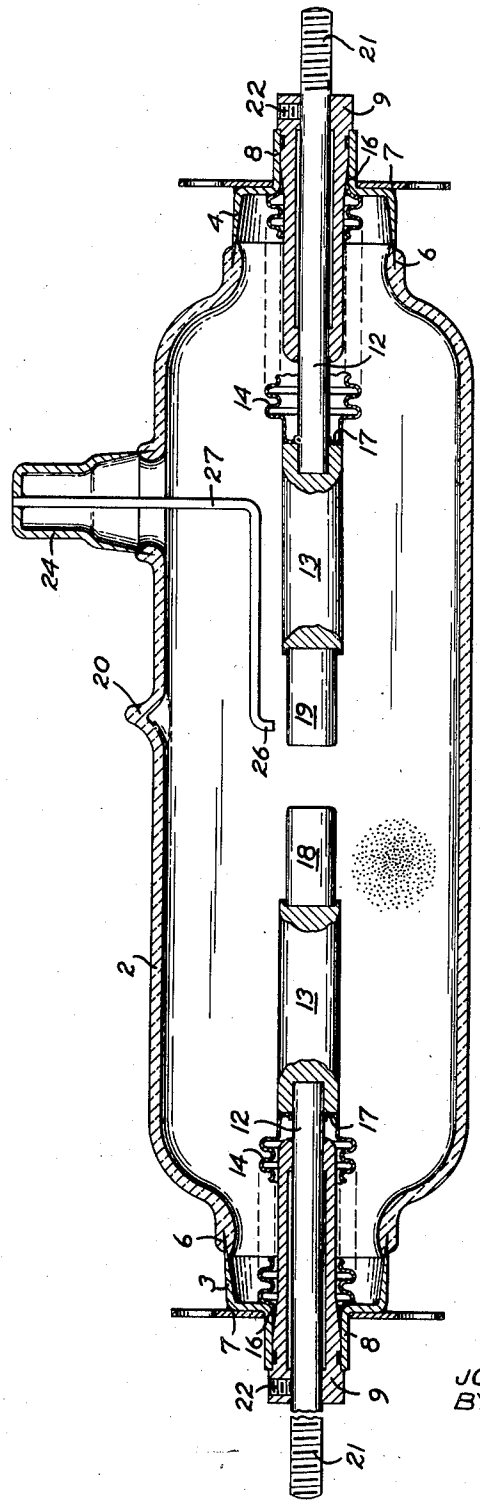
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ADJUSTABLE DISCHARGE TUBE

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INVENTOR
JO EMMETT JENNINGS
BY Charles S. Evans
his ATTORNEY

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ADJUSTABLE DISCHARGE TUBE

Jo Emmett Jennings, San Jose, Calif., assignor to Jennings Radio Manufacturing Corporation, San Jose, Calif., a corporation of California

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My invention relates to a gaseous type discharge device; and one of the objects of my invention is the provision of such a device which is closely adjustable over a wide range.

Another object of the invention is the provision of a discharge device comprising a gas filled tube having spaced electrodes across which the overload arcs, and which includes means for varying the width of the gap.

Another object is the provision of a gas filled discharge tube which embodies automatically operating or controllable means for triggering the discharge of overload or excess voltage.

Another object is the provision of a gas filled discharge tube readily adjustable both as to the maximum voltage at which discharge will occur, and also as to a relatively low triggering voltage.

Another object of the invention is the provision of a discharge device of cold cathode type, which discharges at high voltage with a relatively low triggering voltage.

The invention possesses other objects, some of which with the foregoing will be included in the following description of the invention. I do not limit myself to the showing made by the said description and the drawings, since I may adopt variant forms of the invention within the scope of the appended claims.

Referring to the drawings, the figure is a vertical half-sectional view of an adjustable discharge tube embodying my invention. The scale is approximately full size.

In terms of broad inclusion, my discharge tube comprises a glass envelope of generally tubular form hermetically closed at each end by a metal end cap including a mounting flange. The envelope is filled with an inert gas, preferably argon at about atmospheric pressure.

An electrode is movably mounted in each end cap by means of a bellows interposed therebetween; and the spacing of the inner ends of the electrodes is adjustable to fix the width of the gap between them, and therefore the minimum potential at which a high voltage discharge will occur across the unmodified gap.

Adjustable means including a separate circuit is provided for modifying the conditions about the gap so that the discharge is induced or triggered at a chosen relatively lower voltage. This modification may be arranged to act automatically or it may be otherwise controlled.

After the separate assemblies have been sealed in the tubular glass shell, and properly washed and cleaned, it is evacuated and given a bake-out, after which the contacts are heated, either by induction or resistance heating, and the argon introduced. The seal-off is then made from the pump and the implement calibrated.

Adjustment of the main contacts may be in a range between ten and twenty thousand volts D. C.; and the firing or triggering voltage between two and five thousand volts.

My discharge tube performs the same function in an electric circuit as an expensive high power thuratron or

ignitron tube, but without the complicated controlling circuits.

In more detailed terms, my adjustable discharge tube comprises an envelope in which a tubular dielectric shell 2 is closed at each end with conductive caps 3 and 4, respectively, each united to the shell with the conventional sealing joint 6, and each also integrally united, as by brazing to a radially extending mounting flange 7, which also provides means for connecting the discharge tube into its circuit.

Each end cap is formed with a cylindrical flange 8, concentric about the long axis of the implement; and a bearing tube 9, extending well into the envelope is brazed within each flange 8, to provide a stable slide bearing for the stem 12. On the inner end of each stem is a copper extension or mounting lug 13.

In order to seal each end hermetically about the bearing tube and stem, the bearing tube is enclosed by a generally cylindrical bellows 14, having an open end brazed to both end cap and bearing tube at 16; and having a closed end 17, brazed to the end of the copper extension and around the inner end of the stem 12, which at this point seats in and is brazed to the lug 13. Electrodes or contacts 18 and 19 of tungsten are fixed in the adjacent ends respectively of the copper lugs.

In the manufacture of my discharge tube, the air is exhausted from the completed assembly through tubulation 20 in a manner similar to that followed in the making of vacuum tubes, and an inert gas, preferably argon is introduced up to a pressure approximately equal to the atmosphere. This gas effectively prevents any possibility of oxidation or condensation; and argon is preferred because of its stability and resistance to change after hundreds of discharges.

The width of the gap between the contacts determines the voltage break-down point; and this width is closely adjustable over a wide range by suitable controls connected to the threaded ends 21 of the stems 12. Adjustment is fixed by a set screw 22 threaded into the bearing tube and impinging on the stem. Normally, the assembly including end cap 4 and contact 19 are connected to the low potential side of the circuit, the opposite end being connected into the high potential side. The low potential may be the ground potential. It could be plus or minus, or there could be several hundred volts potential between it and the ground.

Means are provided for inducing a spark or discharge between the contact on the low potential side of the tube and an adjacent conductor so that the gas about the contacts is ionized, and resistance across the gap reduced. The result of this modification of the gas in the gap is to induce or trigger a discharge across the gap from the high potential side of the circuit.

Sealed into the side of the shell 2 near the low potential end of the device is an inwardly opening copper thimble or lead 24, adapted for connection into a triggering circuit. Brazed into the end of the thimble and extending into the envelope and to a contact point 26 close to the low potential contact 19, is a tungsten trigger arm 27, bent at right angles as shown, so that slight lateral movement of the thimble, while it is dead soft after the bake out and before it has hardened again, can be utilized to adjust the point of the trigger arm as desired to pass the triggering voltage to the contact 19.

Discharge tubes, similar to that shown in the drawing, are adjusted to a range between ten and twenty thousand volts D. C. across the main gap; and to a firing or triggering voltage from the trigger arm between two and five thousand volts.

When the overload discharge is expected to take place, a pulse of current is applied in the trigger arm circuit to produce a spark across the gap between the end 26

of the arm and the contact 19. This ionizes the gas between the main contacts and induces or triggers a discharge from the high potential electrode to the low, thus discharging the overload. This flash-over requires only a few milliseconds, depending on the amount of energy to be discharged. Normally the parts and electrodes are cold until the pulse or triggering flash appears. After the high potential discharge occurs, everything returns to normal.

The triggering circuit may be an independent one with manual control means, or it may be actuated or energized automatically by current derived from the main circuit which the discharge tube protects. In the latter case, proportions of parts and spacing of contacts are so related as to produce a high degree of stability as to the exact potential when the discharge occurs.

It should be noted that in the case of electrical mishap resulting in more power or sustained power, the electrodes 18 and 19 can be further separated by drawing out the stems as permitted by the compressed bellows so that any danger of explosion is reduced.

While a single bellows and stem will give mobility of one electrode and a certain range of adjustment between the electrodes, it must be remembered that the bellows is the most fragile element in the assembly. By use of a bellows and mobile electrode mounting at each end of the envelope, the range of adjustment is greatly increased, while at the same time avoiding the extreme expansion and contraction of the bellows which destroys its resilience and shortens its useful life span.

I claim:

1. A discharge device comprising a tubular dielectric shell, conductive end caps closing the shell to form an hermetically tight envelope, a slide bearing integrally united to each end cap, a stem journaled in each slide bearing, a bellows within the envelope and having a closed end integrally united to each stem and an open end integrally united to the adjacent end cap, a contact on the inner end of each stem, and a conductive arm extending into the envelope from a lead outside the envelope to a contact point adjacently spaced from one of the contacts.

2. A discharge device in accordance with claim 1 in which the conductive arm is rigidly fixed on the lead and has an angularly disposed portion extending generally in the direction of the tubular shell axis.

3. A discharge device comprising a tubular dielectric shell, conductive end caps closing the shell to form an hermetically tight envelope, a slide bearing integrally united to each end cap, a stem journaled in each slide bearing, a bellows surrounding the slide bearing within the envelope and having a closed end integrally united to each stem and an open end integrally united to the adjacent end cap, a contact mounted on the inner end of each stem, an inwardly opening conductive thimble hermetically united to the shell adjacent one end, and a rigid arm fixed in the thimble and extending into the envelope and toward the opposite end thereof and ending in a contact point operatively spaced from the near contact.

4. A discharge device in accordance with claim 3 in which the envelope is filled with an inert gas.

5. A discharge device comprising a tubular dielectric shell, conductive end caps closing the shell to form an hermetically tight envelope, a slide bearing integrally united to one of the end caps, a stem journaled in the slide bearing, a bellows within the envelope and having a closed end integrally united to the stem and an open end integrally united to the adjacent end cap, a first contact mounted on the inner end of the stem, a second contact spaced from the first contact and mounted on and integrally united to the other end cap, an inwardly opening conductive thimble hermetically united to the shell adjacent said other end cap, and a rigid arm fixed in the thimble and extending into the envelope and toward the opposite end thereof and ending in a contact point operatively spaced from the second contact.

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