Jan. 4, 1938. G. E. INMAN 2,104,652

ELECTRIC DISCHARGE DEVICE

Filed Jan. 25, 1936 2 Sheets-Sheet 1

Fig. 1.

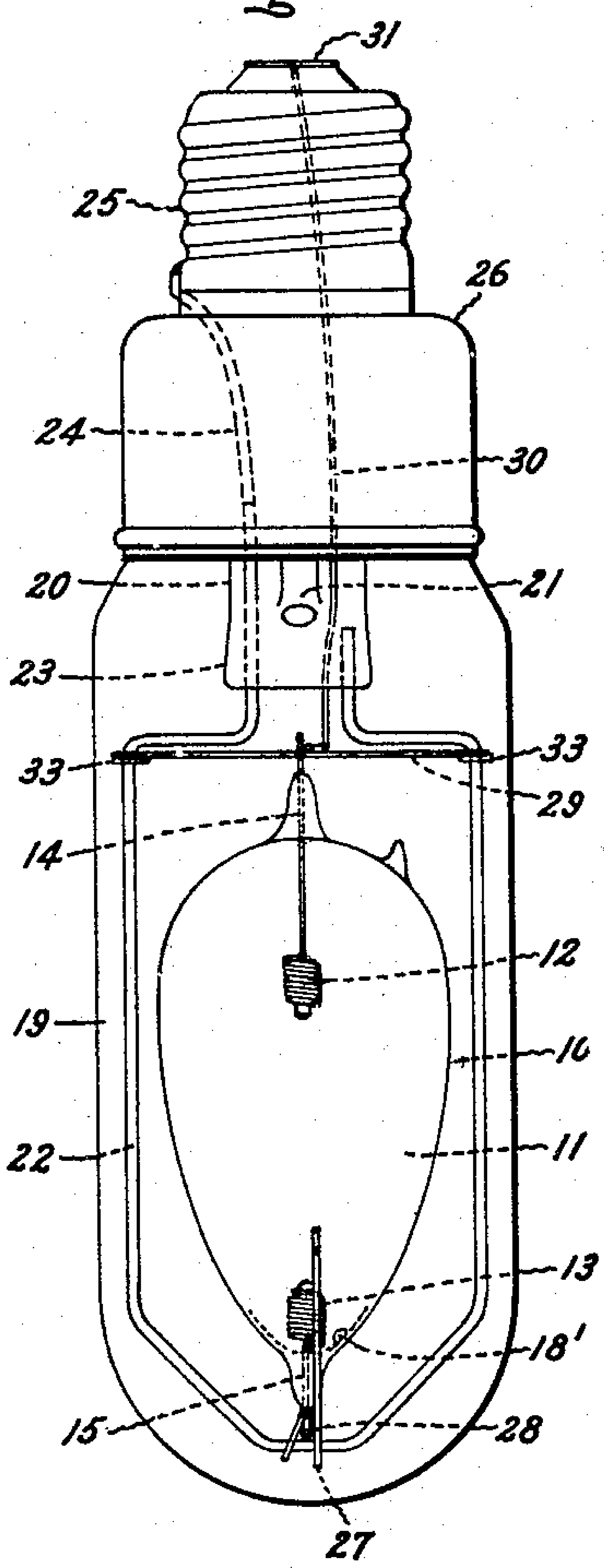

Fig. 2.

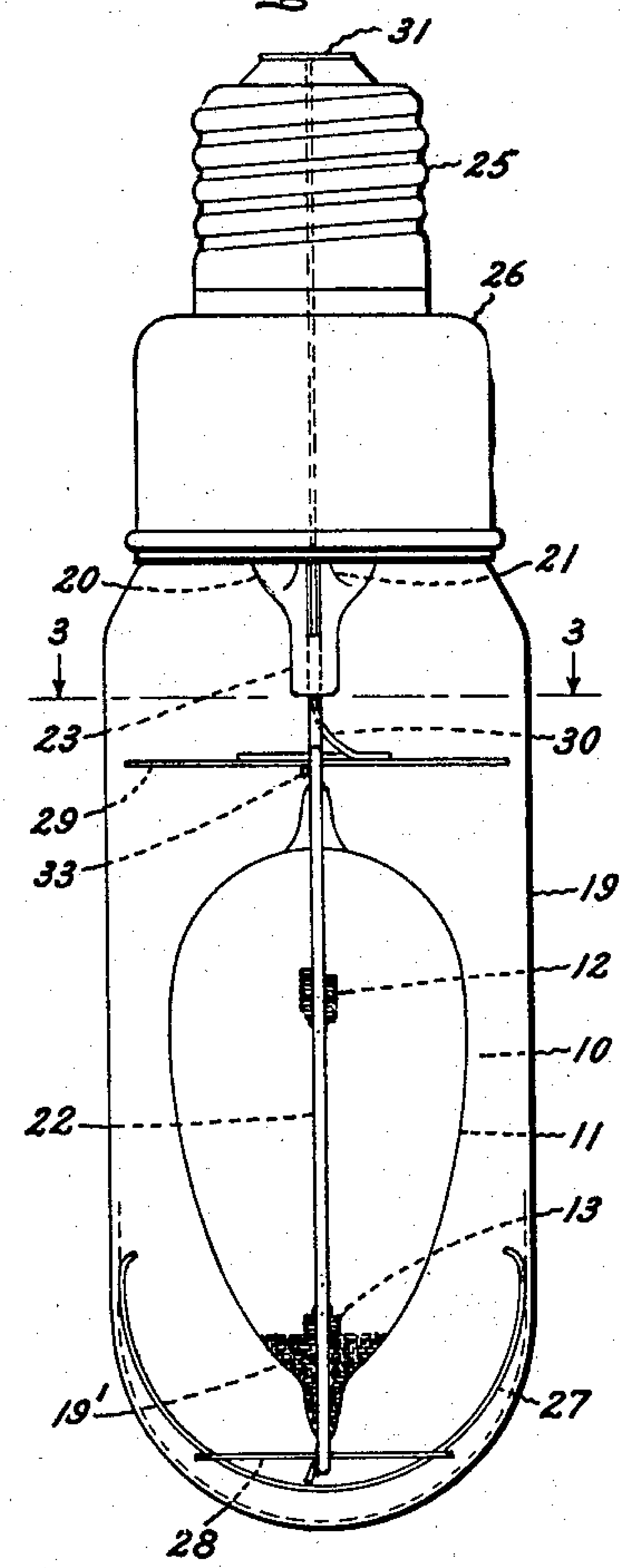

Fig. 4.

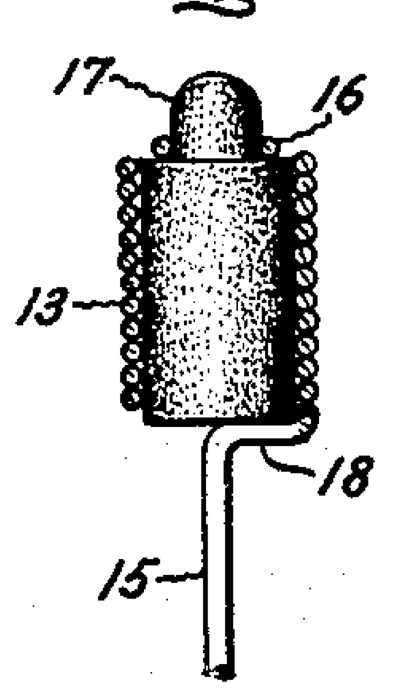

Fig. 3.

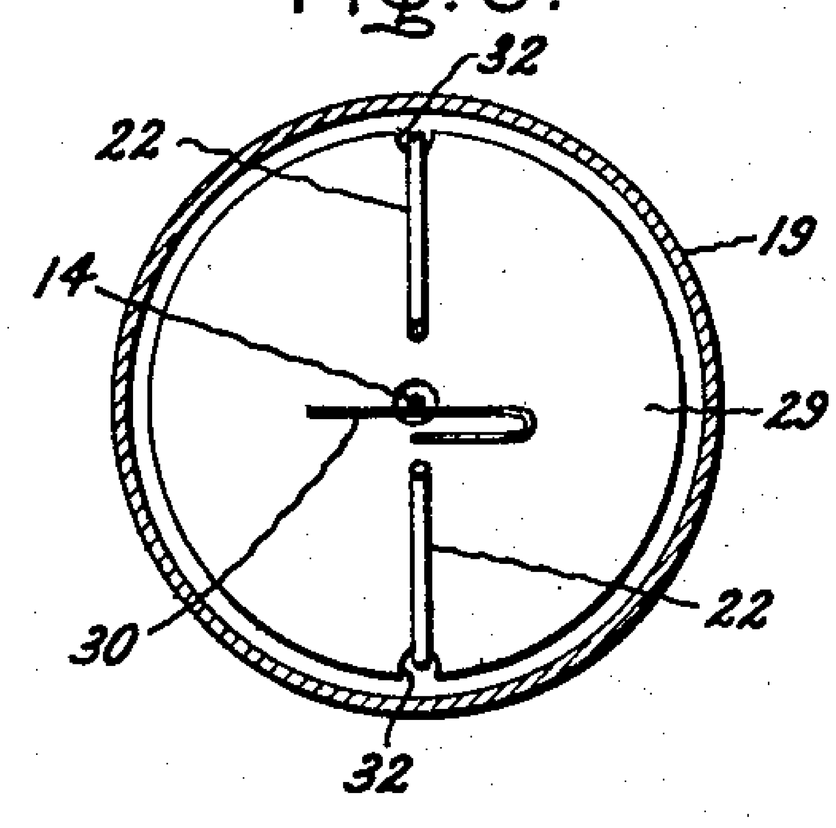

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Fig. 5.

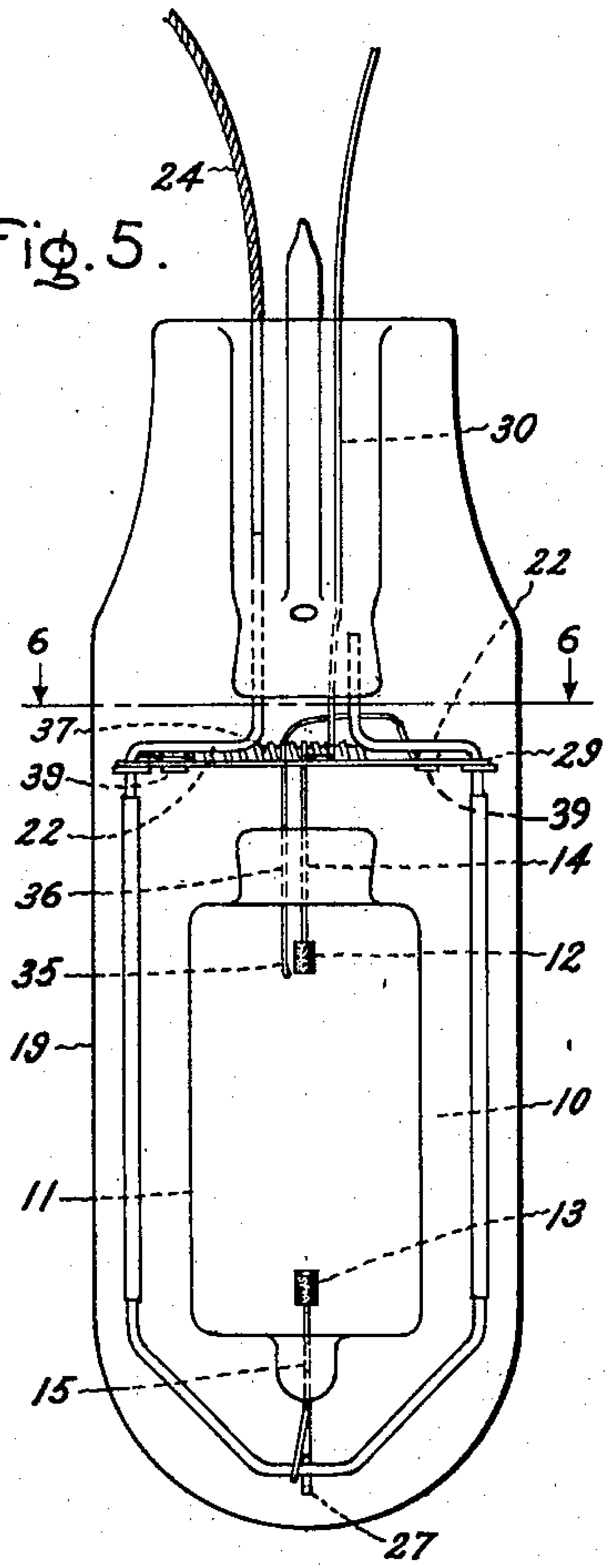


Fig. 6.

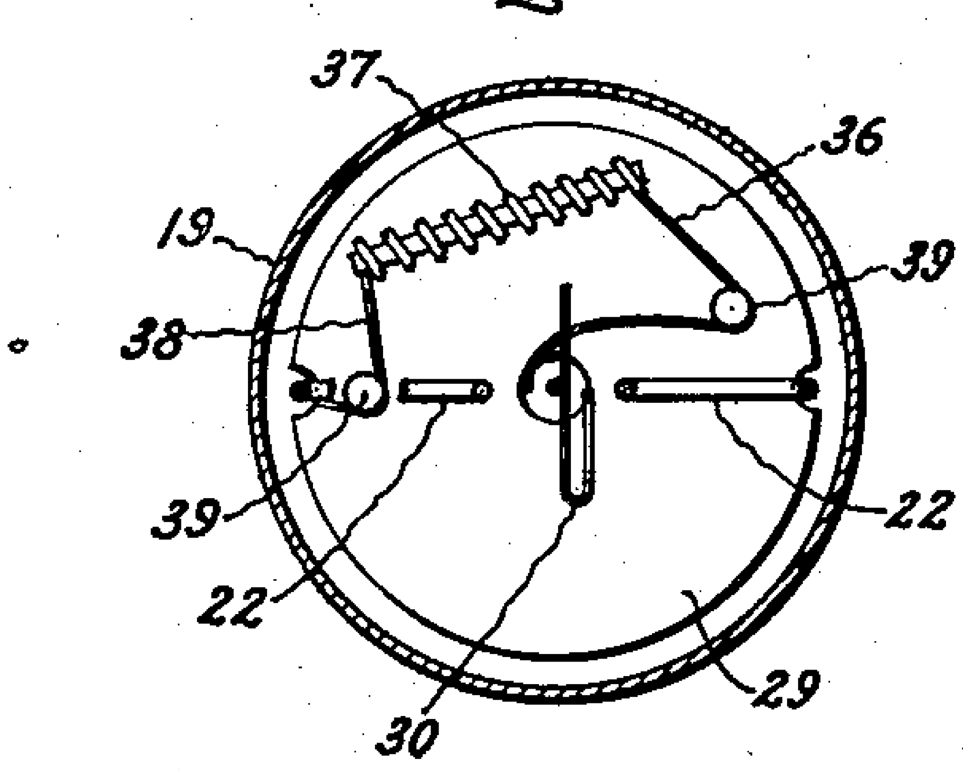
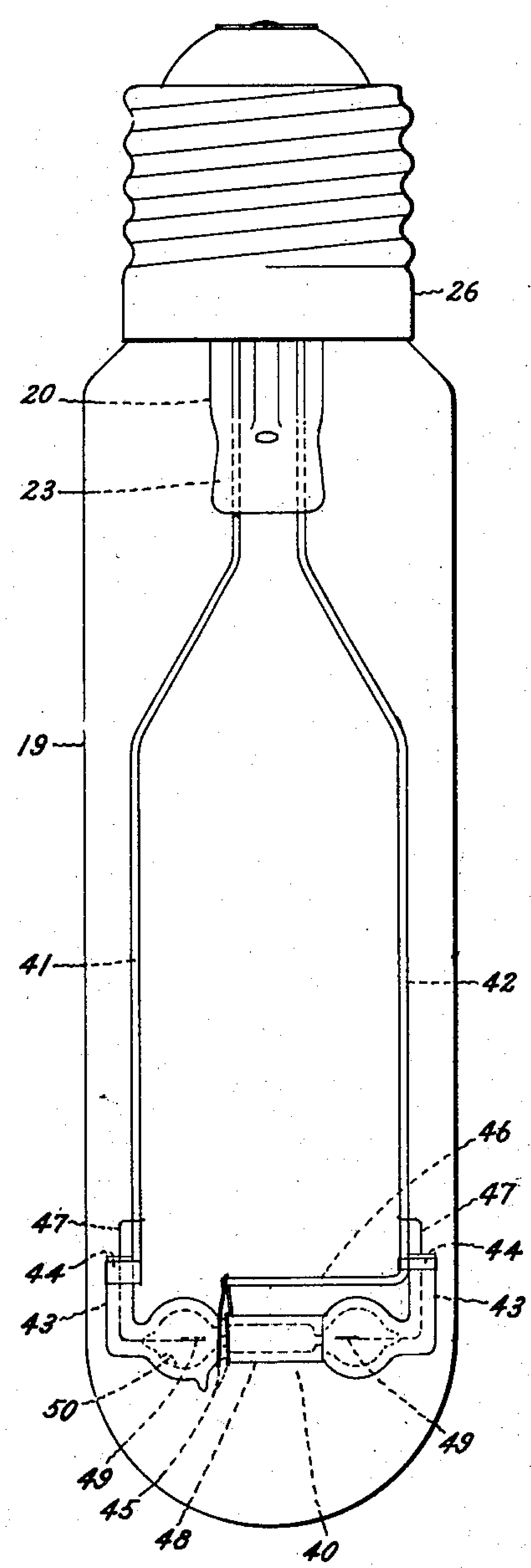


Fig. 7.



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His Attorney.

UNITED STATES PATENT OFFICE

2,104,652

ELECTRIC DISCHARGE DEVICE

George E. Inman, East Cleveland, Ohio, assignor to General Electric Company, a corporation of New York

Application January 25, 1936, Serial No. 60,848

9 Claims. (Cl. 176—122)

My invention relates to electric discharge devices and more particularly to high pressure positive column vapor arc lamps such as high intensity mercury arc lamps.

The luminous efficiency of metal vapor arc lamps depends in general on the pressure or density of metal vapor in the lamp and is influenced by the loss of heat from the lamp to the surrounding atmosphere. Heretofore it has been proposed to enclose the lamps in outer envelopes which were evacuated or filled with gases of low heat conductivity so as to minimize the loss of heat and keep the bulb walls as hot as possible.

According to my invention, the outer bulb is preferably filled with a gas of high heat conductivity to cool the outer surface of the bulb and permit the use of a higher internal temperature. The used of a cooling gas makes it possible to have a greater temperature gradient in the bulb wall, thereby preventing danger of collapse. This means that the pressure and wattage may be increased greatly in the same size bulb. The outer bulb also protects the inner lamp bulb from atmospheric drafts and the irregularity in bulb wall temperatures caused thereby. The gas probably absorbs more heat from the hot spots of the lamp bulb and therefore tends to equalize the bulb wall temperature.

My invention also includes certain novel features in the supporting structure for the inner bulb. Further features and advantages of my invention will appear from the following detailed description of species thereof.

In the drawings, Fig. 1 is an elevation of one form of lamp comprising my invention; Fig. 2 is a similar view at right angles to Fig. 1; Fig. 3 is a section taken on the line **3—3** in Fig. 2; Fig. 4 is a side view, partly in section, of one of the electrodes; Fig. 5 is an elevation of a modified form of lamp; Fig. 6 is a section taken on the line **6—6** in Fig. 5; and Fig. 7 is an elevation of another modified lamp.

Referring to Figs. 1 and 2, the high pressure metal vapor (mercury) arc lamp **10** is of the type shown in U. S. patent application Serial No. 8,286, filed February 26, 1935, by Eugene Lemmers, and assigned to the assignee of this application. The bulb **11** is of larger diameter at the top than at the bottom, being in this case of substantially oval shape. A pair of electrodes **12**, **13** are sealed in the bulb **11**, the upper electrode **12** being substantially adjacent the largest diameter of the bulb while the lower electrode is close to the bottom thereof. The said electrodes **12**, **13** may consist of a sintered body of coarse refractory metal, such as tungsten, impregnated with an electron emissive material, as described in U. S. patent application of Eugene Lemmers and Harry M. Fernberger, Serial No. 16,614, filed April 16, 1935, and assigned to the assignee of the present application. The upper and lower electrodes **12**, **13** are mounted on lead wires **14**, **15** respectively, the ends of which are coiled around the electrodes. The end turn **16** (Fig. 4) is coiled around a reduced end portion **17** of each electrode, while at the other end the lead is bent transversely at **18** across the end of the electrode, thereby firmly holding said electrode in place. The bulb **11** contains a readily ionizable gas such as argon at low pressure to assist in starting, and a vaporizable metal such as a globule of mercury **18'**. The lamp is preferably designed to operate at a pressure of greater than one atmosphere, preferably about two atmospheres. The lower end of the bulb **11** may be coated at **19'** (Fig. 2), as with platinum paint, to increase the heat absorption and raise the temperature of said lower end which tends to be the coolest part of the bulb.

The lamp **10** is enclosed in an outer glass bulb or envelope **19** which is preferably provided with a stem tube **20** and an exhaust tube **21** through which it may be exhausted of air and filled with gas. The support for the lamp **10** comprises a conductive support **22** bent into a substantially U or rectangular shaped frame and having its upper ends sealed in the stem press **23**. One end of said support wire **22** is attached to an outer lead wire **24** which is attached to the screw-threaded shell **25** of a skirted base **26**. The other end of said support wire **22** terminates in the stem press **23**. The lower end of the frame **22** is braced by a substantially semi-circular, preferably springy, wire **27** located in a plane at right angles to the plane of said frame and engaging the walls of the outer bulb **19** at its ends. The said wire **27** is attached to the lower end of the frame **22** by a wire **28** welded at its middle to said frame **22** and at its end to said wire **27**. The lower electrode lead **15** is welded to the lower end of the frame **22** which thus forms one of the current leads for the lamp **10**. The upper electrode lead **14** extends through an opening in a disc or shield **29** of refractory insulating material and is attached to a lead wire **30** which extends through the stem press **23** to the center contact **31** of the base **26**. The inner or lower end of lead **30** is bent into a transversely extending U-shape against which the disc **29** presses, thereby anchoring the upper end of the lamp **10**. The said disc **29** is located between the upper end of the lamp **10** and the stem press 23, preferably just below the upper end of the frame 22 as shown. The said disc 29 may be provided with diametrically opposite notches 32 (Fig. 3) in which the sides of the frame 22 engage and may be held in place by short wires 33 welded to said frame under the disc.

The outer bulb 19 contains any suitable gas which will absorb heat from the outer surface of the lamp 10 fast enough to keep the walls of its bulb 11 below the temperatures at which the glass or other vitreous material of the bulb will soften (e. g., about 500–800° C.). The character and quantity of the gas must depend upon the design of the lamp 10. The best efficiency is obtained by keeping the bulb 11 at a temperature below but as close as safely possible to the softening temperature of the glass, that is, overcooling is to be avoided. Thus, if the construction of a given lamp 10 does not permit of its operation on so high a wattage as to heat its bulb walls to a temperature just below softening, then the gas used must be correspondingly less in quantity or lower in thermal conductivity, or both, so as not to cool the bulb wall too much below its softening temperature.

The preferred gases for use in the outer bulb 19 include hydrogen and helium because of their high thermal conductivity. In cases where a filling of helium in the outer bulb would overcool the inner bulb 13, the helium may be diluted. One filling which was used successfully consisted of a mixture of seventy-five per cent helium and twenty-five per cent nitrogen, by volume, which has a lower thermal conductivity than helium or hydrogen. At higher than atmospheric pressures gases of poorer heat conductivity, such as air or nitrogen, may be used, especially in cases where helium or hydrogen would over-cool the lamp 10. While the cooling effect increases according to the quantity and pressure of the gas filling, the preferred pressure is about atmospheric. If the bulb 19 is filled at atmospheric pressure when the lamp is cold, the pressure may be around two atmospheres when the lamp is in operation. With the same bulb size, the increased wattage made possible by the gas filling in bulb 19 may produce an efficiency about ten per cent greater and a light output as much as one hundred per cent greater or more.

In the lamp shown in Fig. 5, the outer bulb 19 and the supporting structure for the lamp 10 are the same as in Fig. 1, the lamp 10 itself in this case having a bulb 11 and electrodes 12, 13 of different shape and form. The bulb 11 is in this case cylindrical and the electrodes 12, 13 consist of cylindrical bodies similar to those in Fig. 1 and secured to the leads 14 and 15 respectively. This lamp 10 is also provided with an auxiliary starting electrode consisting of the end portion 35 of a lead wire 36. The other end of lead wire 36 is connected to one end of a coil of high resistance wire 37 (Fig. 6), such as nichrome. The other end of the resistance 37 is connected through a conductor 38 to the frame 22. The lead 36 and conductor 38 are anchored to the disc 29 by eyelets 39.

In the device shown in Fig. 7, the lamp 40 is of the extremely high pressure capillary type disclosed in U. S. patent application of Cornelis Bol, Willem Elenbaas, and Hendricus J. Lemmens, Serial No. 46,952, filed October 26, 1935, and assigned to the assignee of this application. The said lamp is mounted transversely of the axis of the outer bulb 19 on rigid leads 41, 42. Upwardly extending seal portions 43 at the ends of the lamp 40 are secured to the leads 41, 42 by loops of wire 44 welded to said leads. The lamp 40 is further supported by several loops of wire 45 welded to a transversely extending end portion 46 of the lead 42. Lead wires 47 extending from the ends of the lamp 40 are secured to the leads 41, 42.

The tubular envelope 48 of the lamp 40 is of highly heat resistant vitreous material, such as quartz, adapted to withstand very high pressures and temperatures. The envelope 48 contains a pair of electrodes 49 and a small quantity of mercury 50 and a filling of rare gas such as argon or neon at low pressure. A lamp of the proportions shown was operated in the outer gas-filled bulb 19 on alternating current with a voltage across the electrodes of about 300 volts and a current of about .6 ampere, the power consumption being about 150 watts. The outer bulb 19 was filled with helium at a pressure of about 600 mm.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The combination of an electric discharge lamp comprising a bulb having a pair of electrodes therein, and an outer envelope enclosing said bulb, with a gas content in said outer envelope at a pressure in excess of half an atmosphere, providing enhanced cooling for the inner bulb, as compared with that afforded by direct atmospheric exposure thereof, so that the lamp may operate on higher current and with higher pressure without heating up the inner bulb wall to its softening temperature.

2. The combination of an electric discharge lamp comprising a bulb having a pair of electrodes therein, and an outer envelope enclosing said bulb, with a quantity of gas confined in said outer envelope at a pressure in excess of half an atmosphere so as to maintain therein, during normal operation of the lamp, a super-atmospheric pressure such as to provide enhanced cooling for the inner bulb, as compared with that afforded by direct atmospheric exposure thereof, so that the lamp may operate on higher current and with higher pressure without heating up the inner bulb wall to its softening temperature.

3. The combination of an electric discharge lamp comprising a bulb having a pair of electrodes therein, and an outer envelope enclosing said bulb, with a quantity of atmospheric gas confined in said outer envelope at a pressure in excess of half an atmosphere so as to maintain therein, during normal operation of the lamp, a pressure substantially exceeding atmospheric, thus providing enchanced cooling for the inner bulb, as compared with that afforded by direct atmospheric exposure thereof, so that the lamp may operate on higher current and with higher pressure without heating up the inner bulb wall to its softening temperature.

4. The combination of an electric discharge lamp comprising a bulb having a pair of electrodes therein, and an outer envelope enclosing said bulb, with a filling of highly heat-conductive gas in said outer envelope at a pressure in excess of half an atmosphere providing enchanced cooling for the inner bulb, as compared with that afforded by direct atmospheric exposure thereof, so that the lamp may operate on higher current and with higher pressure without heating up the inner bulb wall to its softening temperature.

5. The combination of an electric discharge

lamp comprising a bulb having a pair of electrodes therein, and an outer envelope enclosing said bulb, with a quantity of highly heat-conductive gas confined in said outer envelope at a pressure in excess of half an atmosphere so as to maintain therein, during normal operation of the lamp, a pressure substantially exceeding atmospheric, thus providing enhanced cooling for the inner bulb, as compared with that afforded by direct atmospheric exposure thereof, so that the lamp may operate on higher current and with higher pressure without heating up the inner bulb wall to its softening temperature.

6. The combination of a high-pressure metal vapor arc lamp comprising electrodes axially arranged in an upright bulb containing a charge of vaporizable metal and so proportioned that its walls are heated to approximately uniform temperature by the heat of the arc between said electrodes, and an outer envelope enclosing said inner bulb, with a gas content in said outer envelope at a pressure in excess of half an atmosphere providing enchanced cooling for the inner bulb, as compared with that afforded by direct atmospheric exposure thereof, so that the lamp may operate on higher current and with higher metal vapor pressure without heating up the inner bulb wall to its softening temperature.

7. The combination of a high-pressure metal vapor arc lamp comprising electrodes axially arranged in an upright bulb containing a charge of vaporizable metal and so proportioned that its walls are heated to approximately uniform temperature by the heat of the arc between said electrodes, and an outer envelope enclosing said inner bulb, with a quantity of gas confined in said outer envelope at a pressure in excess of half an atmosphere to maintain therein, during normal operation of the lamp, a pressure substantially exceeding atmospheric, thus providing enhanced cooling for the inner bulb, as compared with that afforded by direct atmospheric exposure thereof, so that the lamp may operate on higher current and with higher metal vapor pressure without heating up the inner bulb wall to its softening temperature.

8. The combination of a high-pressure metal vapor arc lamp comprising electrodes axially arranged in an upright bulb containing a charge of vaporizable metal and so proportioned that its walls are heated to approximately uniform temperature by the heat of the arc between said electrodes, and an outer envelope enclosing said inner bulb, with a filling of highly heat-conductive gas in said outer envelope at a pressure in excess of half an atmosphere providing enhanced cooling for the inner bulb, as compared with that afforded by direct atmospheric exposure thereof, so that the lamp may operate on higher current and with higher metal vapor pressure without heating up the inner bulb wall to its softening temperature.

9. In an electric lamp, the combination of an outer envelope, an inner bulb disposed within said envelope and having upper and lower lead wires sealed in and extending through the longitudinal ends thereof, a frame comprising a conductor having its ends sealed in an upper wall of said outer envelope with one end extending through said wall, said conductor extending downward and around said inner bulb substantially in a plane through the longitudinal axis of said inner bulb, a disc of refractory insulating material mounted on the upper end of said frame, the lower lead wire of said inner bulb being secured to the lower end of said frame and the upper lead wire extending through an opening in said disc and being sealed in and extending through the upper end of said outer envelope, and a resilient support member secured to the lower end of said frame and extending transversely of the plane of said frame and engaging the walls of said envelope on opposite sides.

GEORGE E. INMAN.