay connected thereto responsive to switchhook and dial operation on said line, each said line constituting a two-conductor communication channel, a plurality of crossbar switches for extending said communication channel serially through a multistage connection, said communication channel appearing permanently in one of said crossbar switches and having a hold magnet of said switch individual thereto, said hold magnet acting as a cut-off relay for said line relay, a single conductor signaling path for each said line controlled by said line relay, a line finder, said single conductor signaling path appearing in and extensible by said line finder, a sender operable by a said single conductor signaling path extended

by said line finder, said sender controlling said plurality of crossbar switches.

10. In a communication system, a plurality of subscribers' lines, each said line having a relay individual thereto responsive to switchhook and dial operation on said line, a plurality of switches for extending said line serially through a multistage connection, said line relay responding to dial operation on said line and controlling a plurality of said switches to establish a complete multistage connection.

11. In a communication system, a plurality of subscribers' lines, each said line having a relay individual thereto responsive to switchhook and dial operation on said line, a plurality of switches for extending said line serially through a multistage connection, said line relay responding to dial operation on said line and controlling a plurality of said switches to establish a complete multistage connection, and an operating magnet in one of said switches arranged as a cut-off relay for said line relay.

12. In a communication system, a plurality of subscribers' lines, a line circuit for each said line comprising terminals in a switch for extending said line, a magnet of said switch individual to said line, a line relay individual to said line connected to said line through cut-off contacts controlled by said magnet, a signaling path completed by said line relay, a line finder for extending said signaling path, a first branch circuit of said signaling path leading to a start circuit for said line finder, a second branch circuit of said signaling path appearing in and extensible by said line finder, a third branch circuit of said signaling path appearing in said switch and under control of said magnet, a fourth branch circuit of said signaling path leading to said magnet, said third branch circuit serving as a means to hold said magnet energized during the maintenance of a connection through said switch, and a fifth branch circuit of said signaling path leading to means for testing the busy or idle condition of said line and for originally energizing said magnet.

13. In a communication system, a plurality of subscribers' lines, a line circuit for each said line comprising terminals in a switch for extending said line, a magnet of said switch individual to said line, a line relay individual to said line having a primary and a secondary winding, said pri-

mary winding connected to said line through cut-off contacts controlled by said magnet, a signaling path completed by said line relay and including the said secondary winding thereof, a line finder for extending said signaling path, a pulse responsive device accessible to said signaling path via said line finder, a source of signal tone associated with said pulse responsive device for transmission over said line through the coupling of said primary and secondary windings of said line relay, a first branch circuit of said signaling path leading to a start circuit for said line finder, a second branch circuit of said signaling path appearing in and extensible to said pulse responsive device by said line finder, a third branch circuit of said signaling path appearing in said switch and under control of said magnet, a fourth branch circuit of said signaling path leading to said magnet, said third branch circuit serving as a means to hold said magnet energized during the maintenance of and extension of said line through said switch, and a fifth branch circuit of said signaling path leading to means for testing the busy or idle condition of said line and for originally energizing said magnet.

14. In a communication system, a plurality of subscribers' lines, a line circuit for each line comprising terminals in a switch for extending said line, a magnet of said switch individual to said line, a line relay individual to said line connected to said line through cut-off contacts controlled by said magnet, said line relay having a single pair of circuit closing contacts, a first circuit connected to a first of said circuit closing contacts comprising a line finder start circuit, a line finder, a second circuit connected to said first of said circuit closing contacts comprising a circuit appearance in the bank of said line finder, a third circuit connected to the second of said circuit closing contacts comprising a supervisory path connected to one of said terminals in said switch for extending said line, a fourth circuit connected to said second of said circuit closing contacts comprising a connection to the winding of said switch magnet individual to said line and a fifth circuit connected to said second of said circuit closing contacts comprising a signaling path leading to means for testing the busy or idle condition of said line.

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