May 9, 1933. C. S. DEMAREST 1,908,326

SELECTIVE SIGNALING SYSTEM

Filed Aug. 18, 1932 4 Sheets-Sheet 1

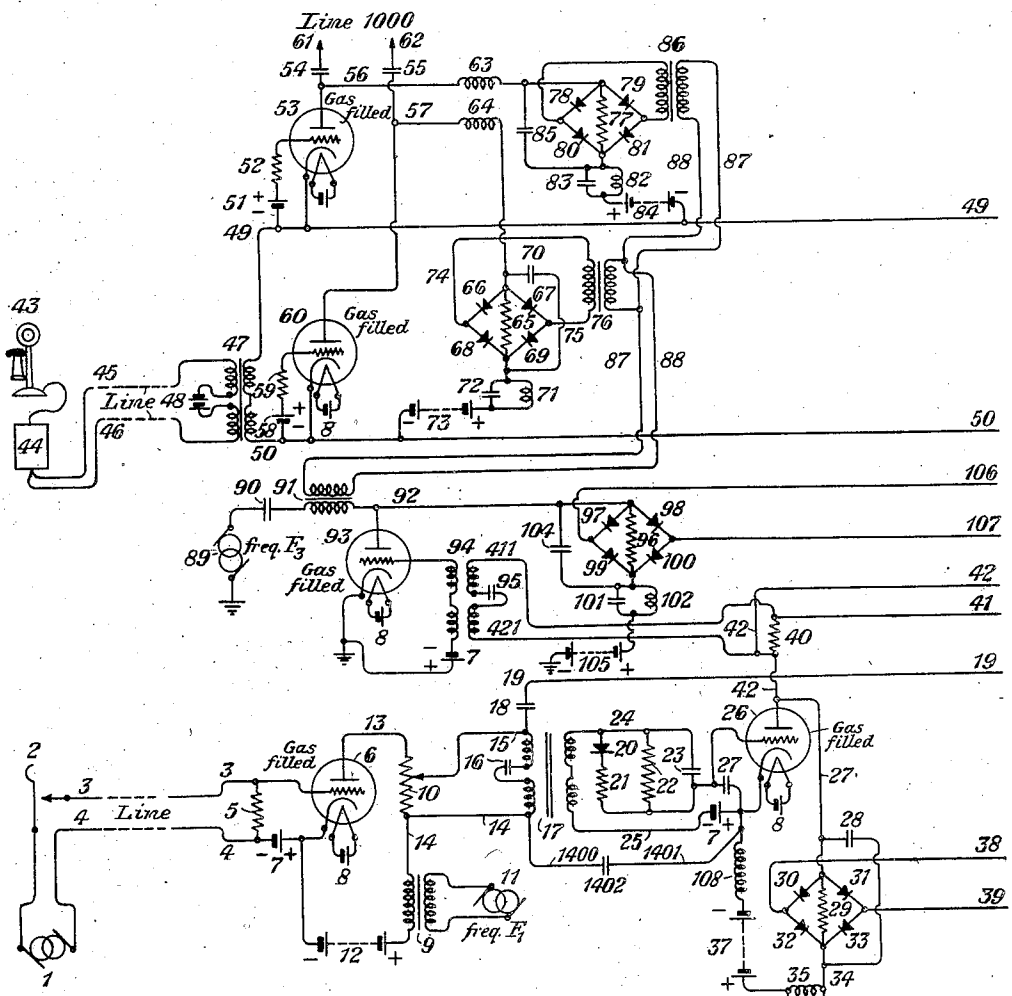

Fig. 1

INVENTOR
C. S. Demarest
BY
ATTORNEY

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Filed Aug. 18, 1932 4 Sheets-Sheet 2

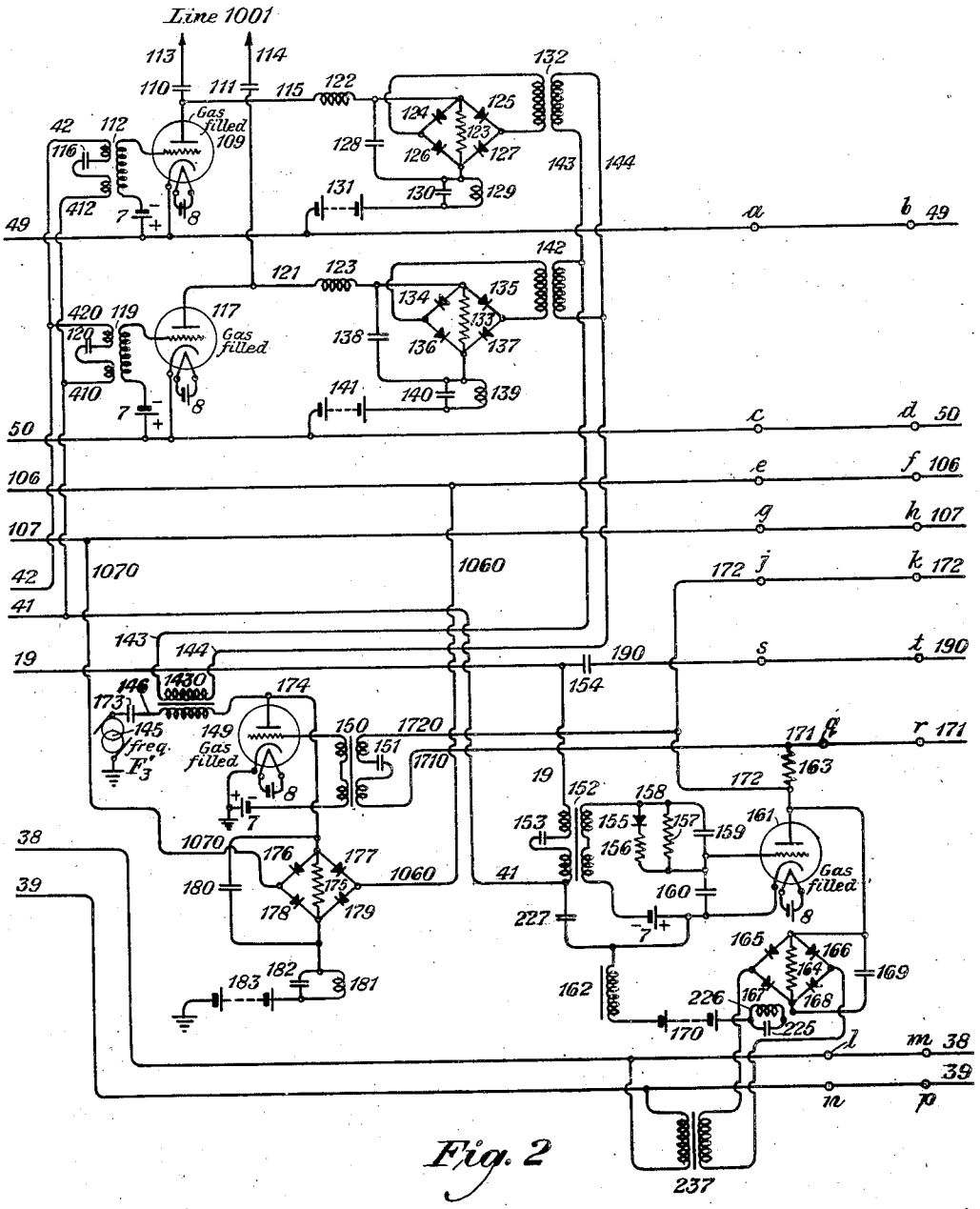

Fig. 2

INVENTOR
C. S. Demarest
BY
ATTORNEY

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SELECTIVE SIGNALING SYSTEM

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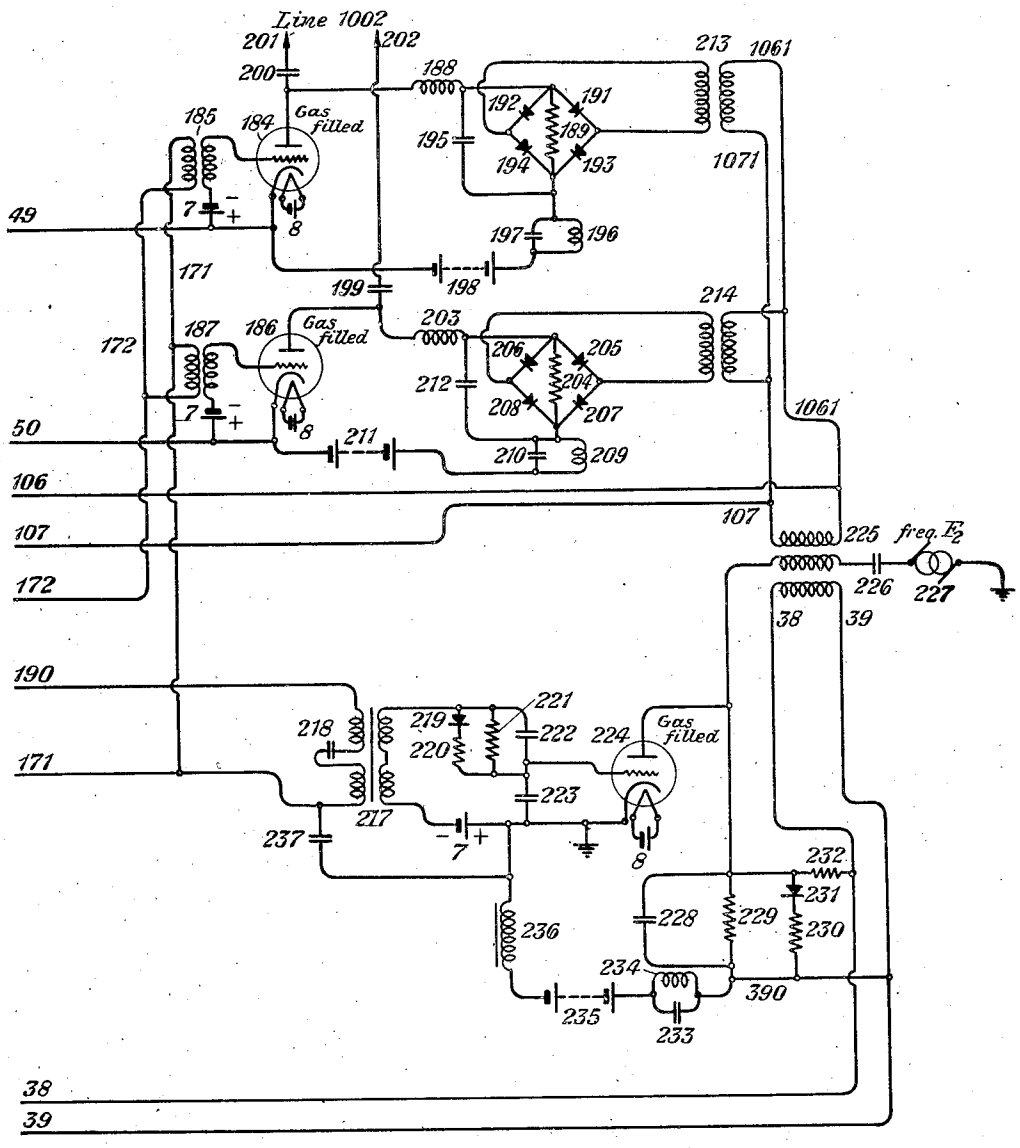

Fig. 3

INVENTOR
C. S. Demarest
BY
ATTORNEY

May 9, 1933. C. S. DEMAREST 1,908,326

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Filed Aug. 18, 1932 4 Sheets-Sheet 4

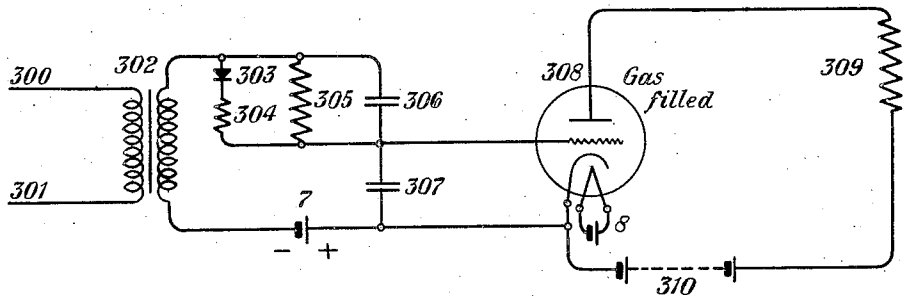

Fig. 4

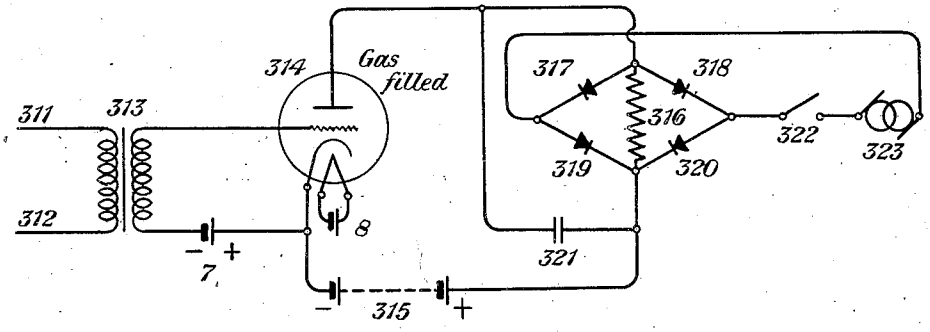

Fig. 5

INVENTOR
C. S. Demarest
BY
ATTORNEY

Patented May 9, 1933 1,908,326

UNITED STATES PATENT OFFICE

CHARLES S. DEMAREST, OF RIDGEWOOD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

SELECTIVE SIGNALING SYSTEM

Application filed August 18, 1932. Serial No. 629,382.

The invention relates to electrical circuits and more particularly to improved means of signaling over telephone or telegraph channels, in which a predetermined code consisting of current impulses selects and signals one out of a plurality of signal receiving devices connected to the telephone or telegraph channel.

Heretofore, selective signaling devices have utilized some form of electro-mechanically operated selector which in response to the signaling impulses completes local circuits and operates the desired signal. Such devices may also serve to switch the telephone or telegraph channel, as in the selectors used in the various forms of automatic, dial operated, telephone systems. As the electro-mechanical type of selector requires direct current for its operation and also requires sufficient current to operate relatively heavy armatures, it has been necessary either to transmit the signaling impulses as direct current or to provide suitable detecting means to convert A. C. impulses to D. C. impulses. Owing to the magnitude of the selector operating currents, it has also been necessary to provide relaying or repeating apparatus in order to provide sufficient current except in the case of very short distances. The ordinary type of selector, having mechanical moving parts requires adjustment and proper attention to operate satisfactorily. It, furthermore, is limited in speed of operation, due to the inertia of these moving parts. This invention provides a device for selective signaling or selective switching, which will operate on very small amounts of energy, either A. C. or D. C., and which has no mechanical moving parts. These features are of particular advantage when the device is to be operated by impulses sent through a transmission channel providing a voice-frequency band, as over telephone circuits, either voice frequency or carrier, or over a radio telephone circuit. D. C. or carrier current telegraph channels may also be used to advantage in connection with this invention.

The invention utilizes the properties of the gas-filled thermionic tube, wherein the resistance from anode to cathode changes from a very high value, substantially that of the insulation, to a negligible value when an arc is established by variation of the input voltage.

This invention may be utilized in a variety of arrangements for selective signaling or switching. Other objects, uses and features of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description together with the accompanying drawings in the Figures 1, 2, 3, 4 and 5 of which the invention is illustrated. Similar reference characters have been used to denote like parts in all of the figures.

In the arrangement shown in Figs. 1, 2 and 3 the gas filled thermionic tubes 26 and 161 may be said to take the place of the stepping electromagnet of the ordinary selector switch in that they serve to connect the signaling impulses selectively to the connecting tubes 109, 117 or 184 and 186, the latter serving to connect the incoming line over wires 45 and 46 to any of the desired lines 1001, or 1002, when operated. Tubes 53 and 60 are arranged to connect the incoming line on conductors 45 and 46 normally to line 1000. Tubes 93 and 149 serve to extinguish the arc in tubes 53 and 60 or in 109 and 117, respectively, thus releasing the connections previously established, while tube 224 serves to extinguish the arc in all other tubes except 53 and 60 which reignite when other tubes are extinguished and the circuit restored to its normal condition.

Before tracing the operation of the circuit in detail, reference will be made to Figs. 4 and 5 which illustrate certain control arrangements for gas filled thermionic tubes used in the complete circuit as shown on Figs. 1, 2 and 3. As these arrangements or both of them are used in connection with many of the tubes of the other figures of the drawings, it will facilitate explanation to consider these particular features separately.

Fig. 4 illustrates an arrangement which

may be described as a slow-operate control circuit for a gas filled thermionic tube. It may also serve as a marginal operation control. In Fig. 4, conductors 300 and 301 represent the input circuit to the tube 308. Alternating current signals received over conductors 300 and 301 are applied through transformer 302 to the grid circuit which contains rectifier element 303, resistances 304 and 305, condensers 306 and 307, and biasing battery 7. The operation of this grid circuit may be seen from the following considerations. It will be supposed first that no alternating current is applied to the conductors 300 and 301, and that no arc exists in the tube 308. Battery 7 maintains the grid at a potential sufficiently negative to prevent the arc from being established between anode and cathode, by virtue of the potential applied to the anode of tube 308 from battery 310 through resistance 309. Battery 8 supplies cathode heating power, the cathode of tube 308 being of the indirectly heated type.

If now an alternating current be applied to conductors 300 and 301, and thus to the primary winding of transformer 302, rectification in rectifier element 303 will take place, the polarity of the rectifier being assumed such that current flows in the direction from the terminal indicated by the triangular symbol to the terminal indicated by the bar symbol, and current will flow from the lower end of the rectifier 303 through resistance 304 to condenser 307, which is charged in such a manner that the polarity will reverse, overriding the voltage from biasing battery 7 and causing the arc to be established in the tube. This condenser 307 will not charge immediately however, the rate of charging being controlled by resistances 304 and 305. It should be observed that prior to the application of an alternating current input to conductors 300 and 301 condenser 307 will be charged to the voltage of battery 7. One pole, the positive, of battery 7 is connected to the cathode of the tube and one terminal of condenser 307, while the negative pole of battery 7 is connected to the other terminal of condenser 307 through the secondary winding of transformer 302 and resistance 305 in series. The output of rectifier 303 will tend to charge up condenser 307 to the reverse polarity, but the voltage available for this purpose is determined by the relative magnitudes of resistances 304 and 305, and the amplitude of the alternating current input. Condenser 306 does not ordinarily serve any purpose, except that it permits marginal instantaneous operation for A. C. inputs of such magnitude that the peak A. C. voltage applied to the grid of tube 308 through the capacity potentiometer formed by condensers 306 and 307 is sufficient to cause the grid to swing above the critical potential at which an arc will strike. The point at which this will occur obviously depends on the relative magnitudes of condensers 306 and 307.

Fig. 5 illustrates an arrangement for stopping the arc in a gas filled thermionic tube operating with a definite delay in a similar manner to the starting arrangement shown in Fig. 4. If an A. C. input has been applied to conductors 311 and 312, and if the peak value of the voltage across the secondary of transformer 313 resulting therefrom is sufficient to swing the grid of tube 314 sufficiently positive to overcome the negative bias from battery 7, an arc will strike. The path of the arc current will be from the positive pole of battery 315 through resistance 316 to the anode of tube 314, thence through the arc path to the cathode of tube 314 and thence to the negative pole of battery 315. The grid now loses control, and the arc will continue even though the input be removed from conductors 311 and 312.

If now switch 322 be closed alternating current from generator 323 will flow through rectifier elements 317, 318, 319 and 320, and through resistance 316, also charging condenser 321, in such a manner as to produce an E. M. F. across resistance 316 opposing the voltage of battery 315 and reducing the voltage between anode and cathode of tube 314 to zero or to a value such that the anode is negative with respect to the cathode, interrupting the arc. If switch 322 remains closed long enough after the E. M. F. has built up by charging condenser 321 to stop the discharge, and for the gas in the tube to become deionized so that the grid regains control, the arc will not then reestablish on opening switch 322 until input voltage is again applied to conductors 311 and 312.

While the arrangement shown works with but slight delay, by utilizing a circuit similar to that in the grid of the tube 308 in Fig. 4, the plate circuit could be made slow-release, the arc becoming extinguished a predetermined time after the closure of switch 322.

With the arrangements thus described in mind, it will be possible to trace in detail the operation of the arrangements of the invention shown on Figs. 1, 2 and 3, with Fig. 2 placed to the right of Fig. 1 and Fig. 3 to the right of Fig. 2.

In Fig. 1, generator 1 is a source of alternating current for signaling, pulses of which under control of key or dial 2 are sent over line 3 and 4 to the control circuits. The telephone line 45 and 46 connects subscribers telephone set 43 and ringer and induction coil constituting bell box 44 to repeating coil 47. Battery 48 supplies transmitter current. The secondary windings of repeating coil 47 are connected

to conductors 49 and 50 to which the switching tubes 53, 60, 109 and 117, 184 and 186 are connected. It would obviously be possible to arrange line 45 and 46 to convey the signaling impulses transmitted over line 3 and 4, but for simplicity separate circuits are here shown.

Tube 6 serves as a relay or repeater of signaling impulses, so that the pulses applied to control tubes 26, 161 and 224 will be of uniform amplitude. Conductors 3 and 4 are terminated in resistance 5, connected between grid and cathode to tube 6. Batteries 7 and 8 supply grid bias and cathode heating power. Batteries having the same reference characters and performing similar functions have been shown in connection with other of the gas filled tubes in the drawings. The anode circuit of tube 6 contains potentiometer 10, and the secondary of transformer 9 in series with anode battery 12. The primary of transformer 9 is connected to generator 11 which supplies alternating current of a frequency F_1 which is large compared with the number of pulses per second sent by dial or signaling key 2. The voltage induced in the secondary of transformer 9 is such that on alternate half cycles the anode of tube 6 becomes negative with respect to the cathode thereof, so that anode current will flow in tube 6 during the other alternate half cycles of the voltage across the secondary of transformer 9 provided that the grid of tube 6 is sufficiently positive so that the arc will strike. The voltage applied to grid of tube 6 will be equal to the voltage drop across resistance 5 due to current therethrough from generator 1 when key 2 is closed, and the biasing voltage of battery 7. The voltage from generator 1 is alternating and of such a magnitude that once every half cycle it will override the negative bias of battery 7.

The resistance of potentiometer 10 limits the current through the arc of tube 6. A pulsating current flows through this device, as a result of the nature of the anode current of tube 6 as previously explained. A portion of the alternating voltage drop in 10, as determined by the position of the moving contact is applied to transformer 17 over conductors 14 and 15. Condenser 16 prevents the flow of direct current in this circuit. The secondary of transformer 17 connects to the grid of tube 26 through a slow-operate circuit of the type shown in Fig. 4 and previously described. This circuit is so adjusted that substantially all of one dial pulse of normal length will be required to establish an arc in the anode circuit of tube 26.

As soon as an arc is established in gas filled thermionic tube 26, an A. C. path is completed from the A. C. drop in potentiometer 10 over conductors 14 and 15, through conductor 1400, condenser 1402, conductor 1401 to the cathode of tube 26, thence over conductor 42 to resistance 40 to conductor 41 and thence to transformer 152 shown on Fig. 2. The A. C. path may be traced through condenser 153 and the primary of transformer 152 to conductor 19 and thence to condenser 18, on Fig. 1, and therethrough to conductor 15.

As previously stated, the major portion of the first dial pulse will be consumed in charging condenser 27 to the voltage required to cause tube 26 to arc. Alternating current will therefore only flow in the circuit just traced for the brief remaining portion of the first dial pulse, and this will be too short to permit the slow to operate circuit interposed between the secondary of transformer 152 and tube 161 to charge condenser 160. Tube 161 will therefore not operate on the first pulse. It will be noted that alternating current in the path traced above flows through resistance 40. An alternating potential drop will therefore exist between conductors 41 and 42. This potential will cause alternating current to flow from conductor 41 to conductors 410, 411 and 412. From each of these, current will flow through the primaries of transformers 119, 94 and 112, respectively, to conductors 420, 421 and 42 and thence back over conductor 42 to resistance 40.

The voltage thus induced in the secondaries of transformers 119, 94 and 112 will cause arcs to be established in tubes 117, 93 and 109, as the positive half cycles of these induced voltages will override the negative bias due to the biasing batteries designated by the symbol 7.

The establishment of arcs in tubes 109 and 117 completes an A. C. path from conductors 49 and 50 to which the incoming line is connected through repeating coil 47 by way of condensers 110 and 111 to conductors 113 and 114 which are connected to the line designated 1001. The establishment of the arc in tube 93 completes an A. C. path from the ungrounded terminal of generator 89, through condenser 90, the primary of transformer 91 to the anode of tube 93, through the arc path of the aforesaid tube to the cathode, thence to ground and to the grounded terminal of generator 89. The alternating voltage induced in the secondary of transformer 91 passes over conductors 87 and 88 to transformers 76 and 86. The secondary of transformer 76 is connected to the rectifier elements 66, 67, 68 and 69, which form a circuit arrangement together with resistance 65 and condenser 70 like that shown in Fig. 5. The secondary of transformer 86 is similarly connected to rectifier elements 78, 79, 80 and 81 which together with resistance 77 and condenser 85 form another device like that shown on Fig. 5. As a result of the

passage of alternating current through the primary of transformer 91, and the application of an alternating voltage from the secondary of transformer 91 over conductors 87 and 88 to transformers 76 and 86, an alternating voltage will appear across the secondaries of the last named transformers and build up voltages in resistances 65 and 77, so stopping the arcs in tubes 53 and 60, and thereby disconnecting the incoming line from line 1000.

Thus the first dial pulse has transferred the connection of the incoming line from line 1000 to line 1001. Tubes 93 and 26 remain in the arcing condition. A second dial pulse will now flow on over the path established through tube 26 when in the arcing condition to tube 161 as described above, and will be of sufficient duration so that the slow operate circuit between the secondary of transformer 152, which circuit is composed of rectifier 155, resistances 156, 157, 158, and condensers 159 and 160 arranged like those shown in Fig. 4, will be operated, starting an arc in tube 161. The last portion of the second dial pulse will, as before, be transmitted through a circuit completed by the arc path of tube 161, and will cause tubes 174, 184 and 186 to operate.

The path of the second dial pulse may be traced in detail as follows: The incoming pulse from generator 1 during the closure of contacts 2 flows over conductor 3, through resistance 5 to conductor 4. Tube 6 operates and remains operated for the duration of the pulse, being quenched at the next negative half cycle of generator 11 after the contacts 2 have opened. Alternating current superimposed on the direct current from battery 12 by the action of generator 11 through transformer 9 will, as before, flow through resistance 10 and the drop in this resistance is applied to transformer 17. Since tube 26 is already in the arcing state due to the first dial pulse, nothing will result from the alternating current flowing in the secondary of transformer 17. Alternating current will also flow through condenser 18, over conductor 19 to transformer 152, through condenser 153 to conductor 41, through resistance 40 to the anode of tube 26, through the arc path thereof over conductor 1401, through condenser 1402 to conductor 1400 and to conductor 14, and over this back to resistance 10. As stated, the delay circuit between transformer 152 and the grid of tube 161 will require most of the duration of the second pulse before an arc strikes in tube 161. Upon the striking of the arc in tube 161 a path is completed from conductors 19 through condenser 154, to conductor 190 through the primary of transformer 217 and condenser 218 to conductor 171, through resistance 163 to and through the arc path in tube 161, through condenser 227 to conductor 41 to and through resistance 40 to the arc path of tube 26, to conductor 1401, through condenser 1402 to conductor 1400 to conductor 14. The A. C. drop in resistance 163 will result in setting up an alternating potential between conductors 171 and 172. These connect to the primaries of transformers 185 and 187 and this will cause tubes 184 and 186 to arc and connect conductors 49 and 50 to conductors 201 and 202 of line 1002, through the arc paths of tubes 184 and 186 and condensers 200 and 201, thereby connecting the incoming line to line 1002. At the same time that alternating voltage is impressed between conductors 171 and 172, an alternating voltage will be set up between conductors 1710 and 1720 which are branches of 171 and 172, and connect to the primary of transformer 150. The voltage induced in the secondary of this transformer will cause an arc to be established in tube 149. When this takes place an A. C. circuit is completed from the ungrounded terminal of generator 145, through condenser 146, the primary of transformer 1430, arc path in tube 149, ground, to the grounded terminal of generator 145. The alternating voltage induced in the secondary of transformer 1430 passes over conductors 143 and 144 to the primaries of transformers 132 and 142. The secondaries of these transformers are connected to rectifier circuits in the plate circuits of tubes 109 and 117, which are made up of rectifier elements 124, 125, 126 and 127 or 134, 135, 136 and 137, respectively, and to which are also connected resistance 123 and capacity 128, or resistance 133 and capacity 138, respectively. These circuits are identical with that shown in Fig. 5 and on the application of alternating current to transformers 132 and 142 function to stop the arcs in the tubes 109 and 117, so disconnecting conductors 49 and 50 from conductors 113 and 114 of line 1001.

As the remainder of the second dial pulse after tube 161 passes current is too short to operate the delay circuit interposed between the grid of tube 224 and transformer 217, tube 224 will not pass current at this time. Thus it will be seen that initially the incoming line is connected to line 1000; one dial pulse transfers the connection to line 1001, while two pulses transfer the connection to line 1002. By connecting additional tube circuits between the points *a* and *b*, *c* and *d*, *e* and *f*, *g* and *h*, *j* and *k*, *l* and *m*, *n* and *p*, *q* and *r*, *s* and *t*, it is obvious that other circuit connections for three, four, or other numbers of dial pulses could be made. If, however, pulses equal to a total, the number of lines (three in the circuits shown on Figs. 1, 2 and 3) be sent in, it is easily seen that on the next impulse after that operating tube 161, tube 224 will pass

an arc. As soon as this occurs an A. C. path will be set up from ungrounded side of generator 227 through condenser 226, the primary of transformer 225, the arc path of tube 224, to ground, to the grounded terminal of generator 227. The secondary winding of transformer 225 is connected to conductors 106 and 107 from which conductors 1060 and 1061, 1070 and 1071 are branches, respectively. Conductors 1061 and 1071 are connected to the primaries of transformers 213 and 214, the secondaries of which are connected to circuits similar to that in Fig. 5 in the anode circuits of tubes 184 and 186. These circuits are made up of rectifier elements 191, 192, 193 and 194, also 205, 206, 207 and 208, condensers 105 and 212, and resistances 189 and 204. As a result, tubes 184 and 186 will be extinguished shortly after the arc is established in tube 224. Conductors 1060 and 1070 connect directly to a rectifier circuit like that of Fig. 5 in the plate circuit of tube 149, which is composed of rectifiers 176, 177, 178 and 179, condenser 180 and resistance 175. Conductors 106 and 107 connect to another similar rectifier circuit in the plate circuit of tube 93 composed of rectifiers 97, 98, 99 and 100, resistance 96 and condenser 104. The arcs in tubes 93 and 149 will also, therefore, be extinguished shortly after an arc is started in tube 224. Nothing will result from the interruption of current in tube 149, but in the case of tube 93 this will remove the input to the rectifiers in the plate circuits of tubes 53 and 60 and as the grids of these tubes are biased positively the arcs therein will restrike, connecting conductors 49 and 50 to conductors 61 and 62 of line 1000 by way of the arc paths in the aforementioned tubes and condensers 54 and 55.

At the same time alternating current will flow out from the tertiary winding of transformer 225 to a rectifier circuit of the type shown in Fig. 5 in the plate circuit of tube 26. This circuit is composed of rectifiers 30, 31, 32 and 33, resistance 29 and condenser 28. The arc in tube 26 will thus be extinguished. The primary of transformer 237 is bridged across conductors 38 and 39 and its secondary connected to a circuit like that of Fig. 5, in plate circuit of tube 161. This circuit is made up of rectifiers 165, 166, 167 and 168, resistance 164 and condenser 169. Tube 161 will, therefore, also be extinguished. There is also provided a circuit similar to the grid circuit rectifier unit of Fig. 4, but having larger current capacity, bridged across conductors 38 and 39 and arranged to charge up condenser 228, and build up a drop in resistor 229, which is in series in the plate circuit of tube 224, connected between the tube and plate battery 235. This circuit is so proportioned as to values of resistances 230 and 229 and capacity 228 that the circuits arranged to extinguish the arcs in tubes 184, 186, 161, 149, 93 and 26 will function before the voltage on condenser 288 attains a value sufficient to extinguish the arc in tube 224.

When the arc in tube 224 has gone out, the circuit has restored to normal. It will be seen that the operation is quite analogous to that of a rotary selector switch which steps around to normal again if one more impulse be sent into it than the total number of steps on the switch.

While the arrangements described are particularly adapted to the step-by-step operation of groups of gas filled tubes, the principles herein disclosed are capable of application to many other uses for the selective switching of communication channels. Accordingly, while the invention has been described as embodied in certain specific arrangements, it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A signaling system comprising a signal transmitting set, a transmission line connected to said signal transmitting set and extending to a plurality of positions at an office, individual lines at each of said positions, a set of gas filled tubes at each of said positions, means at each of said positions for connecting the individual line thereat to said transmission line over the cathode-anode circuits of the set of gas filled tubes thereat, and a set of progressively operated gas filled tubes for controlling the operation of the sets of gas filled tubes at each of said positions.

2. A signaling system comprising a signal transmitting set, a transmission line connected to said signal transmitting set and extending to a plurality of positions at an office, individual lines at each of said positions, a set of gas filled tubes at each of said positions, means at each of said positions for connecting the individual line thereat to said transmission line over the cathode-anode circuits of the set of gas filled tubes thereat, means for transmitting code impulses from said signal transmitting set to said positions, and a set of gas filled tubes operated selectively by said code impulses for controlling the operation of the sets of gas filled tubes at each of said positions.

3. A signaling system comprising a signal transmitting set, a transmission line connected to said signal transmitting set and extending to a plurality of positions at an office, individual lines at each of said positions, a set of gas filled tubes at each of said positions, means at each line thereto to said transmission line over the cathode-anode circuits of the set of gas filled tubes thereat,

means for transmitting code impulses from said signal transmitting set to said positions, a set of gas filled tubes operated progressively by said code impulses for energizing the sets of gas filled tubes at each of said positions and means controlled by the operation of each of said progressively operated gas filled tubes for deenergizing the set of tubes at a preceding position.

4. A signaling system comprising a signal transmitting set, a transmission line connected to said signal transmitting set and extending to a plurality of positions at an office, individual lines at each of said positions, a set of gas filled tubes at each of said positions, means at each of said positions for connecting the individual line thereat to said transmission line over the cathode-anode circuits of the set of gas filled tubes thereat, means for transmitting code impulses of a predetermined length from said signal transmitting set to said positions, a second set of gas filled tubes connected in series for controlling the operation of said first mentioned sets of gas filled tubes at each of said positions, and means for introducing a delay in the operation of each of the gas filled tubes of said second mentioned set of tubes, said delay being of a duration less than the length of said code impulses but over half thereof whereby said tubes of said second set will operate progressively on successive code impulses.

5. A signaling system comprising a signal transmitting set, a transmission line connected to said signal transmitting set and extending to a plurality of positions at an office, individual lines at each of said positions, a set of gas filled tubes at each of said positions, means at each of said positions for connecting the individual line thereat to said transmission line over the cathode-anode circuits of the set of gas filled tubes thereat, means for transmitting code impulses from said signal transmitting set to said positions, a series of gas filled tubes operated progressively by successive ones of said code impulses for progressively operating the sets of gas filled tubes at each of said positions, and means associated with the last one of said series of gas filled tubes for restoring to a condition existing before the transmission of any code impulses the gas filled tubes of said sets and said series.

6. A signaling system comprising a signal transmitting set, a transmission line connected to said signal transmitting set and extending to a plurality of positions at an office, individual lines at each of said positions, a set of gas filled tubes at each of said positions, means at each of said positions for connecting the individual line thereat to said transmission line over the cathode-anode circuits of the set of gas filled tubes thereat, means for transmitting code impulses from said signal transmitting set to said positions, a series of gas filled tubes operated progressively by successive ones of said code impulses for progressively operating the sets of gas filled tubes at each of said positions, means controlled by the operation of the last one of said series of gas filled tubes for deenergizing all of said gas filled tubes in a state of operation, and means for introducing a time lag in the operation of deenergization of said last one of said series of gas filled tubes.

7. A signaling system comprising a signal transmitting set, a transmission line connected to said signal transmitting set and extending to a plurality of positions at an office, individual lines at each of said positions, a set of gas filled tubes at each of said positions, means at each of said positions for connecting the individual line thereat to said transmission line over the cathode-anode circuits of the set of gas filled tubes thereat, means for transmitting code impulses from said signal transmitting set to said positions, a series of gas filled tubes operated progressively by successive ones of said code impulses for controlling the operation of the sets of gas filled tubes at each of said positions, and a gas filled tube for repeating the code impulses transmitted from said signal transmitting set to said series of progressively operated gas filled tubes.

8. A signaling system comprising a signal transmitting set, a transmission line connected to said signal transmitting set and extending to a plurality of positions at an office, individual lines at each of said positions, means at each of said positions for connecting the individual line thereat to said transmission line over the cathode-anode circuits of the set of gas filled tubes thereat, means for transmitting code impulses from said signal transmitting set to said positions, a series of gas filled tubes operated progressively by successive ones of said code impulses for controlling the operation of the sets of gas filled tubes at each of said positions, and means for repeating the code impulses transmitted from said signal transmitting set to said series of progressively operated gas filled tubes, said last mentioned means comprising a gas filled tube having its grid voltage controlled by the alternating potential drop of the current used for said code impulses, a source of alternating current of a frequency higher than that used for said code impulses, means for applying current from said last mentioned source to the cathode-plate circuit of said gas filled repeater tube, a resistance in said cathode-plate circuit, and means for utilizing the alternating voltage drop across said resistance for controlling the voltage on the

grid of the first tube in said series of progressively operated gas filled tubes.

9. A source of alternating current, a line, switching means for applying pulses of current from said source to said line, a gas filled tube having its input circuit connected to said line, a resistance in said input circuit whereby the alternating voltage drop of current from said source may be utilized to control the voltage on the grid of said tube, a second source of alternating current of a frequency higher than that of the alternating current from said first source, means for applying current from said second source to the cathode-anode circuit of said gas filled tube, a resistance in said cathode-anode circuit, and means for applying to a work circuit the alternating voltage drop across said resistance of the alternating current from said second source.

In testimony whereof, I have signed my name to this specification this 17th day of August 1932.

CHARLES S. DEMAREST.