July 5, 1949. E. MESCHTER 2,475,356

STATIC DISCHARGE AND INDICATING DEVICE

Filed July 22, 1948

FIG. 1.

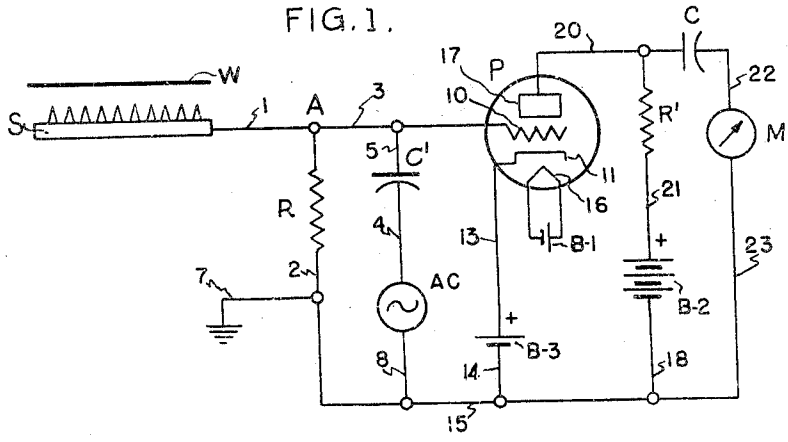



FIG. 2.

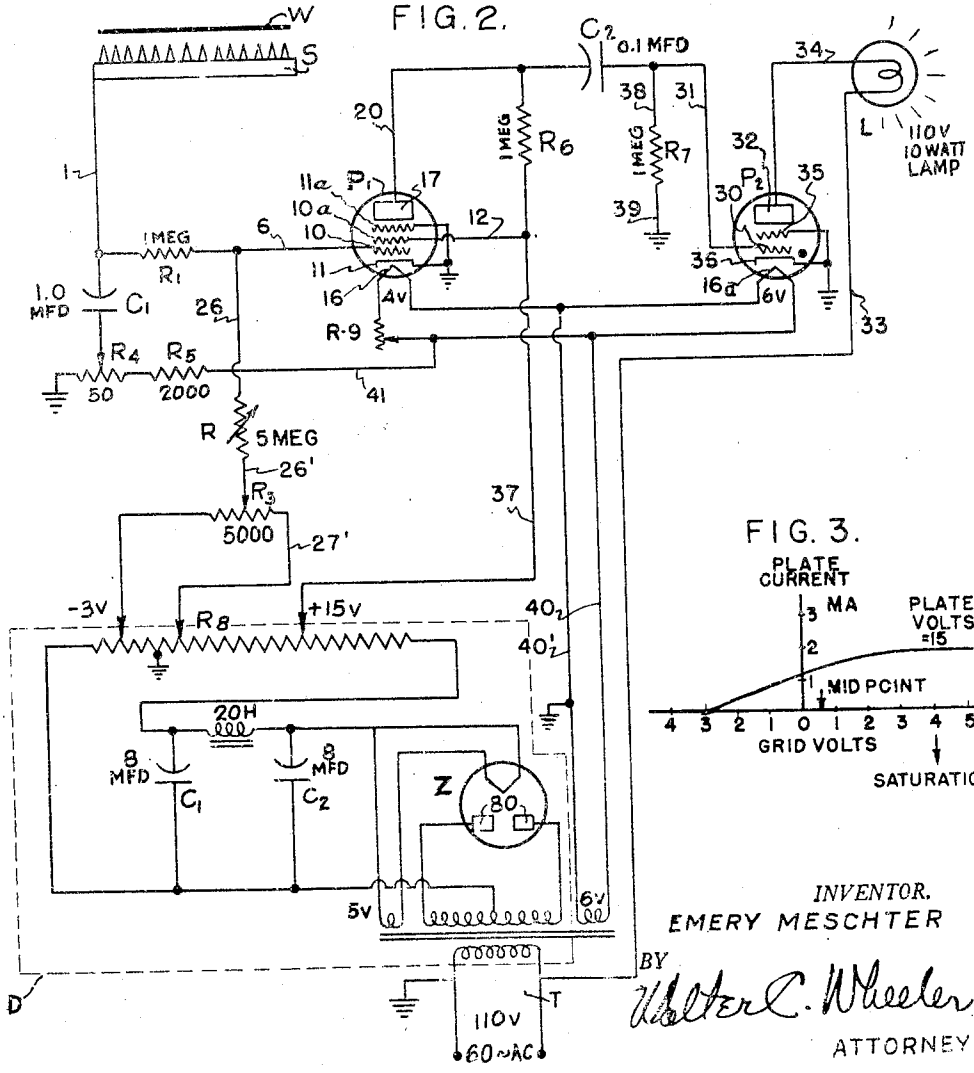



FIG. 3.




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## STATIC DISCHARGE AND INDICATING DEVICE

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6 Claims. (Cl. 177—311)

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This invention relates to static discharge devices for discharging static electricity from objects, and especially from objects such as moving sheets or webs. More particularly, it relates to such devices which comprise means for indicating when the discharge of such electricity is taking place.

Moving sheets or webs of non-conducting material, such as paper, cloth, and plastic materials, sheets or webs of cellulose derivatives, superpolymers and resins often acquire harmful or undesired charges of static electricity in passing over rollers or pulleys. This static electricity constitutes a hazard and it is often the source of other difficulties in the further processing of such sheets or webs. For example the presence of static electricity in moving sheets or webs which are coated with or to be coated with light-sensitive layers, such as gelatin silver halide photographic emulsions, is especially disadvantageous in that the presence of static electricity is apt to render portions of the resulting light-sensitive elements unfit for use.

An object of this invention is to provide devices which are useful for discharging static electricity from charged bodies, such as moving sheets or webs. Another object is to provide devices which will give positive indication that a discharge of electricity is taking place. A further object of the invention is to provide devices which will give a positive indication of the discharge of static electricity regardless of the sign of the charge of such electricity with respect to the ground. Another object is to provide such indicating devices which are entirely free from mechanical moving parts. A further object is to provide such devices which may be constructed from readily available materials. Still other objects will be apparent from the following description of the invention which is made with reference to the drawings in which

Fig. 1 is a schematic view of one embodiment of the static discharge device and indicator which employs an alternating current meter as the indicator;

Fig. 2 is a schematic view of a modified form of static discharge device which is more elaborate than the device of Fig. 1 and employs another type of visual indicator, namely, a lamp; and

Fig. 3 is a graph illustrating the current-voltage relationships of a suitable thermionic triode which may be utilized in the scheme illustrated in Fig. 1.

In general devices embodying the invention comprise a static accumulator S which accumulates the static from the charged object, such as a moving belt W (Fig. 1). The accumulator is connected to the control grid of a thermionic vacuum tube which is maintained at a small predetermined potential with reference to the ground by a battery B3 (Fig. 1) or equivalent source and is grounded through a high resistance sufficient to maintain the small predetermined voltage between the grid and the ground after the discharge occurs. The grid is also connected to a source of fluctuating or alternating current through a condenser in order to superimpose a variable voltage thereon. The anode of the vacuum tube is normally maintained positive and the grid is biased in the normal manner so that with the connection described, the output of the vacuum tube has a fluctuating characteristic when normal voltages are present between the accumulator or grid and ground. When, however, there is an accumulation of static of positive voltage and the voltage drop of positive value from the grid to ground across the ground resistor results in a saturation value of the tube, the fluctuating characteristic of the vacuum tube output ceases. By providing a resistance is the ground connection of the output of the vacuum tube and also a parallel connection to ground through a condenser and a device which is responsive to variable currents, such as an alternating current meter or a lamp, sensory indications will be apparent which shown normal conditions when the vacuum tube output comprises the variable characteristic, and different indications will be apparent with different static discharge conditions when the vacuum tube is at saturation and the output thereof does not comprise the variable characteristic. Conversely when there is an accumulated potential of negative value on the static accumulator and the grid value decreases to the cut-off point of the vacuum tube, the variable output of this tube will again cease and the fluctuating voltage impressed on the indicator will cease, thereby producing an indication in the output indicator similar to that produced when the above described excessive position voltage occurs between the accumulator and ground.

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Referring to the drawings, the device comprises a static accumulator S which is grounded through the resistor R. An indicator such as the meter M of Fig. 1 is connected to normally indicate the presence of a variable output from the thermionic vacuum tube P when the output of the tube is variable and there is no discharge of static, or only a small discharge to the ac-

cumulator. A fluctuating voltage is supplied to the control grid of the tube P from a fluctuating current source AC through the condenser C'. The grid is connected to the other side of the condenser C'. The opposite side of the fluctuating current source is connected to the ground wire 15. The fluctuating current indicator M connected in the ground connection of the output condenser C is connected to the ground wire 15. In the normal operation of tube P the fluctuating voltage impressed on the grid 10 results in a fluctuating output from the anode 17 which in turn effects a fluctuating voltage in the circuit containing the output condenser C and alternating current meter M (Fig. 1) or lamp L (Fig. 2). When, however, an excessive positive voltage between the grid 10 and ground results from static of positive sign collected by the accumulator S and the tube P is saturated, the fluctuating voltage derived from the source AC will not be transmitted by the tube to the output circuit and the meter M or lamp L will cease to be subjected to a fluctuating voltage.

The thermionic vacuum tube P is the kind which is suitable for amplification, and it has a saturation characteristic in which the plate current reaches a maximum when the effective voltage between the cathode and grid is at or above a given maximum. With increasing voltages above zero, the output or current change in the output decreases as the saturation point of the tube is approached. Then upon a further increase in voltage between the cathode and control grid of the tube (or when saturation is reached), as for example when the voltage between the accumulator S (or grid) and ground reaches the saturation value, no change in the output voltage is produced. The output of the tube P (Fig. 1) is connected through a resistor R' to the positive side of the high voltage direct current source, or battery B2, the negative side of which is connected to the ground wire 15. In parallel with the resistor R' and battery B2 of the output circuit is an indicator circuit containing the capacitor C and an alternating current indicator or meter M.

The alternating or fluctuating voltage applied to the grid of the tube is of such value that the normal sum of the voltages derived from its maximum positive component and the non-fluctuating positive value of the accumulator S and grid 10 is a positive voltage below that which produces the saturation current of the tube. This normal positive value should be the grid voltage between the value at saturation and the value at cut-off, and may desirably be the grid voltage about midway between the value at saturation and the value at shut-off so that with an appreciable increase of static on accumulator S of positive voltage, the sum of all voltages impressed on the grid will equal or exceed the saturation voltage of the tube. At saturation, the output of the tube is practically at constant voltage so that no material change is effected across the capacitor in the indicator circuit, or in the indicator circuit. This static together with the positive component of the alternating current voltage impressed on the grid, is a sum equal to or exceeding that which produces saturation of the tube. The indication of the presence of static is a zero reading of the indictor M or an indication representing the absence of a fluctuating output. Conversely when the static fed into the grid circuit is a sufficient negative value to reduce the sum of the voltages so that the difference in voltage between the cathode and grid is zero or negative, the output of the tube will fall to zero and the recorder will again indicate no fluctuating output from the vacuum tube. Thus the indication of no fluctuating output in the indicator M is an indication of the collection of static from the moving web regardless of its sign.



Referring to Fig. 1 of the drawing, the conductive accumulator S is located near, but not in contact with the charged member or moving sheet of material W upon which it is desirable to indicate the presence of and discharge a static charge. The accumulator S is desirably made of metal and may be made in the form of a platen having a large number of points or projections uniformly distributed on the surface facing the web W so that the static charges will be readily and uniformly discharged from the web W to the accumulator. While only one such accumulator may be provided, several of the same may be similarly disposed with reference to the web W and variously modified structures may be used as the accumulator, such as a metal grill, a wire mesh or a metal screen. The accumulator is desirably disposed to extend along as well as across the web. The accumulator is connected to a resistor R through the lead 1 and to the ground through the lead 2.

The accumulator is also connected through the conductor 3 to the control grid 10 of a three element thermionic vacuum tube of the kind commonly used for radio amplification. Impressed also upon the conductor 3 and grid 10 is the voltage derived from a fluctuating current source, such as the alternating current source AC, in one output lead 4 of which is interposed the input capacitor C', the opposite side of which is connected to the grid 10 through the lead 5. The other side of the alternating current source is connected to the ground connection 15. In this manner the operating grid 10 of the tube P has continuously impressed upon it the fluctuating voltage derived from the alternating current source through the capacitor C'. Temporarily or during any time that the accumulator is charged, the voltage between the grid and the ground comprises the sum of these two voltages and its maximum is positive or negative depending upon the value and sign of the charge accumulated on the accumulator S.

The cathode 11 is connected to the positive terminal of a biasing battery B3 through the lead 13, the negative side of which is connected to the ground lead 15 through the connector 14. A heater battery B1 is connected to the filament 16 to heat the cathode 11.

The output of the tube P from the anode 17 is connected to the positive side of the plate battery B2 through lead 20, resistor R' and lead 21. The negative side of the battery is connected to the ground lead 15 by the connector 18.

The condenser C and indicator M are in parallel with the output resistance R'. Indicator M is connected by lead 22 to one side of the capacitor C. The other side of the capacitor C is connected to the output of the tube P through lead 20. The indicator is grounded through lead 23 and ground lead 15 so that the normal variable output from the tube P will indicate a variable output in the indicator M. Where the indicator M is an alternating current meter, a positive reading thereon indicates a very low or no static discharge from the member W to the accumulator S.

When, however, a static charge is collected on the accumulator S so that the positive component impressed on the control grid is increased, the output of the tube will approach saturation depending upon the magnitude of this positive voltage between grid and ground. When the saturation output value of the tube is reached or exceeded there will be no variable output voltage and no change which will effect the indicator M through the capacitor C.

In a particular installation comprising a moving member W which acquired static, the static discharge from accumulator S to ground was found to be 5 microamperes by measurement thereof with a microammeter. A plate voltage of 15 volts for the battery B2 (Fig. 1) to be impressed upon the anode 17 of the thermionic vacuum tube P was selected in order to attain a small spread in grid voltage between the beginning of operating voltage and saturation in accordance with the known characteristics of such a tube as shown in Fig. 3. The thermionic vacuum tube selected has a relatively low current saturation characteristic at 15 volts between the plate and ground. A tube having zero plate current with a grid voltage of −3 and a plate voltage of +15, and at saturation a current of about 2 microamperes at +4 volts on the grid was selected. This tube according to its known characteristics shown in Fig. 3 therefore conducts no current when the grid potential is −3 volts or less, and is saturated when the grid voltage is +4 or more. The mid-point between these extremes is +0.5 volt and from this it appears that a departure of 3.5 volts or more between the grid and ground from a mean voltage of +0.5 volt will either discontinue the operation of the tube or produce no voltage change in the plate current when a fluctuating voltage is impressed on the grid.

However, in this instance, allowance must be made for a device for indicating when static is flowing to ground. For this purpose an alternating current meter M was selected which gave a definite reading when a fluctuating signal of 1 volt (equal to ±0.5 volt from the center neutral point) is impressed. The alternating current or fluctuating voltage on the grid 10 may be supplied by a bell ringing transformer AC or other suitable alternating current generator which is connected between the condensers C and ground in the circuit including lead 22, meter M and lead 23 to ground connection 15. Grid bias of +0.5 volt with respect to the cathode 11 is held constant by the battery B3 which is connected to cathode 11 through lead 13. The negative side of battery B3 is connected to the ground connection 15 through lead 14. This grid bias is superimposed on the grid voltage. Therefore with a voltage of −3.5 to +4.5 volts, or a departure of 4 volts between the collector S and ground from the mid-point will be sufficient to cut off the output from the plate 17 of the tube or to reach the saturation point of the tube. With 4 volts' drop across the ground resistance R and a discharge current of 5 microamperes, the value of R is thus fixed at 800,000 ohms.

The battery B2 furnishes the selected positive voltage of 15 volts on the anode 17. The negative of battery B2 is connected to lead 15 and the ground through lead 18, and the positive plate of the battery B2 is connected through lead 21, resistance R' and lead 20 to the anode 17 of the tube P.

The lead 20 is also connected to a fluctuating current indicator circuit consisting of the condenser C, lead 22, alternating current meter M and lead 23 to the ground connection 15. The values of the resistance R' and condenser C are selected according to the characteristics of the meter M. The heater current for the filament 16 of the heated cathode 11 is supplied by the battery B1.



Accordingly in operation when there is no charge on the belt W, the meter will be connected with and will register a fluctuating current due to the fluctuating voltage derived from the source AC. The grid voltage will therefore be between −3.5 and +4.5, the cathode will be +0.5 volt and the output at the plate P will be a value not greater than the saturation value of about 2 milliamperes, since the voltage on the grid will be some value between −3.5 and +4.5 volts. When, however, an excessive positive discharge to the collector S occurs, occasioned by the generation on the belt of a voltage which produces more than +4.5 volts between the accumulator S, or the grid 10 connected to S, and the ground, the saturation voltage of the grid will have been reached, the varying output voltage will disappear and the meter M will register zero. This zero indication on the meter M therefore is an indication of discharge of static from the belt W and accumulator S to the ground, the potential of which will be in excess of +4.5 volts when the charge is positive. In case the discharge from the belt W to the accumulator S is negative and the potential between the accumulator S and the ground does not exceed −3.5 volts the alternating current voltage will not be neutralized and the meter M will show a reading. When, however, the negative potential is 3.5 or more the tube P will be caused to cut off and the reading in M will become zero, thus indicating a discharge of static to the ground having a negative potential between the accumulator and the ground of some value greater than −3.5 volts.

In the modification shown in Fig. 2 an amplifying vacuum pentode P1 is used instead of the triode shown in Fig. 1. The direct current is supplied by a rectifier represented as D within the dotted lines and the indicator circuit includes a gas filled tetrode P2 having its control grid influenced by the output voltage of the pentode and an illuminating lamp filament in circuit with the anode of the gas filled tube and arranged to receive current from a source of alternating current as long as the pulsating signal received through condenser C2 provides a voltage which permits breakdown. In this arrangement the lamp L indicates the discharge of electricity from the web W to the accumulator S by lighting. In this modification the grid 30 of the gas filled thyratron P2 is substituted for the meter M in the indicator circuit and the indicator circuit includes the anode 32 of thyratron P2, lead 34, lamp L and lead 33 to the ungrounded side of the alternating current source T. When the vacuum tube P1 operates below saturation voltage, the lamp L is lighted, being in the alternating current circuit which is closed from plate 32 and across the tube P2 to ground.

Referring further to Fig. 2, the accumulator S is connected by the conductor 1 to a capacitor C1, the opposite side of which is connected to a variable position slider on a resistor R4. One end of resistor R4 is connected to ground and the other end is connected to a larger fixed resistance R5 which for example may be a resistor of 2,000 ohms. The opposite end of the resistor R5 is

connected to a 6 volt 60 cycle alternating current source, said 6 volts being referred to the ground potential and said source also serving to energize the heaters of amplifying tubes P1 and P2.

The accumulator conductor S is also connected to a fixed resistor R1, of say 1 megohm, the other end of said resistor being connected by leads 6 and 26 to a variable resistance R and by connector 26' to the variable position slider of a resistor R3, which is connected at both ends of a variable position slider which spans the grounded neutral point of the resistor R8. The condenser C1 which furnishes variable voltage to the grid 10 through resistor R1 and lead 6 is connected with its opposite plates to the source of alternating current through resistances R4, R5, lead 41 and lead 40. The other end of resistor R4 is grounded.

The cathode 11 and suppressor grid 11a of pentode P1 are connected to ground. The heater 16 of pentode P1 may be energized by the above mentioned source of 6 volt alternating current, a variable resistor R9 being connected in series with said heater to reduce the voltage across the heater to approximately 4 volts. The heater filament 16a of the gas filled tube P2 is connected in parallel with the filament 16. The screen grid 10a of pentode P1 is connected to a steady source of direct current voltage through leads 12 and 37. Said source of voltage is also connected to a load resistor R6, the other end of R6 being connected to the plate of pentode P1 by the lead 20.

All direct current potentials mentioned up to this point may be derived from batteries, or more conveniently, from a conventional full wave rectifier shown in Fig. 2 within the broken line D. Such a rectifier consists of a transformer, full wave rectifier tube Z, e. g. containing electrodes 80, a capacitor and inductor filter circuit and a so-called bleeder resistor, such rectifiers being well known to those skilled in the electronic art.

The plate 17 of pentode P1 is connected to a capacitor C2, the other plate of which is connected to ground through lead 38, a resistor R7 and lead 39. The control grid of the gas filled tube P2 is connected to lead 38 by lead 31. The gas filled tube P2 may be a tube known as a grid controlled thyratron and is typified by the type sometimes called an "RCA 2050." The heater filament 16a of tube P2 is energized by the above mentioned 6 volt source of alternating current. The cathode 36 and suppressor grid 35 of P2 are connected to ground. The plate 32 of P2 is connected by lead 34 to an incandescent lamp L or other indicating device. The other side of said lamp is connected by lead 33 to one side of a 110 volt alternating current source, said 110 volts being referred to ground potential.

The operation of this circuit is similar in principle to that of Figure 1 and is described more particularly as follows. Static electricity discharged from a moving belt W to the accumulator S is conducted to ground by the path through resistance R1, lead 26, variable resistance R and through the right-hand portion of resistance R3, lead 27' and resistance R8. In passing through these resistors a direct current of low voltage is caused to be applied to the control grid 10 of tube P1 through the lead 6. Superposed on this direct current voltage is a continuous alternating current voltage obtained as follows. There is a 6 volt alternating current voltage applied across resistor R4 and R5. A small fraction of this is picked off through the slider on R4 and fed through the capacitor C1, resistor R1 and lead 6 to the control grid 10 of tube P1. The signal applied to said control grid is thus a continuous variable or alternating voltage superposed on a direct voltage whose magnitude and polarity depend on the positive or negative characteristic of the discharge from W to the accumulator S. The adjustment on resistor R4 serves to vary the magnitude of the alternating voltage in order to obtain proper operation as will appear later. The adjustment on resistor R3 serves to vary the control grid bias of tube P1, also to obtain proper operation. The adjustment of variable resistor R serves to vary the sensitivity of the circuit, larger values of resistance in R serving to make tube P1 responsive to smaller discharges from the static source W to the accumulator S.

The portion of the circuit from the accumulator S through the capacitor C1 and resistor R4 to ground forms a path for alternating current which is low in impedance compared to R1 plus R. This combination therefore serves to filter out random alternating voltages which may be picked up by accumulator S, and prevents them from reaching the grid 10 of tube P1 and producing improper operation.

The normal output of the tube P1 appears as an alternating voltage across resistor R6 which is connected through lead 37 to a 15 volt point in resistor R8. When there is no discharge from W to S there is no direct current voltage across resistor R and the setting of resistor R3 is adjusted to make this output of tube P1 a maximum. This will usually coincide closely with the midpoint between cut-off and saturation, hereinbefore described. If negative electricity is discharged from the static source W to the accumulator S, the potential of the control grid 10 of plate P1 will be lowered by the drop across a resistor R, the tube will be cut off and the alternating output voltage in lead 20 will disappear. If positive electricity is discharged from the static source W to accumulator S the potential of the control grid 10 of plate P1 will be raised by the drop across resistor R, the tube will be saturated and the variable voltage in lead 20 will again disappear.

The variable or alternating output voltage is connected through a capacitor C2 to the control grid 30 of thyratron P2, said grid also being connected to ground through lead 31, lead 38, a high resistor R7 and lead 39. The polarity of this alternating signal applied to the control grid 30 is chosen such that the signal is in a phase opposite to that of the alternating voltage applied to the plate 32 of the tube P2. That is, the control grid voltage reaches its greatest negative voltage at the same time that the plate reaches its maximum positive voltage and vice versa. Under such conditions for a limited voltage applied to the plate 32 of P2 one may select a value of the grid voltage such that the gas in the thyratron never breaks down, the thyratron does not conduct and the lamp remains dark. However, if the grid voltage of grid 30 is decreased below this value the thyratron will conduct during each positive half cycle of the voltage applied to its plate 32 and the lamp L will light. Thus, when no electricity is being discharged from static source W to accumulator S, the alternating output from P1 and hence the voltage applied to the grid of P2 will have its maximum value, P2 will not conduct and lamp L remain dark. But the discharge of either sign of electricity from static source W to accumulator S will decrease the alternating output from tube P1 as previously described, the

voltage applied to the grid of tube P2 will decrease, tube P2 will conduct and the lamp will be lighted by the alternating current derived from the alternating current source which is connected to lamp L through the lead 33. The lighting circuit will then be from the 110 volt, 60 cycle A. C. source T through lead 33, lamp L, lead 34, plate 32, suppressor grid 35 and to ground. This positive indication of the discharge of electricity, the lighting of the lamp, takes place regardless of the sign of the original discharge. A buzzer or other alarm or indicating device of similar operating characteristics may be substituted for the lamp L. An advantage of this particular form of the invention is that the failure of tube P1 or any of the elements associated therewith will result in a failure of output from the grid of tube P2, causing the lamp to light and attracting attention.

Other variations of the invention will become apparent to those skilled in the electronic art. For instance, the amplifying vacuum tube need not be a triode, but may be a suitably connected tetrode or pentode, and the continuous alternating current signal may be applied to some other appropriate grid than the control 10 of the tube P1. Other power amplifying circuits may be substituted for that shown in connection with the tube P2 of Fig. 2.

The indicator thus shows the fact that electrical energy has been accumulated from the moving member when the sum of the voltage due to the variable supply and that due to the accumulated charge reaches a value which effects a change in voltage and the output of the amplifying thermionic tube. The response varies in accordance with the magnitude of the accumulated voltage regardless of its sign. Thus the resistor in the ground connection causes the indicator to show discharge of current to ground by a zero reading of the indicator M whether discharged static is positive or negative in sign. By suitable known connections the output of the device may be used to operate other electrically actuated visual, audible or sensory alarms instead of or in addition to those shown. The sensitivity and operating range of the device may be varied by suitable adjustment of the circuit constants and the magnitudes of the voltages applied. More or less amplification than that shown in the illustrations set forth in the drawings can be employed.

Various illustrative values for the capacitance, voltage, and other characteristics of the various units and circuits are set forth on Fig. 2 of the drawing in order to facilitate a comprehension of the invention. The various units are shown in the conventional manner and need no further comment.

The novel static discharge indicator described above has various advantages. It is simple in construction and operation. The various components are commercially available and the circuits can readily be installed by the ordinary electrical technician. The device has no moving parts.

Another advantage of the device is that it facilitates the discharge of static electricity from moving sheets, webs, films, etc., without the production of sparks. The device provides a positive indication of the discharge of electricity while facilitating such discharge from the moving sheets. The indication depends only on the magnitude of the discharge and not on the polarity of the charges on the moving sheet.



I claim:

1. A device for discharging static electricity from a charged body and indicating the discharge thereof which comprises a conductive accumulator spaced from the charged body, said accumulator being connected to ground through a resistor for developing a direct current voltage across the resistor; a thermionic vacuum amplifying tube having a control grid, a cathode and an anode; said tube having a plate current saturation value when the control grid voltage is higher than that normally maintained for zero current discharge through said resistor; means for connecting said conductive accumulator with the control grid for applying said direct current voltage thereto; a source of variable voltage having a fixed maximum voltage characteristic; means for applying the variable voltage derived from said variable current source to the control grid of said amplifying tube; means for maintaining said cathode at a predetermined fixed potential with respect to ground; a current source for maintaining a relatively high predetermined potential between the plate and ground; a load resistor between said relatively high potential source and the plate, the value of said fluctuating and said non-fluctuating voltages applied to said grid being selected so that the difference in voltage between the cathode and operating grid is less than the voltage required to saturate the tube, but is sufficient with moderate positive values of direct current voltage derived from the accumulator to increase the voltage difference from cathode to grid to tube saturation voltage, and with moderate negative values derived from the accumulator to alter the voltage difference to an opposite value sufficient to cut off the plate current; an output connection connecting the plate of the tube with said source of relatively high voltage through an intermediately disposed load resistor; an indicator circuit connected to said output circuit in parallel with said load resistor for receiving pulsating signals from said output connection when the output of the tube has a varying voltage characteristic; a capacitor in said indicator circuit; and means in said indicator circuit for indicating pulsating signals.

2. A device in accordance with claim 1 in which the thermionic vacuum tube has a plurality of grids, one of which is a control grid, and the source of variable voltage is connected to a grid other than the control grid.

3. A device in accordance with claim 1 in which the means for connecting the accumulator with the ground and with the control grid comprises a resistor capacitance connection for providing a resistance from accumulator to ground which is high for direct current and an impedance which is low for variable voltages.

4. A device in accordance with claim 1 in which the means for connecting the accumulator with the ground and with the control grid comprises a resistor capacitance connection for providing a resistance from grid to ground which is high for direct current and an impedance which is low for alternating current.

5. A device in accordance with claim 1 in which the output indicator circuit is grounded through an indicator circuit resistor and a second circuit to ground is connected in parallel with said indicator circuit resistor, said second circuit comprising means for visually indicating when the output of the thermionic tube ceases to have a variable characteristic.

6. A device in accordance with claim 1 in which

the output indicator circuit is grounded through an indicator circuit resistor and a second circuit to ground is connected in parallel with said indicator circuit resistor, said second circuit comprising a gas filled tube having an anode, a cathode and a control grid; a visual indicator energized by variable current connected between the anode of said gas filled tube and a source of variable current; the control grid of said gas filled tube being responsive to changes in potential in said indicator circuit whereby upon establishing a predetermined voltage between the grid and



anode of said gas filled tube the visual indicator becomes energized.

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## Certificate of Correction

Patent No. 2,475,356. July 5, 1949.

EMERY MESCHTER

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 2, line 25, for the words "resistance is" read *resistance in*; line 31, for "shown" read *show*; line 46, for "position" read *positive*; column 3, line 58, for "shut-off" read *cut-off*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of November, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
*Assistant Commissioner of Patents.*

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[SEAL]

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*Assistant Commissioner of Patents.*