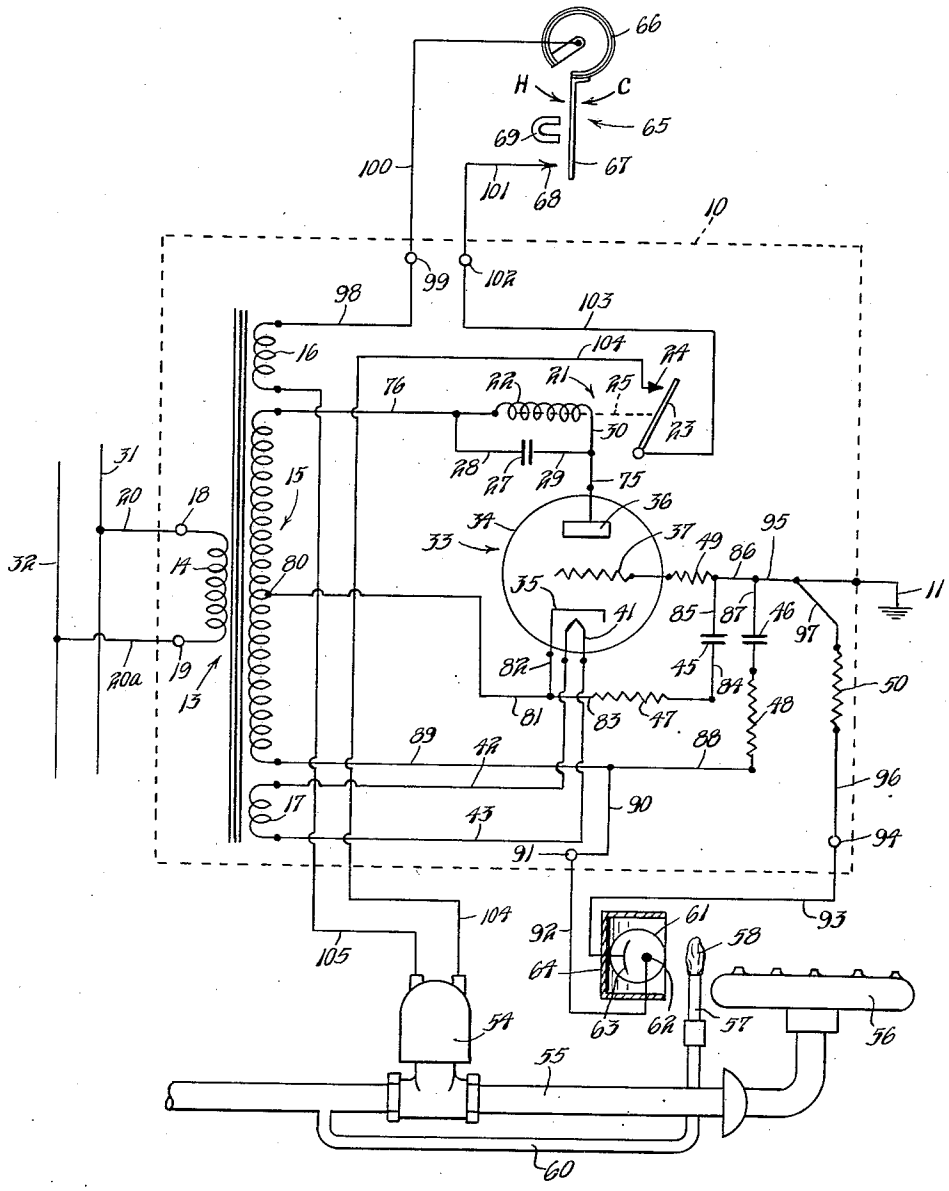
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CONTROL DEVICE

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CONTROL DEVICE

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The present invention is concerned with a control device and more particularly with one employing an electronic circuit for detecting when the impedance across a gap is rectifying.

In my co-pending application for Control device, Serial No. 464,732, filed November 6, 1942, there is described a control device which is adapted to determine whether an impedance connected across a gap is rectifying or not and to act in one manner when the impedance is rectifying and to act in another when the gap is either open-circuited or is bridged by an impedance which is non-rectifying. In this circuit, an electronic discharge amplifier is employed and connections are made between a control element of this device and a single point on a source of power, these connections being effective both to maintain the control element at a value at which the amplifier is non-conductive and to affect the potential of the control element so that the amplifier is conductive when a gap in the connection is bridged by a rectifying impedance. While this control device involved a marked improvement over previous devices of this type which required connections between the control element and a plurality of points on the source of power, it had the disadvantage that it required the use of an electronic amplifier having a zero cut-off voltage.

It is a general object of the present invention to provide a control device of this general type in which it is possible to employ an electronic device operating with any desired bias on the control element and in which the control element is connected only to a single point of the source of power.

A still further object of the present invention is to provide such a control device in which the single point of the source of power with which the control element is connected is a point such that the connection tends to cause the control element to assume a potential at which the space discharge device is effectively non-conductive, and by a means associated with this connection which is effective when the gap in the connection is bridged by a rectifying impedance to cause the potential of the grid to assume a different value at which the discharge device is conductive.

A still further object of the invention is to provide a control device such as set forth in the last object in which the gap is shunted by means substantially non-conductive to a continuous current in the direction of rectification of the impedance so as to permit the connection between the control element and the source of power to be effective as a biasing connection when the gap is open.

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In the specific construction I employed, the means bridging the gap is a condenser and the means for raising the potential of the control element when the gap is bridged by a rectifying impedance is likewise a condenser.

Other objects of the 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 burner control device employed as a flame detecting apparatus for a burner control system.

Referring to the drawing, the control device of the present invention is shown as located within a housing 10. This housing may be of any suitable form. If the housing is of metal, it is desirable to connect it to ground as at 11.

A relay 21 comprises a relay coil 22 and a switch blade 23 adapted to engage a fixed contact 24. Switch blade 23 is associated with an armature 25 which in turn is associated with the relay coil 22. Switch blade 23 is normally biased by gravity or other suitable means away from contact 24. Upon energization of relay coil 22, however, the armature 25 is drawn to the left to move switch blade 23 into engagement with contact 24.

A condenser 27 is connected by conductors 28, 29, and 30 in parallel with relay coil 22. Condenser 27 acts as a shunt condenser to eliminate any pulsations in the current flowing through relay coil 22.

The energization of relay coil 22 is controlled by an electronic discharge device 33. This device comprises a conventional envelope 34 which encloses a cathode 35, an anode 36, and a control grid 37. The cathode 35 is of the indirectly heated type and has a heater 41 associated therewith for heating the same. The heater is connected to secondary winding 17 by conductors 42 and 43. The electronic discharge device 33 is so designed that the voltage amplification is relatively uniform when a voltage is applied to the control circuit of such magnitude that the amplifier is non-conductive only when the potential of the grid is lower than the potential of the cathode by a predetermined amount when the anode is at a predetermined potential above the cathode. In other words, the discharge device is of the conventional type in which the grid is operated with a negative bias. Condensers 45, and 46, and resistors 47, 48, and 49 are associated with the discharge device 33 by connections which will be described presently. The condensers 45 and 46 control the potential of the grid 37 under certain conditions of operation, as will also be explained later.

The relay 21 is illustratively shown as controlling an electrically operated gas valve 54. This gas valve is of the type which when energized permits the flow of gas and which upon deenergization interrupts such flow. The gas valve 54 controls the flow of gas through a pipe 55 to a main gas burner 56. Located adjacent to the main gas burner 56 is a pilot burner 57, the flame of which is indicated by the reference numeral 58. The pilot burner is preferably of the type burning gas unmixed with air so that the flame is yellow. The pilot burner is supplied with gas by a pipe 60 which is connected to the gas supply pipe 55 at a point on the upstream side of valve 54 so that the pilot burner 57 is normally constantly supplied with gas and hence normally constantly burning.

Exposed to the flame 58 of pilot burner 57 is a photo-electric cell 61. This photo-electric cell is of conventional construction having an anode 62 and a cathode 63. The photo-electric cell is mounted in a housing 64, the housing being designed to support the photo-electric cell in such a manner that the light of the flame 58 is directed onto the cathode 63. Because of the flame 58 being yellow, it is desirable that the cell be designed so as to respond primarily to yellow light.

The energization of valve 54 is not only controlled by relay 21 but also by a room thermostat 65. This room thermostat is of conventional construction and comprises a bimetallic element 66 to which is secured a contact arm 67. The contact arm is adapted to be moved into and out of engagement with a fixed contact 68. As indicated by the legends C and H, the bimetallic element 66 is effective to move the contact arm 67 to the left in the direction of contact 68 upon a temperature fall and to the right away from contact 68 upon a temperature rise. A magnet 69 is associated with contact arm 67 to impart a snap action to the contact arm and to cause a suitable differential to exist between the temperature at which the contact arm 67 engages contact 68 and that at which it separates from contact 68.

The anode 36 of the discharge device 33 is connected to one end of secondary 15 by conductors 75 and 30, relay coil 22 and conductor 76. The cathode 35 is connected to center tap 80 of the secondary 15 by conductors 82 and 81. The grid 37 is connected to the lower end of secondary 15 by a connection which has two parallel branches, one of which includes the photoelectric cell 61 and resistor 50 and the other of which includes the condenser 46 and resistor 48. These various connections will be referred to in the accompanying description of the operation of the device.

While the various elements of the system described so far can have a wide range of values, I have found it desirable in one particular embodiment of my invention to employ a transformer in which the voltage of secondary 16 was 24 volts and the voltage of each half of secondary 15, 300 volts. The voltage of secondary 17 is dependent upon the type of heating element 41 that is employed. In the same embodiment of the invention, I employed condensers of 0.02 microfarad and 0.0002 microfarad for condensers 45 and 46 respectively. For resistors 47 and 48, I employed resistors having resistance values of two megohms and one megohm respectively. In the same embodiment I employed a resistor of three to four megohms for resistor 49 and a resistor of one megohm for resistor 50. As previously indicated, however, it is to be understood that these values are merely values employed in a particular embodiment of my invention and that the invention is not in any way limited to the use of elements having these particular values.

Operation

When pilot burner is extinguished

The various elements are shown in the position which they occupy when the pilot burner 57 is extinguished and when the temperature adjacent room thermostat 64 is at or above the desired value so that the thermostat 65 is "satisfied." Under these conditions, a conductive path will be established through condensers 45 and 46 as follows: from the center tap 80 of secondary 15 through conductors 81 and 83, resistor 47, conductor 84, condenser 45, conductors 85, 86, and 87, condenser 46, resistor 48, and conductors 88 and 89 to the lower terminal of secondary 15. The current flow through these two condensers over the conductive path just traced will be the same in both directions. In other words, an alternating current will flow through the condensers 45 and 46. It will be noted that the current conductive path is traced from the center tap 80 to the lower terminal of secondary 15. This is the direction the current flow will assume during the half cycle in which the upper terminal of secondary 15, to which the anode 36 is connected, is positive with respect to the center tap 80, to which the cathode 35 is connected. The effect of this current flow through the condenser 45 in this direction is to cause the upper terminal of condenser 45 to be negative with respect to the lower terminal. The upper terminal of condenser 45 is connected by conductor 85 and resistor 49 to grid 37. The lower terminal of condenser 45 is connected by conductor 84, resistor 47 and conductors 83 and 82 to the cathode 35. The effect of this current flow through condenser 47 is thus to bias grid 37 negatively with respect to cathode 35 during the half cycle in which anode 36 is positive with respect to cathode 35. In other words, the condenser 45 has impressed across it an alternating voltage which is 180° out of phase with respect to the voltage impressed between the anode and cathode. Viewed in another light, the grid 37 is connected through resistor 49, conductors 86 and 87, condenser 46, resistor 48, and conductors 88 and 89, to the lower terminal of secondary 15, which terminal is highly negative with respect to cathode 35 during the half cycle in which anode 36 is positive with respect to cathode 35. Thus, the grid 37 is connected by means of condenser 46 to a point on the source of power whose voltage phase with respect to the cathode is 180° displaced from that of the point at which the anode 36 is connected. Viewed in either light, the effect of the conditions just described is to impress upon grid 37 a biasing voltage, the magnitude of which depends upon the relative values of condensers 45 and 46 as well as resistors 47 and 48. The values of these various elements are so selected that the potential impressed upon grid 37 under these conditions is below or sufficiently close to the cutoff point so that the current flow through relay 22 is inadequate to operate the same.

It will be obvious that under these conditions, it is impossible to establish a circuit to gas valve 54, even if the room thermostat 65 calls for burner operation. As previously noted, the relay 21 controls the circuit to gas valve 54 and when the relay is deenergized, it is impossible to ener-

gize gas valve 54. It is thus assured that no gas flow will be established to the main burner 56 as long as the pilot burner 57 is extinguished.

When pilot burner is properly ignited

If the pilot burner 57 is properly ignited the photo-electric cell 61 will be illuminated by the flame of the pilot burner 58. When this happens, the photo-electric cell 61, which in the previous operation has been effectively non-conductive, now becomes conductive to current flowing from the anode to the cathode. In other words, the photo-electric cell 61 now functions as a rectifier to permit current to flow through it in one direction only. Under these conditions, a circuit is now established through condenser 45 as follows: from the lower terminal of secondary 15 through conductors 89 and 90, terminal 91, conductor 92, photo-electric cell 61, conductor 93, terminal 94, conductor 96, resistor 50, conductors 97, 95, 86, and 85, condenser 45, conductor 84, resistance 47, and conductors 83 and 81, to the center tap 80 of secondary 15. The effect of the current flow through the photo-electric cell 61 and condenser 45 is to impress across condenser 45 a direct current potential, the polarity of which is such as to cause the upper end of condenser 45 to be positive with respect to the lower end. It is still possible to trace a circuit through condenser 45 and condenser 46 as was done in connection with the description of operation when the pilot burner was extinguished. In other words, condenser 46 is in parallel with the photo-electric cell 61 and the gap between terminals 91 and 94 bridged by the cell. As was noted at that time, the effect of this current flow through condensers 45 and 46 is to impress across condenser 46 an alternating current potential 180° displaced in phase with respect to the voltage between the anode and cathode. This voltage is still present on condenser 45. However, there is now superimposed on this alternating current voltage a direct current voltage due to the rectified current flow through photo-electric cell 61 and condenser 45. This direct current component of the voltage across condenser 45 tends to shift the level of the voltage so that during the half cycles in which anode 36 is positive with respect to cathode 35, the potential of grid 37 remains appreciably above the cutoff point so that the current flow through the discharge device 33 is appreciable in magnitude. Under these conditions, current will flow through relay coil 22 in the following circuit: from the upper terminal of secondary 15 through conductor 76, relay coil 22, conductors 38 and 75, anode 36, cathode 35 and conductors 82 and 81 to the center tap 80 of secondary 15. This current flow, due to the relatively high potential of grid 37, will be sufficient to cause relay coil 22 to be energized so as to move switch blade 23 into engagement with contact 24. This permits the energization of gas valve 54 when thermostat 64 calls for burner operation.

Let it now be assumed that the temperature adjacent thermostat 66 drops sufficiently to cause thermostat contact blade 67 to engage the contact 68. When this happens, a circuit is established to the gas valve 54 as follows: from the upper terminal of secondary 16 through conductor 98, terminal 99, conductor 100, bimetallic element 66, contact blade 67, contact 68, conductor 101, terminal 102, conductor 103, switch blade 23, contact 24, conductor 104, gas valve 54, and conductor 105 to the other terminal of secondary 16. The

establishment of this circuit causes energization of gas valve 54 so that the same moves to open position to permit a flow of gas through pipe 55 to main burner 56. Since it has previously been established that pilot burner 58 is ignited it is assured that this gas flowing to the main burner will be properly ignited by pilot burner 58. Under normal circumstances, the burner will continue in operation until the temperature adjacent room thermostat 65 has risen sufficiently to cause separation of contact blade 67 from contact 68 so as to interrupt the circuit to gas valve 54 just traced. When this happens, the gas valve 54 will be deenergized to shut off the flow of gas to the main burner 56 and terminate operation of the main burner.

If, at any time, the pilot burner 58 becomes extinguished, the photo-electric cell 61 will cease to be illuminated. It is quite often desirable that the system be shut down even though the main burner is in operation when the pilot burner becomes extinguished. Where this is the case, the housing 64 of the photo-electric cell is so disposed that it is subjected primarily to the light from the pilot burner 58 and will cease to be sufficiently illuminated when the pilot burner is extinguished even though the main burner is in operation. As soon as the photo-electric cell 61 ceases to be illuminated, it becomes substantially non-conductive so that the unidirectional current flow through condenser 45 is terminated. The only current flow through condenser 45 is again the alternating current flowing through condensers 45 and 46. As previously explained, the alternating voltage impressed across condenser 45 as the result of this flow of alternating current, is of such phase relation with respect to the anode voltage that the grid is biased negatively. Thus, the tube 33 again becomes substantially non-conductive so as to deenergize relay 21 and terminate operation of gas valve 54. Since the dissipation of the direct current component of the voltage across condenser 45 requires only an extremely short period of time, the response of the apparatus to the extinguishment of the pilot burner flame is extremely rapid.

When photo-electric cell is shunted

It may occasionally happen that the contacts of the photo-electric cell will become shunted in some manner or other. The means shunting the photo-electric cell might have a very high resistance approaching that of the flame or it may have an extremely low resistance. In any event, it is essential that the apparatus not respond to the presence of such a shunt as though a flame were present. The present control device is capable of distinguishing between such a shunt condition and the existence of a proper flame. Any resistance shunting the photo-electric cell will normally have no rectifying properties. Such a shunting resistance, in the case of a photo-electric cell, may be caused by some foreign metal body which actually engages the conductors leading to the photo-electric cell or the terminals of the cell. Again, the dielectric of the insulation may deteriorate with age until a point is reached at which the resistance between the leads to the photo-electric cell approaches the resistance of the flame. In all of these cases, the current flow through the resistance bridging the photo-electric cell is the same in both directions. In other words, the current flow is alternating. The only result is that the current flow through condenser 45 is

increased and the alternating current potential drop through condenser 45 is increased even more. This is obvious when it is considered that the photo-electric cell 61 is connected in parallel with resistor 43 and condenser 46. When the photo-electric cell is bridged in any manner by a resistance which is not rectifying, the alternating current impedance between the junction of conductors 88 and 90 and the junction of conductors 87 and 95 is decreased so as to cause a greater proportion of the potential drop between center tap 80 and the lower terminal of secondary 15 to occur across condenser 45. The resistors 47 and 50 act as a protective resistance to avoid an excessive negative potential being applied to grid 37 in the event that a very low impedance is established across the terminals of the photo-electric cell 61.

It will be apparent from the above description that the presence of a resistance shunt across photo-electric cell 61 will not give an indication of flame, even if this resistance is of the same order of magnitude as the resistance of the photo-electric cell.

Conclusion

It will be seen that I have provided an extremely simple control device which permits the use of an electronic device which is operated in a normal manner with a negative bias and which responds only when a rectifying impedance is connected across a gap in the circuit connections between terminals 91 and 94. It is to be understood that while I have shown a photo-electric cell as connected between terminals 91 and 94, that any other rectifying impedance might be so connected. For example, instead of employing a photo-electric cell 61 as responsive to burner flame 58, a flame electrode disposed in the path of flame 58 may be connected to terminal 91. In such cases, the pilot burner 57 would be grounded so that a conductive path would be established through the flame to ground. As is well known, the direction of current flow through a flame is greater in the direction opposed to the direction of propagation of the flame. Such a flame is hence rectifying so that an effect corresponding to the effect of the photo-electric cell is obtained. Where such a flame electrode is used, the control device is effective to distinguish between the condition in which a proper flame exists and one in which a gap between the flame electrode and the burner is bridged by some impedance other than that of the flame. Since either a photo-electric cell or flame electrode can be employed in connection with my control apparatus, it is to be understood that where the expression "means responsive to a burner flame" or equivalent language appears in the specification and claims, it is to be understood that this language is to be construed broadly enough to cover either a photo-electric cell exposed to the light of the burner flame or to a flame electrode disposed in the path of the burner flame.

While I have disclosed my control device in connection with a burner control system and while it is peculiarly adapted for operation with such a system it is to be understood that it could be employed in other cases where it is desired to distinguish between a rectifying and a non-rectifying impedance. In general, while I have disclosed a specific embodiment of my invention, it is to be understood that this is for purposes of illustration and that my invention is to be limited solely by the scope of the appended claims.

I claim as my invention:

1. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element; a source of alternating power; circuit connections for controlling said electrical device including said anode, said cathode, and said source of power and operative to cause said electrical device to be energized when the potential of said control electrode is within a first of two ranges of values; connections between said control electrode and a point on said source of power such that the connections tend to maintain said control element at an alternating potential within one of said two ranges of values; said point being the only point on said source of power independent of the cathode connection to which said control element is connected; said last named connections including a gap adapted to be bridged by a rectifying impedance; means associated with said last named connections and effective when said gap is bridged by a rectifying impedance to maintain said control element at a potential within the other of said two ranges of values; and means in said last named connections in parallel with said gap, said last named means being substantially non-conductive to a continuous current in the direction of rectification of said impedance.

2. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element; a source of alternating power; circuit connections for controlling said electrical device including said anode, said cathode, and said source of power and operative to cause said electrical device to be energized when the potential of said control electrode is within a first of two ranges of values; connections between said control electrode and a point on said source of power such that the connections tend to maintain said control element at an alternating potential within one of said two ranges of values; said point being the only point on said source of power independent of the cathode connection to which said control element is connected; said last named connections including a condenser in parallel with a gap adapted to be bridged by a rectifying impedance; and means associated with said last named connections and effective when said gap is bridged by a rectifying impedance to maintain said control element at a potential within the other of said two ranges of values.

3. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element; a source of alternating power; circuit connections for controlling said electrical device including said anode, said cathode, and said source of power and operative to cause said electrical device to be energized when the potential of said control electrode is within a first of two ranges of values; connections between said control electrode and a point on said source of power such that the connections tend to maintain said control element at an alternating potential within one of said two ranges of values; said point being the only point on said source of power independent of the cathode connection to which said control element is connected; said last named connections including a gap adapted to be bridged by a rectifying impedance; a condenser associated with said last named connections and effective when said gap is bridged by a rectifying impedance to assume a charge such as to maintain said control element at a potential within the other of said

two ranges of values; and means in said last named connections in parallel with said gap, said last named means being substantially non-conductive to a continuous current in the direction of rectification of said impedance.

4. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element; a source of alternating power; circuit connections for controlling said electrical device including said anode, said cathode, and said source of power and operative to cause said electrical device to be energized when the potential of said control electrode is within a first of two ranges of values; connections between said control electrode and a single point on said source of power such that the connections tend to maintain said control element at an alternating potential within one of said two ranges of values; said last named connections including a condenser in parallel with a gap adapted to be bridged by a rectifying impedance; and a further condenser connected between said cathode and said control element and effective when said gap is bridged by a rectifying impedance to assume a charge such as to maintain said control element at a potential within the other of said two ranges of values.

5. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element, said amplifier controlling the energization of said device; connections from a source of alternating voltage to said anode and cathode; a connection between said control electrode and a point on said voltage source whose voltage phase with respect to the cathode is opposite to that of the point to which the anode is connected, said point being the only point on said voltage source independent of the cathode connection to which said control element is connected; said connection including a gap adapted to be bridged by a rectifying impedance; means associated with said connection and effective when said gap is bridged by a rectifying impedance to maintain said control electrode at a sufficiently high potential that said amplifier is effectively conducting; and further means associated with said last named connection effective when said gap is open to cause said control electrode to be maintained at a potential sufficiently negative with respect to the cathode when the anode is positive with respect to the cathode that said amplifier is effectively non-conducting.

6. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element, said amplifier controlling the energization of said device; connections from a source of alternating voltage to said anode and cathode for applying between said anode and cathode an alternating voltage of such magnitude that said amplifier is effectively nonconductive only if the control electrode potential is negative with respect to the cathode potential when the anode potential is positive with respect to the cathode potential; a connection between said control electrode and a point on said voltage source whose voltage phase with respect to the cathode is opposite to that of the point to which the anode is connected, said point being the only point on said voltage source independent of the cathode connection to which said control element is connected; said connection including a gap adapted to be bridged by a rectifying impedance; means associated with said connection and effective when said gap is bridged by a rectifying impedance to maintain said control electrode at a sufficiently high potential that said amplifier is effectively conducting; and means in said last named connection in parallel with said gap, and effective when said gap is open to cause said control electrode to be maintained at a potential negative with respect to the cathode when the anode is positive with respect to the cathode.

7. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element, said amplifier controlling the energization of said device; connections from a source of alternating voltage to said anode and cathode for applying between said anode and cathode an alternating voltage of such magnitude that said amplifier is effectively nonconductive only if the control electrode potential is negative with respect to the cathode potential when the anode potential is positive with respect to the cathode potential; a connection between said control electrode and a point on said voltage source whose voltage phase with respect to the cathode is opposite to that of the point to which the anode is connected so as to tend to maintain said control electrode at a potential negative with respect to the cathode when the anode is positive with respect to the cathode, said point being the only point on said voltage source independent of the cathode connection to which said control element is connected; said connection including a gap adapted to be bridged by a rectifying impedance; means associated with said connection and effective when said gap is bridged by a rectifying impedance to maintain said control electrode at a higher potential at which said amplifier is effectively conducting; and means in said last named connection in parallel with said gap, said last named means being substantially non-conductive to a continuous current in the direction of rectification of said impedance.

8. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element, said amplifier controlling the energization of said device; connections from a source of alternating voltage to said anode and cathode for applying between said anode and cathode an alternating voltage of such magnitude that said amplifier is effectively nonconductive only if the control electrode potential is negative with respect to the cathode potential when the anode potential is positive with respect to the cathode potential; a connection between said control electrode and a point on said voltage source whose voltage phase with respect to the cathode is opposite to that of the point to which the anode is connected so as to tend to maintain said control electrode at a potential negative with respect to the cathode when the anode is positive with respect to the cathode, said point being the only point on said voltage source independent of the cathode connection to which said control element is connected; said connection including a condenser in parallel with a gap adapted to be bridged by a rectifying impedance; and means associated with said connection and effective when said gap is bridged by a rectifying impedance to maintain said control electrode at a higher potential at which said amplifier is effectively conducting.

9. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element, said amplifier controlling the energization of said device; connections from a source of alternating voltage to said anode and cathode for applying between said anode and cathode an alternating voltage of such magni-

tude that said amplifier is effectively nonconductive only if the control electrode potential is negative with respect to the cathode potential when the anode potential is positive with respect to the cathode potential; a connection between said control electrode and a point on said voltage source whose voltage phase with respect to the cathode is opposite to that of the point to which the anode is connected so as to tend to maintain said control electrode at a potential negative with respect to the cathode when the anode is positive with respect to the cathode, said point being the only point on said voltage source independent of the cathode connection to which said control element is connected; said connection including a condenser in parallel with a gap adapted to be bridged by a rectifying impedance; and a further condenser associated with said connection and effective when said gap is bridged by a rectifying impedance to maintain said control electrode at a higher potential at which said amplifier is effectively conducting.

10. In combination, an electrically operated device whose energization is to be controlled in accordance with the presence or absence of a burner flame; a space discharge amplifier having an anode, a cathode, and a control element, said amplifier controlling the energization of said device; connections from a source of alternating voltage to said anode and cathode; a connection between said control electrode and a point on said voltage source whose voltage phase with respect to the cathode is opposite to that of the point to which the anode is connected, said point being the only point on said voltage source independent of the cathode connection to which said control element is connected; said connection including a light sensitive cell adapted to be exposed to a burner flame and acting as a rectifying impedance upon the presence of a burner flame; means associated with said connection and effective when said light sensitive cell is exposed to the burner flame to maintain said control electrode at a sufficiently high potential that said amplifier is effective to energize said device; and means associated with said last named connection in parallel with said light sensitive cell and effective when said light sensitive cell is not exposed to the burner flame to cause said control electrode to be maintained at a potential sufficiently less than that of the cathode when the anode is positive with respect to the cathode that said amplifier is ineffective to energize said device.

11. In combination; an electrical device; a space discharge amplifier having an anode; a cathode, and a control element; a source of alternating power; circuit connections for controlling said electrical device including said anode, said cathode, and said source of power and operative to cause said electrical device to be energized when the potential of said control electrode is within a first of two ranges of values; connections between said control electrode and a point on said source of power such that the connections tend to maintain said control element at an alternating potential within one of said two ranges of values; said point being the only point on said source of power independent of the cathode connection to which said control element is connected; said last named connections including a further space discharge device which is conductive to varying degrees in only one direction; means associated with said last named connections and effective when the conductivity of said space discharge device exceeds a predetermined value to maintain said control element at a potential within the other of said two ranges of values; and means in said last named connections in parallel with said further space discharge device, said last named means being substantially non-conductive to a continuous current in the direction of conductivity of said device.

12. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element; a source of alternating power; circuit connections for controlling said electrical device including said anode, said cathode, and said source of power and operative to cause said electrical device to be energized when the potential of said control electrode is within a first of two ranges of values; connections between said control electrode and a point on said source of power such that the connections tend to maintain said control element at an alternating potential within one of said two ranges of values; said point being the only point on said source of power independent of the cathode connection to which said control element is connected; said last named connections including a rectifying space discharge device and a condenser in parallel therewith; and means associated with said last named connections and effective when the conductivity of said space discharge device exceeds a predetermined value to maintain said control element at a potential within the other of said two ranges of values.

13. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element, said amplifier controlling the energization of said device; connections from a source of alternating voltage to said anode and cathode; a connection between said control electrode and a point on said voltage source whose voltage phase with respect to the cathode is opposite to that of the point to which the anode is connected, said point being the only point on said voltage source independent of the cathode connection to which said control element is connected; said connection including a gap adapted to be bridged by a rectifying impedance; means associated with said connection and effective when said gap is bridged by a rectifying impedance to maintain said control electrode at a sufficiently high potential that said amplifier is effectively conductive; and further means associated with said last named connection effective when said gap is not bridged by a rectifying impedance to cause said control electrode to be maintained at a potential sufficiently negative with respect to the cathode when the anode is positive with respect to the cathode that said amplifier is effectively non-conducting.

14. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element, said amplifier controlling the energization of said device; connections from a source of alternating voltage to said anode and cathode; a connection between said control electrode and a point on said voltage source whose voltage phase with respect to the cathode is opposite to that of the point to which the anode is connected; said connection including a further space discharge device having an anode and a cathode, said cathode being connected to said grid and said anode being connected to said previously named point on said voltage source; a condenser connected between said control element and said cathode of said space discharge amplifier and in series with said

further space discharge device and effective when the conductivity of said further space discharge device is above a predetermined value to maintain said control electrode at a sufficiently high potential that said amplifier is effectively conductive; and a further condenser connected in parallel with said further space discharge device and effective when the conductivity of said further space discharge device does not exceed said predetermined value to cause said control electrode to be maintained at a potential sufficiently negative with respect to the cathode when the anode is positive with respect to the cathode that said amplifier is effectively non-conductive.

15. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element; a source of alternating power; circuit connections between said anode, said cathode and said source of power; means including said circuit connections for causing said electrical device to be effectively energized when the potential of said control electrode is within a first of two ranges of values; a first impedance connection between said control electrode and said cathode; and a second impedance connection between said control electrode and a point on said source of power such that the connection tends to maintain said control element at an alternating potential within the other of said two ranges of values; said impedance connections including a condenser in parallel with a gap adapted to be bridged by a rectifying impedance; said impedance connections being effective only when said gap is bridged by a rectifying impedance to cause the potential of said electrode to assume a value within the first of said two ranges of values.

16. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element; a source of alternating power; circuit connections between said anode, said cathode and said source of power; means including said circuit connections for causing said electrical device to be effectively energized when the potential of said control electrode is within a first of two ranges of values; a first impedance connection between said control electrode and said cathode; and a second impedance connection between said control electrode and a point on said source of power such that the connection tends to maintain said control element at an alternating potential within the other of said two ranges of values, said point being the only point on said source of power independent of the cathode connection to which said control element is connected; said impedance connections including a condenser in parallel with a gap adapted to be bridged by a rectifying impedance; said impedance connections being effective only when said gap is bridged by a rectifying impedance to cause the potential of said electrode to assume a value within the first of said two ranges of values.

17. In combination; an electrical device; a space discharge amplifier having an anode, a cathode, and a control element; a source of alternating power; circuit connections between said anode, said cathode and said source of power; means including said circuit connections for causing said electrical device to be effectively energized when the potential of said control electrole is within a first of two ranges of values; a first impedance connection between said control electrode and said cathode; and a second impedance connection between said control electrode and a point on said source of power such that the connection tends to maintain said control element at an alternating potential within the other of said two ranges of values, said point being the only point on said source of power independent of the cathode connection to which said control element is connected; one of said impedance connections including a condenser and a photoelectric cell in parallel; said impedance connections being effective only when said photoelectric cell is illuminated to cause the potential of said electrode to assume a value within the first of said two ranges of values.

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