May 9, 1944. R. E. MATHES 2,348,555

IONIC RELAY CIRCUIT ARRANGEMENT

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Fig. 1.

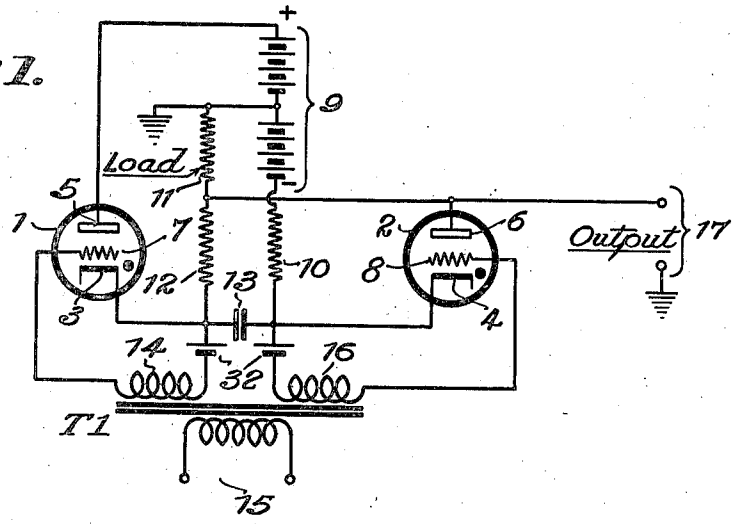
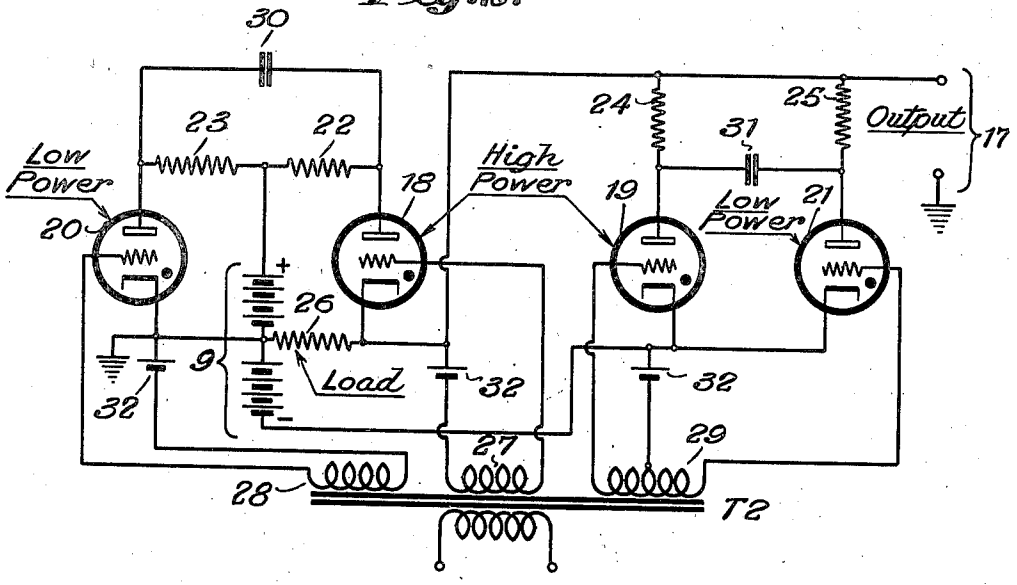


Fig. 2.



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IONIC RELAY CIRCUIT ARRANGEMENT

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8 Claims. (Cl. 250—27)

This invention relates to relay circuit arrangements and more particularly to a device for amplifying, wave shaping, and repeating telegraph signals or other impulses.

In carrying out my invention I have found that the use of gaseous discharge tubes for wave shaping and amplifying purposes is particularly appropriate in telegraph systems generally. The reason for this is that gaseous discharge tubes are especially suitable for conducting heavy currents, while at the same time they may be controlled as to their ignition times by very small potentials. Various methods of extinguishing the gaseous discharge tubes have been resorted to in the past, but the methods which I employ are believed to be novel and to have a number of advantageous features.

It is an object of my invention to provide an ionic relay system which, under the control of relatively low power input signals, will deliver high power output signals.

It is another object of my invention to provide an ionic relay system which embodies two or more gaseous discharge tubes operating at different potentials relative to a grounded neutral potential and co-operating to produce a square wave output.

Among the novel features of my invention I believe the following to be of primary importance:

The system as hereinafter disclosed is capable of precision control of the ignition times in a set of gaseous discharge tubes, so that signal waves of alternating polarity may be applied to the input circuit, while square wave signals of high power are derived from the output circuit of the system.

Another feature of my invention resides in the special circuit arrangements whereby the ignition of one gaseous discharge tube causes the cathode potential in a companion gaseous discharge tube, wherein ionization already exists, to be momentarily shifted in the direction of the anode potential of the last mentioned tube in order to extinguish the same. I accomplish this control of the extinction times by means of sudden variations of potential across one or more capacitors as will be more fully understood in the description to follow.

My invention will now be described in full detail, reference being made to the accompanying drawing in which:

Figure 1 shows diagrammatically a preferred embodiment of the invention; and

Figure 2 shows, also diagrammatically, a more elaborate relay system comprising four gaseous discharge tubes and their circuit connections.

Referring first to Fig. 1, I show therein a pair of gaseous discharge tubes 1 and 2, each having a cathode 3 or 4, an anode 5 or 6, and a control grid 7 or 8. A direct current source 9 has a grounded neutral connection. The positive terminal is connected to the anode 5, while the negative terminal is connected through a resistor 10 to the cathode 4. The anode 6 is connected through any suitable load 11 to the grounded neutral terminal of the source 9. The cathode 3 is connected across a suitable resistor 12 and thence through the load 11 to said grounded neutral terminal of the source 9. The cathodes 3 and 4 are intercoupled by means of a capacitor 13.

Each tube has an input circuit connected between its cathode and control grid. The input circuit for tube 1 includes a secondary winding 14 on an input transformer T1, the primary terminals of which are indicated at 15. Likewise, the tube 2 has an input circuit which includes the secondary 16 on this transformer. The windings 14 and 16 are so connected in their respective input circuits that controphasal potentials will be applied to the grids 7 and 8 with respect to the cathodes of the two tubes. The input circuits may also include grid biasing sources 32, although these are not essential except when certain types of tubes are used.

The impulses, or the wave form, impressed upon the input terminals 15 may vary widely in their characteristics. Thus, for example, telegraph signals having their marking and spacing elements characterized by potentials of opposite polarity might be applied to the input terminals 15. In this case any distortion of the incoming signals would result in a reshaping of the same in the output circuit of the relay. This relay may also be used as an amplifier and square-wave shaping device operable in response to the application of a sine wave to the input terminals. The square-wave signals delivered at the output terminals of the relay would then be of great regularity.

The circuit arrangement of Fig. 1 operates as follows:

Assume first that the right-hand terminals of the secondary windings 14 and 16 become positive relative to their left-hand terminals. Assume also that at this instant tube 1 has ionization current flowing therein and that tube 2 is about to be ignited. Ignition will take place, as is well understood by those skilled in the

art, due to the positive bias applied to grid 8 with respect to the cathode 4. Up until this moment of ignition of tube 2 there will be a charge on capacitor 13 which is positive on the left-hand side and negative on the right-hand side due to differences of potential of the cathodes 3 and 4 when cathode 3 is only slightly negative relative to the positive terminal of the source 9, and when also the cathode 4 stands at substantially the negative potential of the source 9, that is, when substantially no current is flowing in the resistor 10 and there is no appreciable potential drop in the latter.

Upon ignition of the tube 2 the lower end of resistor 10 will be driven positive to such an extent that a surge impulse across capacitor 13 before it has had time to discharge will drive the cathode 3 highly positive. Tests have shown that this surge impulse is capable of producing a positive potential on the cathode 3 even in excess of the potential on the anode 5, tube 1 being in an ionized state. This action, therefore, results in the extinction of the discharge in tube 1.

Now, when tube 2 has become ionized and tube 1 extinguished, the charge appearing on capacitor 13 is reduced to substantially the value of the potential drop in the space path of tube 2. This condition may readily be understood when it is seen that there is no current flow through resistor 12 when tube 1 is extinguished, and hence the potential of the cathode 3 will stand at the same value as that of the anode 6.

The reversal of currents in the transformer windings 14 and 16 so that grid 7 receives a positive impulse, and grid 8 is driven negative, causes tube 1 to be controlled by its grid 7 to start ionization therein. The consequent sudden flow of current through the resistor 12 produces a surge impulse across capacitor 13, the polarity of which suddenly raises the potential of cathode 4 to a value sufficiently close to that of anode 6 to cause extinction of the discharge in tube 2 at this instant.

It may readily be understood in view of the foregoing description that output impulses of square wave formation may be derived from the terminals 17. The marking and spacing intervals of the square wave must correspond with the intervals of extinction and ignition, respectively, in the tube 2 as determined by the times of arrival of corresponding marking and spacing impulses of suitable potentials on the input terminals 15. Of course, the input waves become effective for relaying purposes when their front and back slopes are maximum, since the currents induced in the secondaries 14 and 16 simultaneously reach maximum values for controlling the tubes.

Referring now to Fig. 2, I show a somewhat different arrangement in which four gaseous discharge tubes are employed. The tubes 18 and 19 have relatively high power characteristics, while the tubes 20 and 21 may well be low power tubes. Each of these tubes is a gaseous triode. The tubes 18 and 20 have their anodes connected to the positive terminal of the source 9 through resistors 22 and 23, respectively. Likewise, the anodes of the tubes 19 and 21 are connected through the respective resistors 24 and 25 and thence through a load impedance 26 to the grounded neutral terminal of the source 9. The cathodes of tubes 19 and 21 are interconnected and are supplied with operating potential from the negative terminal of source 9. The cathode of tube 20 is grounded, while the cathode of tube 18 has the load 26 in circuit between itself and ground.

Each of the tubes 18 and 20 possesses an input circuit individual thereto, and including independent secondary windings 27 and 28 on an input transformer T2. A third secondary winding 29 on this transformer has a mid-tap connected in common to the cathodes of tubes 19 and 21, while the terminals of winding 29 connect respectively with the grids of the tubes 19 and 21. The use of grid biasing sources 32 depends upon the type of tube employed, as explained above in connection with Fig. 1.

The anodes of tubes 18 and 20 are intercoupled by means of capacitor 30. Likewise, the anodes of tubes 19 and 21 are intercoupled by means of capacitor 31. The values of resistors 22 and 24 are low compared with the values of resistors 23 and 25. These values are suitably determined for efficient operation of the high and low power tubes, respectively.

The relay system shown in Fig. 2 preferably has the same function as that described in connection with Fig. 1, but its operation is somewhat different, as will now be described:

The potentials induced in secondary windings 27, 28, and 29 will be assumed first to be of a polarity such that the right-hand terminals of these windings are all driven positive. The current induced in winding 28 will have no effect, but the positive potentials derived from windings 27 and 29, respectively, will result in the ignition of tubes 18 and 21 simultaneously. The sudden drop of potential on the anodes of tubes 18 and 21 produces surge impulses across capacitors 30 and 31 such as to drive the anodes of tubes 19 and 20 very negative, and thus causes the latter tubes to be extinguished.

The cathode potential in tube 20 is fixed by its direct connection to ground. The cathode potential in tubes 19 and 21 is also substantially fixed by direct connection to the negative terminal of the source 9. The cathode potential in tube 18 fluctuates, however, in accordance with the potential drop across the load 26. This cathode potential is more positive than ground when tube 18 is conductive; it is more negative than ground when tube 19 is conductive, because it then assumes a voltage which differs from that of the anode in tube 19 by the small potential drop in resistor 24, the latter having a low ohmic value.

When the left-hand terminals of the secondary windings 27, 28, and 29 on the transformer T2 are driven positive, tubes 19 and 20 become simultaneously ignited. Surge impulses are thereupon impressed across capacitors 30 and 31 such as to extinguish tubes 18 and 21.

The interaction between tubes 18 and 20 is independent of that between tubes 19 and 21. Therefore, there is no disadvantageous voltage relationship between the power tubes 18 and 19. The latter, however, are caused to be conductive at mutually exclusive times corresponding to the marking and spacing elements of the telegraph signals.

My invention is capable of exemplification in accordance with other modifications which might suggest themselves to those skilled in the art. No limitation should be imposed, therefore, upon the scope of the invention other than is necessitated by the claims.

I claim:

1. A circuit arrangement having two thermionic sections here designated section A and sec-

tion B, each section comprising at least one gaseous discharge tube of the type having a cathode, an anode and a control electrode, a source of direct current potential having a grounded neutral tap connected to the cathode side of section A and to the anode side of section B, a connection from the positive terminal of said source to the anode side of section A, another connection from the negative terminal of said source to the cathode side of section B, a load impedance having one terminal connected to ground and the other terminal connected to a point in said circuit arrangement the potential of which shifts alternately between positive and negative values with respect to ground in dependence upon the alternate ionization of different space paths in said gaseous discharge tubes, means for alternately exciting different tubes of said circuit arrangement thereby to reverse the direction of current flow in said load, capacitive means cross-coupling like electrodes in different tubes and operative to extinguish one tube when another tube is ignited, a control source coupled to certain input circuits for said tubes and effective to ignite at least one of said tubes by application to its control grid of a positive impulse, and similarly effective to ignite at least one complementary tube upon polarity reversal of the control potential, and an output circuit connected across said load.

2. A circuit arrangement according to claim 1 wherein the capacitively cross-coupled electrodes are cathodes.

3. A circuit arrangement according to claim 1 wherein the capacitively cross-coupled electrodes are anodes.

4. A circuit arrangement according to claim 1 wherein each thermionic section comprises only one gaseous discharge tube.

5. A circuit arrangement according to claim 1 wherein each thermionic section comprises a high power gaseous discharge tube complemented by a low power gaseous discharge tube.

6. A wave shaping circuit arrangement comprising two gaseous discharge tubes each having a cathode, an anode, and a control grid, a circuit connected between the cathode of one tube and the anode of the other tube and including an impedance and a direct current source, a connection from the anode of said one tube through a load impedance to a grounded mid-tap on said source, a connection from the cathode of said other tube through a resistor and through said load impedance to ground, means including independent input circuits for each of said tubes for exciting the same alternately in response to polarity reversals of input potentials, means including a capacitor intercoupling the cathodes of the two tubes for causing each tube when it is ignited to extinguish the other tube, and an output circuit connected across said load impedance.

7. A wave shaping circuit arrangement comprising two pairs of gaseous discharge tubes each tube having a cathode, an anode, and a control grid, one tube in each pair having high power characteristics and the other tube in each pair having low power characteristics, input circuits for said tubes operable in response to signals for rendering the high power tubes alternately conductive and for rendering the tubes of each pair alternately conductive, a direct current source having a grounded mid-tap connected to the cathode in the low power tube of one pair, the positive terminal of said source being connected through suitable impedances to the anodes of said one pair, a load interconnecting the cathodes of said one pair, a connection from the negative terminal of said source to the cathodes of the tubes in the other pair, a connection from the cathode in the high power tube of said one pair through suitable impedances to the anodes of said other pair, and capacitive means intercoupling one anode with the other in the same pair, each pair respectively, for causing each tube when it is ignited to extinguish the complementary tube of the same pair, said circuit being further characterized in that it possesses two states of stability in one of which current flows through said load toward ground, and in the other of which current flows from ground through said load.

8. A wave shaping circuit arrangement comprising two gaseous discharge tubes each having a cathode, an anode, and a control grid, means including separate input circuits for said tubes whereby one tube is caused to be ignited upon arrival of a positive signal wave front, and the other tube is caused to be ignited upon arrival of a negative signal wave front, a source of direct current potential having a grounded neutral tap, said source being in circuit between the cathode of one tube and the anode of the other tube, a load interconnecting the anode of said one tube and said neutral tap, a resistor in series with the space path of each tube, and capacitive means operable in response to variations of potential drop through said resistors for causing each tube when it becomes ignited to extinguish the other.

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