July 24, 1951 M. GERBER 2,562,031

CORONA VOLTAGE REGULATOR TUBE

Filed April 28, 1950

FIG. 1

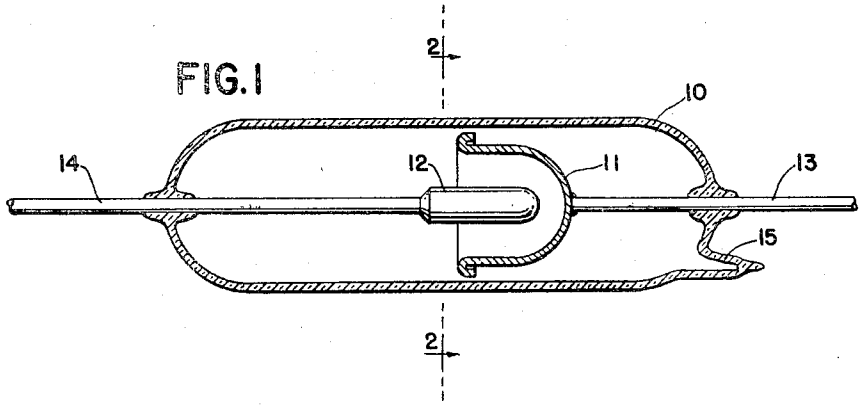


FIG. 2

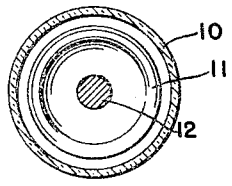


FIG. 4

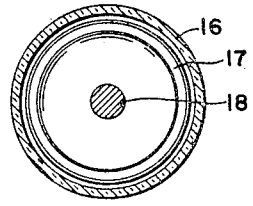
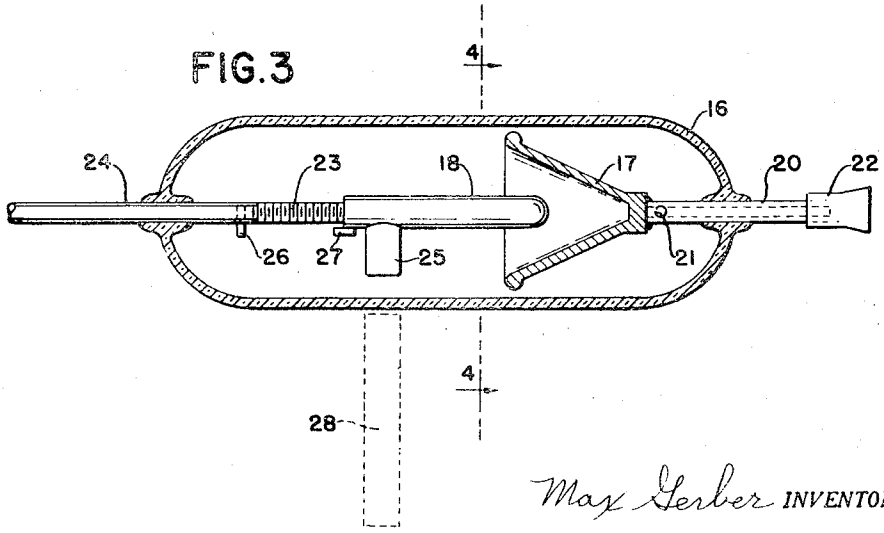


FIG. 3



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CORONA VOLTAGE REGULATOR TUBE

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2 Claims. (Cl. 313—146)

1

This invention relates to corona voltage regulator tubes for maintaining a predetermined constant voltage between two conductors. In greater detail it relates to electron discharge tubes which function as voltage regulators while passing current during the condition known as corona discharge. While the invention is subject to a wide range of application and circuits, it is especially suited for use in high voltage supply circuits which range in potential from 2,000 to 20,000 volts. The regulator tubes pass currents which range from .001 to .1 microamperes and hence consume small amounts of power.

As used throughout the specification and claims, the term "corona discharge" refers to an electrical discharge between two conductors in a gas in which the ionization is confined to a small area on the smaller electrode.

Voltage regulator tubes utilizing the glow discharge condition in gas filled diodes are well known and have been used for many years. In the glow discharge type of regulator the voltage regulation is accomplished by a constant drop of potential which is approximately independent of the current over a wide range of values. This type of glow discharge is only possible at low gas pressures.

Corona regulator tubes usually operate at higher voltages and at higher gas pressures. The voltage applied across a corona type tube causes ionization only in the neighborhood of the smaller electrode, which in all the present examples will be made the anode. Because of the high field intensity at the anode surface, electrons are given sufficient energy to cause ionization and liberate positive ions. The ions may cause additional ionization in the vicinity of the anode, but when out of the high intensity field, they drift to the cathode to maintain the current flow. When the current through a corona regulator tube increases, the intensity and diameter of the ionized space increases and the voltage across the tube remains approximately constant.

One of the objects of this invention is to provide an improved voltage regulator having different discharge characteristics as compared to prior art regulators.

Another object of the invention is to reduce the current consumed in voltage regulator tubes.

Another object of the invention is to improve the operating characteristics of corona regulator tubes so that regulation is effected over a greater range of current values.

Another object of the invention is to provide a regulator tube which may have its voltage adjusted by varying the electrode spacing.

The invention includes an envelope which encloses two electrodes and a filling of hydrogen gas. One electrode is formed in the shape of a cup or cone. The second electrode is positioned

2

within the cup and has an effective area which is much smaller than the first electrode. A feature of an alternate design of the regulator tube includes an electrode mounted on a screw thread with an eccentric weight for keeping the electrode in a non-rotating position when the regulator tube is mounted in a horizontal alignment. By turning the tube the electrode spacing is varied.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accompanying drawings.

Fig. 1 is a sectional view of a corona voltage regulator tube in which the electrodes are a fixed distance apart.

Fig. 2 is a cross sectional view of the tube shown in Fig. 1, taken along line 2—2 of that figure.

Fig. 3 is a sectional view of an adjustable corona voltage regulator tube in which one electrode is made adjustable.

Fig. 4 is a cross sectional view of the tube shown in Fig. 3, taken along line 4—4 of that figure.

Referring now to Figs. 1 and 2, a glass envelope 10 encloses two electrodes 11 and 12. The first electrode 11 is a cup shaped cathode which is welded to a lead-in conductor 13 sealed into the envelope 10. The second electrode 12 is a rod shape anode, rounded on the end, which is also welded or otherwise joined to a lead-in conductor 14 sealed into the envelope. The regulator tubes which have a predetermined voltage constant of from 2,000 volts to 6,000 volts are filled with hydrogen gas at pressure lower than atmospheric and hence an ordinary glass tubulation 15 is used which may conveniently be sealed off by a gas flame. Voltage regulators using a gas filling which has a pressure higher than atmospheric employ a pinch type seal which will be described later.

One type of corona tube which regulates to a value of 6,000 volts uses an axial electrode spacing of 10 mm. and hydrogen gas at a pressure of 65 cm. of mercury.

The corona regulator tube shown in Figs. 3 and 4 employs an envelope 16, a cone shaped cathode 17, and a rod shaped anode 18. The cathode 17 is welded to a hollow lead-in conductor 20 which communicates with the inside of the envelope 16 by means of a hole 21. This tube is sealed to the exhausting and filling system while the tube is being cleaned, filled, and aged, and when ready for sealing, a copper sleeve 22 is moved into place over the lead-in conductor and the two tubes collapsed by a strong clamp. The tube is cut off from the exhausting system and the end immediately dipped in molten solder.

This provides a gas tight seal and is used for tubes which are filled with a pressure greater than atmospheric pressure.

The anode 18 of Fig. 3 is rotatably mounted on a screw 23 which is cut on the inner end of lead-in conductor 24. A weight 25, usually made of iron, is secured to one side of the anode so that when the tube is held in a horizontal position and turned on its longitudinal axis, the weight 25 will retain the anode in a non-rotating position, thereby shifting its position with respect to the cathode 17. This is one convenient way of adjusting the regulated voltage to a desired value. A pin 26 and a stop 27 cooperate to prevent sticking at the end of the thread.

If it is desired to operate the voltage regulator tube in a vertical position, a magnet 28, shown in dotted lines, may be used to retain the weight 25 in non-rotatable position.

One type of high pressure adjustable corona regulator tube which regulates to a voltage of 17,600 volts ±10% is filled with pure hydrogen at a pressure of 228 cm. of mercury.

It has been found that corona tubes of this kind are sensitive to impurities in the hydrogen gas. Oxygen is particular causes instability in the corona discharge at currents below .1 microamperes and care must be exercised to have all traces of oxygen removed. To this end a getter of magnesium and aluminum is employed to absorb all traces of oxygen after the tube has been sealed.

Corona regulator tubes as described above may be used in the same general type of circuit that is used with glow discharge regulator tubes.

While there have been described and illustrated specific embodiments of the invention, it will be obvious that various changes and modifications may be made therein without departing from the field of the invention which should be limited only by the scope of the appended claims.

I claim:

1. A corona voltage regulator tube for regulating voltage during a corona discharge comprising, an envelope filled with hydrogen gas, a cathode and an anode mounted within the envelope, said anode comprising a conductor having a radius of curvature less than one-third the diameter of the envelope, said cathode comprising a cup shaped conductor surrounding the end of the anode and having an area at least three times the area of the anode, a getter within said envelope for forming a stable solid compound with oxygen, and screw adjusting means within the envelope including an eccentric weight for varying the spacing between said anode and cathode.

2. A corona voltage regulator tube for regulating voltage during a corona discharge comprising, an envelope filled with hydrogen gas, a cathode and an anode mounted within the envelope, said anode comprising a conductor having a radius of curvature less than one-third of the diameter of the envelope, said cathode comprising a cup shaped conductor surrounding the end of the anode and having an area at least three times the area of the anode, and screw adjusting means within the envelope for varying the spacing between the anode and cathode including an eccentric magnetic rod positioned for actuation by a magnet on the outside of the envelope.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,749,772	Lorenz	Mar. 11, 1930
1,879,158	Foulke	Sept. 27, 1932
1,879,159	Foulke	Sept. 27, 1932
2,456,563	McCarthy	Dec. 14, 1948