Feb. 15, 1955 N. FELICI 2,702,355

ADJUSTABLE VOLTAGE GLOW DISCHARGE DEVICE

Filed Feb. 19, 1949 4 Sheets-Sheet 1

Fig. 1

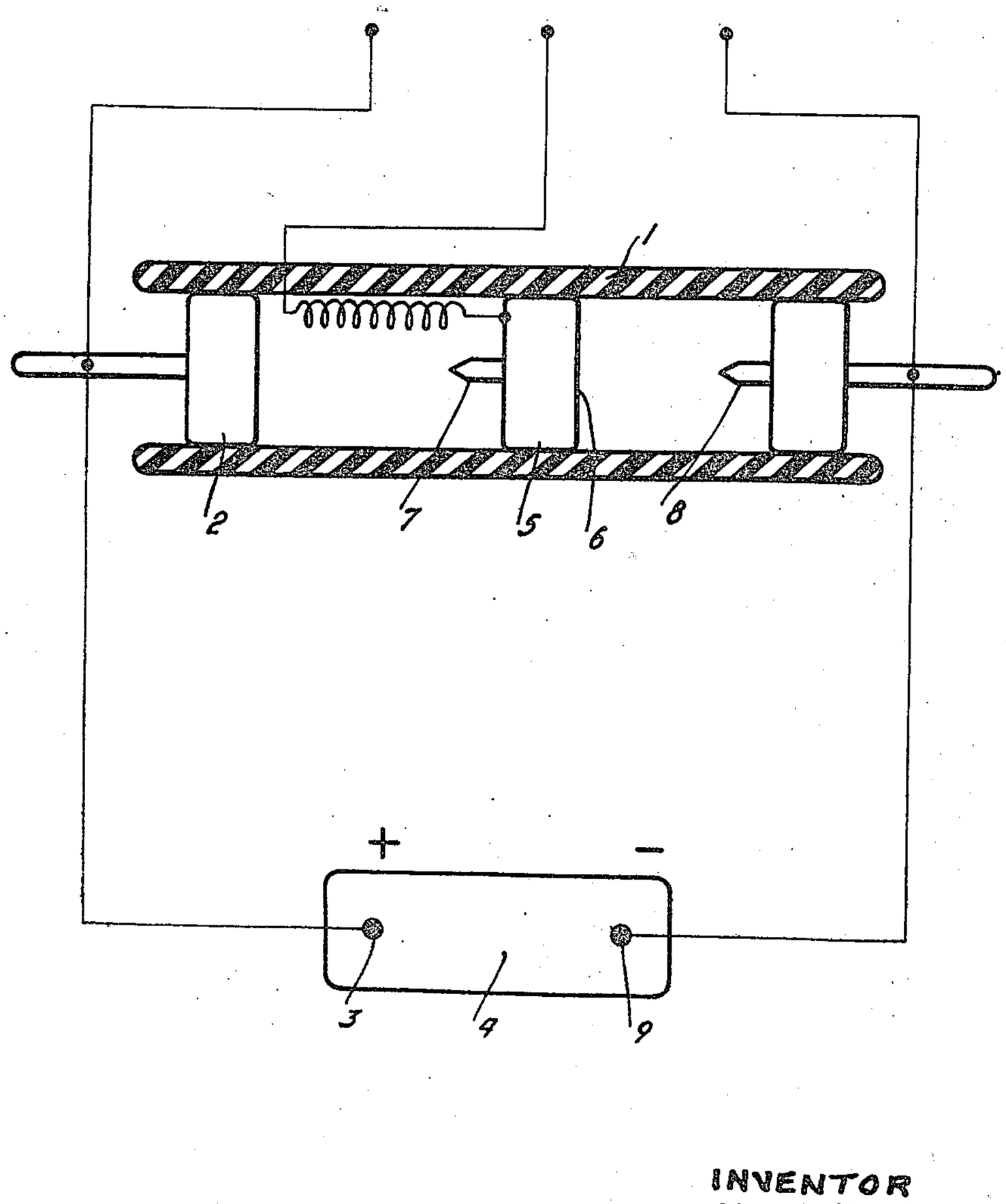

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Fig. 2

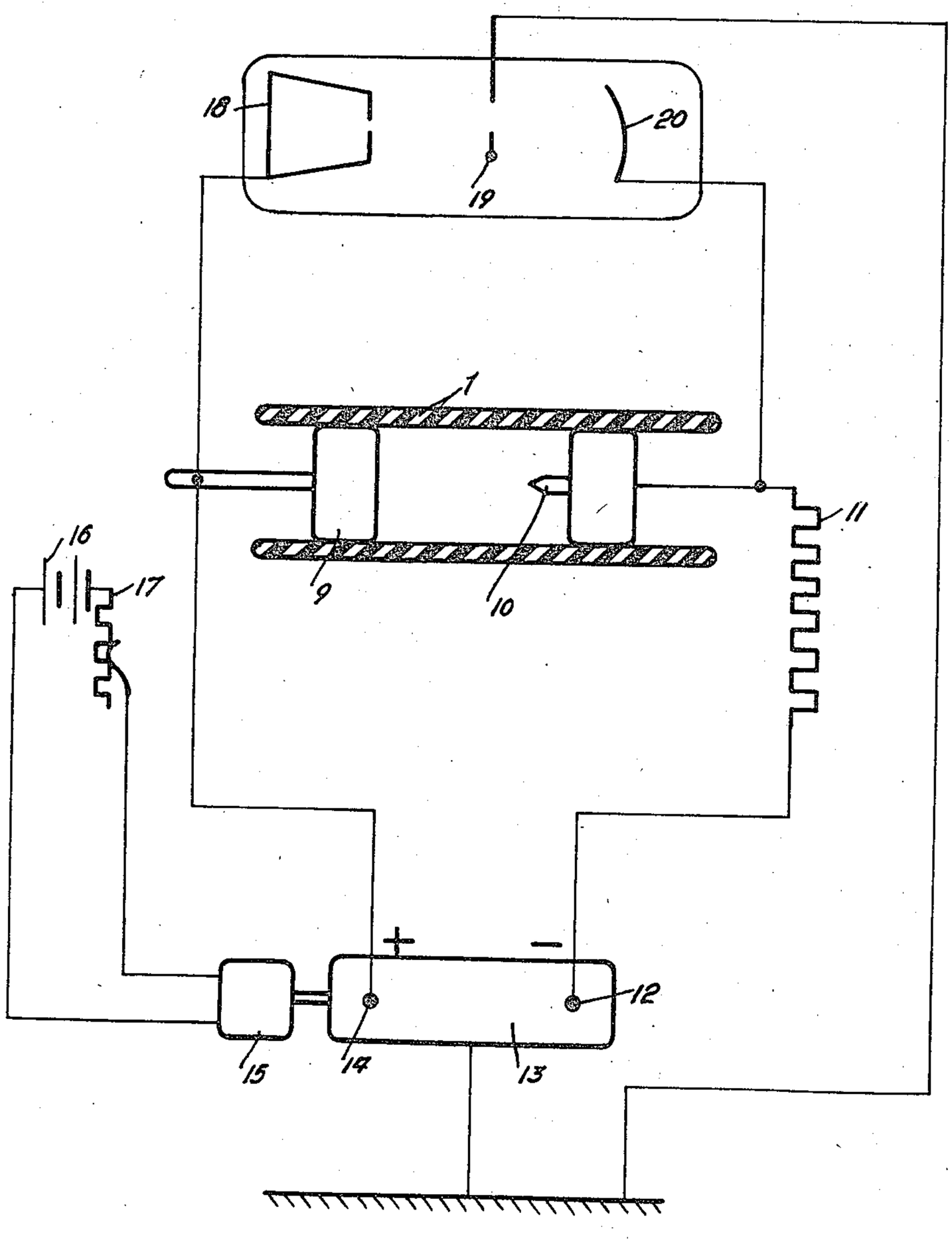

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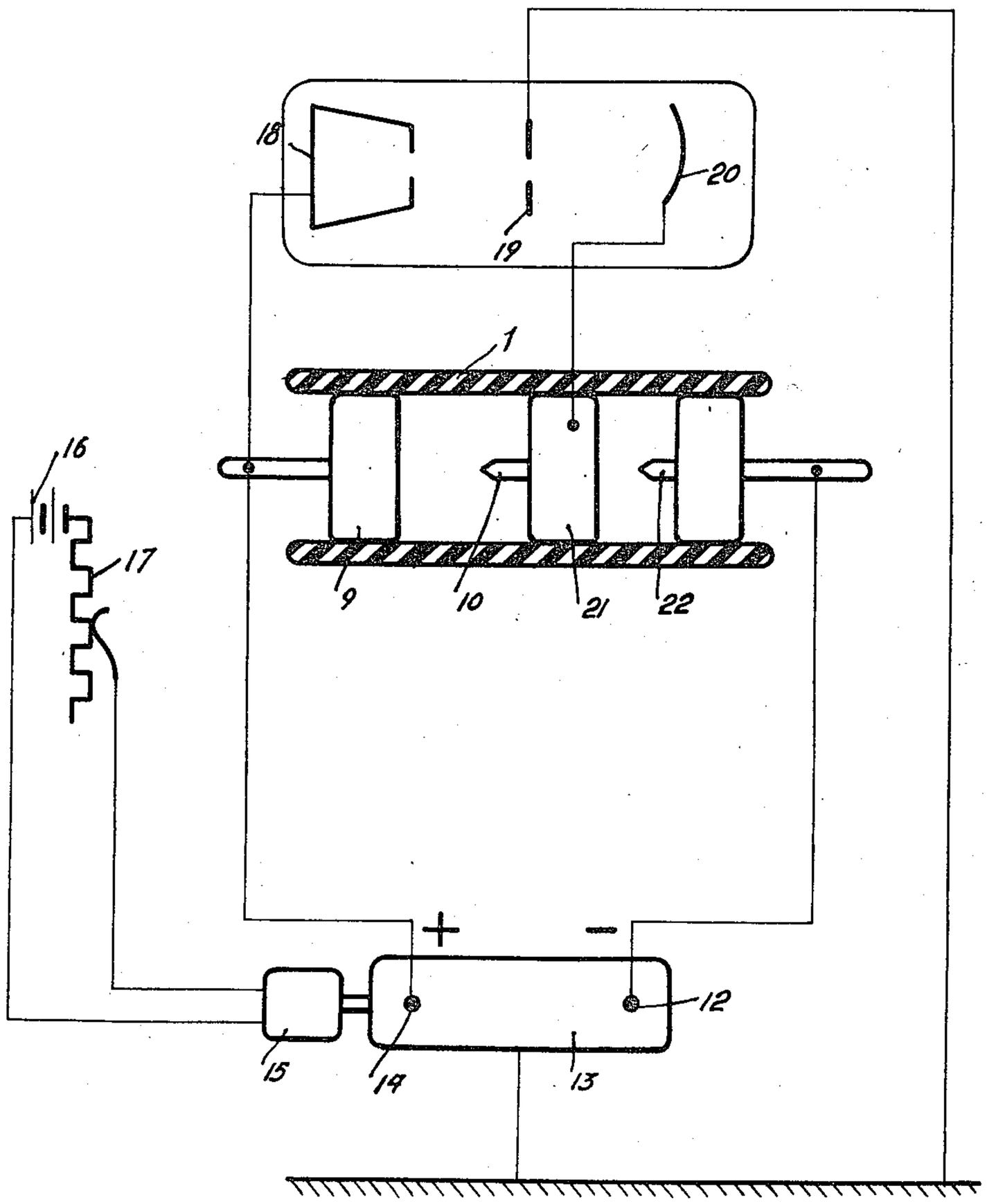
Fig. 3



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Feb. 15, 1955 N. FELICI 2,702,355

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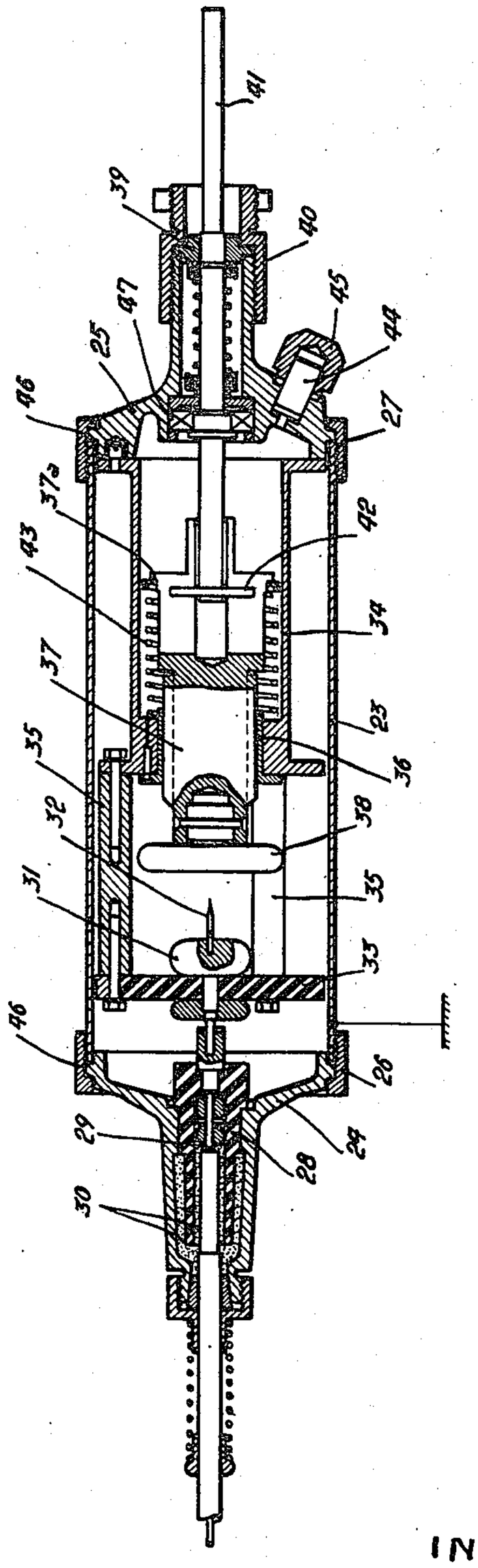
Fig. 4



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United States Patent Office

2,702,355

Patented Feb. 15, 1955

2,702,355

ADJUSTABLE VOLTAGE GLOW DISCHARGE DEVICE

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Application February 19, 1949, Serial No. 77,317

Claims priority, application France February 26, 1948

2 Claims. (Cl. 313—149)

In numerous electrical devices used presently it is necessary to supply a plurality of very high direct voltages, of the order of tens of kilovolts, capable of being adjusted separately. This is particularly the case with electronic converters which transform an image carried by rays which are invisible to the eye, such as, for instance, infrared, ultra-violet or X-rays into a visible image, with electrostatic electronic microscopes with a variable magnifying power, cathodic oscillographs and similar devices.

Owing to the high voltages which are used in such devices the use of resistor voltage dividers has not proven very satisfactory. When such dividers are used with said devices, they must comprise resistors having very high resistances, of the order of tens or hundreds of megohms, in order to avoid an undue dissipation of energy. The manufacture of such resistors is difficult; they often alter with time and their use is inconvenient. It is difficult to obtain a continuous variation of the obtained partial voltages and the necessity of avoiding leakage leads to bulky resistors.

An object of the present invention is to provide a continuously adjustable voltage divider which may be used with high or very high voltages, which has a relatively small bulk, is not very expensive to manufacture, which absorbs a very reduced electric power and allows of voltage adjustments which it is impossible to obtain with resistances only.

The invention is based upon the ionization phenomena which are produced in a gas in the neighbourhood of a conductor reducing in cross section to a sharply curved end brought to a high voltage, more particularly to a negative potential with respect to a plate located opposite said conductor. The invention makes use, more particularly, of the ionization obtained in such conditions when the above mentioned conductor has a pointed end.

A divider according to the invention comprises at least one device capable of establishing self maintained discharge of the glow type in which said discharge occurs between a conductor with a sharply curved end, preferably a pointed end, which serves as a cathode and a plate which serves as anode, the conductor and the plate being arranged opposite each other inside a tight casing or tube filled with a gas of such a nature and under such a pressure that the luminescent discharge may occur under the desired potential difference, means being provided for varying the potential difference under which the luminescent discharge occurs, through variation of the distance between the sharp end conductor and the plate and/or the pressure of the gas which fills the tube. The created negative ions are attracted by the plate and a current is established as soon as the applied voltage is sufficient for producing the ionization.

Experience shows that the difference of potential between the point and the plate essentially depends, for the usual current intensities (about 5 to 100 microamperes), on the distance which separates the point from the plate as well as on the pressure and the chemical nature of the gas filling the tube. On the other hand, the current intensity for a relatively large range of current intensity has little influence on the potential difference between point and plate whilst the difference of potential across the terminals of a resistance would be proportional to the intensity of the current flowing through this resistance.

It is thus very easy to adjust the voltage in a continuous manner and have the current remain between the preceding limits. It is sufficient to vary the distance between point and plate or the pressure of the gas in the tube.

A voltage divider according to the invention may comprise one and, generally, a plurality of point and plate units connected in series. In case of substantial outputs, for example, more than 200 microamperes, a plurality of point and plate units may be grouped in parallel.

Various embodiments of voltage dividers according to the invention are shown in the appended drawings in which:

Fig. 1 is a diagrammatical sectional view of a voltage divider comprising two point and plate units in series;

Fig. 2 is a diagram of the application of a voltage divider formed of a point and plate unit and of a resistance to the feeding of an electronic image converter;

Fig. 3 is a view similar to that of Fig. 2 in the case when the voltage divider is formed of two point and plate units connected in series;

Fig. 4 is a longitudinal sectional view of a glow discharge device according to the invention.

The voltage divider shown in Fig. 1 is formed of a tube 1 made of an insulating material in which are located a first movable conducting plate 2 connected to the positive terminal 3 of a D. C. generator 4, a central conducting member 5 formed of a plate 6 and a point 7 and a second movable conducting point 8 connected with the negative terminal 9 of generator 4.

Through varying the position of the movable plate 2 and/or of the movable point 8 it is possible to give any desired value to the ratio of the differences of potential between members 2 and 5, on the one hand, and 5 and 8, on the other hand, as well as to the absolute values of these differences of potential.

In order that the voltage divider may work in a satisfactory manner it is advisable to take the necessary steps to avoid prejudicial modifications or alterations therein in the course of time, as a result of the passage of the current. For this purpose, it is advantageous to limit the output of generator 4, through means which are known per se and, for this reason, not shown, to a reasonable value such as, for instance, a value less than 200 microamperes in order that the power dissipated in the divider may be moderate. Also the gas which fills the divider should be chosen so as not to yield, under the action of the luminescent discharge on the points, products which would attack the insulating substances or the conductors in the device. For this reason, it is advisable to avoid gases which are capable of freeing oxygen, fluorine, chlorine or halogens in general and to use a gas such as, for example, nitrogen or hydrogen.

In order to insure the stability of the voltage divider and reduce its bulk, the output of the generator should be higher than one or two microamperes. The pressure of the gas should not be too low in order to avoid any risk of disruptive discharge; nor must it be too high because the negative ions could then not reach the plate. When the voltage is higher than 6 or 7 kilovolts the gas should preferably be substantially at atmospheric pressure; when the voltage is lower it is advantageous to operate under a reduced pressure.

The bulk of a divider according to the invention is of the order of one centimeter length for each 10 kilovolts. If the current which flows therethrough is substantially constant, with only a small percentage variation, which is practically very easy to obtain, each partial voltage will be constant with a variation of less than 1 percent.

The above described embodiment relates to the case when a total voltage is divided into two partial voltages, but it is obvious that a larger number of point and plate units may be connected in series; it is sufficient that the above indicated conditions of difference of potential, nature and pressure of the gas are fulfilled for each unit.

The divider may also comprise a combination of point and plate units and of resistances connected in series.

As shown in Fig. 2, the divider comprises a movable plate 9, a fixed point 10 connected to one end of a fixed resistance 11 the other end of which is connected to the

negative terminal **12** of a generator **13**. This generator may be, for example, a self-exciting electrostatic machine the terminals **12** and **14** of which are at potentials of opposed signs with respect to the ground.

As may be seen, the total voltage supplied by the machine is distributed between the voltage across the terminals of the resistance **11**, on the one hand, and the voltage across point **10** and plate **9**, on the other hand. The electrostatic machine is driven by an electric motor **15** fed through a storage battery **16** and the speed of which can be controlled through a resistor **17** inserted in the feeding circuit of said motor. The positive terminal **14** of the electrostatic machine is connected to the fluorescent screen **18** of an image converter while the median electrode **19** of this converter is electrically grounded. The photocathode **20** of the converter is connected with the fixed point **10**.

When the speed of the motor and the potential difference across the terminals of the converter, the latter being proportional to the distance between plate **9** and point **10**, are such that point **10** is negative with respect to the ground, the photocathode sends out electrons under the action of impinging light and the fluorescent screen **18** is excited. Through acting upon the speed of the motor by means of resistor **17** the intensity of the current supplied by machine **13** may be varied, which modifies the voltage drop in resistance **11**. On the contrary the voltage drop between point **10** and plate **9** is but little influenced by the variation of said intensity of the current, so that the potential difference across the terminals **18**, **20**, of the converter is maintained constant. The ratio, however, between the potentials of the fluorescent screen **18** and photocathode **20** with respect to the ground can be modified at will be adjustment of the voltage applied to the terminals of the unit formed of the resistance, the converter and the divider, that is to say the voltage across the terminals **12—14** of generator **13**. This adjustment may be obtained, for example, through acting upon the speed of motor **15** by means of resistor **17**. It is possible, more particularly, if the apparatus is correctly calculated, to bring both potentials to be in the desired ratio in order to focus on the fluorescent screen the electrons sent out by the photocathode.

By modifying the distance between plate **9** and point **10**, for example by axially shifting the plate, the voltage drop between point **10** and plate **9** is modified. If generator **13** is such that the current which is supplied remains proportional to the difference of potential between its terminals, then the ratio between the potentials of screen **18** and photocathode **20** with respect to ground is not modified through the shifting of plate **9** but the absolute values of these potentials are increased or reduced; it is thus possible to act upon the luminosity of the image visible on screen **18** without changing the focussing thereof.

It is also possible to feed the image converter by means of a voltage divider formed no longer of a point and plate unit and a resistance but of two point and plate units connected in series, as shown in Fig. 3. In Figs. 2 and 3 the same elements are designated by the same reference numerals. Resistance **11** is substituted by a unit formed of a conducting plate **21** fast with point **10** and of a point **22** connected to the negative terminal **12** of generator **13**. As the voltage drop in both parts of the divider depends but little on the current, the focussing of the electrons and the luminosity of the screen are but little influenced by the output of the machine, in contradistinction to what was the case in the preceding example. The focussing of the electrons and the luminosity may be regulated by shifting movable point **22** and/or movable plate **9**. If the insulation of the voltage divider and of the converter is sufficient it is possible to require from generator **13** only a very small power and, accordingly, to reduce to a minimum the bulk, weight and consumption of energy of the whole device feeding the converter.

The device shown in Fig. 4 comprises a tube **23** which can be grounded and which is closed at its ends by members **24** and **25** maintained by caps **26** and **27** screwed onto tube **23**. Gaskets **46** are interposed between members **24** and **25**, on the one hand, and tube **23**, on the other hand.

Inside member **24** is located an insulating element **28** through which passes a conductor **29** which can be connected to a high voltage supply. The space existing between member **24** and element **28** as well as the space existing between said element **28** and conductor **29** is filled with an insulating sealing compound **30**. Conductor **29** is connected to an electrode **31** provided with a point **32** and supported by an insulating disk **33**.

Secured to member **25** is a carrier member or frame **34** connected to disk **33** by braces **35**. Secured in a bore of reduced diameter of the carrier member **34** is an internally threaded sleeve **36** into which a threaded member **37** is screwed and upon which is fastened a plate-shaped electrode **38**. The end of member **25** comprises an oil bath stuffing-box **39** secured by a screw cap **40** and in which a control rod **41** is supported for rotation by bearing **47** carried in the member **25**. This rod is fastened to the threaded member **37** through a key **42**. An adjusting spring **43** intended for taking up the play is interposed between a shoulder **37***a* of threaded member **37** and carrier member **34**. A filling valve **44** which can be closed by a cap **45** is provided in piece **25**.

The device is filled, for example, with nitrogen and it may be seen that it is possible to vary the distance between plate **38** and point **32** by imparting a movement of rotation to rod **41**.

What I claim is:

1. An adjustable voltage glow discharge device comprising a cylindrical gas filled sealed tube, a rigid frame supported within said tube, a member supported by said frame in threaded relation thereto for rotation of said member on the axis of the thread and concomitant movement of said member relative to said frame along said axis, a rod extending into said tube and sealingly journaled therein for rotation thereof on the axis of the rod, a torque transmitting connection between said rod and said member for rotating said member upon rotation of said rod to effect said movement of said member along said axis of said member, an electrode supported by said member for axial movement therewith and having a surface of substantial area transverse to said axis of said member, a second electrode supported by said frame in insulated relation to said first electrode and having a pointed portion spaced from and extending toward said surface of said first electrode generally in alignment with said axis of said member, and an electrical conductor connected to said pointed electrode and extending outwardly of said tube in sealed relation thereto.

2. An adjustable voltage glow discharge device comprising a gas confining container having an end wall, a rigid frame supported upon said end wall and extending therefrom within said container, a member supported in said frame for rectilinear movement of said member relative to said frame, an element extending into said container through said end wall and supported by said wall for predetermined movement thereof in gas tight relation to said wall and operable at the exterior of said container to effect such movement thereof, means operatively connecting said element to said member for effecting said rectilinear movement of said member concomitantly with said predetermined movement of said element, an electrode supported by said member for rectilinear movement therewith and providing a surface of substantial area extending transversely of said rectilinear movement of said electrode, a second electrode supported by said frame at the end of said frame spaced from said wall and in insulated relation to said first electrode and having a pointed portion spaced from and pointed toward said first electrode surface generally in alignment with said rectilinear movement of said first electrode, and electrical conductors connected respectively to said electrodes for connection of said device across a glow discharge producing potential difference.

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