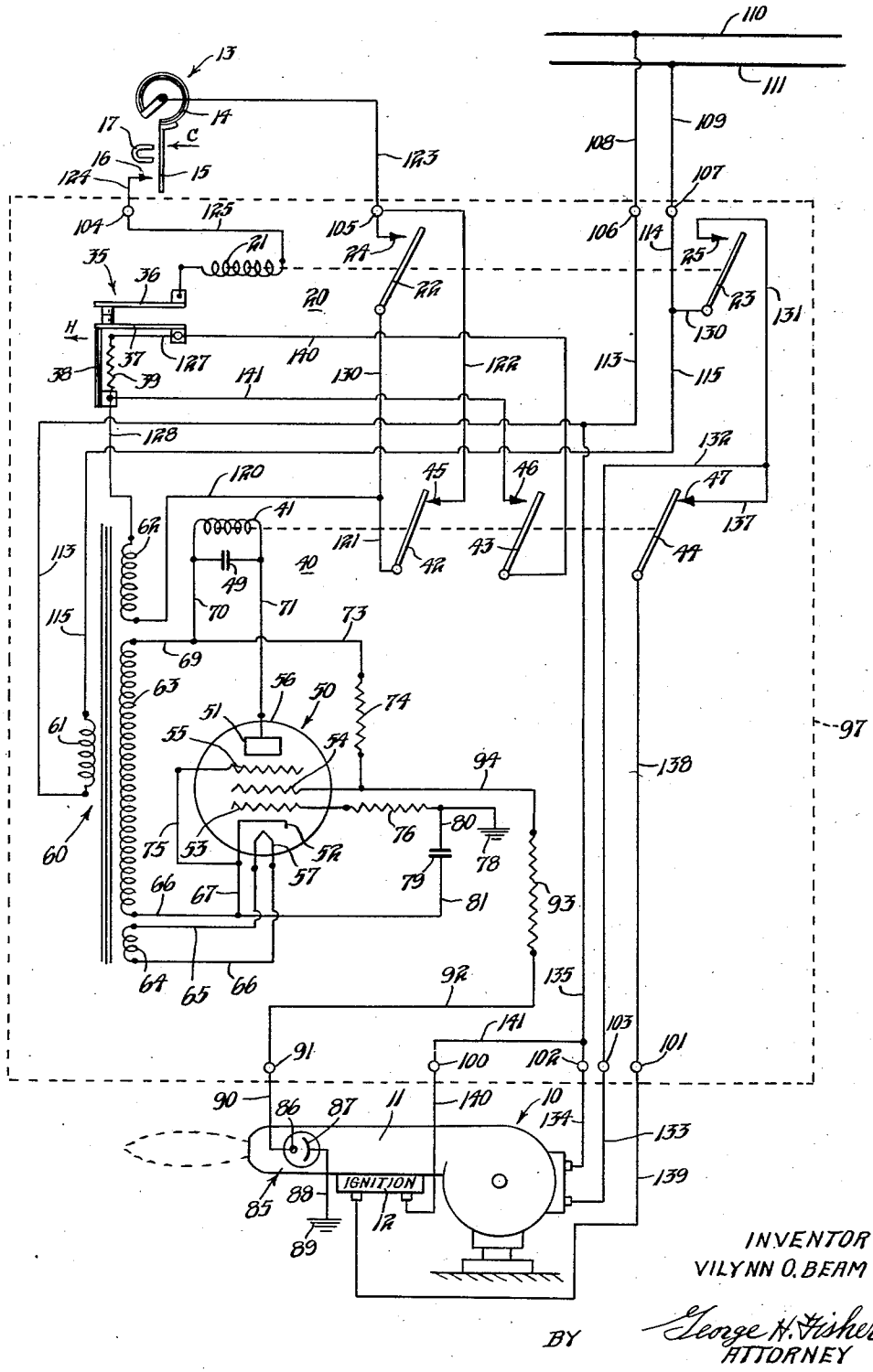
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ELECTRONIC APPARATUS

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ELECTRONIC APPARATUS

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The present invention is concerned with electronic apparatus and more particularly apparatus designed to detect the presence of a rectifying impedance.

It has been previously suggested to employ for flame detecting purposes, electronic apparatus including a flame sensitive device having the characteristic of acting as a rectifying impedance when exposed to a burner flame, the electronic apparatus being so designed as to respond oniy to the presence of an electronic impedance and being ineffective to falsely indicate a flame when exposed to a symmetrically conductive impedance regardless of its value.

An object of the present invention is to provide an improved apparatus for detecting the presence of a rectifying impedance.

More specifically, it is an object of my invention to provide such an arrangement employing an electronic discharge device having two control electrodes one of which is normally controlled in accordance with the conductivity of the rectifying impedance and the other of which is effective in the event of the impedance being bridged by a symmetrically conductive impedance to cause the electronic apparatus to respond in the same manner as when the asymmetrically conductive impedance is non-conductive.

A further object of the invention is to provide such an arrangement in which a condenser is employed between the normal control electrode and the cathode and in which the gap between the other electrode and cathode is connected in parallel with the condenser and the rectifying impedance.

A still further object of the present invention is to provide such an arrangement in which the rectifying impedance is a flame responsive means which is asymmetrically conductive when exposed to a flame.

A still further object of the present invention is to provide an arrangement in which the rectifying impedance is a photoelectric cell.

A further object of the present invention is to provide such an arrangement in which the two control electrodes are the control grid and the screen grid of a screen grid tube.

Other objects of the present invention will be apparent from a consideration of the accompanying specification, claims, and drawing, of which the single figure is a schematic view of my improved electronic apparatus employed in a burner control system for controlling the operation of the burner in accordance with the presence or absence of flame.

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Referring specifically to the drawing, the reference numeral **10** is employed to indicate a burner of conventionad design having a burner nozzle **11** through which a mixture of fuel and air is supplied. Associated with the burner **10** is a suitable ignition means **12** which is effective to ignite the fuel mixture issuing from nozzle **11**. The burner and ignition means may both be of conventional construction and their details form no part of the present invention.

The operation of the burner is controlled by a main control switch which in the present instance is shown in the form of a room thermostat **13**. This thermostat comprises a bimetallic element **14** to which is secured a contact arm **15** adapted to cooperate with a contact **16**. As indicated by the legend adjacent the drawing, the contact arm **15** moves to the left upon a drop in temperature. Cooperating with contact arm **15** is a magnet **17** which is effective to cause the contact arm to engage and disengage from contact **16** with a snap action.

The thermostat **13** controls the energization of a relay **20**. This relay comprises a relay coil **21** and a plurality of switch blades **22** and **23** which cooperate with contacts **24** and **25**, respectively. Switch blades **22** and **23** are biased out of engagement with contacts **24** and **25**. Upon energization of the relay coil **21**, the switch blades are moved into engagement with the respective contacts with which they are associated.

A thermal safety switch **35** also controls the energization of relay **20**. This safety switch may be of any type which at the end of a period of time moves to a circuit interrupting position and remains in that position until manually reset. A typical switch of this type which may be employed is that shown in the patent to John M. Wilson No. 2,290,399. As shown schematically in the drawing, the switch consists of a pair of switch blades **36** and **37**, the switch blade **37** being held in engagement with switch blade **36** against its bias by a bimetallic element **38**. An electric heater **39** is located adjacent bimetallic element **38** and is effective when energized to heat bimetallic element **38** to cause it to warp to the left as indicated by the legend adjacent the element **38**. Upon continued energization of heater **39** beyond a predetermined period of time, the bimetallic element **38** moves out from under switch blade **37**, permitting switch blade **37** to drop away from switch blade **36**. When this happens, the switch blades **36** and **37** must be manually reengaged.

The reference numeral **40** is employed to gen-

erally designate a further relay. This relay comprises a coil 41 and a plurality of switch blades 42, 43, and 44 which cooperate with contacts 45, 46, and 47, respectively. The switch blades 42 and 44 are biased into engagement with contacts 45 and 47, being moved out of engagement therewith upon energization of relay coil 41. The switch blade 43 is biased out of engagement with contact 46 and is moved into engagement therewith upon energization of the coil 41. A condenser 49 is connected in parallel with relay coil 41. The relay coil 41, as will be more evident later, is energized by current which is fluctuating in character. The condenser 49 tends to bypass the fluctuating component of this current.

The energization of relay 40 is controlled by an electronic discharge tube 50. This device is shown as a pentode tube which comprises an anode 51, a cathode 52, a control grid 53, a screen grid 54, and a suppressor grid 55. The anode and cathode and the three control electrodes are housed within an envelope 56 which is evacuated. A cathode heater 57 is associated with the cathode 52.

A transformer 60 is employed to energize the control apparatus as well as the tube 50. This transformer comprises a primary winding 61, a low voltage secondary 62, a high voltage secondary 63, and a further low voltage secondary 64. The secondary 64 is employed to energize the cathode heater 57, being connected to it by conductors 65 and 66. The low voltage secondary 62 is employed to control the energization of relay 20 as will be more fully apparent in the description of the operation of the system. The high voltage secondary 63 is employed to control the energization of tube 50 and of relay 41 controlled by tube 50. The lower terminal of secondary 63 is connected by conductors 66 and 67 to the cathode 52 while the upper terminal is connected by conductors 69 and 70, relay coil 41, and conductor 71 to the anode 51. The upper terminal of the secondary 63 is also connected to the screen grid 54 by conductors 69 and 73, and a resistor 74.

The control grid 53 is connected through a resistor 76 to ground at 78. The upper terminal of the condenser 79 is connected by a conductor 80 to the grounded terminal of resistor 76 and hence to grid 53. The lower terminal of this condenser 79 is connected by conductors 81 and 67 to cathode 52. Thus, condenser 79 is effectively connected between the control grid 53 and cathode 52. The suppressor grid 55 is connected through a conductor 75 to the cathode 52.

A photoelectric cell 85 is mounted so as to be exposed to the burner flame. One location which has been found particularly suitable is within the blast tube 11. The photoelectric cell 85 comprises an anode 86 and a cathode 87. The cathode 87 is connected by conductor 88 to ground at 89, while the anode 86 is connected through a conductor 90 to a terminal 91 of the burner control apparatus and from terminal 91 through conductor 92, a resistor 93, and conductor 94 to the lower terminal of resistor 74.

The apparatus including the tube 50, the relays 20 and 40, the safety switch 35, and the transformer 60, together with the condensers and resistors referred to, constitute burner control apparatus which would normally be manufactured as a single unit. This burner control apparatus is enclosed within a housing schematically indicated by the dotted line 97. This apparatus includes terminal 91 previously referred to, ignition terminals 100 and 101, burner terminals 102 and 103, thermostat terminals 104 and 105, and power terminals 106 and 107.

The power terminals 106 and 107 are connected by conductors 108 and 109 to line wires 110 and 111, respectively.

While the elements described above may have various values, I have found the following values to be effective in one particular embodiment of my invention. In this embodiment, the resistors 74, 93, and 76 were 50,000 ohm, 5 megohm, and 2 megohm resistors, respectively. Condenser 79 was a .02 microfarad condenser, whereas condenser 49 was a 0.5 microfarad condenser. The relay coil 41 had an impedance of 6,000 ohms. A 6AC7 tube was employed. The secondary 63 had an output voltage of 300 volts, while the secondary winding 64 had an output voltage of 7 volts. As previously noted, however, the size of these elements can be varied widely, and my invention is not to be limited in any way by the particular values given above.

Operation

The apparatus is shown in the condition which it assumes when the thermostat 13 is satisfied. Under these conditions, the burner 10 is not in operation and both relays 20 and 40 are deenergized. Power is constantly supplied to the primary 61 from the power terminals 106 and 107 by conductors 113, 114, and 115.

Now let it be assumed that the thermostat 13 calls for heat; that is, that contact are 15 moves into engagement with contact 16. When this happens, an energizing circuit is established to relay winding 21 as follows: from the lower terminal of secondary 62 through conductors 120 and 121, switch blade 42, contact 45 conductor 122, thermostat terminal 105, conductor 123, bimetallic element 14, contact arm 15, contact 16, conductor 124, terminal 104, conductor 125, relay coil 21, thermal safety switch blades 36 and 37, conductor 127, heater 39, and conductor 128 to the upper terminal of secondary 62. As a result of the establishment of this circuit, the relay 20 is energized to cause engagement of switch blades 22 and 23 with contacts 24 and 25. The movement of switch blade 22 into engagement with contact 24 results in the establishment of a holding circuit for relay 20 which is independent of switch blade 42 and contact 45, this circuit being as follows: from the lower terminal of secondary 62, through conductors 120 and 130, switch blade 22, contact 24, terminal 105, conductor 123, bimetallic element 14, contact arm 15, contact 16, conductor 124, terminal 104, conductor 125, relay coil 21, switch blades 36 and 37, conductor 127, heater 39, and conductor 128 to the upper terminal of secondary 62. The purpose of establishment of this circuit is to prevent the deenergization of relay 20 upon the subsequent energization of relay 40. It was desirable to include the switch blade 42 and contact 45 in the original energizing circuit of relay 20 to insure that the relay 20 would not be energized to initiate operation of the apparatus if relay 40 were already deenergized. Since, as will be more apparent later, relay 40 is energized in response to flame, it would be highly undesirable to initiate operation of the system if the relay 40 was accidentally stuck or otherwise maintained in its energized position despite the absence of flame. By preventing the energization of relay coil 20 unless relay 40 is in its deenergized position, this possibility is avoided.

The engagement of switch blade 23 with contact

25 results in the establishment of an energizing circuit to the burner 10 as follows: from power terminal 107 through conductors 114 and 130, switch blade 23, contact 25, conductors 131 and 132, terminal 103, conductor 133, burner 10, conductor 134, terminal 102, and conductors 135 and 113 to the other power terminal 106.

At the same time, a circuit is established to the ignition 12 as follows: from power terminal 107 through conductors 114 and 130, switch blade 23, contact 25, conductors 131 and 127, contact 47, switch blade 44, conductor 138, terminal 101, conductor 139, ignition 12, conductor 140, terminal 100, conductors 141, 135, and 113, to the other power terminal 106. The energization of both the burner and ignition as a result of the establishment of the circuits traced in the above paragraph will normally result in the establishment of a burner flame so that the photoelectric cell 85 is illuminated.

The operation of the flame detecting apparatus including tube 50 will now be described.

As long as no flame is present so that the photoelectric cell 85 is dark and hence substantially non-conductive, the only connection to control grid 53 is that provided by resistor 76 and condenser 79 from the cathode 52. The grid 53 is hence essentially floating and tends to assume a negative charge so as to prevent any substantial current flowing through the tube. Even though a small current may flow, this current is insufficient to cause energization of the relay 41. Now when the photoelectric cell is illuminated as a result of the establishment of the burner flame, a charging circuit is established for condenser 79 as follows: from the upper terminal of secondary 63 through conductors 69 and 73, resistor 74, conductor 94, resistor 93, conductor 92, terminal 91, conductor 90, anode 86, cathode 87, conductor 88, ground terminals 89 and 78, conductor 80, condenser 79, and conductors 81 and 66 to the lower terminal of secondary 63. Current flows through the circuit only in the direction traced due to the rectifying characteristics of the photoelectric cell 85. Thus, the effect of the current flowing through the circuit just traced is to charge condenser 79, the polarity of this charge being such that the upper terminal of condenser 79 is positive with respect to the lower terminal. The effect of this positive charge on condenser 79 is to raise the potential of control grid 53 to cause tube 50 to become sufficiently conductive to result in the effective energization of relay coil 41. The energizing circuit for relay coil 41 is as follows: from the upper terminal of secondary 63 through conductors 69 and 70, relay coil 41, conductor 71, anode 51, cathode 52, and conductors 67 and 66 to the lower terminal of secondary 63. While the current tending to flow through relay 41 has the form of a half wave rectified current, the condenser 49 by-passes much of the fluctuating component of this current so that a relatively smooth direct current flows through the relay coil. As a result, the relay is energized to cause movement of switch blades 42, 43, and 44 to their energized positions.

The movement of switch blade 44 to its energized position in which it is out of engagement with contact 47 interrupts the circuit to the ignition 12. Since the burner is now ignited, the continued operation of the ignition is no longer necessary.

The movement of switch blade 43 into engagement with contact 46 establishes a shunt around the heater 39 of the thermal safety switch, this

shunt extending from the upper terminal of heater 39 through conductors 127 and 140, switch blade 43, contact 46, and conductor 141 to the lower terminal of heater 39. The effect of the establishment of this shunt circuit around heater 39 is to terminate the heating of bimetallic element 38 by heater 39. Since the burner operation has been successfully established, it is desirable that the operation of the safety switch be interrupted so that the burner can continue in operation.

If combustion is not initially established, the relay 40 is not energized so that no shunt will be connected around heater 39. In this event, the bimetallic element 38 will continue to heat up until switch blades 36 and 37 separate from each other. When this happens, relay 20 is deenergized to cause a shut-down of the system. As noted above, the thermal safety switch must be manually reclosed so that manual intervention is necessary before the system is again placed in operation.

If combustion has been established and fails for some reason or other, the electronic apparatus of my invention responds almost instantly to cause deenergization of relay 40. As soon as combustion fails, the photoelectric cell becomes nonconductive so that the circuit for the charging of condenser 79 ceases to exist. The condenser immediately loses its positive charge through the conductive path provided by the grid and cathode 52. The grid 53 quickly assumes a negative charge such as assumed at the beginning of the operation. The deenergization of relay 40 causes reenegagement of switch blade 44 with contact 47 to reenergize the ignition and also separation of switch blade 43 from contact 46 to cause reenergization of heater 39. Thus, the ignition and the safety switch 35 are again in operation. If after a timed period, combustion is not reestablished, the safety switch opens to shut down the system. If it is established, the relay 40 is energized to terminate the ignition and the operation of the safety switch.

In the foregoing operation, it has been shown how the apparatus promptly responds to the establishment of or failure of combustion. A very important feature of the apparatus is that it is not responsive to the bridging of the photoelectric cell by a symmetrically conductive impedance. It may often happen that a complete or partial short circuit is established across the terminals of the photoelectric cell due to the accumulation of carbon or for other reasons. Again, some object may accidentally come into contact with the terminals of the photoelectric cell. In many conventional types of flame detecting circuits working on the basis of the impedance of the photoelectric cell or of the flame, no means is provided to distinguish between a normal flame condition and that which occurs when the bridging impedance has substantially the same impedance value as that of the photoelectric cell or the flame. In my apparatus, this false operation is avoided.

Where the photoelectric cell is bridged by a non-rectifying impedance, the current which would flow through condenser 79 by reason of the impedances in the circuit including resistors 74 and 93 and the impedance bridging photoelectric cell 85 would be alternating in character since all of these impedances are symmetrically conductive. However, the resistor 93 and the impedance bridging photoelectric cell 85 and the condenser 79 have connected in parallel there-

with the path between the screen grid and the cathode 52. This will be apparent when it is considered that the screen grid 54 is connected to the upper end of resistor 93 while the cathode 52 is connected to the lower terminal of condenser 79. The screen grid-cathode path tends to act as a rectifying impedance. In other words, current can flow from the screen grid 54 to the cathode 52 but not in the opposite direction. Thus, during the half cycles in which the upper end of the secondary 63 is positive with respect to the lower end, the current tends to flow between the screen grid 54 and the cathode 52 more readily than through the resistor 93, the impedance around photoelectric cell 85, and the condenser 79. On the opposite half cycle in which the lower end of secondary 63 is positive with respect to the upper end, the screen grid-cathode path is non-conductive so that all the current flowing through resistor 74 must flow through condenser 79. As a result, the condenser 79 receives a charge of such polarity that the upper terminal of the condenser 79 becomes negative with respect to the lower terminal. This renders the tube 50 sufficiently non-conductive as to cause effective deenergization of relay 40.

It will be seen from the above that even though the tube 50 be bridged by an impedance having exactly the same impedance value as the photoelectric cell, relay 40 will be deenergized, thus avoiding a false indication of flame. This is true so long as the bridging impedance is symmetrically conductive. Since it is highly unlikely that the tube would be bridged by a rectifying impedance, the system from a practical standpoint distinguishes between a true condition of flame and any false condition simulating that of flame.

Where the bridging impedance has an extremely low impedance value, for example, where the photoelectric cell 85 is short circuited, my circuit still operates to cause deenergization of relay 40. Due to the presence of resistor 93, the impedance to current flow through the path including resistor 93 and condenser 79 is still sufficiently high with respect to the impedance of the screen grid cathode path that the latter still operates as a shunt during the conductive half cycles around the resistor 93 and condenser 79. Furthermore, as the impedance of the impedance element bridging resistor 85 decreases, the current flow through resistor 74 increases. This causes the voltage drop through resistor 74 to be greater so that the potential of the screen grid 54 is lower. This in turn reduces the conductivity of tube 50.

While I have described a photoelectric cell as a flame responsive impedance device, I may if desired employ a flame electrode which is separated from a grounded member such as a burner by a gap normally bridged by the flame. A burner flame has the characteristic of transmitting current more readily in the direction opposite to that of propagation of flame than in the direction of propagation. Thus, such a flame gap when bridged by a flame constitutes a rectifying impedance having the same direction of rectification as far as the circuit is concerned, as the photoelectric cell 85.

It will be seen that I have provided an electronic system for detecting the presence of a rectifying impedance which is particularly adaptable for use in a burner control system which while employing only a single untapped source of power for energizing the plate circuit and the various grid circuits, distinguishes between a

rectifying impedance and a symmetrically conductive impedance of the same impedance value.

While I have shown a specific embodiment of my invention, it is to be understood that this is only for purposes of illustration and that the scope of the invention is to be limited solely by the appended claims.

I claim as my invention:

1. In apparatus designed to respond to the presence of a rectifying impedance, an electrically operated device, a source of alternating power, means for controlling the energization of said device including said source of power and an electronic discharge device having an anode, a cathode, and two control electrodes, a condenser connected between one of said control electrodes and said cathode, said control electrode normally assuming a potential such as to prevent said discharge device from operatively energizing said electrically operated device, electrical connections from said source of power to said condenser, said electrical connections adapted to include an impedance which is capable of being asymmetrically conductive, means including said connections effective when said impedance is asymmetrically conductive to impress across said condenser a voltage such as to render said discharge device sufficiently conductive to cause operative energization of said electrically operated device, and means including said other control electrode effective when said impedance is symmetrically conductive to impress across said condenser a voltage such that said electrically operated device is effectively deenergized, regardless of the effective magnitude of said impedance.

2. In apparatus designed to respond to the presence of a rectifying impedance, an electrically operated device, a source of alternating power, means for controlling the energization of said device including said source of power and an electronic discharge device having an anode, a cathode, a control grid, and a screen grid, a condenser connected between said control grid and said cathode, said control grid normally assuming a potential such as to prevent said discharge device from operatively energizing said electrically operated device, electrical connections from said source of power to said condenser, said electrical connections being adapted to include an impedance which is capable of being asymmetrically conductive, means including said connections effective when said impedance is asymmetrically conductive to impress across said condenser a voltage such as to render said discharge device sufficiently conductive to cause operative energization of said electrically operated device, and means including said screen grid effective when said impedance is symmetrically conductive to impress across said condenser a voltage such that said electrically operated device is effectively deenergized, regardless of the effective magnitude of said impedance.

3. In apparatus designed to respond to the presence of a rectifying impedance, an electrically operated device, a source of alternating power, means for controlling the energization of said device including said source of power and an electronic discharge device having an anode, a cathode, a control grid, and a screen grid, a condenser connected between said control grid and said cathode, said control grid normally assuming a potential such as to prevent said discharge device from operatively energizing said electrically operated device, electrical connections from said source of power to said condenser, said

electrical connections being adapted to include an impedance which is capable of being asymmetrically conductive, means including said connections effective when said impedance is asymmetrically conductive to impress across said condenser a voltage such as to render said discharge device sufficiently conductive to cause operative energization of said electrically operated device, and means connecting said screen grid and cathode in parallel with said condenser in such a direction that when said impedance is symmetrically conductive there is impressed across said condenser a voltage such that said electrically operated device is effectively deenergized, regardless of the effective magnitude of said impedance.

4. In apparatus designed to respond to the presence of a rectifying impedance, an electrically operated device, a source of alternating power, means for controlling the energization of said device including said source of power and an electronic discharge device having an anode, a cathode, and two control electrodes, a condenser connected between one of said control electrodes and said cathode, said control electrode normally assuming a potential such as to prevent said discharge device from operatively energizing said electrically operated device, electrical connections from said source of power to said condenser including in series with said condenser an impedance which is capable of being asymmetrically conductive, means including said connections effective when said impedance is asymmetrically conductive to impress across said condenser a voltage such as to render said discharge device sufficiently conductive to cause operative energization of said electrically operated device, and means connecting said other control electrode and cathode in parallel with said series connected impedance and condenser in such a direction that when said impedance is symmetrically conductive there is impressed across said condenser a voltage such that said electrically operated device is effectively deenergized, regardless of the effective magnitude of said impedance.

5. In apparatus designed to respond to the illumination of a photoelectric cell, an electrically operated device, a source of alternating power, means for controlling the energization of said device including said source of power and an electronic discharge device having an anode, a cathode, and two control electrodes, a condenser connected between one of said control electrodes and said cathode, said control electrode normally assuming a potential such as to prevent said discharge device from operatively energizing said electrically operated device, a photoelectric cell, electrical connections from said source of power to said condenser including said photoelectric cell, means including said connections effective when said photoelectric cell is illuminated and hence asymmetrically conductive to impress across said condenser a voltage such as to render said discharge device sufficiently conductive to cause operative energization of said electrically operated device, and means including said other control electrode effective when said photoelectric cell is bridged by a symmetrically conductive impedance to impress across said condenser a voltage such that said electrically operated device is effectively deenergized, regardless of the magnitude of said symmetrically conductive impedance.

6. In combination, an electrically operated device, a source of alternating power, means for controlling the energization of said device including said source of power and an electronic discharge device having an anode, a cathode, a control grid, and a screen grid, a condenser connected between said control grid and said cathode, said control grid normally assuming a potential such as to prevent said discharge device from operatively energizing said electrically operated device, means including a resistor connecting said screen grid to said source of power, and electrical connections from said resistor to said condenser including in series with said condenser, an impedance which is capable of being asymmetrically conductive, and means including said connections effective when said impedance is asymmetrically conductive to impress across said condenser a voltage such as to render said discharge device sufficiently conductive to cause operative energization of said electrically operated device, regardless of the magnitude of said impedance.

7. In combination, an electrically operated device, a source of alternating power, means for controlling the energization of said device including said source of power and an electronic discharge device having an anode, a cathode, a control grid, and a screen grid, a condenser connected between said control grid and said cathode, said control grid normally assuming a potential such as to prevent said discharge device from operatively energizing said electrically operated device, means including a resistor connecting said screen grid to said source of power, electrical connections from said resistor to said condenser including in series with said condenser a second resistor having a relatively high resistance and an impedance which is capable of being asymmetrically conductive, and means including said connections effective when said impedance is asymmetrically conductive to impress across said condenser a voltage such as to render said discharge device sufficiently conductive to cause operative energization of said electrically operated device, regardless of the magnitude of said impedance.

8. In combination, an electrically operated device, a source of alternating power, means for controlling the energization of said device including said source of power and an electronic discharge device having an anode, a cathode, a control grid, and an auxiliary electrode, a first resistor and a condenser connected in the order named between said control grid and said cathode, said control grid normally assuming a potential such as to prevent said discharge device from operatively energizing said electrically operated device, means including a second resistor connecting said auxiliary electrode to said source of power at a point having a potential, the phase relation of which with respect to the cathode is the same as that of the anode, an electrical connection from said second resistor to the junction of said first resistor and said condenser, said connection including in series a third relatively large resistor and an impedance which is capable of being asymmetrically conductive and means including said connections effective when said impedance is asymmetrically conductive to impress across said condenser a voltage such as to render said discharge device sufficiently conductive to cause operative energization of said electrically operated device regardless of the magnitude of said impedance.

9. In combination, an electrically operated device, a source of alternating power, means for controlling the energization of said device including said source of power and an electronic discharge device having an anode, a cathode, a

control grid, and a screen grid, a first resistor and a condenser connected in the order named between said control grid and said cathode, said control grid normally assuming a potential such as to prevent said discharge device from operatively energizing said electrically operated device, means including a second resistor connecting said screen grid to said source of power at a point having a potential, the phase relation of which with respect to the cathode is the same as that of the anode, an electrical connection from said second resistor to the junction of said first resistor and said condenser, said connection including in series a third relatively large resistor and an impedance which is capable of being asymmetrically conductive, and means including said connections effective when said impedance is asymmetrically conductive to impress across said condenser a voltage such as to render said discharge device sufficiently conductive to cause operative energization of said electrically operated device regardless of the magnitude of said impedance.

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