

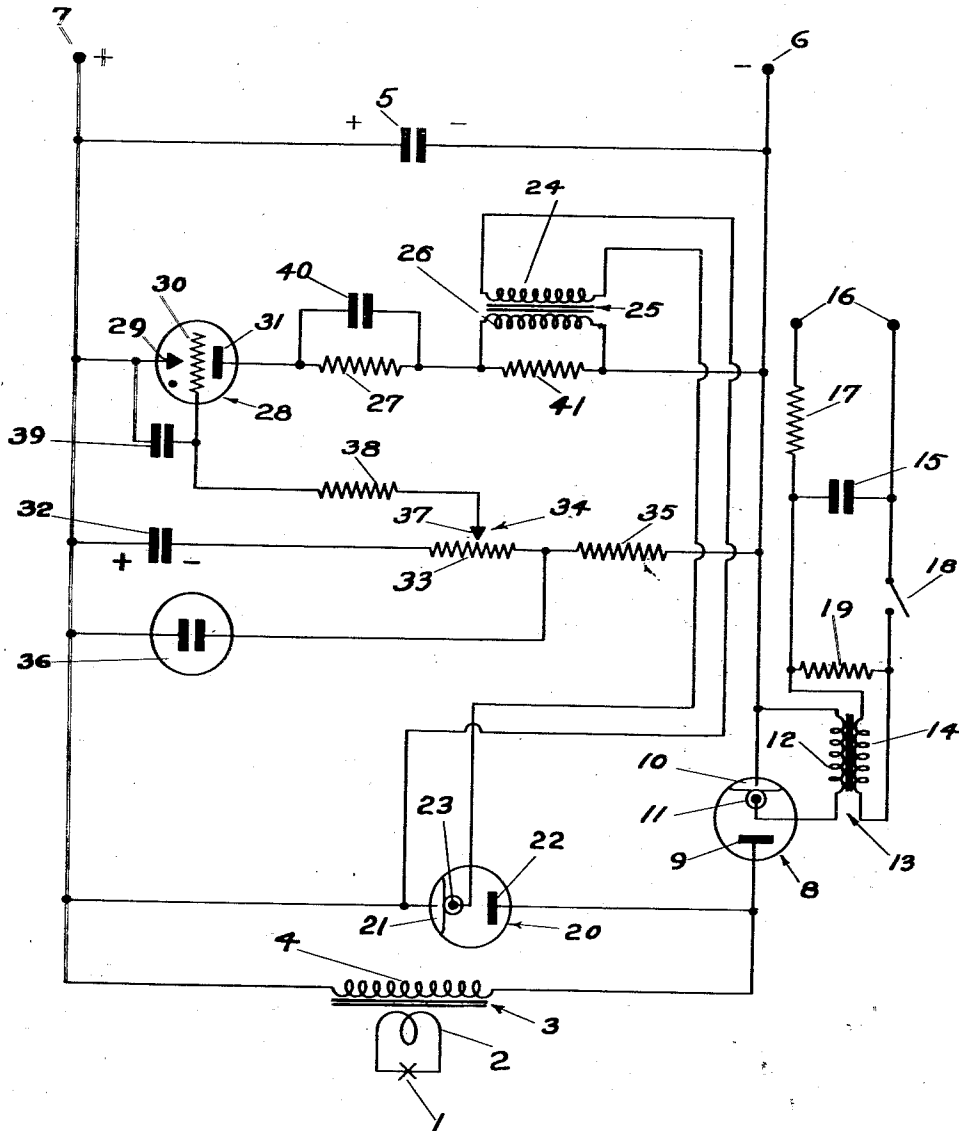
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CONTROLLED IGNITION DISCHARGE TUBE SYSTEM

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CONTROLLED IGNITION DISCHARGE TUBE SYSTEM

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This invention relates to controlled ignition discharge tube systems, and particularly to firing arrangements for such tubes. The tubes referred to hereinabove are of the type having a pool cathode and an igniting electrode which is adapted when supplied with an igniting impulse to initiate an arc on said pool.

An object of the present invention is the provision of a system for reliably firing controlled ignition discharge tubes.

Another object of the present invention is the provision of means, in controlled ignition discharge systems having a circuit in which the rate of current flow is varying, for firing a controlled ignition discharge tube when the rate of current flow in said circuit has reached a predetermined value.

Still another object of the present invention is the provision, in a controlled ignition discharge tube system in which the anode voltage applied to said tube is varying, of means for supplying igniting impulses to the igniting electrode of said tube when the anode voltage thereon has reached a predetermined value.

In certain condenser discharge systems in which the condenser is discharged through an inductance the discharge tends to be oscillatory and the potentials across said condenser and said inductance reverse in polarity. In certain of such systems it is desired to fire a controlled ignition discharge tube upon such reversal of potential. The tube to be fired, for example may be a shunt tube arranged across the inductance to enable the exponential decay of the current flowing through said inductance. Therefore, a further object of the present invention is the provision in a system of the type described of means for firing the controlled ignition discharge tube when the reversed potential on the condenser and/or the inductance has reached a predetermined value, and for delaying said firing until said value has been reached.

A still further object of the present invention is the provision of a condenser discharge system of the type hereinbefore described in which igniting impulses are supplied to the shunt tube when the reversed potential thereon has reached a high enough value to insure reliable ignition of said shunt tube.

Other and further objects and advantages of the present invention will become apparent, and the foregoing will be best understood from the following description of an exemplification thereof, reference being had to the drawing in which

the figure is a schematic diagram of a condenser welding system utilizing controlled ignition discharge tubes.

Referring now to the figure, a welding load 1 is to be supplied with welding current from the secondary 2 of a welding transformer 3 having a primary winding 4. The primary 4 is adapted to be supplied with energy from the discharge of a condenser 5. Condenser 5 is adapted to be charged from any suitable source of direct current, such as for example, a direct current generator, battery, rectifier, or the like. For this purpose said condenser may have its negative side connected to a terminal 6, and its positive side connected to a terminal 7, terminals 6 and 7 being adapted to be connected to a suitable source of direct current supply. Condenser 5 may have its positive side connected directly to one end of the primary winding 4, and its negative side connected through a controlled ignition discharge tube 8 to the other side of the primary winding 4. Tube 8 is preferably of the type having a pool cathode and an electrostatic igniting electrode. By the term electrostatic igniting electrode, I refer to the type of igniting electrode insulated and separated from the pool by a thin glass covering. Tube 8 has its anode 9 connected to one end of the primary winding 4, and its cathode 10 connected to the negative side of condenser 5. Igniting impulses may be supplied to the igniting electrode 11 of tube 8 through the secondary winding 12 of an igniting transformer 13 having a primary winding 14. Any suitable means may be used to supply pulses of current to the primary winding 14, the one here-illustrated consisting of a condenser 15 adapted to be charged from any suitable source of direct current 16 through a current limiting resistance 17. Condenser 15 is connected to the primary winding 14 of the igniting transformer 13 through a manually operable switch 18, which switch is adapted upon being closed to discharge condenser 15 through the primary winding 14. A resistance 19 may be arranged across the primary winding 14.

It will be seen that when switch 18 is closed an igniting impulse is supplied to the igniting electrode 11 of tube 8, and tube 8 is thereby fired. Upon the firing of tube 8, condenser 5 discharges through the primary winding 4 of the welding transformer 3. As condenser 5 discharges, the voltage across inductance 4 decreases as the current passing therethrough increases, the voltage reaching a zero value when the current flow is at

a maximum. Due to the inductance associated with said circuit, current continues to flow in the original direction through the primary winding 4 as the potential across said winding 4 reverses.

In order to enable the current flowing through said winding to decay exponentially another controlled ignition discharge tube 20 is arranged in shunt across the primary winding 4. Tube 20 may be similar to tube 8, and may be provided with a pool type cathode 21 connected to one end of the primary winding 4 and an anode 22 connected to the end of the primary winding 4 which is connected to anode 9 of tube 8. Tube 20 may be provided with an igniting electrode 23 of the same type as igniting electrode 11 of tube 8. Igniting impulses for firing tube 20 may be supplied to the igniting electrode 23 from the secondary winding 24 of an igniting transformer 25 having a primary winding 26 which is adapted to be connected to a suitable source of igniting impulses.

When condenser 5 is discharged into the primary winding 4 of the welding transformer 3 upon firing of tube 8, the potential drop across said primary winding diminishes rapidly as the rate of current flow through said winding increases. When the current through said winding has reached a maximum, the potential across said winding has a zero value. The potential across said winding reverses as the current begins to decay. When the reversed potential reaches a predetermined value igniting impulses are adapted to be supplied to the primary 26 of the igniting transformer 25, to thereby fire shunt tube 20 and to thereby enable the exponential decay of the current through primary winding 4. The reversed potential across condenser 5 may be used to provide the igniting impulses for the primary winding 26. For this purpose the primary winding 26 has one end thereof connected to the side of condenser 5 which was originally charged to a negative potential. The other side of the primary winding 26 is connected in series with a resistor 27 and a controlled gaseous rectifying tube 28 to the positive side of condenser 5. Tube 28 is preferably of the type having a continuously energized cathode 29 and a control grid 30. Anode 31 of tube 28 is connected to one end of resistor 27, while the cathode 29 of said tube is connected to the positive side of condenser 5. It will be seen that when the potential across condenser 5 reverses, a positive potential is applied to the anode 31 of tube 28, and tube 28 will thereupon conduct. Upon conduction of tube 28 a pulse of current will pass through the primary 26 of igniting transformer 25. It will further be seen that upon reversal of the potential across primary winding 4 a positive potential will be applied to the anode 22 of tube 20. This potential will rise as the reversal of potential across the winding 4 continues until it reaches a value at which tube 20 is ready to conduct and at which value tube 20 will conduct if igniting impulses are supplied thereto. Referring back to tube 28, it will be seen that tube 28 tends to conduct immediately upon the reversal of potential, and the igniting impulses produced by the initial conduction of tube 28 may be applied to the igniting electrode 23 of tube 20 before the reversed potential applied to the anode 22 of tube 20 has reached a sufficient value to cause tube 20 to fire. In such event, tube 20 will not be fired, for even though tube 28 continues to conduct, the current passing through said tube and through the primary winding 26 of the igniting transformer 25 will then have reached

a fairly steady value and there will be insufficient change in the flux in said transformer to induce an igniting pulse in the secondary 24 thereof. It is accordingly desired that tube 28 shall not conduct until the voltage applied to the anode 22 of tube 20 by the reversed potential across the primary winding 4 has reached a value sufficient to cause tube 20 to conduct when an igniting impulse is applied to the igniting electrode thereof. This may be accomplished by applying a cut-off bias to the grid 30 of tube 28 until such time as tube 20 is ready to conduct. For this purpose a condenser 32, in series with the resistance 33 of a potentiometer 34 and in series with another resistance 35, is arranged across condenser 5. When condenser 5 is charged condenser 32 is charged in the same direction. In order that a constant voltage may be applied across condenser 32 so as to limit the potential to which said condenser is charged to a constant value, a constant voltage device, such as for example, a glow discharge tube 36, has one side thereof connected to the positive side of condenser 32 and the other side thereof connected to a point intermediate resistance 35 and potentiometer 34. The arm 37 of potentiometer 34 is connected through a suitable grid resistor 38 to the grid 30 of tube 28.

It will be seen that when condenser 5 is being charged, condenser 32 will be charged to the voltage determined by the glow discharge tube 36. The direction of the charge on condenser 32 is such that a negative voltage will be applied to the grid 30 of tube 28 by said condenser, thereby preventing conduction in said tube. As condenser 5 is discharged the potential across condenser 5 reverses.

As condenser 5 is discharging condenser 32 also tends to discharge, but due to the impedances in series with condenser 32 the discharge of said condenser is comparatively very much slower. Condenser 5 is discharged and the potential thereacross reverses and builds up before condenser 32 has discharged to any appreciable extent. Therefore, it will be seen that when the potential across condenser 5 reverses, tube 28 will not conduct due to the bias applied thereto by condenser 32. It will be seen that when the potential across condenser 5 reverses, said potential is applied through resistance 35 and through a portion of the potentiometer resistance 34 to grid 30. The direction of this potential is such as to tend to make tube 28 conduct, that is condenser 5 tends to apply a positive voltage to the grid 30 of tube 28 when the potential on said condenser is reversed. Tube 28 will only begin to conduct when the reversed potential across condenser 5 reaches such a value that the potential applied by said condenser to the grid 30 of tube 28 overcomes the cut-off bias applied to said grid by condenser 32. The potential applied to grid 30 by condenser 5 is equal to the potential across said condenser less the voltage drop across resistance 35, a portion of resistance 33 of potentiometer 34, and a small amount across grid resistor 38. The potentiometer applied by a condenser 32 to grid 30 is equal to the potential across said condenser minus the potential drop across the portion of resistance 33 of potentiometer 34 which is to the left of the potentiometer arm 37, and resistance 38. It will be seen that by varying these resistances the proportion of the potentials on either of condensers 5 or 32 which is applied to the grid 30 of tube 28 can be likewise varied. It will be apparent that by adjusting potentiometer arm

37 the precise point at which tube 28 will begin to conduct can be determined.

A condenser 39 may be arranged between the grid 30 of the cathode 29 of tube 28 to eliminate transients. In order to enable tube 28 to start conducting rapidly as soon as the cut-off bias on its grid is eliminated, a condenser 40 may be arranged in shunt across resistor 27, the condenser 40 lowering the impedance of the circuit to a surge of current. In such case, resistance 27 acts as a bleeder. Condenser 40 also serves to prevent damage to tube 28 in case tube 20 fails to fire when the potential across condenser 5 reverses, since the condenser 40 becomes charged in a direction to oppose the flow of too much current through the circuit including tube 28. A resistance 41 may be arranged across the primary winding 26 of the igniting transformer 25.

In one specific system employing my invention, the following constants are used for certain elements of the system. Glow discharge tube 36 has a constant voltage drop of 60 volts. Condenser 23 has a value of .6 microfarad. Resistance 35 plus the portion of resistance 33 to the right of potentiometer arm 37 has a total value of .6 megohm. The portion of resistance 33 between the potentiometer arm 37 and the negative side of condenser 32 has a value of .4 megohm. It will be seen that when condenser 5 of this system is charged, condenser 32 is charged to a value of 60 volts, and that this 60 volts is applied through grid resistor 38 to the grid 30 of tube 28 thereby preventing said tube from conducting. In this specific system tube 20 is of the type requiring about 80 volts anode voltage to enable said tube to conduct, and it is preferred to have said tube conduct when the anode voltage thereon is 100 volts. As will be apparent from the following, the parameters of the circuit are such that an igniting impulse is applied to the igniting electrode 23 of tube 20 only when the anode voltage on tube 20 has reached 100 volts. This is accomplished as is explained below by preventing tube 28 from conducting until the anode voltage on tube 20 is of this value.

Condenser 5 which is originally charged to from 1500 to 3000 volts, depending upon the welding load, is discharged by the firing of series tube 8 into the primary winding 4 of transformer 3. The voltage across primary winding 4 declines to zero and then reverses. Tube 28 does not fire immediately upon the reversal of such potential even though a positive voltage is applied to the anode 31 thereof. This is due to the bias applied by condenser 32 which is 60 volts. Tube 28 cannot fire until the bias applied by condenser 32 is overcome. Tube 28 in this system is of the type which is adapted to conduct when the bias on its grid 30 is substantially zero or positive. The bias applied to said grid becomes zero when the reversed potential of condenser 5 minus the drop across resistance 35 and the portion of resistance 34 to the right of potentiometer arm 37 is equal to the potential of condenser 32 minus the potential drop across the portion of resistance 33 to the left of the potentiometer arm 37. Assuming that the reversed potential across the primary winding 4 has reached a value of 100 volts, and that the potential drop in tube 8 is 10 volts, it will be seen that the reversed potential on condenser 5 is 90 volts. When the potential on condenser 5 minus the potential drop across resistance 35 and the portion of resistance 34 to the right of potentiometer arm 37 is equal to the potential across condenser 32 minus the po-

tential drop across the side of resistance 33 to the left of potentiometer arm 37

$$R_1/R_2=E_1/E_2$$

where

R_1 =the value of the portion of the resistance 32 to the left of potentiometer arm 37 which as stated hereinabove was equal to .4 megohm.

R_2 =the value of resistance 35 plus the value of the portion of the resistance 33 to the right of potentiometer arm 37, which as stated hereinbefore was equal to .6 megohm.

E_1 =potential across condenser 32 which is 60 volts.

E_2 =reversed potential across condenser 5 which is 90 volts.

Applying these figures to the equation

$$.4 \times 10^6 / .6 \times 10^6 = 60 / 90$$

or

$$36 \times 10^6 = 36 \times 10^6$$

Thus, it will be seen that when the reversed potential across the primary winding 4 is 100 volts, the potential across condenser 5 then being 90 volts, the potential across condenser 5 nullifies the effect on the grid 30 of the potential across condenser 32 thereby removing the cut-off bias applied by said condenser 32 and thereby enabling tube 28 to conduct.

Upon conduction of tube 28 an igniting impulse is applied to the igniting electrode 23 to tube 20, and since the anode voltage on tube 20 has reached the predetermined value of 100 volts at which tube 20 is capable of being fired, tube 20 is thereupon ignited.

From the foregoing it will be seen that the precise point at which tube 20 is to be fired may be determined by proportioning the resistances R_1 and R_2 . This, of course, can be readily accomplished in the system illustrated, by adjusting potentiometer arm 37. Another way of determining the precise firing point is by changing the potential to which condenser 32 is charged. This also may be done by simply inserting a resistance in series with glow discharge tube 36, or by utilizing a glow discharge tube having a different constant voltage drop.

From the foregoing description it will be seen that I have provided means for reliably firing a controlled ignition discharge tube at a predetermined point when the anode voltage applied to said tube is varying. It will also be seen that I have disclosed means for firing a controlled ignition discharge tube at a precise point in relation to a circuit in which the current is varying. It will furthermore be seen that I have provided means for firing a controlled ignition discharge tube at a precise point during the discharge of a condenser through an inductance, and specifically have shown means for precisely firing the shunt tube arranged across the inductance.

While I have pointed out hereinabove certain modifications that may be made in the system here described, it will be apparent that other modifications may be made in accordance with the teaching of this invention. Therefore it is desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. In an electrical system including an electrical energy storage device across which the potential is first of one polarity and thereafter

declines and builds up with a reverse polarity, a controlled ignition discharge tube adapted to be fired when the reversed potential across said device has reached a predetermined value, means for supplying igniting impulses to said tube, and means for deenergizing said igniting impulses supplying means, said deenergizing means being adapted to be rendered ineffectual when said reversed potential has reached a predetermined value.

2. A condenser discharge system having a condenser adapted to be discharged through a load containing inductance, said discharge tending to be oscillatory and the polarity of the potential across said inductance reversing, a controlled ignition discharge tube arranged in shunt across said load and adapted to be fired when said reversed potential has reached a predetermined value, means for supplying igniting impulses to said tube, and means for deenergizing said igniting impulses supplying means, said deenergizing means being adapted to be rendered ineffectual when said reversed potential has reached a predetermined value.

3. In an electrical system having two points therein across which the potential is first of one polarity and thereafter declines and builds up with a reverse polarity, a controlled ignition discharge tube adapted to be fired when the reversed potential across said two points has reached a predetermined value, means for supplying igniting impulses to said tube, and means for deenergizing said igniting impulses supplying means, said deenergizing means being adapted to be rendered ineffectual when said reversed potential has reached a predetermined value.

4. In an electrical system including an electrical energy storage device across which the potential is first of one polarity and thereafter declines and builds up with a reverse polarity, a controlled ignition discharge tube adapted to be fired when the reversed potential across said device has reached a predetermined value, means for supplying igniting impulses for firing said ignition tube, said means including a rectifying tube adapted to conduct upon reversal of the potential across said device to thereby supply igniting impulses, and means for preventing conduction of said rectifying tube until the reversed potential on said electrical energy storage device has reached a predetermined value.

5. In an electrical system including a condenser across which the potential is first of one polarity and thereafter declines and builds up with a reverse polarity, a controlled ignition discharge tube adapted to be fired when the reversed potential across said condenser has reached a predetermined value, means for supplying igniting impulses for firing said ignition tube, said means including a rectifying tube adapted to conduct upon reversal of the potential across said condenser to thereby supply igniting impulses, and means for preventing conduction of said rectifying tube until the reversed potential on said condenser has reached a predetermined value.

6. In an electrical system including an inductance across which the potential is first of one polarity and thereafter declines and builds up with a reverse polarity, a controlled ignition discharge tube adapted to be fired when the reversed potential across said inductance has reached a predetermined value, means for supplying igniting impulses for firing said ignition tube, said means including a rectifying tube adapted to conduct upon reversal of the poten-

tial across said inductance, and means for preventing conduction of said rectifying tube until the reversed potential on said inductance has reached a predetermined value.

7. In an electrical system having two points therein across which the potential is first of one polarity and thereafter declines and builds up with a reverse polarity, a controlled ignition discharge tube adapted to be fired when the reversed potential across said points has reached a predetermined value, means for supplying igniting impulses for firing said ignition tube, said means including a rectifying tube adapted to conduct upon reversal of the potential across said points to thereby supply igniting impulses, and for preventing conduction of said rectifying tube until the reversed potential on said points has reached a predetermined value.

8. In an electrical system including an electrical energy storage device across which the potential is first of one polarity and thereafter declines and builds up with a reverse polarity, a controlled ignition discharge tube adapted to be fired when the reversed potential across said device has reached a predetermined value, means for supplying igniting impulses for firing said ignition tube, said means including a rectifying tube having a control grid, said rectifying tube being adapted to conduct upon reversal of the potential across said device to thereby supply igniting impulses, and electrical energy storage means arranged so that at least a part of the potential thereon is impressed on said grid to prevent conduction of said rectifying tube, said device being connected so that at least a part of the reversed potential thereon is applied to said grid with a polarity to oppose the potential applied thereto by said electrical energy storage means, said device being adapted, when said reversed potential has reached a predetermined value, to enable said rectifying tube to conduct.

9. In an electrical system including an electrical energy storage device across which the potential is first of one polarity and thereafter declines and builds up with a reverse polarity, a controlled ignition discharge tube adapted to be fired when the reversed potential across said device has reached a predetermined value, means for supplying igniting impulses for firing said ignition tube, said means including a rectifying tube having a control grid, said rectifying tube being adapted to conduct upon reversal of the potential across said device to thereby supply igniting impulses, and a condenser adapted to be charged to a predetermined potential by the potential across said device, said condenser being arranged so that at least a part of the potential thereon is impressed on said grid to prevent conduction of said rectifying tube, said device being connected so that at least a part of the reversed potential thereon is applied to said grid with a polarity to oppose the potential applied thereto by said condenser, said device being adapted, when said reversed potential has reached a predetermined value, to enable said rectifying tube to conduct.

10. In an electrical system including a condenser across which the potential is first of one polarity and thereafter declines and builds up with a reverse polarity, a controlled ignition discharge tube adapted to be fired when the reversed potential across said condenser has reached a predetermined value, means for supplying igniting impulses for firing said ignition tube, said means including a rectifying tube having a con-

trol grid, said rectifying tube being adapted to conduct upon reversal of the potential across said condenser to thereby supply igniting impulses, and a second condenser, adapted to be charged to a predetermined potential by the potential across said condenser, said second condenser being arranged so that at least a part of the potential thereon is impressed on said grid to prevent conduction of said rectifying tube, said first-mentioned condenser being connected so that at least a part of the reversed potential thereon is applied to said grid with a polarity to oppose the potential applied thereto by said second condenser, said first-mentioned condenser being adapted, when said reversed potential has reached a predetermined value, to cause said rectifying tube to conduct.

11. A condenser discharge system having a condenser adapted to be charged and to be thereafter discharged through a load containing inductance, said discharge tending to be oscillatory and the polarity of the potential across said load reversing, a controlled ignition discharge tube

5 arranged in shunt across said load and adapted to be fired when said reversed potential has reached a predetermined value, means for supplying igniting impulses to said tube, said means including a controlled rectifying tube adapted upon conduction thereof to supply said igniting impulses, said rectifying tube having a control grid, and a second condenser adapted to be charged with the same polarity as said first-mentioned condenser, means for limiting the charge on said second condenser to a predetermined voltage, the voltage on said second condenser being applied to said control grid with a polarity to prevent conduction thereof, said first-mentioned condenser being connected to said control grid and being adapted when the potential on said first-mentioned condenser has reversed to apply a potential to said control grid with a polarity opposed to that of the voltage applied by said second condenser to thereby enable said rectifying tube to conduct when said reversed potential has reached a predetermined value.

JOHN W. DAWSON.

CERTIFICATE OF CORRECTION.

Patent No. 2,320,916.

June 1, 1943.

JOHN W. DAWSON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 65-66, for "potentiometer" read --potential--; line 66, strike out "a" before "condenser"; page 4, second column, line 15, claim 7, after "and" insert --means--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of July, A. D. 1943.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.

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