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CIRCUITS FOR GRID CONTROLLED GAS FILLED ELECTRON TUBES

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**Fig. 1**

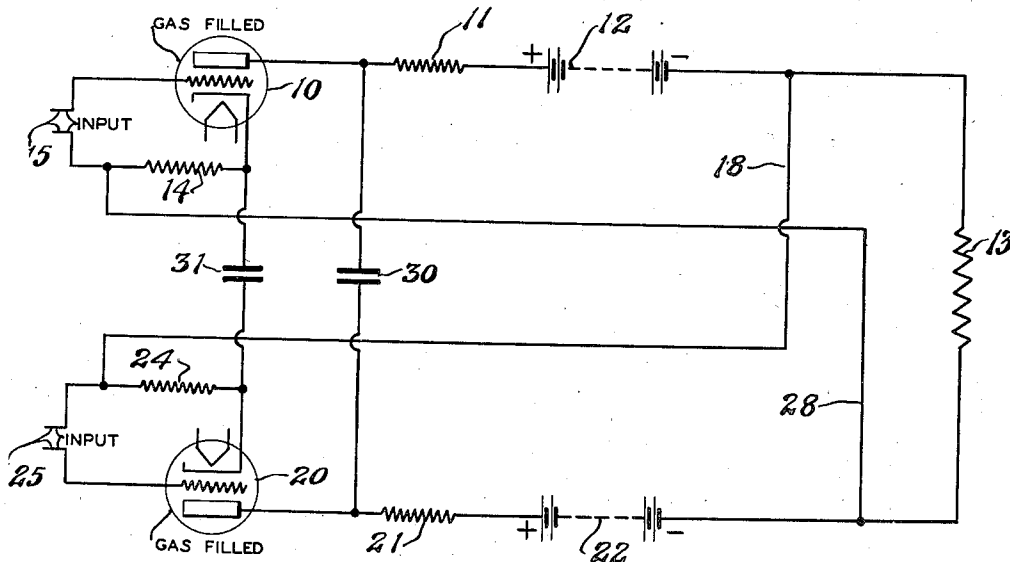
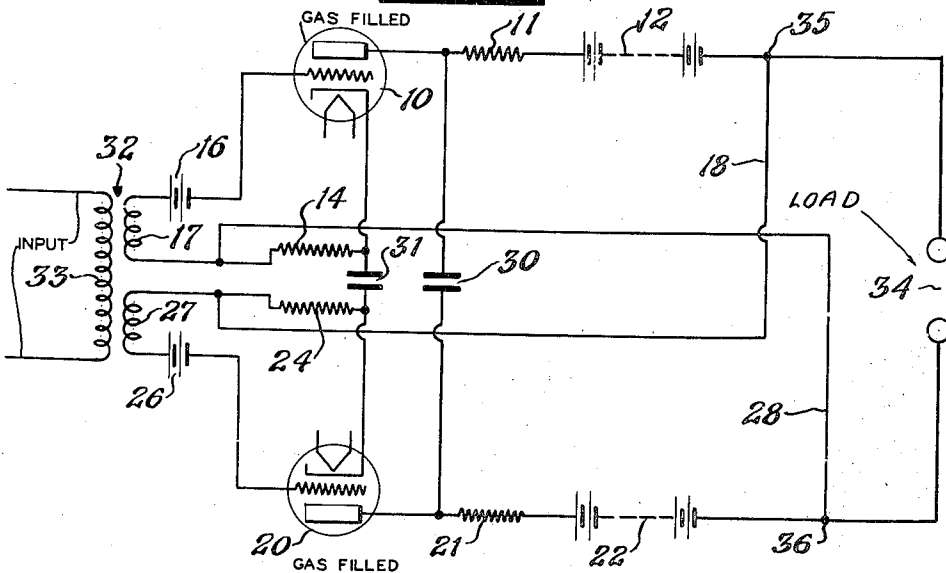


**Fig. 2**



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## UNITED STATES PATENT OFFICE

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CIRCUITS FOR GRID CONTROLLED GAS  
FILLED ELECTRON TUBES

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6 Claims. (Cl. 250—27)

The present invention relates to circuits for grid controlled gas filled electron tubes, and particularly to circuits which make it possible to utilize such tubes for causing current reversals at high speeds.

It is an object of the invention to provide a circuit for grid controlled electron tubes of the gas filled type whereby these tubes may be utilized to give controlled reversals at high speed.

It is another object of the invention to utilize a pair of tubes and to provide a circuit which will make it possible to fire one of the tubes and at the same time extinguish the other tube of the pair quickly.

It is a further object of the invention to provide a circuit as mentioned above in which the apparatus for accomplishing the purposes mentioned shall be simple and inexpensive.

Further objects and features of the invention will appear when the following description is considered in connection with the appended drawing, in which

Figure 1 is a diagram showing the circuit connections for utilizing two gas filled grid controlled electron tubes as a polarity reversing means; and

Figure 2 is a diagram similar to Figure 1 showing in addition, however, one method of connecting the tubes to a control circuit, and biasing batteries for biasing the grids of the two tubes. The method shown in this figure may be utilized for the repeating of polar telegraph signals.

Referring now to Figure 1, there are two grid controlled gas filled electron tubes 10 and 20. These electron tubes may be of either the hot cathode or cold cathode type and may be either negative, positive, or combination control tubes. In the present instance, however, it is assumed that the tubes are of the hot cathode type, and also of the negative control type. Tube 10 has an anode-cathode circuit which includes a resistance 11, current source 12, load 13 and resistance 14, as well as a grid cathode circuit which includes resistance 14 and a source of control potential.

In a similar manner the tube 20 is provided with an anode-cathode circuit comprising resistance 21, current source 22, load 13, and resistance 24, and with a grid cathode circuit including resistance 24 and a source of control potential 25. It will be seen that the load 13 is common to the output circuits of the two tubes 10 and 20, and that therefore if one tube can be caused to extinguish its arc whenever the other tube ignites, then current reversals may be produced in the load 13.

In the present instance the resistances 11, 21, 55

14 and 24, together with the condensers 30 and 31, the former of which is connected across the anodes and the latter across the cathodes of the two tubes, combine to produce circuit conditions which cause the extinction of one tube of the pair in a time period of the order of micro-seconds after ignition of the other tube.

Figure 2 shows a circuit substantially identical with that of Figure 1 except that in Figure 2 the grid circuits for the two tubes include biasing batteries 16 and 26 and secondary windings 17 and 27 of a transformer 32. The primary winding 33 of transformer 32 is connected to a controlling source which may be a telegraph line. The control signals of the primary winding appear in the secondaries of the transformer as voltages, which are effective in causing the firing and thus the extinction of the tubes in a proper manner in response to the control signal.

Without limiting myself as to the mode of operation of the circuit described, or as to the theory of its operation, I believe that the circuit operation is as follows:

If a potential is applied to the winding 33 of transformer 32, this potential may generate a potential with positive polarity toward the grid in transformer winding 17 and simultaneously one of negative polarity toward the grid in transformer winding 27. If the impulse in winding 17 is sufficiently large it will cause tube 10 to be fired. Of course, the negative impulse in winding 27 will apply a negative voltage to the grid of tube 20 which will have no effect on this tube.

Due to the ignition of tube 10, current will flow through a circuit including battery 12, resistance 11, tube 10, resistance 14, conductor 28, terminal 36, line 34, any load which there may be on that line, and terminal 35. Due to flow of current in this circuit there will be voltages applied to the various circuit components, the voltages across condenser 30 being equal to the load voltage (i. e., the voltage across terminals 35 and 36) plus the voltage across resistance 11. Condenser 30 will be charged in such a manner that the terminal adjacent tube 10 will be negative and that adjacent tube 20 will be positive.

Condenser 31 will also acquire a charge. The potential across this condenser will be the potential of battery 12 minus the voltage drops across resistance 11 and tube 10. The charge on this condenser will be such that the terminals adjacent the cathode of tube 10 will be positive and that adjacent the cathode of tube 20 will be negative.

If, now, a control signal of opposite polarity is

applied to winding 33, voltages are generated in the grid circuits of tubes 10 and 20 in the opposite direction to those previously described. Therefore, tube 20 will ignite. The negative impulse applied to the grid of the tube 10 is without effect and the current therefore continues to flow through tube 10. Since tube 10 is not extinguished and tube 20 is fired, it is obvious that the two tubes will be conducting at the same time and the path of current flow will thus be from battery 12 through conductor 18, resistance 24, tube 20, resistance 21, battery 22, conductor 28, resistance 14, tube 10, resistance 11, and back to battery 12.

Due to this condition, the voltage across terminals 35 and 36, or in other words the voltage across the line or load, becomes zero, and in addition the voltages applied to condensers 30 and 31 become zero. However, these condensers have been charged, as was explained before, and since the ignition of tube 20 takes place in a few micro-seconds, condensers 30 and 31 retain substantially all of their original charge and are therefore at the voltages mentioned hereinabove.

The voltage which exists across tube 10 at this instant may be found by adding the voltages around any loop of the circuit starting and ending at tube 10. Since it is the effect of the voltages across condensers 30 and 31 which is of primary interest, the loop from tube 10 going through condenser 30, tube 20, condenser 31, and back to the cathode of tube 10 will be considered.

As explained, the polarity of condenser 30 was negative toward the anode of tube 10 and that of condenser 31 positive toward the cathode of tube 10. Therefore the potential between the cathode and anode of tube 10 must be the voltage of condenser 30 plus the voltage of condenser 31, minus the internal voltage drop within tube 20. The voltage drop within the tube is low relative to the voltages across condensers 30 and 31, and therefore the polarity of the voltage on tube 10 will be negative at the anode and positive at the cathode. This will, of course, be effective to stop conduction through tube 10 and permit the grid of that tube to regain control.

At this time condensers 30 and 31 will discharge and cause a negative potential to be applied to the anode and a positive potential to the cathode of tube 10, thereby stopping conduction. The discharge current will in this case flow through resistance 14 and cause a high negative potential on the grid of tube 10.

However, although the action above described occurs almost instantly when tube 20 ignites, the grid of tube 10 has not actually reacquired control of the tube until the gas in the tube is completely de-ionized, or until the ions are assembled at a point where they will not cause resumption of conduction when the anode again becomes positive. It is common practice to insert a negatively charged electrode in an ion chamber to prevent the resumption of conduction due to the anode becoming positive. I have found that the grid serves this purpose when, as described above, the grid is made highly negative by the discharge of condenser 31 through resistance 14, which is in the grid circuit.

By the time that the discharge and recharging of condensers 30 and 31 in the opposite direction is complete, the grid of tube 10 has regained complete control of that tube and the reappearance of a positive potential at the anode relative to the cathode will fail to fire the tube. Tube 20 is now conducting and its anode current has

reached a steady state, which is exactly the condition which existed after the firing of tube 10, except that now tube 20 is conducting instead of tube 10, the direction of current flow through the load is reversed, and the polarity of the charging potential across condensers 30 and 31 is reversed. These polarities bear the same relation to tube 20 that the former ones did to tube 10, so that when the next signal reversal is received on the incoming line a positive pulse of voltage in the grid circuit of tube 10 will be produced, and tube 10 will be fired while tube 20 will be extinguished. It will be seen that upon each reversal a current impulse of corresponding polarity is sent into the outgoing line 34 or the load resistance 13 as the case may be.

It is, of course, assumed that the various resistances and condensers are selected to properly perform their functions, but it is to be understood that the values of these elements are not critical and that on the contrary it is the combination of resistances 11, 21, 14 and 24 with the condensers 30 and 31 which brings about the result achieved, rather than any particular or critical values of these elements.

Although it is preferable to utilize all the circuit elements mentioned, the circuit is operable when resistances 11 and 21 are omitted.

It is, of course, obvious that the values of the various resistances and condensers will vary in accordance with the particular tubes utilized and likewise obvious that the values of the resistances associated with the two tubes must be substantially equal if similar batteries 12 and 22 are to be utilized and the positive and negative outgoing impulses are to be substantially identical with respect to their amplitude.

While I have shown a preferred embodiment of my invention, it is to be understood that many modifications and alterations might be made within the scope of the invention, and therefore I do not wish to be limited by the foregoing description but on the contrary wish to have my invention limited only by the appended claims.

What I claim is:

1. In electronic reversing switch apparatus, in combination, two grid-controlled gas filled electron tubes, each having anode, cathode and grid electrodes, an input circuit extending from the grid to the cathode of each tube, each said circuit comprising a source of grid bias, a signal source and a series resistor, one end of said resistor being connected to said cathode, an output circuit extending from anode to cathode of each tube, each said output circuit comprising a series resistor one end of which is connected to the anode, a battery, a load, and a return to cathode through said series input resistor, said load being common to the output circuits and said other elements being individual to the particular output circuit, a capacity interconnecting the cathodes of said tubes and a capacity interconnecting the anodes of said tubes.

2. In an electronic device for producing in a load circuit current reversals in accordance with received signals, in combination, two grid controlled gas filled electron tubes each having anode, cathode and control electrodes, a single load circuit connected to the anodes and cathodes of both said tubes, an input circuit extending from grid to cathode of each tube, each input circuit including means for applying received signal potentials to the corresponding grid, said applying means being reversed in one input circuit with respect to the other, whereby a signal of given

polarity will tend to render one tube conducting and a signal of opposite polarity will tend to render the other tube conducting, an output circuit for each tube, each circuit comprising a source of potential and said common load, and a capacity connecting the anode of one tube to the anode of the other, said capacity being discharged and charged in the opposite direction upon reversals of the received signal and consequent ignition of the second of the two tubes, said reversal acting to reduce the anode voltage of the first tube to a value below that at which conduction can continue.

3. In an electronic device for producing in a load circuit current reversals in accordance with received signals, in combination, two grid controlled gas filled electron tubes each having anode, cathode and control electrodes, a load circuit connected to the anodes and cathodes of both said tubes, an input circuit extending from grid to cathode of each tube, each input circuit including means for applying received signal potentials to the corresponding grid, said applying means being reversed in one input circuit with respect to the other, whereby a signal of given polarity will tend to render one tube conducting and a signal of opposite polarity will tend to render the other tube conducting, an output circuit for each tube, each output circuit comprising a source of potential, said common load, and a resistor, said resistor being likewise included in the corresponding input circuit, and a capacity connecting the anode of one tube to the anode of the other, said capacity being discharged and charged in the opposite direction upon the reversals of the received signal and consequent ignition of the second of the two tubes, said reversal acting to reduce the anode voltage of the first tube to a value below that at which conduction can continue.

4. In an electronic device for producing in a load circuit current reversals in accordance with received signals, in combination, two grid controlled gas filled electron tubes, each having anode, cathode and control electrodes, a load circuit connected to the anodes and cathodes of both said tubes, an input circuit extending from grid to cathode of each tube, each input circuit including means for applying received signal potentials to the corresponding grid, said applying means being reversed in one input circuit with respect to the other, whereby a signal of given polarity will tend to render one tube conducting and a signal of opposite polarity will tend to render the other tube conducting, an output circuit for each tube, each output circuit comprising a source of potential, said common load, and a resistor, said resistor being likewise included in the corresponding input circuit, a capacity connected from the cathode of one tube to the cathode of the other, said capacity being discharged and recharged in the opposite direction upon reversal of the received signals and consequent ignition of the second tube, said discharge flowing through said series input resistor and acting to raise the cathode potential of the first tube to such a value with respect to the anode of that tube that conduction cannot continue.

5. In an electronic device for producing in a load circuit current reversals in accordance with received signals, in combination, two grid controlled gas filled electron tubes each having anode, cathode and control electrodes, a load circuit connected to the anodes and cathodes of both said tubes, an input circuit extending from grid to cathode of each tube, each input circuit including means for applying received signal potentials to the corresponding grid, said applying means being reversed in one input circuit with respect to the other, whereby a signal of given polarity will tend to render one tube conducting and a signal of opposite polarity will tend to render the other tube conducting, an output circuit for each tube, a capacity connecting the anode of one tube to the anode of the other, said capacity being discharged and charged in the opposite direction upon reversals of the received signal and consequent ignition of the second of the two tubes, an output circuit for each tube, each output circuit comprising a source of potential, said common load, and a resistor, said resistor being likewise included in the corresponding input circuit, said reversal acting to reduce the anode voltage of the first tube, and a capacity connected from the cathode of one tube to the cathode of the other, said capacity being discharged and charged in the opposite direction upon reversal of the received signals and consequent ignition of the second tube, said discharge taking place through the said series input resistor and acting to raise the cathode potential of the first tube, said reduction in anode potential and increase in cathode potential of the first tube together acting to render said first tube non-conducting and to maintain it in that condition.

6. In an electronic device for producing in a load circuit current reversals in accordance with received signals, in combination, two grid controlled gas filled electron tubes each having anode, cathode and control electrodes, a load circuit connected to the anodes and cathodes of both said tubes, an input circuit extending from grid to cathode of each tube, each input circuit including means for applying received signal potentials to the corresponding grid, said applying means being reversed in one input circuit with respect to the other, whereby a signal of given polarity will tend to render one tube conducting and a signal of opposite polarity will tend to render the other tube conducting, an output circuit for each tube, each said output circuit comprising a source of potential, two resistances, one of which is also included in the corresponding input circuit, and said common load, and a capacity connecting the anode of one tube to the anode of the other, said capacity being discharged and charged in the opposite direction upon reversals of the received signal and consequent ignition of the second of the two tubes, said reversal of charge acting to produce a potential drop through said anode resistance of said first tube to thereby reduce the anode potential of that tube to a value below that at which conduction can occur.

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