Aug. 10, 1943. N. I. HALL 2,326,458

SELECTION SYSTEM

Filed Feb. 17, 1942 3 Sheets-Sheet 1

FIG. 1

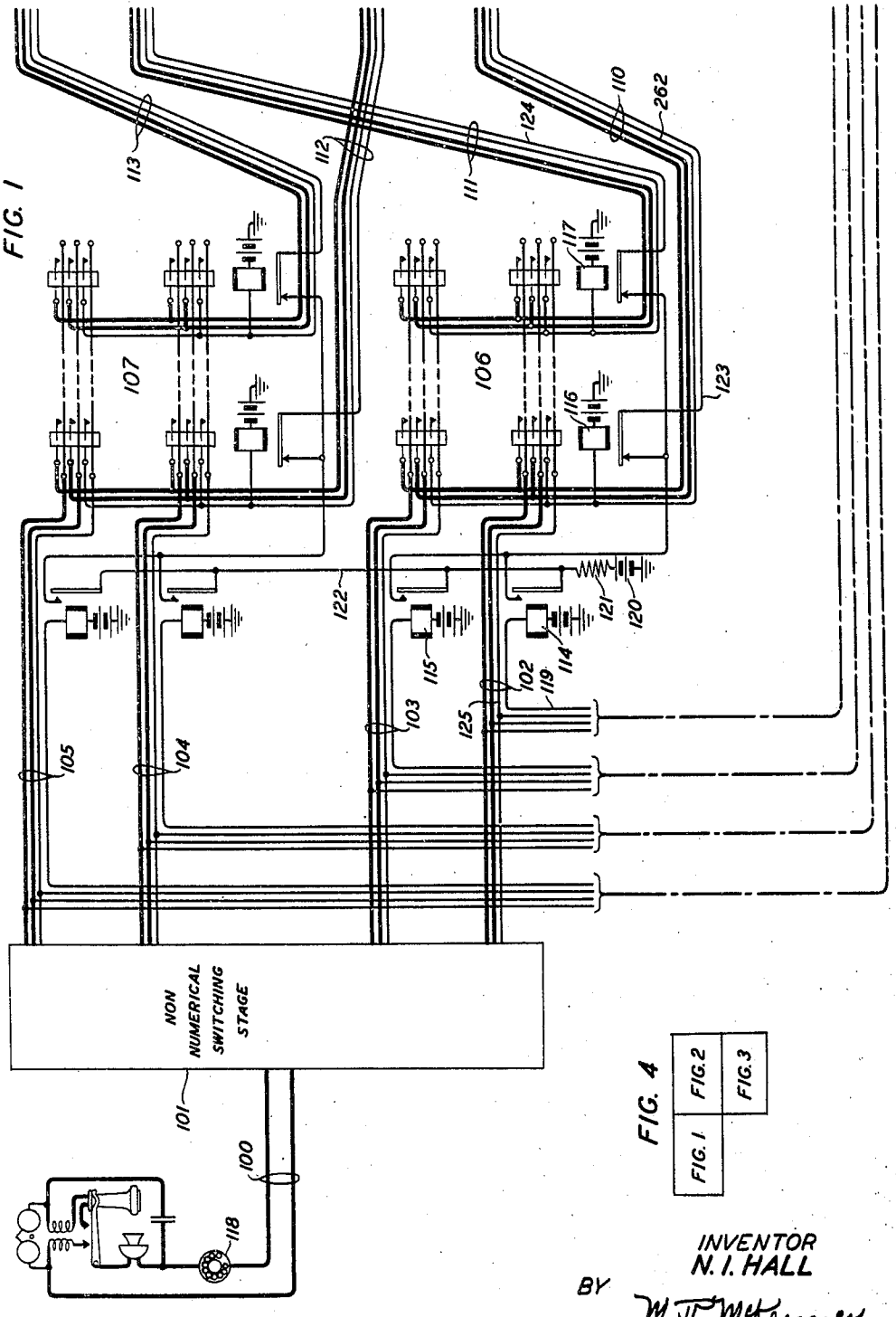

FIG. 4

FIG. 1	FIG. 2
	FIG. 3

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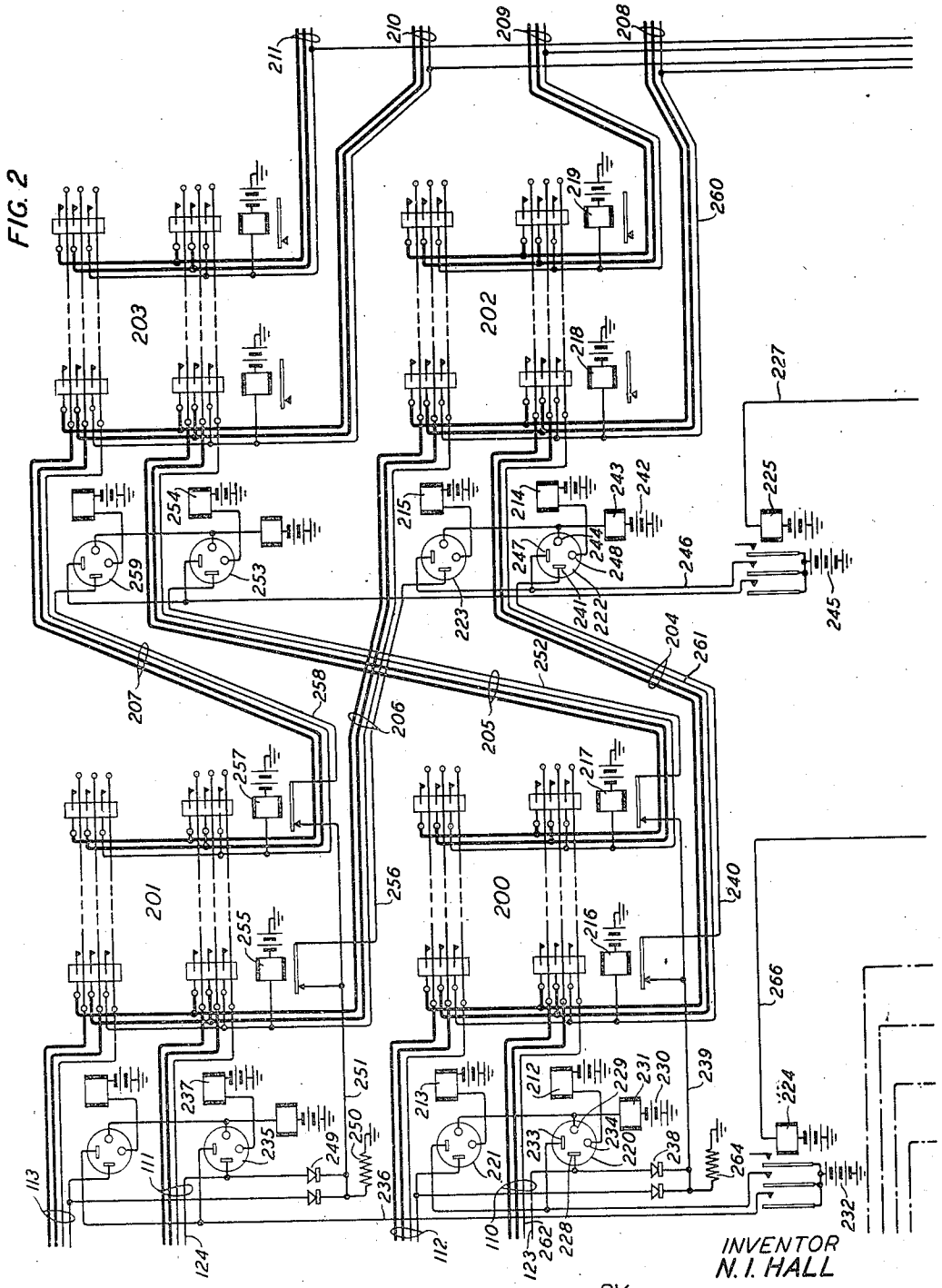
FIG. 2



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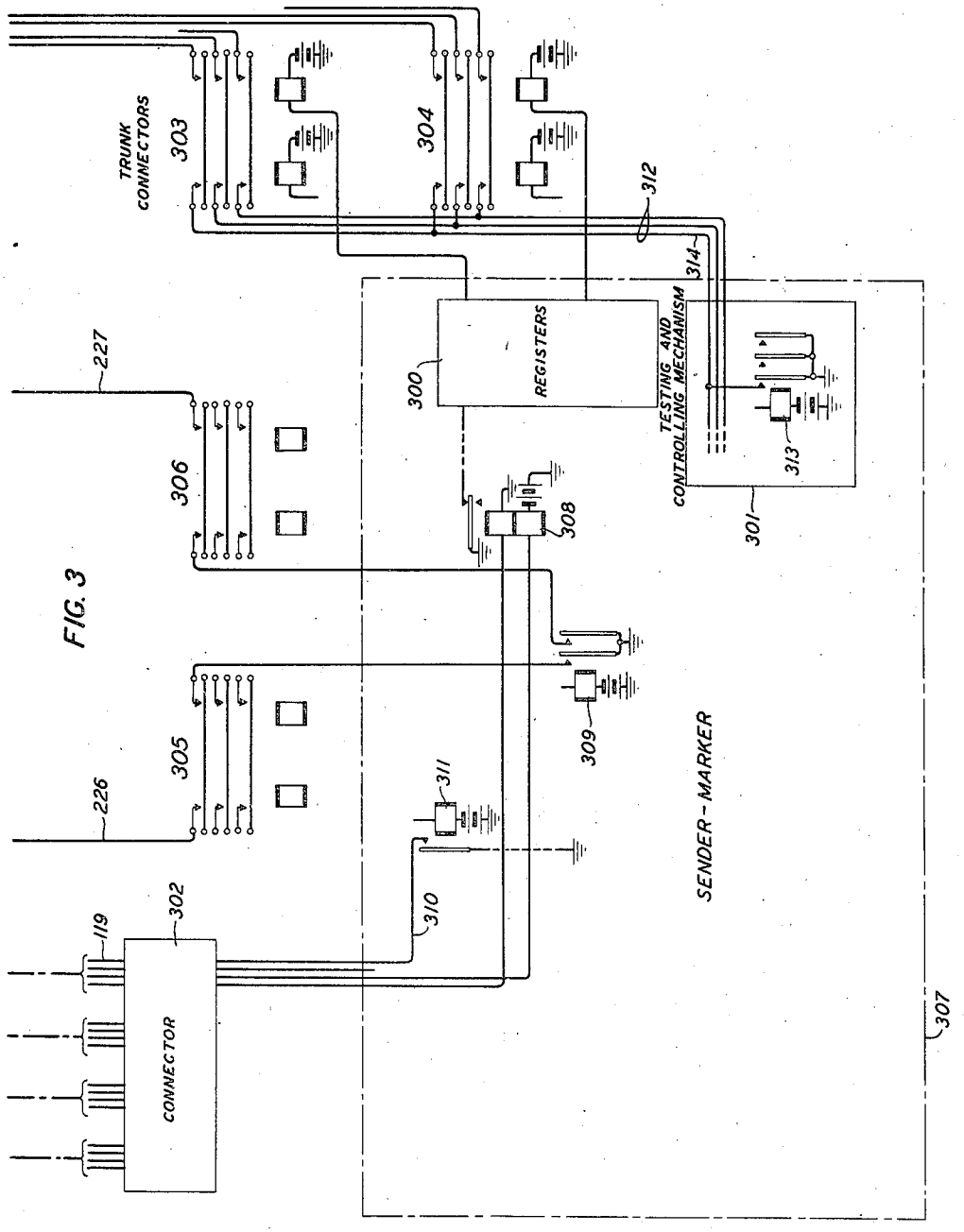

FIG. 3

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UNITED STATES PATENT OFFICE

2,326,458

SELECTION SYSTEM

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Application February 17, 1942, Serial No. 431,235

6 Claims. (Cl. 179—18)

This invention relates to selection systems and particularly to systems of this character when used for the purpose of establishing telephone or other communication connections.

The objects of the invention are to minimize as much as possible the common controlling equipment used in the establishment of connections through selective switching stages; to invest the switching stages with the faculty of performing their own testing, selecting, and switch-operating functions; to simplify the controlling and switch-operating equipment; and in other respects to realize improvements and advantages in systems of this general character.

It has been the practice heretofore in automatic telephone switching systems and particularly in those employing stages of crossbar switches for establishing connections to provide common senders and markers for performing the numerous controlling and operating functions involved in the establishment of a telephone connection through the switching stages. Usually the marker, which is common to one or more stages of crossbar switches, receives the designation information from the sender, associates itself through frame connectors with the desired frames of crossbar switches, tests the various serially related links extending through these switches, and then, having found an idle channel, proceeds to operate the magnets of the switches to extend the incoming circuit over the idle channel through the switching stages to the desired outgoing circuit.

According to the foregoing objects of the present invention advantages are realized over these prior switching systems by means of a new and improved system in which the testing and switch-operating functions are removed from the common controlling markers and are vested in the switches themselves. More specifically the presence of a call on a particular trunk incoming to and appearing in a particular one of a plurality of originating crossbar switches at the switching stage causes an automatic testing operation to proceed through the successive switches of the stage to determine all of the idle channels extending from said particular originating switch over links through the following intermediate switches and thence over links to all of the terminating switches of the stage. As the test progresses the select magnets of the originating, intermediate, and terminating switches are operated corresponding to all idle channels that might be used in the extension of the incoming trunk to any outgoing trunk appearing in any of the terminating switches, thus preparing all of these channels for seizure. Thereafter a desired outgoing trunk is chosen by a simplified marker, which seizes it in accordance with the digits of the received designation, and an electrical condition is placed upon said outgoing trunk. This condition causes a selective operation to proceed through the stage in the opposite direction for the purpose of energizing the hold magnets of the successive switches to seize the particular idle channel which extends between the seized outgoing trunk and the incoming trunk on which the call appears. The operation of these hold magnets completes the connection through the switching stage, and all of the other prepared switches are restored to their normal condition.

The foregoing and other features of the invention will be discussed more fully in the following detailed specification.

In the drawings accompanying the specifications, Figs. 1, 2 and 3, when arranged as illustrated in Fig. 4, disclose a portion of an automatic telephone system incorporating the features of this invention.

Fig. 1 shows a non-numerical switching stage for extending subscribers' lines over trunks to the originating switches of a selective switching stage. Two of these originating switches are disclosed in this figure.

Fig. 2 shows two of the intermediate switches and two of the final switches of the selective switching stage together with a number of outgoing trunks; and

Fig. 3 discloses (in diagrammatic manner) a sender-marker for controlling the switches of said selective stage.

While the invention is not necessarily limited to selective systems in which any specific type of switch is used for performing the switching operations, it is particularly useful in such systems when switches of the crossbar type are employed. For a better understanding of the construction and operation of crossbar switches and of the various circuits and mechanisms used in controlling them in the establishment of telephone connections, reference may be had to the patent to Reynolds 2,021,329 of November 19, 1935, and to the patents to Carpenter 2,093,117 of September 14, 1937, and 2,235,803 of March 18, 1941.

Referring to the drawings, the incoming trunks, such as trunks 102, 103, 104, 105, appear in and are distributed among a plurality of first or originating crossbar switches in the selective switching stage. These trunks may come from

any destination. For convenience, they are illustrated as coming from a non-numerical switching stage 101 through which calls are extended to them automatically from subscribers' lines, such as the line 103. The number of switches on the frame comprising the selective switching stage may be chosen arbitrarily depending upon the particular conditions existing. It is, however, convenient to assume that there are ten of these originating switches 106, 107, etc., in which the incoming trunks appear. Trunks 102 and 103 appear in the switch 106, and trunks 104 and 105 in the switch 107, and it will be noted that each trunk appears in only one of the originating switches. In addition to the originating or first switches on the frame of the switching stage, there are a plurality of intermediate switches and a plurality of final or terminating switches. If it is assumed that there are ten originating switches, it is also convenient to assume that there are likewise ten intermediate switches 200 and 201, etc., and similarly ten terminating switches 202, 203, etc.

The switches of the stage are interconnected with link circuits which are connectable in serial relation to form channels extending through the stage from the incoming trunks on the one side to the outgoing trunks on the other side. These links are so distributed that it is possible to form a channel between any trunk incoming to any originating switch and any trunk outgoing from any terminating switch. For example, the originating switch 106 has ten link circuits distributed respectively among the ten intermediate switches 200, 201. As illustrated the link 110 extends from the originating switch 106 to the intermediate switch 200, and the link 111 extends from originating switch 106 to the intermediate switch 201. Similarly links 112 and 113 extend between switch 107 and switches 200 and 201, respectively. In like manner switches 106 and 107 are provided with eight other links extending respectively to the eight other intermediate switches, and a similar distribution is true of the links extending from the eight other originating switches (not shown) to the ten intermediate switches. In the same manner the ten intermediate switches 200, 201, etc., are connected to the terminating switches by link circuits, each intermediate switch having a link circuit extending to each of the terminating switches 202, 203, etc. As illustrated, the links 204 and 205 interconnect the intermediate switch 200 and the terminating switches 202 and 203, respectively, and the links 206 and 207 interconnecting the intermediate switch 201 and the terminating switches 202 and 203, respectively. The outgoing trunks 208, 209, 210 and 211 are distributed among the terminating switches, each trunk appearing in a single switch and being accessible to the ten links incoming to such switch.

The crossbar switches are provided with select magnets each of which is individual to an incoming circuit and serves when energized to prepare the switch for subsequently connecting the incoming circuit to any one of the outgoing circuits. For example, the originating switch 106 is provided with select magnets 114 and 115, which are individual respectively to the incoming trunks 102 and 103 and serve to prepare the switch for extending these trunks over any of the outgoing links. The intermediate switch 200 is provided with select magnets 212 and 213 which are individual respectively to the incoming links 110 and 112. Likewise the terminating switch 202 is provided with select magnets 214 and 215 which are individual respectively to the incoming links 204 and 206. The switches are also provided with hold magnets, one for each of the outgoing circuits. When one of these hold magnets is operated following the previous energization of a select magnet, the full operation of the switch takes place, and the incoming circuit represented by the energized select magnet is connected to the outgoing circuit individual to the energized hold magnet. Thereafter the select magnet may be deenergized, the connection being held by the continued energization of the hold magnet. In the switch 106 the hold magnets 116 and 117 are individual respectively to the outgoing links 110 and 111; in the switch 200 the hold magnets 216 and 217 are individual respectively to the outgoing links 204 and 205; and in the terminating switch 202 the hold magnets 218 and 219 are individual respectively to the outgoing trunks 208 and 209.

In addition to the select magnets, the intermediate and final switches are provided with space-discharge tubes, there being one of these tubes for each select magnet. For example, tubes 220 and 221 are individual respectively to the select magnets 212 and 213, and tubes 222 and 223 are individual respectively to the select magnets 214 and 215. The purpose of these tubes is to enable the simultaneous preparation of all the switches in the stage so that a connection may subsequently be completed from any incoming trunk through an idle channel to any desired outgoing trunk. This preparation is made by energizing all of the select magnets representing links in idle channels. Since, however, there may be two or more channels extending through the same switch in the desired direction or directions, it is essential to prevent the operation of more than one select magnet at a time. The energization of a single select magnet is accomplished by the discharge tubes, which are so arranged in a common circuit that the discharge of one of them creates a blocking potential which prevents all others from discharging. Thus, the successfully operated tube brings about the energization of the associated select magnet to prepare the switch for that particular channel while the other channels through the same switch remain disabled.

The testing and switch preparing operation is initiated at the calling incoming trunk appearing in a particular one of the originating switches by applying an electrical condition to the calling trunk. This condition causes a test potential to be projected simultaneously over all links outgoing from the said particular originating switch to all of the ten intermediate switches in which these links appear, causing the operation of the corresponding select tubes and magnets. At each of the intermediate switches the test potential is further projected over all idle links outgoing from such intermediate switch to the corresponding terminating switches, causing the operation of the associated select tubes and magnets. Thus all channels in the whole switching stage which extend from the particular originating switch containing the calling incoming trunk and which are idle at the time the test is made are placed in readiness for use by the energization of the corresponding select magnets. Thereafter the completion of the switch operation is initiated by placing an electrical condition on a desired one of the outgoing trunks 208, 209, 210, etc. In response to an applied potential on the chosen outgoing

trunk the hold magnets in the terminating, intermediate, and originating switches, corresponding to a prepared idle channel extending between the calling originating trunk and the chosen outgoing trunk, are operated successively to cause the seizure of this channel and the completion of the connection between the trunks.

The selection of a desired outgoing trunk group and the testing of the group for an idle one is performed by a common sender-marker mechanism which is associated with the switching stage and is taken in use whenever a call is extended through the stage. Since the greater part of the testing and selecting operation is accomplished in the stage itself, much of the equipment heretofore required in the senders and markers may be omitted. One of these simplified sender-markers is illustrated in Fig. 3 of the drawings and consists of a register mechanism 300 for receiving the digits transmitted from the calling subscriber and a testing mechanism 301 for testing the chosen group of outgoing trunks to locate an idle one. Since the sender-marker is common to all of the trunks incoming to the switching stage a connector 302 is provided for connecting the calling trunk to the sender-marker and excluding other trunks until the connected one has been served. Also trunk connectors 303, 304, etc., are provided for connecting the test and control leads from the sender-marker to the desired group of outgoing trunks. Furthermore, the sender-marker has access to the switching stage by way of connectors 305 and 306 to perform certain controlling operations.

The outgoing trunks may be arranged in any suitable manner, singly or in groups. For example, it will be assumed in the present discussion that trunks 208 and 210 are two trunks of a group represented by a given designation. This group may, of course, contain other trunks as well as the two shown. Similarly the trunks 209 and 211 belong to another trunk group.

A detailed description of the operation will now be given. For this purpose assume that the subscriber of line 100 wishes to set up a telephone connection over the route represented by the trunk group 208, 210. The initiation of the call causes the operation of the non-numerical switching stage 101 to extend the subscriber's line over an idle incoming trunk, such as the trunk 102, to the directive switching stage. The selection of the incoming trunk 102 also results in the operation of the connector switch 302 to associate the trunk with the sender-marker 307.

The subscriber's line 100 is now extended to the impulse relay 308 in the sender-marker, and the subscriber proceeds to operate his dial 118 to transmit the digits representing the designation of the desired trunk group 208, 210. The digit impulses are received by the relay 308, which in turn causes the setting of the registers 300. The number of registers involved will usually be governed by the number of out-trunk groups from which selection must be made and this, of course, is a matter of choice.

At some suitable time following the seizure of the sender-marker 307, the connectors 305 and 306 are operated to cause the operation of the battery supply relays 224 and 225 associated with the switching stage. The circuit for relay 224 may be traced from battery through the winding of the relay, conductor 226 through the contacts of connector 305 to ground at the contact of the relay 309 in the marker, which has been operated at this time. Similarly, the circuit for relay 225 may be traced from battery through the winding of said relay, conductor 227, contacts of connector 306 to ground at the contact of relay 309.

Also at any suitable time following the seizure of the sender-marker 307, an electrical condition is placed upon the calling incoming trunk 102 for the purpose of initiating the testing operation in the switching stage. To this end the sender-marker operates the select magnet 114 individual to the incoming trunk 102 in a circuit traceable from battery through the winding of said magnet, conductor 119 through the connector 302, conductor 310 through the contacts of operated relay 311 to ground. Magnet 114 prepares the switch for connecting the incoming trunk 102 to any one of the ten outgoing links 110, 111. Magnet 114 also closes a circuit for impressing a potential upon the control conductors of all idle links in the group 110, 111. If these links are idle they are so identified by the deenergized condition of their holding magnets 116, 117, whereas busy links have their hold magnets energized.

Assume that at the time the test is made both of the links 110 and 111 are idle. Since link 110 is idle, a test circuit is closed from the positive pole of battery 120, resistor 121, conductor 122, contacts of magnet 114, back contacts of hold magnet 116, control conductor 123 of the link 110 to the starting anode 228 of the discharge tube 220. The positive potential thus impressed upon the anode 228, when added to the negative potential of battery 230 normally impressed upon the starting cathode 229, is sufficient to ionize the control gap of the tube. The negative pole of battery 230 is connected to the starting cathodes of all ten tubes 220, 221, etc. through an inductance element 231. If, therefore, positive potential is applied over corresponding links to the starting anodes of two or more of these tubes at the same time, the first tube to start the ionization of its control gap causes an induced voltage in the element 231 which is applied to the starting cathodes of all tubes to prevent the ionization of the starting gap of a second tube. In this way a single tube succeeds in completing the ionization of its control gap, and the remaining tubes are locked out. If, as assumed, the tube 220 succeeds in ionizing its control gap, the main gap also discharges, and a circuit is traceable from the positive pole of battery 232, contacts of relay 224, main anode 233, main cathode 234, winding of select magnet 212 to the negative pole of battery. The magnet 212 operates in this circuit and prepares the incoming link 110 for connection to any idle one of the ten outgoing links 204, 205.

Link 111 also being idle at this time, a circuit is closed from battery 120 over conductor 122, contacts of select magnet 114, back contacts of magnet 117, conductor 124 to the starting anode of tube 235. Tube 235 operates in the manner described, and a circuit is closed from positive pole of battery 232, contacts of relay 224, conductor 236, main anode and cathode of tube 235 through the winding of select magnet 237 to battery. Magnet 237 operates and prepares the switch 201 for connecting the incoming link 111 to any idle one of the ten outgoing links 206, 207.

The test circuits thus extended from the calling incoming trunk 102 over idle links to corresponding ones of the intermediate switches 200, 201 are also further extended over idle links to the terminating switches 202, 203. For example,

the positive potential applied by the battery 120 to the control conductor 123 of link 110 causes current to flow over conductor 122 through the contacts of magnet 114, normal contacts of magnet 116, conductor 123 through the unidirectional element 238, resistor 264 to ground. Current flowing in the resistor 264 applies a corresponding potential over conductor 239, back contacts of hold magne 216, assuming the link 204 to be idle, conductor 240 thence to the starting anode 241 of the tube 222. This potential, when added to the negative potential of battery 242, which is applied through the common inductance 243 to the starting cathode 244, is sufficient to ionize the control gap comprising anode 241 and cathode 244. The inductance 243 serves as explained to prevent more than one tube from completing the ionization of its control gap. When tube 222 ionizes its control gap, a circuit is completed for the flow of current from the positive pole of battery 245, contacts of relay 225, conductor 246, main anode 247, main cathode 248 through the winding of select magnet 214 to the negative pole of battery. Magnet 214 energizes and prepares the terminating switch 202 for connecting the incoming link 204 to any one of the ten trunks 208, 209, outgoing from said terminating switch. If at the same time the link 205 is idle, the potential impressed upon conductor 239 is applied through the back contacts of magnet 217 over conductor 252 to operate the tube 253 at the terminating switch 203. Tube 253 causes the operation of select magnet 254 in an obvious circuit, and the switch 203 is prepared to connect the links 205 to any one of the idle outgoing trunks 210, 211. Also the positive potential applied over conductor 122 and over conductor 124 causes current to flow through the unidirectional element 249 and resistor 250 to ground. Consequently a positive potential is applied to the conductor 251 which is extended through the back contacts of the hold magnets of all idle links to the corresponding terminating switches. If, for example, link 206 is idle, this potential is applied through the normal contacts of hold magnet 255, conductor 256 to the starting anode of the tube 223. Similarly if link 207 is idle, the potential is applied through the normal contacts of hold magnet 257, conductor 258 to the starting anode of tube 259. And the same is true of all other idle links in the switch 201. Thus a positive potential may be applied to the starting anodes of a plurality of tubes in each of the final switches. As above explained, however, only one tube in each switch is permitted to ionize, so that only one select magnet can be energized. This precaution provides against the possibility of extending a connection to a single outgoing trunk over two or more link channels. It was assumed that the tube 222 of switch 202 succeeded in ionizing, and it may also be assumed that tube 253 is the successful one in the switch 203. Therefore, the select magnets 214 and 254 of switches 202 and 203 are energized to prepare for the selection of trunks outgoing from these switches. Similarly there may be one select magnet energized in each of a number of the remaining eight terminating switches to prepare the switches for the selection of the corresponding outgoing trunks.

Thus the testing operation has been completed in the switching stage, and the switches have been prepared by the energization of their select magnets so that it is possible by the subsequent operation of the proper hold magnets to establish a connection over any idle channel, if one exists, between the incoming switch 106 and any one of the ten terminating switches 202, 203.

Following the registration of the designation digits on the registers 300, the trunk connector 303 is operated to extend the test conductors 312 from the sender-marker to the test conductors of the respective trunks of the groups 208, 210. These trunks are tested, and an idle one is chosen, which may be assumed to be the trunk 208. The trunk 208 having been chosen and the testing operation having been completed in the switching stage, a circuit is completed for placing an electrical condition on the chosen trunk 208 and for operating the hold magnet thereof. This circuit may be traced from ground through the contacts of relay 313, conductor 314 through the contacts of connector 303, test conductor 260 through the winding of hold magnet 218 to battery. Magnet 218 operates and causes the closure of the cross-point contacts to connect the link circuit 204 to the chosen outgoing trunk 208. This results in the extension of the ground potential on conductor 260 through the cross-point contacts of the switch 202 thence over conductor 261 through the winding of the hold magnet 216 to battery. Magnet 216 operates and closes the cross-point contacts to connect the link circuit 110 to the link circuit 204, and the ground potential on conductor 261 is extended through the contacts of the switch 209 over conductor 262 through the winding of the hold magnet 116 to battery. Magnet 116 operates and closes the cross-point contacts of the switch 106 to connect the incoming trunk 102 to the link 110. Also the ground potential on conductor 262 is extended through the cross-point contacts of the switch 106 to the test conductor 125. In the well-known manner a ground potential is applied to the conductor 125 from the control circuits of the trunk 102, and this potential is extended forward through the successive switches to maintain the hold magnets 116, 216 and 218 in their energized condition independently of the sender-marker.

The connection has now been extended from the incoming trunk 102 to the outgoing trunk 208, and the sender-marker may be released by releasing the connectors 302, 305 and 306 and the trunk connector 303. When relays 311 and 309 are released in the sender-marker, the select magnet 114 and relays 224 and 225 deenergize. Magnet 114 disconnects the battery 120 from all idle links. The release of relay 224 opens the circuits of select magnets 212, 237 and all other intermediate switch select magnets that may have been operated in the preparation of the idle channels. Similarly the release of relay 225 opens the circuits of select magnets 214 and 254 and all other operated select magnets in the final switches. The connection through the switching stage is now held solely by the hold magnets of the switches 106, 200 and 202, and all other switches and magnets are restored to their normal condition ready for subsequent use.

At the end of the conversation the connection is released in any well-known manner by the removal of the ground potential on the conductor 125. This results in the deenergization of magnets 116, 216 and 218 and the restoration of the switches to their normal condition.

The discharge tubes disclosed herein may be of any well-known type, such as those having gas-filled envelopes and cold cathodes. A tube of the type having a separate control or starting gap formed by a starting anode and a starting

cathode is disclosed in the patent to Holden, No 2,273,958 of Feb. 24, 1942.

What is claimed is:

1. In combination, a switching stage comprising a plurality of originating, intermediate, and terminating switches, incoming trunks distributed among said originating switches, outgoing trunks distributed among said terminating switches, links extending from each originating switch to each intermediate switch, links extending from each intermediate switch to each terminating switch, said switches when operated serving to connect the incoming trunks to the outgoing trunks over channels comprising serially related links, means for seizing any incoming trunk appearing in any particular one of said originating switches, means for testing all channels extending from said particular originating switch through said intermediate switches to said terminating switches and for preparing said switches for operation to seize all channels found to be idle, means for seizing a desired one of said outgoing trunks, and means for operating the prepared switches corresponding to an idle channel extending between the seized incoming and outgoing trunks to establish a connection between said trunks over said idle channel.

2. In combination, a switching stage comprising a plurality of originating, intermediate and terminating switches, incoming lines distributed among said originating switches, outgoing lines distributed among said terminating switches, links, some of which interconnect each originating switch and each intermediate switch and others of which interconnect each intermediate switch and each terminating switch, said switches being operable to connect the incoming lines to the outgoing lines over channels comprising serially related links, means for seizing any incoming line appearing in any particular one of said originating switches, means for placing an electrical condition on the seized incoming line, means responsive to said electrical condition for automatically testing the links of all channels extending from said particular orginating switch through said intermediate switches to said terminating switches and for preparing for operation the switches corresponding to all channels found to be idle, means for seizing any particular one of said outgoing lines, and means for operating the prepared switches corresponding to an idle channel extending between the seized incoming line and said outgoing line to establish a connection between such lines over said idle channel.

3. In combination, a switching stage comprising a plurality of originating, intermediate, and terminating switches, incoming trunks distributed among said originating switches, outgoing trunks distributed among said terminating switches, links extending from said originating switch to each intermediate switch, links extending from each intermediate switch to each terminating switch, said switches when operated serving to connect the incoming trunks to the outgoing trunks over channels comprising serially related links, means for seizing any incoming trunk appearing in any particular one of said originating switches, means for testing all channels extending from said particular originating switch through said intermediate switches to said terminating switches and for preparing said switches for operation to seize all channels found to be idle, means for seizing a desired one of said outgoing trunks, and means for operating in succession the prepared terminating, intermediate and originating switches coresponding to an idle channel extending between the seized incoming and outgoing trunks to establish a connection between said trunks over said idle channel.

4. In combination, a switching stage comprising a plurality of originating, intermediate, and terminating switches, incoming trunks distributed among said originating switches, outgoing trunks distributed among said terminating switches, links extending from each originating switch to each intermediate switch, links extending from each intermediate switch to each terminating switch, said switches when operated serving to connect the incoming trunks to the outgoing trunks over channels comprising serially related links, means for seizing any incoming trunk appearing in any particular one of said originating switches, means for causing a testing operation to progress from said particular originating switch through said intermediate switches to all of said terminating switches for testing all channels extending from said particular originating switch through said intermediate switches to the terminating switches and for preparing said switches for operation to seize all channels found to be idle as a result of said test, means for seizing a particular one of said outgoing trunks, and means for operating the proper switches corresponding to an idle channel extending between the seized incoming trunk and the said particular outgoing trunk to establish a connection between such trunks over said idle channel.

5. In combination, a switching stage comprising a plurality of originating, intermediate and terminating crossbar switches, each having select and hold magnets, incoming lines appearing in and distributed among said originating switches, outgoing lines appearing in and distributed among said terminating switches, links extending from each originating to each intermediate switch, links extending from each intermediate switch to each terminating switch, said switches being operable to connect the incoming lines to the outgoing lines over channels comprising said links in serial relation, means for seizing any incoming line, means for testing the channels extending from the particular originating switch in which the seized incoming line appears through said intermediate switches to said terminating switches and for energizing the select magnets of said switches to prepare said switches for operation to seize all channels found to be in an idle condition, means for seizing a desired one of said outgoing lines, and means for energizing the hold magnets of the prepared switches corresponding to an idle channel extending between the seized incoming and outgoing lines to establish a connection over said idle channel.

6. In combination, a switching stage comprising a plurality of originating, intermediate, and terminating switches, incoming trunks distributed among said originating switches, outgoing trunks distributed among said terminating switches, links extending from each originating switch to each intermediate switch, links extending from each intermediate switch to each terminating switch, said switches when operated serving to connect the incoming trunks to the outgoing trunks over channels comprising serially related links, means for seizing any incoming trunk appearing in any particular one of

said originating switches, means for testing all channels extending from said particular originating switch through said intermediate switches to said terminating switches and for preparing said switches for operation to seize all channels found to be idle, means controlled in accordance with a desired designation for seizing a particular one of said outgoing trunks, and means for operating the prepared switches corresponding to an idle channel extending between the seized incoming and outgoing trunks to establish a telephone connection over said channel.

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