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GAS-FILLED TUBE TELEGRAPH RELAY CIRCUIT

Filed June 30, 1933

FIG. 1

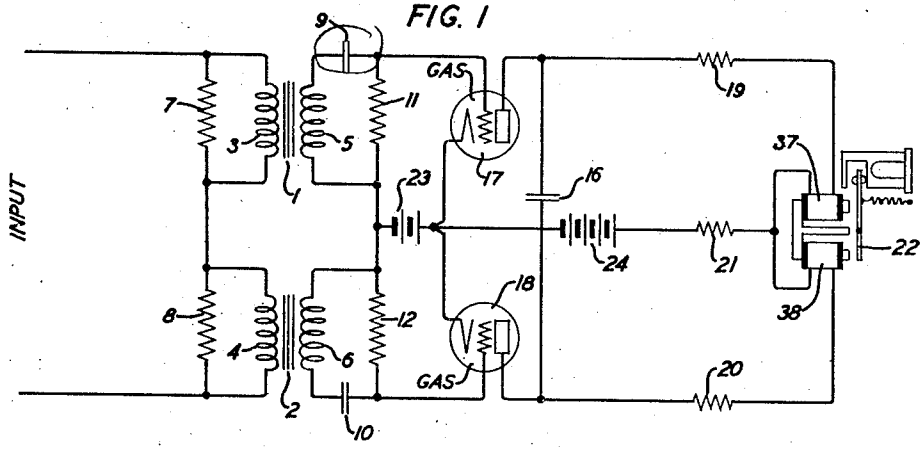


FIG. 2

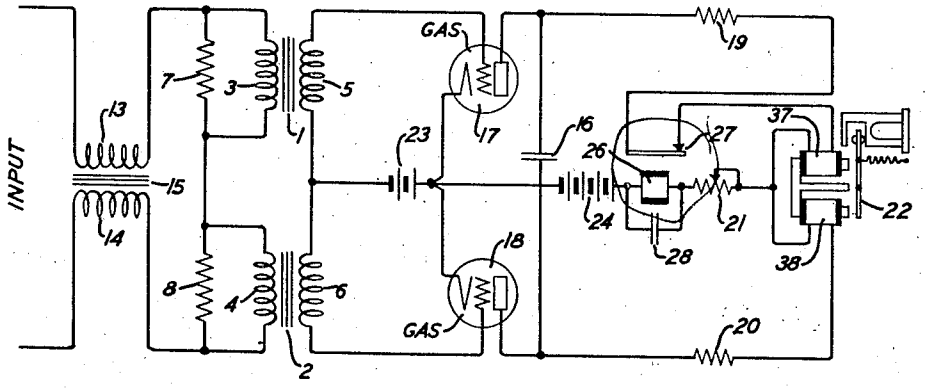
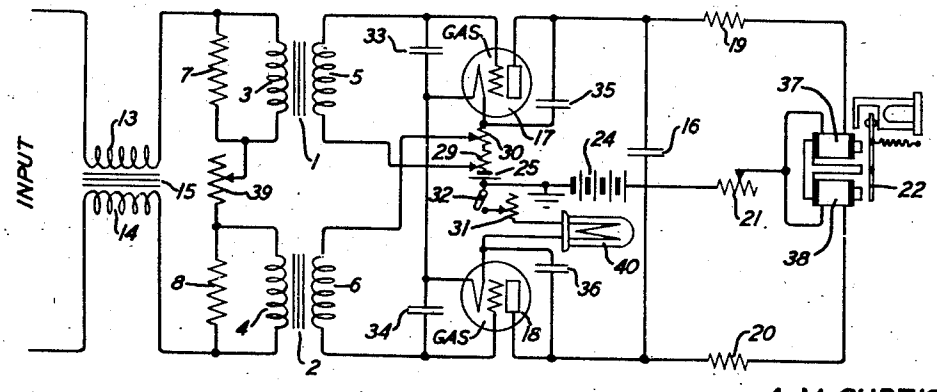


FIG. 3



INVENTORS A. M. CURTIS
E. M. BOARDMAN

BY J. W. Schmied

ATTORNEY

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GAS-FILLED TUBE TELEGRAPH RELAY CIRCUIT

Austen M. Curtis, East Orange, N. J., and Edward M. Boardman, New York, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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16 Claims. (Cl. 178—88)

This invention relates to telegraph relays and more particularly to telegraph relays which employ electrostatically controlled gas discharge tubes.

The main object of this invention is to increase the sensitivity and speed of a telegraph relay similar to the one disclosed in an application of E. T. Burton, Serial No. 454,311, filed May 21, 1930, as well as to improve its stability.

A feature of the invention is that means are provided to reduce the effect of the relay upon the circuit to which it is connected.

A restoring or non-locking feature is provided as well as means for reducing the effect of stray fields upon the relay.

In addition, false and improper operation of the relay is prevented by applying a cathode heating potential and the control bias or potential simultaneously.

One specific embodiment of the invention provides two gas discharge tubes arranged in push-pull. An input transformer is provided for each tube and an inductance is connected in series with the input circuit to reduce the surges due to the operation of said tube. The output circuits of the tubes are connected so that when one tube starts to conduct or glow, the other tube is stopped. In addition, a slow relay is connected to this circuit so as to operate when both tubes glow at the same time. The slow relay opens the anode circuit of one of the tubes so that it is restored to the non-conducting condition after which the slow release relay releases.

In another embodiment by-pass condensers are connected to the tubes to by-pass voltages due to stray fields and thus reduce the effects of these fields upon this telegraph relay. These condensers also prevent improper operation of the tubes.

To enable one to obtain a better understanding of the invention recited in the appended claims, several specific embodiments of the invention will be described with reference to the attached drawing, in which:

Fig. 1 describes one embodiment of the invention having means to prevent the current flowing in the external circuit of the control element or grid of the gas discharge device which is in the glowing condition from saturating the cores of the input transformers. Means are also provided to prevent the low impedance between the control element and other elements of the gas discharge device which is in the glowing condition from short-circuiting the input secondary windings of the input transformers connected to the gas discharge devices which are not in the glowing condition;

Fig. 2 illustrates another embodiment in which means are provided to reduce the effect of these tubes on the input circuit as well as means to prevent both tubes from conducting at the same time; and

Fig. 3 shows the details of a complete circuit in which means are provided for reducing the effects of stray fields.

In the usual relay employing gas discharge tubes the tubes are connected so that only one tube glows or conducts at a time. When the other tube starts to glow it automatically extinguishes the first tube. A single input transformer is usually employed, the secondary of which has a center tap which is connected through a grid bias potential source to the cathode of the two tubes. The grids or control elements of each tube are connected to the opposite ends of the secondary winding.

With this arrangement the circuit is somewhat insensitive and rather erratic. This is due, largely, to the saturation of the input transformer core by the grid current of the glowing tube which flows through the secondary winding of this transformer, and to the partial short circuit which this grid puts on the input transformer secondary winding, and to a certain extent because of the coupling between the two grid circuits. When the resistance of the grid circuits is increased so that the transformer will not be saturated by the grid current nor effectively short circuited by the grid circuit of the glowing gas discharge device, the grid current is so low that the grid is unable to help to rapidly deionize the gas in the tube so that the quenching of the glowing tube by the operation of the other tube becomes quite erratic. In addition the entire circuit becomes very sensitive to stray fields.

To reduce the coupling between the grid circuits two input transformers 1 and 2 are employed as shown in Fig. 1. Their respective secondary windings 5 and 6 are connected to the grids of tubes 17 and 18 through stopping condensers 9 and 10, respectively, which prevent the grid current of the tubes from saturating the cores of the input transformers 1 and 2. A source of grid bias potential 23 is connected to the grids through resistances 11 and 12. The anodes of tubes 17 and 18 are connected to sounder 22 through resistances 19, 20, and 21. A condenser 16 is connected between the two anodes and is used to extinguish the tubes in a well known manner. Battery 24 supplies the necessary anode

potential. The cathode heating potential source and circuit are not shown but may be of any well known type.

Now assume a positive impulse is applied to the input terminals of this circuit. A similar positive impulse will be applied to the grid of tube 17 through transformer 1 and condenser 9. This will cause tube 17 to glow or conduct current so that sounder 22 will be energized through the circuit from battery 24, resistance 21, the winding 37 of sounder 22, resistance 19 to the anode of tube 17. This will cause sounder 22 to be actuated to the marking position. Now assume a spacing or negative impulse is applied to the input terminals of this circuit. In this case, a positive impulse is applied to the grid of tube 18 through transformer 2 and condenser 10. This causes tube 18 to start to conduct. Tube 18 in starting to conduct lowers the potential of condenser 16 which in turn lowers the potential on the anode of tube 17 to such an extent that tube 17 is extinguished. This interrupts the current through winding 37 of sounder 22 while at the same time the starting tube 18 completes the circuit for the other winding 38 of sounder 22. This will operate sounder 22 to the spacing position. The next marking impulse will again start tube 17 which will in turn extinguish tube 18 and actuate sounder 22 to the marking position as before. Thus the input signals are relayed by tubes 17 and 18 in the associated circuit to sounder 22. It is quite obvious that sounder 22 may be replaced by any suitable telegraph relay, printing magnet or suitable impedances when the circuit repeats the signals directly to another line.

In addition to reducing the coupling between the grid circuits of tubes 17 and 18 and preventing the grid currents of these tubes from flowing in the secondary windings 5 and 6 and saturating the cores of transformers 1 and 2, this circuit arrangment also removes the low grid impedance shunt of the glowing tube from the input transformer and grid circuit of the other tube so that this circuit operates more satisfactorily than the usual circuit employing only one input transformer. The sensitivity of this arrangement is limited by the fact that it is not possible to use a very high step-up ratio between the primary and secondary windings of the input transformers 1 and 2 since resistances 11 and 12 cannot be made as high as the grid impedance of a non-glowing tube without interfering with the assistance the grid-filament ion current gives in quenching the glowing tube when the other tube starts.

Fig. 2 illustrates a somewhat more sensitive arrangement in which condensers 9 and 10 and resistances 11 and 12 have been omitted so that the step-up ratio of the input transformers may be increased until the transformer secondary impedance more nearly matches the grid impedance of the non-glowing tube. As in Fig. 1 two input transformers are employed to reduce the coupling between the two grid circuits and also to prevent the low impedance of the grid of a glowing tube from shunting and substantially short circuiting the high grid impedance of the non-glowing tube. In this arrangement as shown in Fig. 2, the grid-filament ion current will flow through secondary windings 5 and 6 of input transformers 1 and 2. The resistance of these windings is not high enough to interfere with the quenching action of the grid-filament ion current. This current, however, tends to saturate the input transformer of the glowing tube. The primary impedance of the saturated transformer is therefore reduced so that a larger portion of the input energy will be applied to the grid of the non-glowing tube and thus further increase the sensitivity of the entire circuit.

The operation of this circuit, as shown in Fig. 2, is quite similar to the operation of the circuit shown in Fig. 1. Marking or positive impulses applied to the input circuit will cause tube 17 to start to conduct. This extinguishes tube 18 if it is glowing and will actuate sounder 22 to the marking position. A grid current will now flow through the secondary winding 5 of the input transformer 1 which will tend to saturate its core. This saturation current together with the low grid to cathode impedance of this conducting tube which shunts the secondary winding 5 will effectively short-circuit this transformer. It should be noted that this does not shunt the high impedance grid circuit of the non-glowing tube 18 but rather tends to cause the entire voltage of the next spacing impulse to be applied to transformer 2 and then to the grid of tube 18. This will cause tube 18 to conduct which will extinguish tube 17 and actuate sounder 22 through winding 38 to its spacing position in the same manner as sounder 22 is actuated in Fig. 1. In this case, however, when tube 17 is extinguished the grid current flowing through the secondary winding 5 of transformer 1 is interrupted while grid current from tube 18 will flow through the secondary winding 6 of transformer 2 and saturate the core of this transformer. These changes in grid currents through the secondary windings 5 and 6 of transformers 1 and 2 will induce voltages in the primary windings 3 and 4 of these transformers. To reduce these voltages resistances 7 and 8 are connected in parallel with the primary windings 3 and 4, respectively. In addition, to further reduce the effect of these voltages on the circuit to which the input terminals are connected a retard coil 15 is provided having windings 13 and 14 connected in series with these transformer windings. This arrangement effectively attenuates the surges due to the changes in grid currents of the tubes. In addition to the grid current of tube 18 which is now conducting tending to saturate the core of transformer 2, the low grid cathode impedance of this tube at this time shunts the secondary 6 of this transformer so that transformer 6 is now effectively short circuited. As a result almost the entire voltage of the next marking impulse will be applied to the grid of tube 17 through transformer 1. It should be noted that when tube 17 was extinguished its grid-cathode impedance becomes quite high and thus removes the low impedance shunt from the secondary 5 of transformer 1 so that the step-up ratio of the transformer may be fully used.

Thus in the normal operation of the circuit shown in Fig. 2, tubes 17 and 18 glow or operate alternately. During the time one of the tubes is glowing, condenser 16 receives a charge which serves to momentarily reduce the potential applied to the anode of the glowing tube when the other tube starts to glow. The potential of the plate of the glowing tube is reduced only momentarily during the discharge time of condenser 16 so that if stray potentials due to stray fields are applied to control elements of both tubes for a period of time longer than the discharge time of condenser 16, both tubes will continue to glow, irrespective of any applied signal.

This renders the relay inoperative until one or both of the tubes are extinguished by removing them or removing the power connected to them. To correct this condition, means are provided for extinguishing one of the tubes, when both tubes continue to operate or glow concurrently.

A marginal relay **26** is connected in series with battery **24** and is adjusted so that it will operate when both tubes **17** and **18** conduct current at the same time but will not operate when only one tube is conducting current. Relay **26** in operating opens its contacts **27** which disconnects the anode of tube **17**. Tube **17** is therefore extinguished. Condenser **28** is connected in parallel with relay **27** which causes this relay to be somewhat slow in releasing to provide sufficient time for tube **17** to be extinguished. When relay **26** releases it restores the circuit to its normal operating condition. This circuit is more sensitive than that shown in Fig. 1 but is somewhat subject to the effects of stray fields which may cause both tubes to glow at the same time or cause other improper operation of the circuit.

To eliminate these effects of stray fields and potentials condensers **33** and **34** (see Fig. 3) are connected between the cathode and grid of tubes **17** and **18**, respectively, and condensers **35** and **36** are connected between the anodes and cathodes of these tubes respectively. These condensers effectively by-pass the potentials due to these stray fields so that they do not materially affect the operation of this circuit. Usually a capacity value of from 100 to 500 micromicrofarads will be found sufficient.

In the embodiment of the invention shown in Fig. 3, the cathode circuit is shown in detail. A source of current **25** is provided which is connected in series with both cathodes and potentiometers **29** and **30** as well as rheostat **31**, switch **32** and ballast lamp **40**. Rheostat **31** and ballast lamp **40** are provided to regulate the value of the cathode heating current. Potentiometers **29** and **30** are provided to secure the desired grid biasing potentials for tubes **17** and **18**. Switch **32** is provided to turn off the tubes in case it is desired to remove the circuit from service. It should be noted that this circuit arrangement applies the cathode potential simultaneously with the grid biasing potential. It is thus impossible to energize the cathodes of these tubes and allow the tubes to conduct current before the grid biasing potential is applied. This provides an easy way of removing the circuit from operation and returning it to operation without causing any improper operation of tubes **17** and **18**. Potentiometers **29** and **30** and variable resistance **31** may be replaced by fixed resistances if the circuit is to always use or be supplied from the same filament battery voltage.

Condensers **33**, **34**, **35**, and **36** usually provide sufficient protection against stray fields so that relay **26** and condenser **28** are not required. However, in case that it is found that both tubes **17** and **18** still operate simultaneously occasionally, relay **26** may be provided to extinguish tube **17** in a manner similar to that described in Fig. 2.

A variable resistance **39** is connected between the primary windings **3** and **4** of transformers to adjust the input impedance of this circuit to the impedance of the circuit to which it is connected so as to reduce reflection losses and surges.

What is claimed is:

1. A telegraph relay comprising a plurality of electrostatically controlled gas discharge tubes, input and output circuits connected to said tubes, a plurality of input transformers connected in said input circuits, and means connected to said transformers to prevent currents from said tubes from saturating said transformers.

2. A telegraph relay comprising a plurality of electrostatically controlled vapor discharge tubes, input and output circuits connected thereto, input transformers individual to each of said tubes connected in said input circuit, and means connected to said input circuit to reduce the effects of the operation of said tubes upon said input circuit.

3. A telegraph relay comprising a plurality of electrostatically controlled gas discharge tubes, means connected thereto to reduce the effects of stray fields upon said tubes, input and output circuits connected to said tubes, means connected to said output circuits of said tubes to prevent the continued operation of more than one of said tubes, an input transformer connecting each of said tubes to said input circuit, and means connected to said input circuit for suppressing disturbances due to the operation of said tubes.

4. A telegraph relay comprising a plurality of gas discharge devices, an input transformer connected to each of said devices, means connected to said transformers to attenuate the disturbances due to the operation of said gas discharge devices and an output circuit connected to said gas discharge device.

5. A telegraph relay comprising a plurality of three-element gas discharge devices having a cathode, anode and control element, an input transformer individual to each of said gas discharge devices connected to the cathode and control element of said device, an output circuit connected to the cathodes and anodes of said devices, and relay means connected in said output circuit to prevent the continued operation of more than one of said devices.

6. A relay comprising a pair of three-element gas discharge devices having a cathode, anode and a control electrode, two input transformers having primary and secondary windings, the secondary windings of each transformer being connected to the cathode and control element of one of said devices, a resistance connected in parallel with the primary windings of each transformer, said primary windings being connected in series, and in series with an inductance, a small condenser connected between the cathode and control element of each of said devices, a second small condenser connected between the cathode and anode of each of said devices, and an output circuit connected to said anode and said cathode of said devices.

7. A telegraph relay comprising a plurality of electrostatically controlled gas discharge tubes, input and output circuits connected to said tubes, and means connected in said input circuit for preventing the low input impedance of said tubes which are glowing from shunting the high input impedance of the other of tubes which are not glowing.

8. A gaseous discharge relay comprising an input circuit, two transformers connected to said input circuit, a multi-element gaseous discharge device connected to each of said transformers, means connected to said input circuit to attenuate disturbances due to the operation of said gaseous discharge devices, an output transformer connected to said discharge devices, means for supplying cathode, anode and control element potentials, and means for simultaneously applying the cathode and control element potential.

9. A gaseous discharge relay comprising an input circuit, a multi-element gaseous discharge device connected to said input circuit, an output circuit connected to said discharge device, and means connected to the elements of said multi-element gaseous discharge device for by-passing substantially all stray currents between the elements of said device.

10. A gaseous discharge relay comprising an input circuit, a plurality of multi-element gaseous discharge tubes connected in said input circuit, an output circuit connected to said devices, and means in said output circuit for extinguishing all but one of said devices when more than one of said devices continue to operate concurrently.

11. A gaseous discharge relay comprising an input circuit, an output circuit, a gaseous discharge device connected in said circuits, and means in said input circuit for attenuating disturbances due to the operation of said device.

12. A gaseous discharge relay comprising a multi-element gaseous discharge device having anode, cathode, and control elements, an input circuit connected to said cathode and control element, and an output circuit connected to said anode and cathode, potential sources for energizing said device, a condenser connected to said control element and said cathode, a second condenser connected to said anode and to said cathode for by-passing extraneous potentials due to stray fields.

13. A gaseous discharge relay comprising an input circuit affected by two different electrical conditions, a multi-element gaseous discharge tube connected to said input circuit responsive solely to one of said conditions, a second multi-element gaseous discharge tube responsive solely to the other of said conditions connected to said input circuit, an output circuit connected to said gaseous discharge tubes, means connected in said output circuit for extinguishing one of said tubes when the other tube starts to discharge, and additional means for extinguishing one of said tubes when said first-mentioned extinguishing means fails to extinguish either of said tubes.

14. An impulse relaying circuit comprising a plurality of space discharge devices having an impulse supplying circuit and a circuit to be supplied with impulses in combination with electrical means connected to the circuits of said devices non-responsive to the discharge current of some definite given number of said devices but responsive upon the simultaneous discharge of a greater number thereof to suppress the discharge in at least one thereof.

15. A relay device comprising a first circuit, a second circuit, a plurality of gaseous discharge tubes connected between said circuits to repeat impulses from one of said circuits to the other of said circuits, other instrumentalities interlinking said tubes to extinguish a discharging tube when another of said tubes starts to discharge, and additional means to prevent a continued and concurrent discharge of more than one of said tubes.

16. An impulse relaying circuit comprising in combination a plurality of gaseous conduction devices, input circuits therefor, output circuits therefor, marginal means connected to said output circuit only operative in response to the combined discharges of at least two of said devices for suppressing the discharge in at least one of said devices.

AUSTEN M. CURTIS.
EDWARD M. BOARDMAN.