

April 27, 1943.

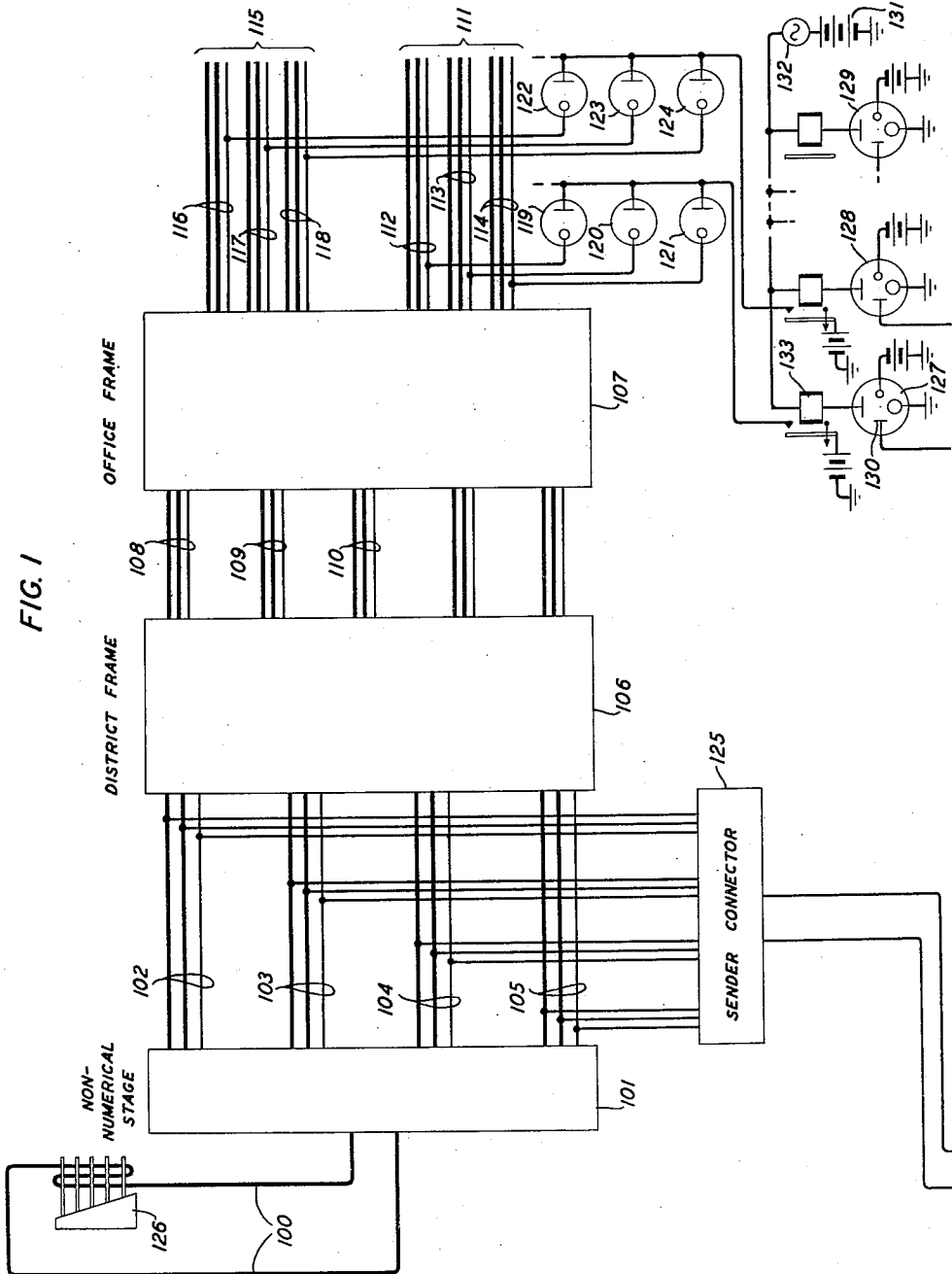
L. A. MEACHAM

2,317,471

SELECTION SYSTEM

Filed Feb. 17, 1942

3 Sheets-Sheet 1



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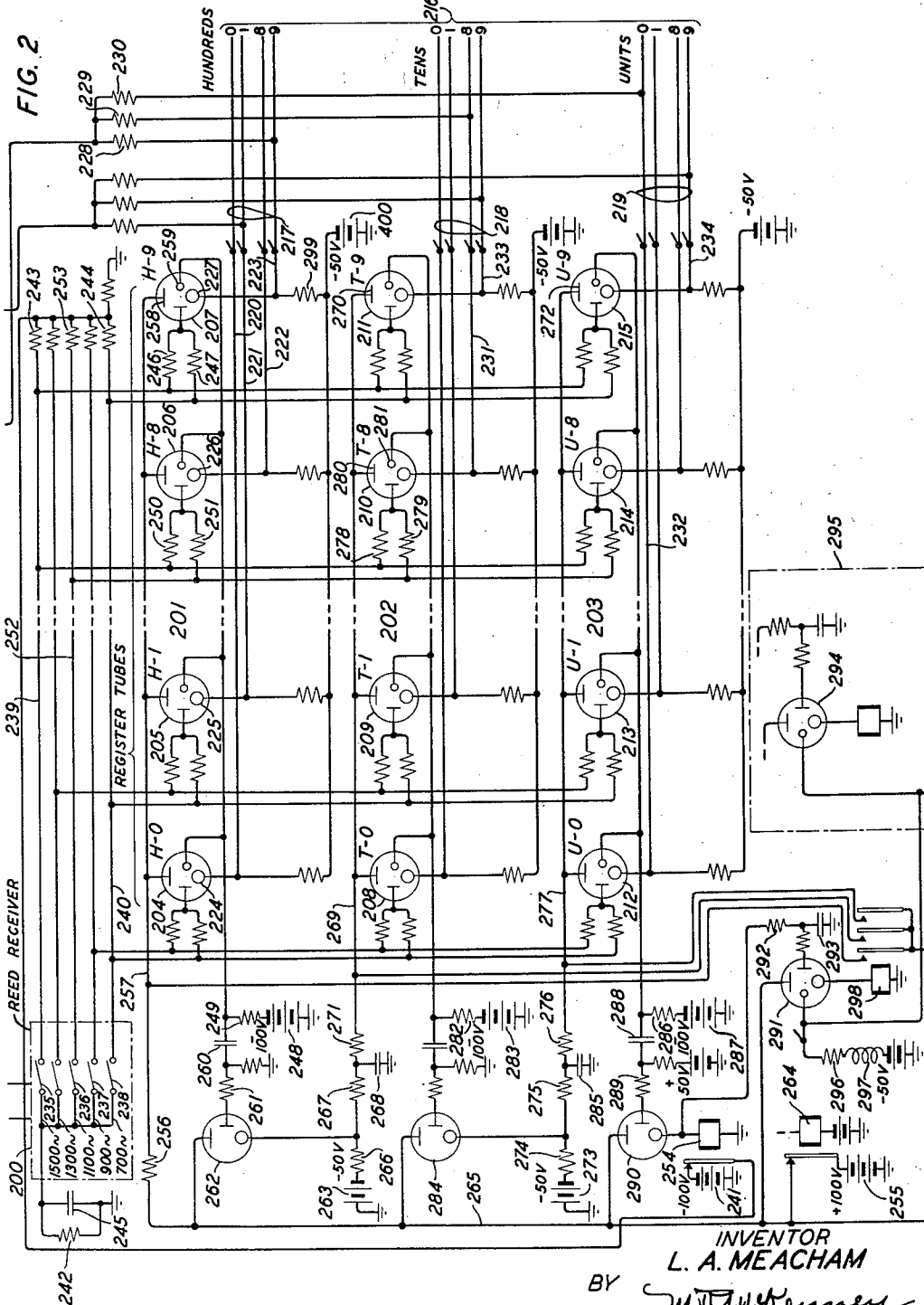
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3 Sheets-Sheet 2



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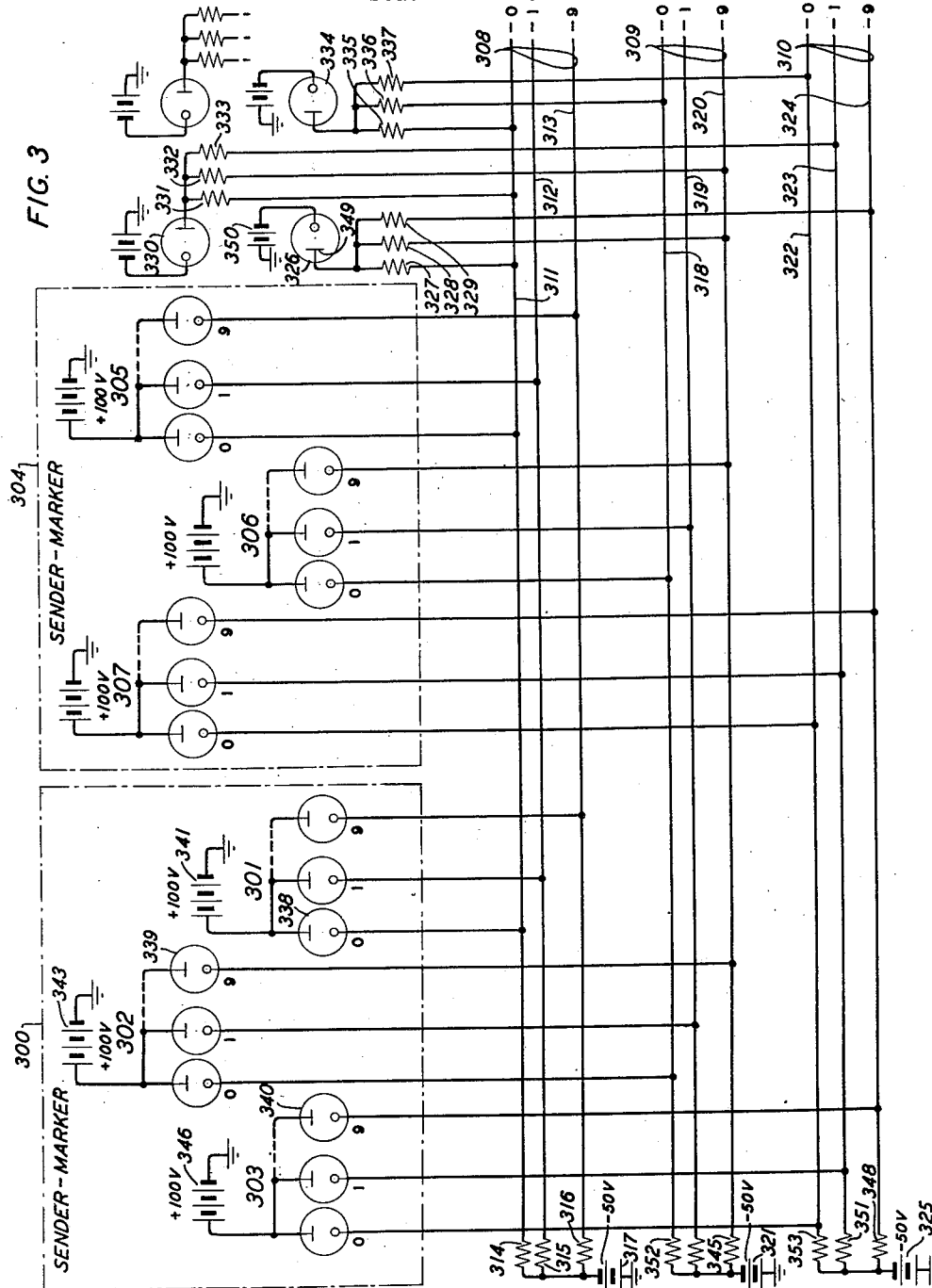
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SELECTION SYSTEM

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,317,471

SELECTION SYSTEM

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Application February 17, 1942, Serial No. 431,237

8 Claims. (Cl. 179—18)

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

The objects are to obtain a simplified and efficient means for making a desired selection from a plurality of circuits, trunks or other equivalent units; to make use of a common group of marking conductors for establishing connection with and for selecting a desired one of equivalent units, such as trunk groups; to effect the selection of a particular group by applying potentials of different incremental values to said marking conductors; to utilize the characteristics of electronic devices for first registering the designation of a desired group of trunks or circuits and then connecting said devices conductively to said marking conductors for the purpose of selecting said group to the exclusion of others; to enable a plurality of designation registers to have access one at a time to said marking conductors; and to effect other improvements in systems of this general character.

The foregoing objects are realized by means of a new and improved system in which groups of trunks, circuits, or other equivalent electrical units are selected for use under the control of designation means by applying voltages in incremental values to responsive devices representing these trunks, circuits, or other units. More specifically, the several trunk groups are provided with individual discharge tubes, and these tubes are operated selectively, to signify the choice of the associated groups, by applying potentials to a plurality of marking conductors which are disposed between the individual trunk group tubes and the designation registers. These marking conductors are arranged in groups of ten, each group representing the ten values of the digit in the corresponding digital place of the trunk designation code. The registers for receiving the designations consist of discharge tubes which are partially ionized in response to the incoming digit impulses to register the successive digits of the designation of the trunk group. Thereafter these partially ionized tubes are fully discharged to apply full operating potential to the marking conductors, one in each group, corresponding to the digits of the desired designation. These marking conductors are connected permanently to the individual trunk tubes through sets of resistors, the resistors of each set being connected to the respective marking conductors which represent the digits of that particular trunk group. When, therefore, marking potential is applied to the

marking conductors, the full value thereof is impressed upon the desired trunk tube through its set of associated resistors. However, the potential on the marking conductors causes current to flow through the resistor sets of all other sets having one or more but less than all of its resistors connected to the marked conductors, the result being that the potential applied to the trunk tubes associated with these other resistor sets is less than the operating value of the tube by increments which depend upon the number of resistors in the set that are connected to marked conductors. Therefore, only the desired tube representing the wanted trunk group is operated, and all others remain in a normal condition.

A feature of the invention is the arrangement whereby the register tubes are first ionized partially for the purpose of registering the designation and are subsequently ionized fully to cause the application of the marking potential to the associated marking conductors to which these register tubes are permanently wired. This method of storing the registration first and then making it effective to apply the marking potentials to the marking conductors improves the efficiency of the system particularly where a plurality of register mechanisms have common access to the marking conductors. Each sender remains effectively disconnected from the marking conductors until it has received its complete designation. Thereupon a common lockout circuit serves to permit the connection of one register mechanism to the marking conductors to the exclusion of all others.

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

In the drawings:

Figs. 1 and 2 taken together disclose a portion of an automatic telephone system incorporating the features of this invention.

Fig. 1 illustrates in diagram a non-numerical switching stage, a numerical switching stage, and outgoing trunks for extending calls from subscribers' lines;

Fig. 2 discloses a register sender-marker common to a number of said stages for controlling the selective operation of the automatic switches; and

Fig. 3 is a diagram illustrating the relation between the sender-markers and the common groups of marking conductors.

While the invention is not 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 subscribers' lines, such as line 100, appear in a stage of non-numerical switches 101 which serve to extend them automatically over trunks or junctors 102, 103, 104, 105 to a selective or numerical switching stage. The junctors 102, 103, etc., also appear in a sender connector switch 125 which serves to extend the calling subscribers' lines to idle sender-markers. The numerical switching stage comprises a district frame 106 and an office frame 107 of crossbar switches interconnected by a plurality of links 108, 109, 110, etc. The office switches 107 have access to a plurality of groups of outgoing trunks each represented by a different designation. Two of these groups are illustrated, group 111 including the trunks 112, 113 and 114, and group 115 including trunks 116, 117 and 118.

The switches of the district and office frames 106 and 107 are first prepared by initiating a testing operation over the calling incoming junctor, such as the junctor 102. Thereafter the operation of the appropriate switches is initiated by placing an electrical condition upon a selected idle one of the trunks in the outgoing group. The selection of the outgoing group is effected by the sender-marker, and the electrical condition is placed upon the chosen idle trunk by means of discharge tubes which are individual respectively to the trunks of the selected group. For example, tubes 119, 120, 121 are individual to trunks 112, 113, and 114 of group 111 and serve to choose an idle one of these trunks, when the group is selected by the sender-marker, and to initiate the operation of the switches 106 and 107 to complete the connection between the calling incoming junctor and chosen idle outgoing trunk. Similarly the tubes 122, 123 and 124 are provided for the trunks 116, 117 and 118 of the group 115. For a better understanding of the manner in which the switches of the stage are first prepared and then operated automatically to establish the desired connection, reference may be had to the copending application of L. A. Meacham, Serial No. 431,236, filed Feb. 17, 1942.

The sender-marker disclosed in Fig. 2 includes a signal receiver 200 which is arranged to receive designation code signals transmitted from the subscriber's station. These signals comprise alternating currents of different frequencies, and each character of a designation is represented by a combination of two frequencies. These code signals are generated at the subscriber's station by any suitable means, such as a reed transmitter 126 having five reeds of different natural periods which are plucked by a subscriber's keyboard to transmit the desired signals. The signal receiver 200, which is illustrated diagrammatically in the drawing, may be of any suitable type, such as the one disclosed in detail in the patent to Lundstrom, No. 2,237,742 of April 8, 1941. The reed transmitter 126 at the subscriber's station, which is also schematically illustrated, may be of any suitable type, such as that disclosed in the patent to Mallina, No. 2,147,710 of February 21, 1939.

The sender-marker also includes a plurality of discharge tube registers for registering the digits of the code designation representing the trunk groups outgoing from the switching stage in Fig. 1. Assuming a three-digit code, there are three of these registers 201, 202 and 203. Each register comprises ten discharge tubes, only four of which are illustrated in the drawing. For example, the No. 0, No. 1, No. 8 and No. 9 tubes 204, 205, 206, 207 of the register 201 are shown. Similarly, the corresponding tubes 208, 209, 210 and 211 of register 202 and tubes 212, 213, 214, 215 of register 203 are illustrated. The code signals of alternating currents of different frequencies representing the digits of a desired designation are received by the frequency receiver 200 which in turn causes the partial ionization of the proper tubes of the registers 201, 202 and 203 in succession to register the digits of the designation. Thereafter the sender-marker appropriates the marking conductors 216, which are common to all of the sender-markers, and the partially ionized register tubes are fully ionized to make effective connection with the corresponding ones of these marking conductors.

The purpose of the marking conductors is to enable the register tubes of any sender-marker to effect the selection of a desired one of the trunk group tubes 127, 128, 129 by applying potentials to the marking conductors which represent the digits of the designation identifying the desired trunk group. To this end the marking conductors 216 are divided into three groups of ten each, the hundreds group 217, the tens group 218 and the units group 219. The ten hundreds conductors 220, 221, 222, 223 are connected respectively to the main cathodes 224, 225, 226, 227 of the tubes of register 201. Similarly the conductors of groups 218 and 219 are connected respectively to the main cathodes of the tubes of registers 202 and 203.

The trunk group tubes 127, 128, 129, there being one of these tubes for each group of outgoing trunks, 111, 115, are connected to the marking conductors through sets of impedances, preferably resistors. Since each trunk group tube is individual to a group having a three-digit designation, the tube is connected through resistors to a marking conductor in each of the three groups 217, 218, 219. By varying the combinations of three resistors it is possible to obtain one thousand different sets of three or one thousand different trunk group designations. For example, the trunk group tube 127, which is individual to the outgoing trunk group 111, has its starting anode 130 connected through three equal resistors 228, 229 and 230 to marking conductors 223, 231 and 232. Inspection of the numerical values of these three leads will show that the designation of the trunk group 111 is 980. The tube 128, which is individual to the trunk group 115, has its starting anode connected through three similar resistances to the marking conductors 221, 233 and 234, wherefore the designation of trunk group 115 is 199. In like manner the tube 129 and all remaining tubes have their starting anodes connected to the appropriate marking conductors.

The manner in which the application of potentials to the marking conductors by the register tubes of the sender-marker causes the selective operation of the trunk group tubes will be better understood by referring to Fig. 3. This figure illustrates two of the sender-markers, the com-

mon field of marking conductors, and a plurality of trunk group tubes. The first sender-marker 300 illustrates the three digit registers 301, 302 and 303, each register having only three of the ten discharge tubes. Similarly the second sender-marker 304 is provided with three digit registers 305, 306 and 307, each register having only three of its ten discharge tubes illustrated. The three groups of common marking conductors 308, 309 and 310 are connected through individual resistors to the negative pole of battery. For example, the No. 0, No. 1 and No. 9 conductors 311, 312 and 313 of the hundreds group are connected through equal resistors 314, 315 and 316 to the negative pole of battery 317. Similarly, conductors 318, 319 and 320 of the tens group are connected through corresponding resistors to the negative pole of battery 321. Also conductors 322, 323 and 324 of the units group are connected through resistors to the negative pole of battery 325. The main cathodes of the registers 301, 302 and 303 are connected respectively to the correspondingly numbered marking conductors in the hundreds, tens and units groups. For example, the cathodes of the No. 0, No. 1 and No. 9 tubes of the register 301 are connected respectively to the No. 0, No. 1 and No. 9 marking conductors of the hundreds group 308. Similarly, the cathodes of tubes 302 and 303 are connected to the corresponding marking conductors of the tens and units groups 309 and 310. And the same is true of the tubes of the registers 305, 306 and 307 of the sender-marker 304.

The individual trunk group tubes, of which there may be as many as one thousand, are connected to the common field of marking conductors through sets of resistances as previously explained. For instance, trunk group tube 326, which is individual to the trunk group having the designation "099," has its anode connected through resistors 327, 328 and 329 to conductors 311, 320 and 324 respectively. Trunk group tube 330, representing the trunk group having the designation "091," is connected through resistors 331, 332 and 333 to marking conductors 311, 320 and 323. Trunk group tube 334, representing the group having the designation "000," is connected through resistors 335, 336 and 337 to marking conductors 311, 318 and 322. And the remaining trunk group tubes are connected in various combinations to the marking conductors.

To explain more fully the manner in which the trunk group tubes are selectably operated, it will be assumed that the sender-marker 300 is seized and that the designation "099" is registered on registers 301, 302 and 303. The first digit "0" is registered on register 301 by discharging the No. 0 tube 338; the second digit "9" is registered on register 302 by discharging the tube 339; and the third digit "9" is registered on register 303 by discharging the tube 340. A circuit is closed from the positive pole of battery 341, through the anode and cathode of the discharged tube 338, conductor 311 through resistor 314 to the negative pole of battery 317. Although any suitable values may be chosen, it will be assumed for the purpose of illustration that the battery 341 has a voltage of 100 volts, that battery 317 has a voltage of 50 volts, and that the voltage drop across the discharge tube 338 is approximately 60 volts. With these values it will be noted that the current flowing in the circuit traced through the resistor 314 raises the potential of marking conductor 311 to 40 volts above ground potential, provided the resistor 314 constitutes the greater part of the re-

sistance in this circuit. In like manner a circuit is traceable from the positive pole of battery 343 through discharged tube 339, conductor 320, resistor 345 to the negative pole of battery 321, and the marking conductor 320 is thereby raised to a potential of 40 volts above ground potential. Similarly current flows from the positive pole of battery 346 through the discharged tube 340, marking conductor 324, resistor 348 to the negative pole of battery 325, and marking conductor 324 is raised to a potential of 40 volts. Thus the three marking conductors 311, 320 and 324 are all raised from a negative potential of 50 volts to a positive potential of 40 volts, and, since no current flows through either of the resistors 327, 328 and 329, the full potential of 40 volts is applied through these resistors to the anode 349 of the tube 326. This potential when added to the voltage of battery 350 is sufficient to operate the tube 326, which in turn effects the selection of the desired trunk group.

Although other sets of resistors have one or two resistors connected to the marked conductors 311, 320 and 324, no other set has all three of its resistors connected to these three conductors. For example, the resistors 331 and 332 are connected respectively to the marked conductors 311 and 320, but the third resistor 333 of the set is connected to conductor 323 which is not marked with the positive potential of 40 volts. Therefore, current flows from conductor 311 through the resistor 331 through resistor 333, conductor 323 through resistor 351 to the negative pole of battery 325. Similarly current flows from conductor 320, resistor 332, resistor 333, conductor 323, resistor 351 to the negative pole of battery 325. It will be found upon calculation that the flow of current through the resistors 331, 332, 333, reduces the potential applied to the anode of tube 330 to about 10 volts, a value which represents approximately two-thirds of the volt change that is applied to the desired tube 326. This potential is insufficient to cause the operation of tube 330.

Other sets of resistors will have only a single resistor connected to one of the three marked conductors. For instance, the resistor 335 is connected to conductor 311 whereas resistors 336 and 337 are connected to the unmarked conductors 318 and 322. In this case current flows from the conductor 311 through resistor 335 thence through resistor 336, conductor 318, resistor 352 to the negative pole of battery 321. Also current flows from conductor 311 through resistor 335 thence through resistor 337, conductor 322, resistor 353 to the negative pole of battery 325. Calculation will show that the current flow through resistors 335, 336, 337 reduces the potential applied to the anode of tube 334 to a negative value of about 20 volts, which represents approximately one-third of the 90 volt change applied to the desired tube 326.

Thus the registration of any one of the thousand designations on the registers of the sender-marker causes the application of a positive marking potential increment of 90 volts to the three marking conductors representing the three digits, and this change of potential is applied through a single set of resistors to one of the thousand trunk group tubes, whereas the potential increments applied to all other trunk group tubes having one or two resistors connected to a marked conductor are reduced to approximately two-thirds or one-third of this value depend-

ing upon the number of resistors connected to the marked conductors.

Referring again to Figs. 1 and 2, a detailed description will now be given of the operation of the system. Assume for this purpose that the subscriber of line 100 wishes to extend a connection over an idle one of the trunks in the group 111, the designation of which is 980. Upon the initiation of the call the automatic line switches 101 operate in the well-known manner to extend the subscriber's line 100 over an idle junctor 105 to the district frame 106, and the sender-connector 125 operates automatically to extend the subscriber's line through to the idle sender-marker shown in Fig. 2.

The subscriber now manipulates his reed transmitter to send impulses of current of the frequencies representing the three successive digits 9, 8, 0. If the first digit "9" is represented by a signal comprising frequencies of 1500 cycles and 700 cycles, the receiver 200 responds to these frequencies and momentarily closes the corresponding contacts 235 and 238. Normally the conductors 239 and 240 are at the full negative potential of battery 241. When, however, the contacts 235 and 238 close, full ground potential is momentarily applied to these conductors through the resistor 242 and the contacts 235 and 238. The conductors 239 and 240 gradually become more and more negative as current flows through resistors 243 and 244 and through the condenser 245. However, while the full ground potential exists on conductors 239 and 240, it is applied through the resistors 246 and 247 to the starting anode of register tube 207. The full ground potential thus applied to the starting anode of tube 207, when added to the negative potential applied from the battery 248 through resistor 249 to the starting cathode of tube 207, is sufficient to ionize the control gap of the tube. Since no one of the other nine tubes of the register 201 has both of its starting anode resistors connected to the marked conductors 239 and 240, the full value of the ground potential is not applied to the starting anode of any one of these other tubes. For instance, considering register tube 206, positive potential on conductor 239 causes current to flow through resistors 250 and 251, conductor 252, resistor 253, contact of relay 254 to the negative pole of battery 241. The flow of current through resistors 250 and 251 reduces the potential applied to the anode of tube 206 below the ionizing value. Thus only the No. 9 tube 207 ionizes its control gap in response to the transmission of the first code digit "9." The full value of the positive potential on conductors 239 and 240 is, however, applied to the starting anodes of the No. 9 tubes 211 and 215 of the tens and units registers 202 and 203; and these tubes, as well as tube 207, ionize their control gaps.

The full positive potential of battery 255 being applied through resistor 256 to the main anodes of all tubes in the register 201, an initial transfer of ionization in the tube 207 takes place, and current now flows from the battery 255 through resistor 256, conductor 257, main anode 258, starting cathode 259 through the resistor 249 to battery 248. Initial transfer, however, cannot take place at this time in the tube 211 for the reason that the main anode 270 is maintained at negative potential over a path from battery 263, resistor 266, resistors 267 and 271 and conductor 269; nor can initial transfer take place in the tube 215 since the main anode 272 is maintained at negative potential over a path from

battery 273, resistors 274, 275 and 276 to conductor 277. The current flowing through the resistors 256 and 249, resulting from the initial transfer in tube 207, lowers the voltage applied across the main anode and starting cathode of each of the remaining tubes in the register 201 so that no one of these tubes can experience the initial transfer in case its starting gap is subsequently ionized. The current flow through the resistor 249 raises the potential of the starting cathode 259 to a value substantially equal to the potential of the main cathode 227, and the result is that the second transfer from the main anode to the main cathode does not take place at this time.

At the instant the potential of the starting cathode 259 is raised by the flow of current in the resistor 249 a positive impulse is applied through the condenser 260 and resistor 261 to the starting anode of steering tube 262. This positive potential when added to the negative potential of battery 263 ionizes the control gap of tube 262. The tube 262 immediately ionizes its main gap, and current flows from the positive pole of battery 255, contacts of relay 264, conductor 265, anode and cathode of tube 262, resistor 266 to the negative pole of battery 263. After an interval which is determined by the constants of resistor 267 and condenser 268 the potential of the conductor 269, which is connected to the main anodes of the tubes 202, is raised to a positive value sufficient to permit the initial transfer in any one of these tubes. The time interval measured by resistor 267 and condenser 268 is introduced to insure that the register 202 is not enabled until the registration of the first digit has been completed.

The calling subscriber, proceeding to transmit the second digit "8," plucks his transmitter 126 to send currents of frequencies 1500 and 1100, resulting in the closure of contacts 235 and 236 of the receiver 200. Ground potential is thereby applied to conductors 239 and 252, and the full value of this potential is applied through resistors 278 and 279 to the starting anode of tube 210 and through the corresponding resistors of tubes 206 and 214 to cause the ionization of the control gaps of these tubes. As above explained, the first transfer of ionization cannot take place in the tube 206 since the voltage across the main anode and starting cathode is reduced below the transfer value by the current flowing in the corresponding gap of the ionized tube 207. Nor can the initial transfer take place in the units tube 214 since the negative pole of battery 273 is connected to the main anode. Initial transfer, however, does take place in the tube 210 of the tens register because the main anode is now at positive potential resulting from the current flow in the steering tube 262. The circuit for the flow of the transfer current may be traced from conductor 269, main anode 280, starting cathode 281, resistor 282 to the negative pole of battery 283. The flow of current through resistors 267, 271 and 282 lowers the voltage across the remaining tubes of the register 202 to prevent the initial transfer in another one of these tubes.

In the manner above described the flow of current in resistor 282 produces a positive voltage impulse on the starting anode of the second steering tube 284, this tube ionizes its control gap, and the main discharge immediately occurs, current flowing through the main gap of the tube and resistor 274. After an interval determined by the resistor 275 and the associated condenser

285, the conductor 277 is raised to a positive potential to condition the tubes of the units register 203.

When the subscriber transmits frequencies 900 and 700 for the final digit "0," the receiver 200 closes contacts 237 and 238, and positive potential is applied through the associated resistors to the starting anodes of tubes 204, 208 and 212. The starting gaps of all three tubes ionize, but tubes 204 and 208 being disabled as above explained, the initial transfer does not take place. The initial transfer, however, does take place in the tube 212, and current flows from conductor 277, main anode and starting cathode of said tube, resistor 286 to battery 287. Thus the three tubes 207, 210, and 212 have been operated in their first stage by ionizing the gaps between their main anodes and starting cathodes to store the designation 980 of the desired trunk group.

The flow of current through resistor 286 produces a positive voltage impulse which is applied through condenser 288 and resistor 289 to ionize the control gap of the third steering tube 290. Current now flows from battery 255, contacts of relay 264, conductor 265 through the main gap of tube 290, relay 254 to ground. Relay 254 operates with the result that the starting anodes of all register tubes are raised to ground potential. Because of the lockout arrangement above described no additional tubes in the registers are ionized at this time.

The flow of current in the tube 290 causes the application of positive potential to the starting anode of the sender-connector tube 291 following an interval measured by the resistor 292 and condenser 293. The tube 291, the tube 294 and similar tubes, not shown, each of which is individual to a sender-marker, serve to effect the connection of the sender-markers, one at a time, to the common marking conductors 216. When the starting anode of the tube 291 is raised to a positive potential following the discharge of the tube 290, the control gap of the tube 291 ionizes. If at this same instant another sender 295 has reached the same stage of operation, the control gap of its connector tube 294 also ionizes. Following the ionization of the control gaps of the connector tubes, one of these tubes, say the tube 291, will experience a transfer of ionization somewhat in advance of the other tubes. Upon this initial transfer, current flows from battery 255, contacts of relay 264, main anode and starting cathode of the tube 291 thence through the common impedance elements 296 and 297 to the negative pole of battery. The flow of current in these impedances raises the potential of the starting cathodes of all other tubes to prevent the initial transfer of ionization to the main anode of any tube. Immediately following the first transfer in the tube 291 a second transfer takes place, and current now flows from the main anode to the main cathode and thence through the relay 298 to ground. Thus the tube 291 has succeeded in fully ionizing to determine that its sender will be the one to effect the connection with the marking conductors, and a flow of current is maintained between the main anode and starting cathode of tube 291 to hold the starting cathodes of all other tubes at a potential insufficient to permit the initial transfer as long as the tube 291 is ionized.

The operation of relay 298, which takes place as soon as tube 291 completes its ionization to indicate that its sender is the successful one, conditions the partially ionized register tubes 207, 210

and 212 for full ionization, that is, for operation in their next and final stage to effect connection to the corresponding conductors of the marking conductor group 216. More particularly the relay 298 closes short-circuits around the resistors 256, 271 and 276 to allow the application of the full positive potential of battery 255 to the main anodes of the tubes of the corresponding registers. The second and final transfer now takes place in tube 207, and current flows from battery 255, conductor 265, contact of relay 298, conductor 257, main anode and main cathode of tube 207, resistor 299 to the negative pole of battery 400. Thus the marking potential is applied to the No. 9 conductor 223 in the hundreds marking group 217. In a similar manner the second transfer takes place in tubes 210 and 212 and the marking potential is applied through the main gaps of these tubes to the No. 8 marking conductor 231 in the tens group 218 and to the No. 0 marking conductor 232 in the units group 219. When the main anodes of the register tubes are raised in voltage by the operation of relay 298, the voltage of the starting cathodes is also raised. False ionization of the starting gaps cannot occur at this time, however, for the reason that the potential of the starting anodes has already been raised by the previous operation of relay 254. The full marking potential thus impressed upon the marking conductors is applied through the resistors 228, 229 and 230 to the starting anode of the trunk group tube 127. This tube ionizes and current flows from the positive pole of battery 131, generator 132, winding of slow-release relay 133 through the main gap of the tube 127 to ground. Relay 133 operates and in the manner fully explained in said copending application, Serial No. 431,236, filed Feb. 17, 1942, the tubes 119, 120, 121, etc., are prepared for the selection of an idle one of the trunks in the chosen group 111. Thereafter the switches 106 and 107 are operated as above explained to complete the connection from the calling line to the selected idle trunk in the group 111.

The sender-marker may now be released by the operation of relay 264 and by the release of the sender-connector 125. The operation of relay 264 disconnects the battery 255 to effect the deenergization of all operated tubes and the resultant release of the energized relays.

The connection through the switching stage 106, 107 may be released in any well-known manner under the control of the calling subscriber's line.

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 plurality of trunks, each having designations comprising a plurality of digits, groups of marking conductors, one for each digit in said designations, responsive devices individual respectively to said trunks, impedance elements, each of said responsive devices being permanently connected through a set of said impedance elements to said groups of marking conductors, each impedance element of a set being connected to the particular conductor of the marking group which represents the value of the digit of the corresponding designation, means for

registering the designation of a desired trunk, means controlled by said registering means for applying a given marking potential to the marking conductors, one in each marking group, which represent the digits of the registered designation, the full value of said potential being applied over the particular set of impedance elements which has each one of its elements connected to one of said marked conductors to operate the associated responsive device, circuits for the flow of current through each impedance element of all other sets which are connected to the marked conductors, the flow of current through said elements reducing the potential applied to the associated responsive devices below the operating value of said devices, and means controlled by the operated responsive device for selecting the corresponding trunk for use.

2. In combination, a plurality of trunk groups each having designations comprising a plurality of digits, groups of marking conductors, one for each successive digit in said designations, space discharge tubes associated individually with the respective trunk groups, resistors, each of said discharge tubes being permanently connected through a set of said resistors to said groups of marking conductors, each resistor of a set being connected to the particular conductor of the marking group which represents the value of the corresponding digit, means for registering the designation of a desired trunk group, means controlled by said registering means for applying a given marking potential to the marking conductors, one in each marking group, which represent the digits of the registered designation, the full value of said potential being applied over the particular set of resistors which has each one of its resistors connected to one of said marked conductors to operate the associated discharge tube, circuits for the flow of current through all other resistor sets having one or more resistors connected to marked conductors, the current flow in each resistor set varying with the number of resistors connected to marked conductors and serving to reduce by corresponding incremental values the potential applied to the associated discharge tubes, and means controlled by the operated discharge tube for selecting the corresponding trunk group for use.

3. In combination, a plurality of trunk groups, each having designations comprising a plurality of digits, groups of marking conductors, one for each successive digit in said designations, space discharge tubes associated individually with the respective trunk groups, resistors, each of said discharge tubes being permanently connected through a set of said resistors to said groups of marking conductors, each resistor of a set being connected to the particular conductor of the marking group which represents the value of the corresponding digit, means for registering the designation of a desired trunk group, means controlled by said registering means for applying a given marking potential to the marking conductors, one in each marking group, which represent the digits of the registered designation, the full value of said potential being applied over the particular set of resistors which has all of its resistors connected to marked conductors to operate the associated discharge tube, circuit means for causing the flow of current through each other resistor set having less than all of its resistors connected to conductors having said marking potential thereon, the flow of current through

each such resistor set varying with the number of resistors connected to marked conductors and serving to reduce the potential applied to the associated discharge tube by corresponding amounts below the operating value of such tube, and means controlled by the operated discharge tube for selecting the corresponding trunk group for use.

4. In combination, a stage of selective switches, a plurality of trunk groups outgoing from said stage, each trunk group having a designation comprising a series of digits, marking conductors corresponding to the successive digits of said designations, discharge tubes individual respectively to said trunk groups, impedance elements, each of said tubes being connected through a set of said impedance elements to said marking conductors, the impedance elements of each set being connected to the marking conductors which represent the values of the digits of the corresponding designation, a digit registering mechanism associated with said stage of selective switches, means in said mechanism for registering the designation of a desired group of said trunks, means controlled by said registering means for applying a marking potential to the particular ones of said marking conductors which represent the digits of the registered designation, the full value of said potential being applied over the corresponding set of impedance elements to operate the associated discharge tube, circuit means including the impedance elements of other sets for decreasing below the operating value the potential applied to other discharge tubes, means controlled by the operated discharge tube for selecting the corresponding trunk group for use, and means for operating the switches of said stage to establish a connection over an idle one of the selected trunk group.

5. In combination, a stage of selective switches, a plurality of trunk groups outgoing from said stage, each trunk group having a designation comprising a series of digits, marking conductors corresponding to the successive digits of said designations, discharge tubes individual respectively to said trunk groups, impedance elements, each of said tubes being connected through a set of said impedance elements to said marking conductors, the impedance elements of each set being connected to the marking conductors which represent the values of the digits of the corresponding designation, a digit registering mechanism associated with said stage of selective switches, said mechanism including a plurality of discharge tubes responsive to digital impulses for registering the designation of a desired group of said trunks, means controlled by said register tubes for applying a marking potential to the particular ones of said marking conductors which represent the digits of the registered designation, the full value of said potential being applied over the corresponding set of impedance elements to operate the associated trunk group discharge tube, circuit means including the impedance elements of other sets for decreasing below the operating value the potential applied to other trunk group discharge tubes, means controlled by the operated trunk group discharge tube for selecting the corresponding trunk group for use, and means for operating the switches of said stage to establish a connection over an idle one of the selected trunk group.

6. In combination, a plurality of trunk groups having different designations, a plurality of marking conductors, responsive devices individual re-

spectively to said trunk groups, a registering mechanism having digit registers, means for transmitting impulses corresponding to the digits of a desired trunk group, means responsive to said impulses for operating said registers in one stage to register the digits of the designation, means for subsequently operating said registers in a second stage for applying a marking potential to said marking conductors, circuit means interconnecting said marking conductors and each of said responsive devices, said circuit means serving to apply an operating potential to the particular one of said responsive devices which is individual to the desired trunk group, the potential applied to all other responsive devices being insufficient to operate the same, and means controlled by the operated responsive device for selecting the associated trunk group for use.

7. In combination, a plurality of trunk groups having different designations, a plurality of marking conductors, responsive devices individual respectively to said trunk groups, a registering mechanism having digit registers each comprising a plurality of space discharge tubes, means for transmitting impulses corresponding to the digits of a desired trunk group, means responsive to said impulses for causing the initial discharge of said tubes to register the designation digits of the desired group of trunks, means for subsequently causing the full discharge of said register tubes to apply a marking potential to said marking conductors, circuit means interconnecting said marking conductors and each of said responsive devices, said circuit means serving to apply an operating potential to the particular one of said responsive devices which is individual to the desired trunk group, the potential applied to all other responsive devices being insufficient to op-

erate the same, and means controlled by the operated responsive device for selecting the associated trunk group for use.

8. In combination, a plurality of trunk groups having different designations, a plurality of marking conductors, responsive devices individual respectively to said trunk groups, a plurality of registering mechanisms common to said marking conductors and normally disconnected therefrom, each registering mechanism having digit registers each comprising a plurality of space discharge tubes, means for seizing an idle one of said registering mechanisms for use, means for transmitting to the seized mechanism impulses corresponding to the digits of a desired trunk group, means responsive to said impulses for causing the partial discharge of the register tubes to register the designation of the desired trunk group, means for causing the full discharge of the partially discharged register tubes to connect said tubes to said marking conductors and to apply a marking potential to the particular ones of said conductors which represent the digits of the desired trunk group, circuit means interconnecting said marking conductors and each of said responsive devices, said circuit means serving to apply an operating potential to the particular one of said responsive devices which is individual to the desired trunk group, the potential applied to all other responsive devices being insufficient to operate the same, means controlled by the operated responsive device for selecting the associated trunk group for use, and means for preventing a second one of said registering mechanisms from making operative connection with said marking conductors.

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