

Nov. 14, 1933.

C. S. DEMAREST

1,934,685

MULTIPLEX SIGNALING SYSTEM

Filed July 13, 1932

3 Sheets-Sheet 1

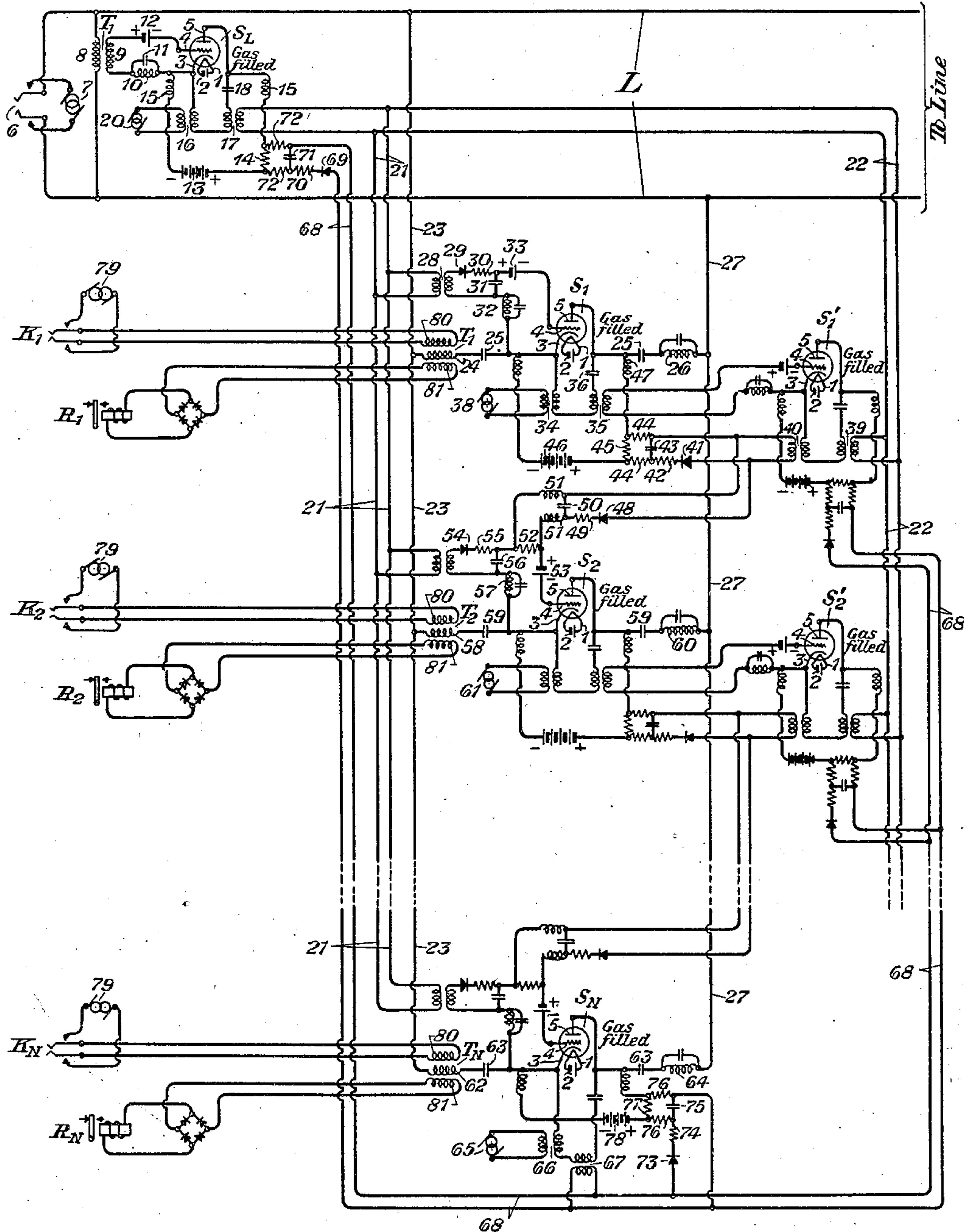


Fig. 1

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3 Sheets-Sheet 2

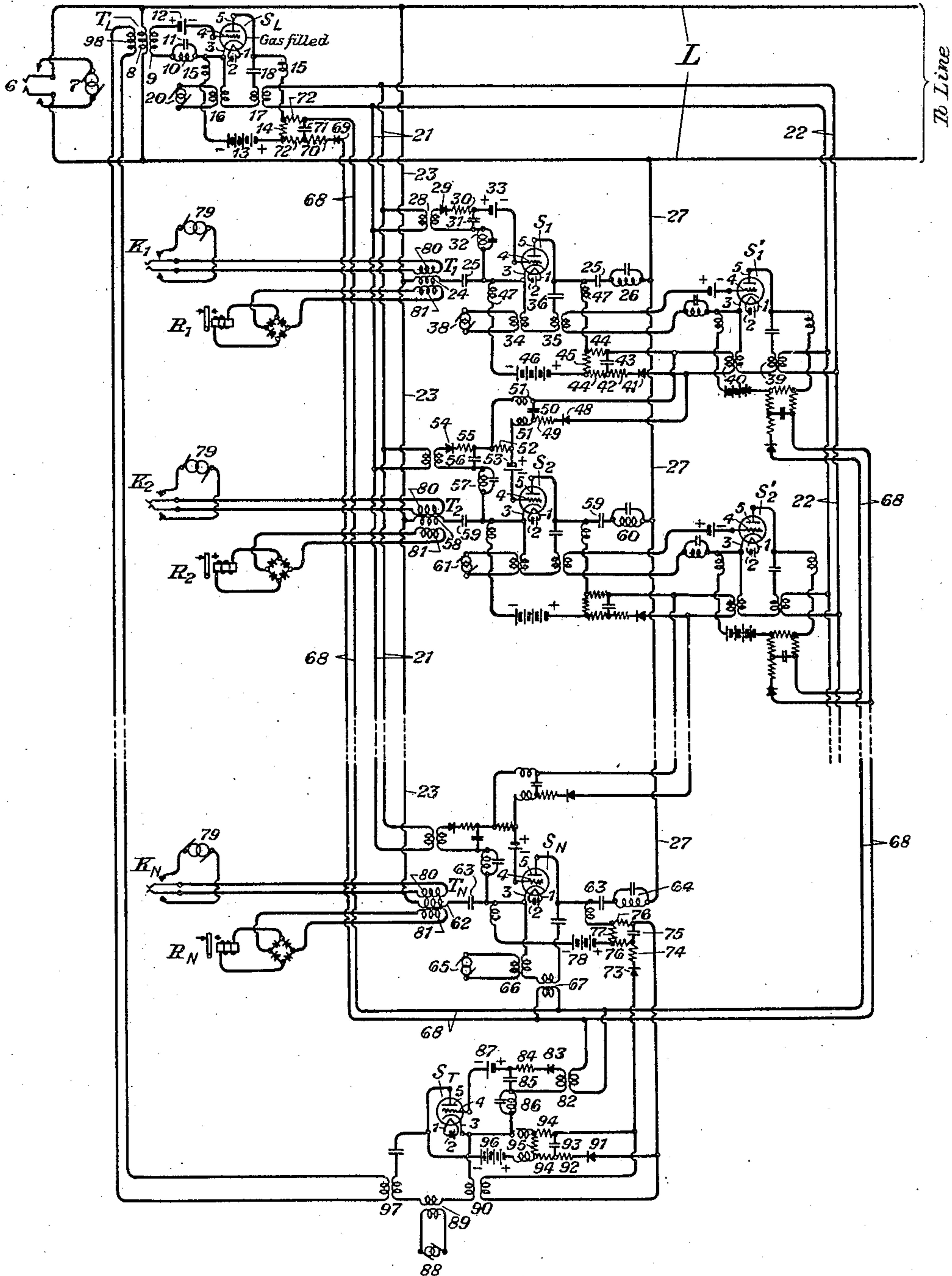


Fig. 2

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3 Sheets-Sheet 3

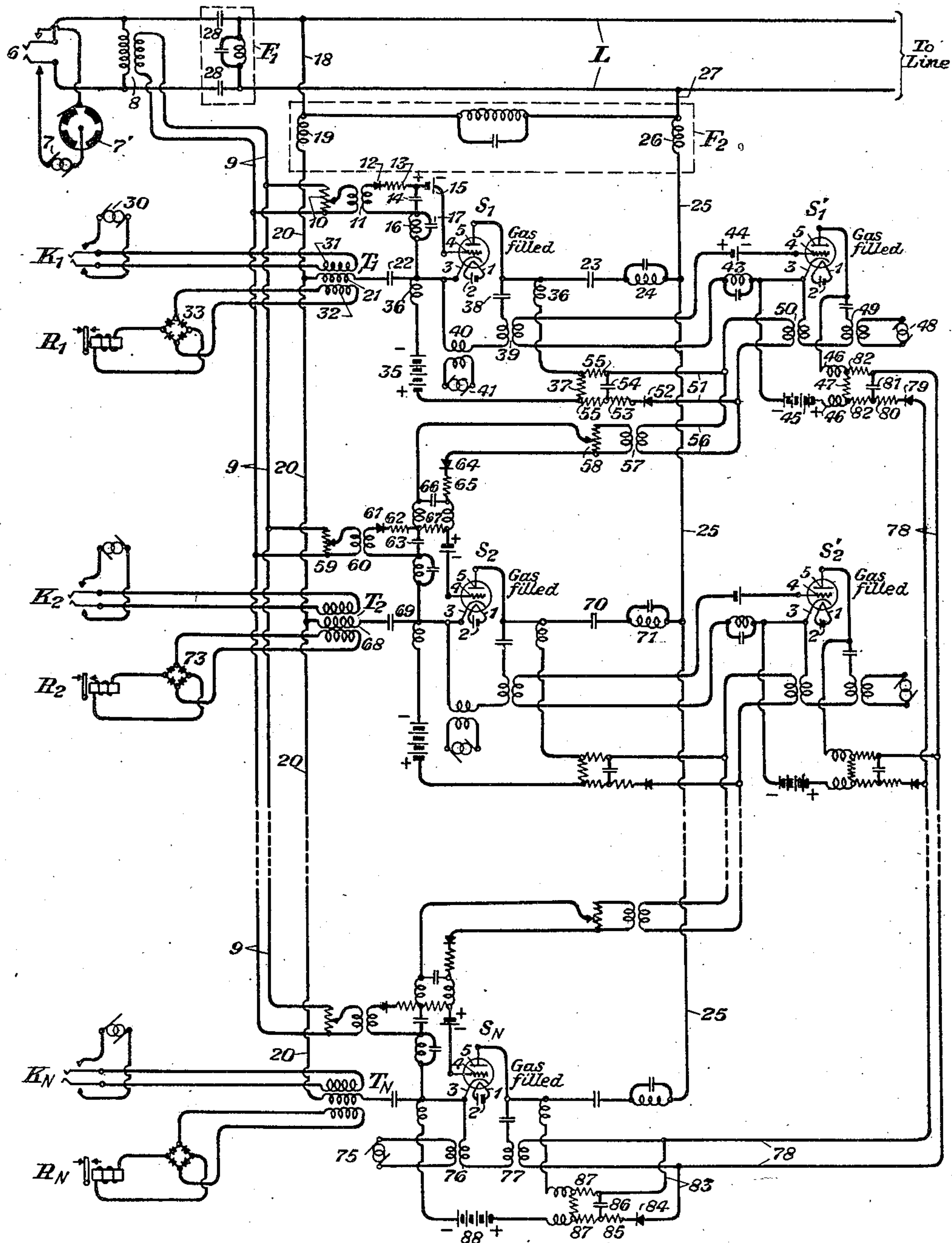


Fig. 3

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UNITED STATES PATENT OFFICE

1,934,685

MULTIPLEX SIGNALING SYSTEM

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Application July 13, 1932. Serial No. 622,347

12 Claims. (Cl. 178—52)

This invention relates to signaling systems and to synchronous switching arrangements for such systems and to means for providing start-stop operation or multiplex operation in signaling systems.

In synchronous switching systems at the present time the means employed to provide successive separate transmission paths is ordinarily a mechanically rotated distributor at the transmitting end of a circuit operated in synchronism with a similar device at the receiving end. These distributors at any instant provide a complete circuit through brushes and contact elements which is distinct from the circuit completed an instant later through different contact elements on each distributor. Common uses of such devices include means for multiplex telephone signaling and for certain types of telegraph service. A number of separate signals are transmitted in each revolution of the distributor brush to identify each character transmitted. These distributors may be rotated at high speeds so that a large number of separate signals may be transmitted.

Various means are employed for synchronizing the distributors at the two ends of a circuit. In start-stop operation the distributor brushes are normally held unoperated until the start signal is applied at the sending end, after which one revolution of the sending distributor is permitted and the brush is again stopped. The start signal is also transmitted to the receiving end followed by the successive signals corresponding to the condition of the distributor bars swept over in each revolution. At the receiving end the start signal releases the distributor brush, permitting one revolution, and the successive signals are impressed on the corresponding bars of the distributor. By operating both distributors at approximately the same speed the lack of synchronism in one revolution is negligible. For continuous operation of the distributors a synchronizing channel separate from the signaling channels may be employed or other means for holding synchronism locally without transmitting a separate signal therefor.

In the arrangements disclosed in this invention the mechanically rotated distributors are replaced by switching units employing gas-filled tubes. These tubes are used both as circuit elements and as parts of the synchronizing system, thus performing both of the functions heretofore performed by the mechanical distributor. The arrangements are such that start-stop or continuous synchronous operation may be obtained. Other features and objects of the invention will

be shown more fully in the following detailed description.

The invention may be more fully understood from the following description together with the accompanying drawings in the Figures 1, 2 and 3 of which the invention is illustrated. Fig. 1 is a circuit diagram embodying one form of the invention. Figs. 2 and 3 are circuit diagrams showing modifications of the invention. Similar reference characters have been utilized to denote like parts in all of the figures.

Figs. 1 and 2 show circuit arrangements for providing start-stop operation. Since the sending and receiving apparatus and circuits are identical only one end of the circuit is shown in these figures. Synchronism of the sending and receiving circuits is provided by adjustment of the corresponding timing elements in the synchronizing circuits at each end of the circuit.

Fig. 1 shows an arrangement in which the application of the start signal causes the apparatus to operate through one cycle and stop until the start signal is again applied. The signals transmitted over the various channels during the cycle will depend upon the condition of the corresponding sending keys K_1, K_2 , etc. These are shown here as separate keys but may be contacts operated, for instance, by a master key which closes certain of these contacts to transmit a desired sequence of signals. Printing telegraph equipment might also be used to control these keys. As these signals are received they are distributed to the receiving elements corresponding to sending elements at the other end of the circuit. The receiving elements are shown here for convenience as a rectifier and relay but may be any one of a number of well known receiving devices; for instance, the relays may be the operating magnets controlling a desired display of light signals.

Fig. 2 shows an arrangement by which the start-stop system of Fig. 1 may be operated as a continuous system by providing a start signal at a predetermined interval after the cycle of operations has been stopped.

Fig. 3 shows a continuously operating system in which synchronism is controlled to a very high degree of accuracy by the continuous transmission of a separate synchronizing signal of a frequency different from that of the channel signals.

In Fig. 1 is shown an arrangement of gas-filled tubes in two general groups: The first group, $S_1, S_2 \dots S_N$, performing the functions of closing and opening the separate transmission paths in addition to aiding in the synchronization, and the second, S_L, S_1', S_2' , etc., being used only for

synchronizing purposes. These tubes are so interconnected that the line circuit is normally held open until the start signal is transmitted, whereupon voltage is applied to the input circuits of all the tubes $S_1, S_2, \dots S_N$. Tube S_1 operates immediately and operates S_1' , which, after a predetermined interval, quenches S_1 and shortly thereafter operates S_2 . The operation of S_2 causes the operation of S_2' , which in turn quenches S_2 and then after an interval operates a succeeding tube similar to S_2 . This sequence continues until S_N is operated. This tube quenches the start tube S_L , removing power from the inputs of S_1, S_2 , etc., and also the auxiliary tubes S_1', S_2' , etc. After the desired interval S_N quenches itself and the circuit is restored to normal, ready for the next start signal. A start signal is also transmitted to the distant end of the circuit at the time it is transmitted to the tubes at the sending end and the closing and opening of the various transmission paths through tubes $S_1, S_2, \dots S_N$ is duplicated in identical fashion at the receiving end. If the sending keys are closed or open the corresponding signal or lack of signal will be received on the proper channels provided the adjustment of the operation and quenching of corresponding tubes is closely enough in synchronism at the two ends of the circuit. As the condition of the various sending keys changes for each cycle of operation different groups of signal impulses corresponding to different characters are received.

In Fig. 1 the gas-filled thermionic tubes each consists of a filament or heater 1 energized by a battery 2, a cathode 3, grid 4 and anode or plate 5 enclosed in an envelope containing gas at the desired pressure. The gaseous content of the tube might, for example, be neon. In this figure the start signal is transmitted by closing key 6 momentarily. Current from the alternating current source 7 is then transmitted through key 6 to winding 8 of transformer T_L and at the same time over leads L in the line circuit to the corresponding winding 8 of transformer T_L at the receiving end of the line circuit. The current through winding 8 induces a voltage in winding 9 which is applied between grid and cathode of tube S_L , through the tuned circuit consisting of inductance 10 and condenser 11 in parallel and battery 12. The tuned circuit is tuned to the frequency of the alternating current supplied to the anode circuit in order to prevent this frequency from affecting the grid circuit of the tube. Battery 12 is provided to hold the grid of S_L normally more negative than the ionizing voltage of the tube. The application of the voltage from winding 9 is sufficient to drive the grid in the positive direction to cause ionization of the gas present. Anode voltage is supplied by battery 13, the plate current flowing, when the tube ionizes, from battery 13 through resistance 14, choke coils 15, and the anode-cathode arc path in the tube. Resistance 14 is adjusted to limit the current flow to the value required to maintain the arc. When the arc is established the resistance of the anode-cathode path drops from a very high to a very low value, thus effectively closing a circuit through transformers 16 and 17 and condenser 18. This condenser is provided to open the circuit to direct current to prevent short-circuiting battery 13. When this circuit is closed voltage from the alternating current source 20 is transmitted through transformers 16 and 17 to leads 21 and 22. Tube S_L remains ionized until the end of the cycle of operations to be herein-

after described. Consequently, the voltage supplied to these two sets of leads is continuous until that time. The voltage on leads 21 is applied to the input circuits of tubes $S_1, S_2, \dots S_N$ simultaneously, but as described below tubes $S_2, \dots S_N$ are arranged not to operate on this input alone. Tube S_1 , however, is arranged to ionize a predetermined time after tube S_L has been operated as will be hereinafter pointed out. The ionization of S_1 closes the line circuit through lead 23, winding 24 of transformer T_1 , condensers 25, the anode-cathode arc path of tube S_1 , tuned circuit 26 and lead 27 to the other side of line L . S_1 remains ionized until quenched by tube S_1' , as described below. The operation of tube S_1 occurs as follows: Voltage from leads 21 is impressed through transformer 28 on the input circuit consisting of rectifier 29, resistance 30 and condenser 31. Due to the constants of the rectifier, condenser and resistance the voltage across condenser 31 builds up until the grid potential reaches the point at which ionization of tube S_1 occurs. This causes the tube S_1 to operate a predetermined time after the operation of tube S_L . Tuned circuit 32 is provided to prevent operation of S_1 by the alternating current supplied to the anode circuit.

When tube S_1 has ionized, the circuit through transformers 34 and 35 and condenser 36 is closed. The condenser serves the same purpose as the corresponding unit 18 associated with tube S_L . Voltage from source 38 is then transmitted through the transformers to the input circuit of tube S_1' which ionizes immediately and remains ionized until the end of the cycle of operations when it is quenched by tube S_N . Upon the ionization of S_1' the voltage on leads 22 which is supplied by source 20 through tube S_L , as described above, is applied through transformers 39 and 40 to the rectifier circuits associated with tubes S_1 and S_2 . Rectifier 41, resistance 42 and condenser 43, associated with the anode circuit of tube S_1 are so adjusted as to build up a voltage across the condensers which opposes the voltage of battery 46 and reduces the effective anode voltage of tube S_1 below that required to maintain the arc, thus quenching S_1 and opening the heretofore described signal transmission path through this tube after the desired transmitting interval has elapsed. Resistances 44 are provided to dissipate the charge on condenser 43 after the alternating current voltage is removed when tube S_1' is quenched. Resistance 45 limits the anode current from battery 46. Choke coils 47 are provided to offer a high impedance to alternating current of either the frequency of source 38 or source 20. At the same time that voltage is being applied to the circuit of rectifier 41 it is also applied to the circuit consisting of rectifier 48, resistance 49 and condenser 50 associated with the grid circuit of tube S_2 . The voltage across condenser 50 builds up to apply positive voltage to the grid of S_2 , opposing the voltage of battery 53. However, tube S_2 will not ionize due to this input alone, but requires the combined inputs of rectifiers 48 and 54. The voltage across condenser 56 has already been built up to its maximum value from the voltage applied by leads 21 during the time of operation of tube S_1 . The constants of resistance 49 and condenser 50 are so chosen that tube S_2 will ionize shortly after tube S_1 has been quenched by the action of rectifier 41 described above. This closes the line circuit from one side of line L through lead 23, winding

58 of transformer T_2 , condensers 59, the arc path of tube S_2 , tuned circuit 60 and lead 27 to the other side of line L. Under this condition voltage from the alternating current source 61 is supplied to tube S_2' in a manner similar to that described for tubes S_1 and S_1' and S_2' ionizes and remains ionized until the end of the cycle of operations. Tube S_2 is quenched after the desired transmission interval and succeeding sets of tubes are ionized shortly thereafter in the same manner as described for tube S_2 , and so on until tube S_N is in turn ionized, closing the transmission path from one side of line L through lead 23, winding 62 of transformer T_N , condensers 63, the arc path of tube S_N , tuned circuit 64 and lead 27 to the other side of line L.

Upon the ionization of tube S_N the voltage supplied by source 65 is transmitted through transformers 66 and 67 to leads 68. This voltage is applied to the rectifier circuit associated with tube S_L . Rectifier 69, resistance 70 and condenser 71 are so adjusted that the voltage across the condenser opposes the voltage of battery 13, thus quenching tube S_L . Resistances 72 are provided to dissipate the charge on condenser 71 when the voltage from leads 68 is removed by the quenching of S_N . The adjustment of resistance 70 and condenser 71 is such as to cause tube S_L to quench shortly after tube S_N ionizes. The voltage on leads 68 is also impressed at the same time on the rectifier circuits associated with tubes S_1' , S_2' , etc., causing these tubes to be quenched also, but after the quenching of S_L , so that tube S_1 will not again ionize upon the quenching of S_1' . Voltage from leads 68 is also impressed upon rectifier 73 associated with the anode circuit of tube S_N , and resistance 74 and condenser 75 are so adjusted that S_N will be quenched after both S_L and the auxiliary tubes S_1' , S_2' , etc., have been quenched and after the desired transmission interval has elapsed. This completes the cycle of operations and restores the circuit to the normal condition when it may be restarted by momentarily closing the starting key 6.

During the cycle of operations just described the line circuit has been closed successively at each end of the circuit through transmission paths 1, 2, 3 . . . N in succession. The signals transmitted over each separate path are dependent upon whether keys K_1 , K_2 . . . K_N are operated or released. If these keys are operated signals are transmitted from the alternating current signal source 79 through windings 80 of transformers T_1 , T_2 . . . T_N , over the line circuit and are received at the other end of the circuit over the corresponding transmission paths through windings 81 of the corresponding transformers. The receiving units R_1 , R_2 . . . R_N will then operate or not, depending upon whether the corresponding keys K_1 , K_2 . . . K_N are closed or open.

In Fig. 2 is shown a circuit which has elements identical with those of Fig. 1 for operation in a similar manner, except for several changes in the circuit of tube S_N and the addition of tube S_T for the purpose of restarting the cycle automatically to obtain repeated operation. The operation of the various tubes S_1 , S_2 . . . S_N and the auxiliary tubes S_1' , S_2' , etc., is the same as described in connection with Fig. 1. Upon operation of tube S_N voltages will be applied to leads 68 as before from source 65. The voltage on these leads is applied to the rectifier circuit of tube S_L to quench this tube as before and also to the rectifier cir-

cuits of tubes S_1' , S_2' , etc., to quench these tubes following the quenching of S_L . In this arrangement, however, the voltage on lead 68 is also applied to the grid circuit rectifier of an additional tube S_T whose purpose is to quench S_N and also to restart the cycle. The detailed operation is as follows: The voltage on leads 68 is applied through transformer 82 to rectifier 83, resistance 84 and condenser 85 and in a predetermined time causes the ionization of tube S_T . When this occurs voltage from source 88 is applied through transformers 89 and 90 to the rectifier circuits associated with the plate circuits of tubes S_N and S_T . The adjustment of rectifier 73, resistance 74 and condenser 75 is such as to quench tube S_N after transmission path N has been closed for the desired time. The adjustment of rectifier 91, resistance 92 and condenser 93 is such that tube S_T is quenched shortly after tube S_N has been quenched. However, since tube S_N is quenched after S_L and S_1' , S_2' , etc., and thus removes the quenching voltage from the plate circuit rectifier of tube S_L , the voltage from source 88 applied through transformers 89 and 97 to the winding 98 of transformer T_L will re-ionize tube S_L and start a new cycle. Tube S_T is arranged to be self-quenching shortly after the new cycle is started.

Fig. 3 shows an arrangement for continuous operation in which the synchronization is controlled by a separate synchronizing signal of a different frequency from the channel signals. Filters F_1 and F_2 are provided to confine these two frequencies to the proper channels. In this arrangement which uses tube circuits somewhat similar to those described in connection with Figs. 1 and 2, the input rectifier circuits are so adjusted that ionization will occur only when the peak value of the synchronizing voltage is reached or when spurts of interrupted high frequency current are transmitted. In this way successive operation of the tubes S_1 , S_2 , etc., may be very accurately spaced and synchronized with the corresponding tubes at the receiving end of the circuit.

As shown in Fig. 3 a line L connects two similar groups of gas-filled tubes S_1 , S_2 . . . S_N arranged to be used as either transmitting or receiving elements. Filters F_1 and F_2 are provided to separate the synchronizing frequency from the signal frequency. At the sending end the closing of key 6 transmits alternating current of frequency F_1 from the source 7 and interrupter 7' through transformer 8 to leads 9 which are connected to the grid circuits of the various tubes S_1 , S_2 . . . S_N . The grid circuits of tubes S_2 . . . S_N are so adjusted that they will cause ionization at the peak values of the signal voltage only when an additional input is received from the preceding auxiliary tubes S_1' , S_2' , etc. When the synchronizing voltage is first applied by the closing of key 6 it is applied to tube S_1 through potentiometer 10 and transformer 11 to the grid circuit which consists of rectifier 12, resistance 13, condenser 14, battery 15 and a tuned circuit containing a coil 16 and condenser 17. The alternating current received from the synchronizing source 7 is rectified by rectifier 12 and builds up a charge on condenser 14 which is applied between the cathode and grid of tube S_1 . Battery 15 is provided to hold the grid 4 normally more negative than the value required to ionize tube S_1 so that the tube will not be operated until the peak value of synchronizing voltage is applied. The tuned circuit is provided to prevent alternating current applied to the anode circuit from affecting the grid circuit. By adjusting the potentiometer 10 and the values of

resistance 13 and condenser 14 the tube may be made to ionize only at the peak value of the synchronizing voltage.

When tube S_1 ionizes, the arc path resistance between the anode 5 and cathode 3 drops from a very high to a very low value and effectively closes a circuit consisting of one side of line L, lead 18, coil 19 of filter F_2 , lead 20, winding 21 of transformer T_1 , condenser 22, the arc path of tube S_1 , condenser 23, tuned circuit 24, lead 25, coil 26 of filter F_2 , lead 27 and the other side of line L. At the time when key 6 is closed the synchronizing frequency is also transmitted from source 7 through condensers 28 of filter F_1 to the line L and thence to the receiving end of the circuit where it passes through the corresponding filter F_1 to transformer 8 and to the input circuit of tube S_1 at the receiving station. The adjustments of the tube circuits at the receiving end are identical with those at the transmitting end so that the corresponding tubes will ionize and close the circuit through their arc paths at the same time that these paths are closed at the sending end. Under the conditions for tube S_1 if key K_1 is closed, a current of frequency F_2 from source 30 will flow through winding 31 of transformer T_1 , causing current to flow through the circuit described above and inducing a voltage in winding 32 of the receiving transformer T_1 . This causes the current to flow through the rectifier 33 to the receiving device R_1 which may be of any well known form.

The plate potential of tube S_1 is provided by battery 35 which is applied through chokes 36 and resistance 37 between the cathode and anode. When the tube ionizes as described above, the path consisting of the arc path of the tube, condenser 38 and the windings of transformers 39 and 40 is closed and power is then supplied by the alternating current source 41 through transformers 39 and 40 to the grid circuit of S_1' . Condenser 38 is provided to prevent short-circuiting battery 35.

When alternating current is applied to transformer 39 and thence to the grid circuit of tube S_1' through tuned circuit 43 and battery 44, this tube ionizes immediately, its plate voltage being supplied by battery 45 through chokes 46 and resistance 47. Alternating current from the source 48 is transmitted through transformers 49 and 50 over leads 51 to the rectifier 52. Resistance 53 and condenser 54 are so proportioned that the charge built up on condenser 54 requires a predetermined time to reach such a value that tube S_1 is quenched. This time is determined so that tube S_1 is de-ionized before tube S_2 is ionized to prevent both paths being closed in parallel. Resistances 55 are provided to limit the rate at which condenser 54 discharges during the negative half cycle of voltage applied to the rectifier from source 48. Tube S_1' will continue in the ionized state until the entire cycle of operations has been performed and the quenching voltage is transmitted from tube S_N to all the auxiliary tubes. The continued ionization of S_1' prevents S_1 from ionizing again during the same cycle.

Power is also transmitted from source 48 through transformers 49 and 50 and leads 56 to the rectifier circuit associated with the grid of tube S_2 . The grid circuit of this tube has two rectifier circuits connected in series, the adjustments of potentiometers 58 and 59 being arranged so that neither rectifier alone will provide sufficient voltage to cause ionization of the tube. Thus tube S_2 is prevented from operating until

S_1 has been operated and quenched and similarly for all succeeding tubes.

When alternating current is transmitted from source 7 through key 6, transformer 8 and leads 9 to potentiometer 10 associated with tube S_1 , the same voltage is applied to potentiometer 59 and thence through transformer 60 to rectifier 61. Resistance 62 and condenser 63 are so proportioned that the charge on the condenser builds up to a maximum at each peak of the rectifier input voltage. After tubes S_1 and S_1' have been operated and alternating current is transmitted through transformer 57 and potentiometer 58 to rectifier 64, resistance 65 and condenser 66, the voltage drop across resistance 67 added to the peak value of charge on condenser 63 is sufficient to operate S_2 .

Tube S_2 is ionized shortly after tube S_1 has been quenched as described above and closes a path through winding 68 of transformer T_2 , condenser 69, the cathode-anode path through the tube condenser 70 and tuned circuit 71. The line circuit is then closed through tube S_2 in place of tube S_1 and a signal will be transmitted over line L to the far end depending upon the condition of switch K_2 . At that time the corresponding tubes at the far end of the line have been operated in a manner identical with that described for the transmitting end. The signal transmitted through switch K_2 will be received through transformer T_2 at the receiving end rectified by rectifier unit 73 and operate receiving device R_2 .

The quenching of S_2 through the operation of S_2' and the subsequent operation of other similar sets of tubes, will occur in a manner similar to that described above for S_1 and S_2' . Since the auxiliary tubes S_1' , S_2' , etc., remain ionized until the end of the cycle, tubes S_1 , S_2 , etc., are prevented from ionizing twice during a complete cycle upon successive peaks of signaling voltage. When S_N is operated, closing the circuit through T_N , and transmitting the signal determined by the condition of key K_N , the alternating current supplied by source 75 will be transmitted through transformers 76 and 77 and leads 78 to the rectifiers associated with the plate circuits of all the auxiliary tubes S_1' , S_2' , etc. Thus, in connection with tube S_1' , rectifier 79, resistance 80 and condenser 81 are arranged to build up a voltage across the condenser to oppose the voltage of battery 45 so that tube S_1' will be quenched. Tube S_2' and other corresponding tubes are quenched in a similar manner.

Voltage from source 75 is also applied to leads 83 and thus to rectifier 84, resistance 85 and condenser 86 to provide a voltage opposing the voltage of battery 88, thus quenching tube S_N . Resistance 85 and condenser 86 are so proportioned that tube S_N is not quenched until all of the auxiliary tubes have been quenched.

When tube S_1' has been quenched tube S_1 is again permitted to be ionized by the synchronizing signals from source 7, providing key 6 is still closed. In this case the same cycle of operation will occur.

While the arrangements described are particularly adapted to start-stop or multiplex operation of signaling systems the principles disclosed are adaptable to other uses. Accordingly, while the invention has been described as embodied in certain specific arrangements, it is understood that it may be used in various forms without departing from the scope of the appended claims.

What is claimed is:

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1. A multiplex signaling system comprising a transmission line, a series of gas filled discharge tubes, means associated with said line for successively rendering the grids of said discharge tubes less negative with respect to their cathodes whereby the tubes of said series will operate in succession, and means controlled by the ionization of each of said tubes for completing individual signaling circuits over said transmission line.

2. A multiplex signaling system comprising a transmission line, a series of gas filled discharge tubes, means associated with said line for ionizing the gas filled tubes of said series successively, means controlled by the ionization of each of said tubes for completing individual signaling circuits over said transmission line, and means controlled by the ionization of the last tube of said series for restoring the tubes of said series to a normal condition of deenergization.

3. A multiplex signaling system comprising a transmission line, a series of gas filled discharge tubes, means associated with said line for successively rendering the grids of said discharge tubes less negative with respect to their cathodes whereby the tubes of said series will operate in succession, means for deenergizing each of the tubes of said series before the succeeding tube has been ionized, and means controlled by the ionization of each of said tubes for completing a signaling circuit over said transmission line.

4. A multiplex signaling system comprising a transmission line, a series of gas filled discharge tubes, means associated with said line for ionizing the gas filled tubes of said series successively, means for deenergizing each of the tubes of said series before the succeeding tube has been ionized, and means controlled by the ionization of the last tube of said series for restoring said apparatus to its original condition.

5. A multiplex signaling system comprising a transmission line, a series of gas filled discharge tubes, switching means associated with said line for ionizing the gas filled tubes of said series successively, means for deenergizing each of the tubes of said series before the succeeding tube has been ionized, means for maintaining said deenergized tubes in a condition of deenergization, means operative when each of the tubes of said series is ionized for completing individual signaling circuits over said transmission line, and means controlled by the ionization of the last tube of said series for restoring said apparatus to its original condition.

6. A multiplex signaling system comprising a transmission line, a series of sets of gas filled tubes, each of said sets comprising a first tube adapted upon ionization to ionize a second tube in said set, switching means associated with said line for applying a voltage to said line and to the grids of the first tube in each of said sets of tubes whereby the first tube of the first set of said tubes will be ionized, means responsive to the ionization of the second tube of said first set for extinguishing the first tube of said first set and for applying a voltage to the grid of the first tube of the succeeding set of tubes to ionize said last mentioned first tube, means responsive to the ionization of the second tube of said last mentioned set for extinguishing the first tube of said set and for applying a voltage to the grid of the first tube of the next succeeding set of tubes to operate said last mentioned first tube, and means controlled by the ionization of each of the first tubes of each of said sets of tubes

for completing individual signaling circuits over said transmission line.

7. A multiplex signaling system comprising a transmission line, a series of sets of gas filled tubes, each of said sets comprising a first tube adapted upon ionization to ionize a second tube in said set, switching means associated with said line for applying a voltage to said line and to the grids of the first tube in each of said sets of tubes whereby the first tube of the first set of said tubes will be ionized, means responsive to the ionization of the second tube of said first set for extinguishing the first tube of said first set and for applying a voltage to the grid of the first tube of the succeeding set of tubes to ionize said last mentioned first tube, means responsive to the ionization of the second tube of said last mentioned set for extinguishing the first tube of said set and for applying a voltage to the grid of the first tube of the next succeeding set of tubes to operate said last mentioned first tube, means responsive to the ionization of the first tube of the last of said sets of tubes in said series for causing the deenergization of each of the second tubes in each set of tubes of said series, and means controlled by the ionization of each of the first tubes of each of said sets of tubes for completing individual signaling circuits over said transmission line.

8. A multiplex signaling system comprising a transmission line, a series of gas filled discharge tubes, switching means associated with said line for ionizing the gas filled tubes of said series successively, means for deenergizing each of the tubes of said series before the succeeding tube has been ionized, means for maintaining said deenergized tubes in a condition of deenergization, means operative when each of the tubes of said series is ionized for completing individual signaling circuits over said transmission line, and means controlled by the ionization of the last tube of said series for restoring said apparatus to its original condition and for subsequently reoperating said switching means to cause a repetition of said cycle of operations with respect to said tubes.

9. A multiplex signaling system comprising a transmission line, a gas filled discharge tube associated with said line for controlling the operation of said signaling system, switching means for applying to said line and to the grid of said control tube a voltage to cause the ionization of said control tube, a series of gas filled discharge tubes, means operative upon the ionization of said control tube for ionizing the gas filled tubes of said series successively, means for deenergizing each of the tubes of said series before the succeeding tube has been ionized, means operative when each of the tubes of said series is ionized for completing individual signaling circuits over said transmission line, and means controlled by the ionization of the last tube of said series for restoring the tubes of said series to their original condition and for deenergizing said control tube.

10. A multiplex signaling system comprising a transmission line, a gas filled discharge tube associated with said line for controlling the operation of said signaling system, switching means for applying to said line and to the grid of said control tube a voltage to cause the ionization of said control tube, a series of gas filled discharge tubes, means operative upon the ionization of said control tube for ionizing the gas filled tubes of said series successively, means for deenergizing each of the tubes of said series before

the succeeding tube has been ionized, means operative when each of the tubes of said series is ionized for completing individual signaling circuits over said transmission line, an additional
5 discharge tube ionized upon the operation of the last tube of said series of tubes, and means controlled by the ionization of said additional tube for restoring the tubes of said series to their original condition, for deenergizing said control
10 tube, for subsequently ionizing said control tube to initiate a cyclic repetition of said operation of said series of tubes, and for subsequently causing its own deenergization.

11. A multiplex signaling system comprising a
15 transmission line extending from a sending station to a receiving station, a series of gas filled discharge tubes at said sending station, a similar series of gas filled discharge tubes at said receiving station, switching means associated with said
20 line for successively ionizing the gas filled tubes of each of said series of tubes, means for deenergizing each of said tubes in each of said series of tubes before the succeeding tube therein has been ionized, means operative when corresponding
25 tubes in each of said series of tubes are

ionized for completing individual signaling circuits over said transmission line.

12. A multiplex signaling system comprising a transmission line extending from a sending station to a receiving station, a series of gas filled
80 discharge tubes at said sending station, a similar series of gas filled discharge tubes at said receiving station, switching means for applying to said line a synchronizing operating voltage for successively ionizing the gas filled tubes of each of
85 said series of tubes, said synchronizing operating voltage being produced by spurts of high frequency current applied to said line and to the input circuits of the tubes of said series and said tube input circuits being adjusted so that
90 said tubes will become ionized only upon the application to said input circuits of said operating intermittent synchronizing voltage, means for deenergizing each of the tubes in each of said series of tubes before the succeeding tube therein
95 has been ionized, and means operative when corresponding tubes in each of said series of tubes are ionized for completing individual signaling circuits over said transmission line.

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