Jan. 1, 1957 S. C. PEEK, JR., ET AL 2,776,391

INDUCTION LAMP

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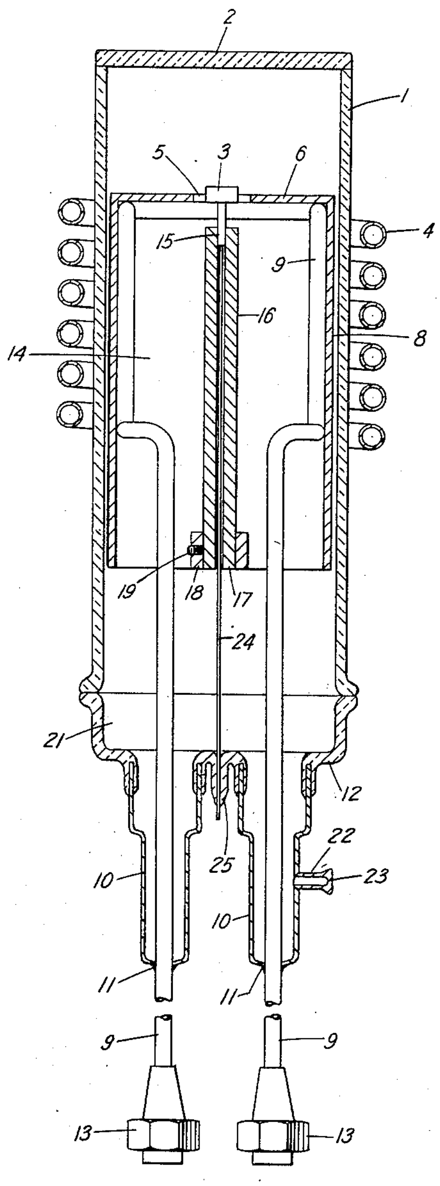

Fig. 1

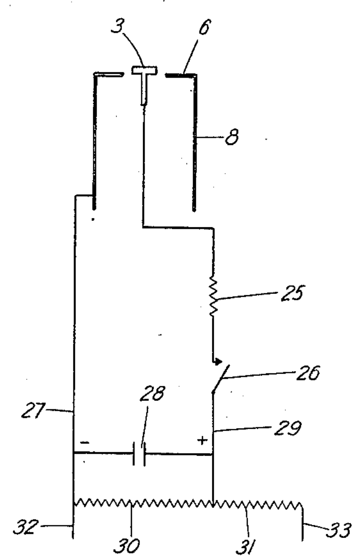

Fig. 2

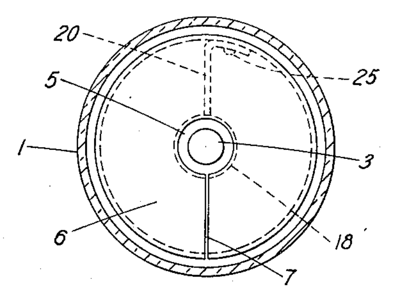

Fig. 3

INVENTORS:
JOHN F. WAYMOUTH
SANDFORD CHRISTOPHER PEEK

BY Laurence Burns,

ATTORNEY.

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INDUCTION LAMP

Sandford Christopher Peek, Jr., Hamilton, Ohio, and John F. Waymouth, Marblehead, Mass., assignors to Sylvania Electric Products Inc., Salem, Mass., a corporation of Massachusetts

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1 Claim. (Cl. 313—161)

This invention relates to increasing the useful life of induction lamps, and particularly to such lamps having a field concentrator around a light-emissive target.

Such lamps are shown for example in a patent application, Serial No. 520,718 of Sanford Christopher Peek, filed in the United States Patent Office on July 8, 1955. The target is heated to incandescence by the action of a high frequency coil outside the concentrator, the latter generally comprising a slotted annular metal disc, inside the central opening of which the target is set.

During operation of the lamp, the target material evaporates, condensing on the metal concentrator to form crystals of the target material, generally tantalum carbide. The crystals grow across the gap between the inside of the annular disc and the outside of the target, eventually bridging it and thereby increasing the heat loss from the target. This decreases the temperature of the target for a given input, and also causes uneven temperatures over the target surface. It also has the effect of limiting the useful life of the lamp to about fifty hours.

We have discovered that a lamp which has reached the end of its life because of such crystal growth can be made operable again by applying a high voltage across the gap, the application of the voltage causing the crystals to vaporize and remove themselves from the gap. The high voltage may be a direct current voltage or an alternating voltage, but we have found the use of a condenser discharge across the gap to be particularly effective.

The crystals can be removed as they form, without waiting for them to bridge the bap, by applying a sufficiently high voltage across said gap at desired intervals of lamp operation. In that way, the lamp life can be greatly extended because the crystal growth is no longer the limiting factor.

In order to facilitate the removal of the crystals at various intervals during the life of the lamp, it is best to include a condenser, and a push-button for discharging it across the lamp, in the equipment for operating the lamp. The condenser can then be discharged across the gap by the operator after or before each use of the lamp.

In order to permit the application of a voltage across the gap, electrical connections must be brought from the concentrator and the target to the outside of the lamp. If the concentrator is connected to a water jacket, as in the device of the previously-mentioned patent application by Peek, the tubes which bring the water through the lamp envelope can be used as one connection, and a lead-in wire brought from the target through the glass envelope, for the other electrical connection.

In some cases, it may be desirable to apply an alternating or direct voltage across said gap continually while the lamp is in operation. To prevent continuous arcing or sparking across the gap, the voltage would preferably be below the value necessary to arc or spark across said gap when the latter is free of crystals, yet high enough to spark or arc across when the gap is partially bridged by crystals. Then as soon as a predetermined amount of crystal structure appears, it will be removed by the voltage. In order to keep the arcing or sparking from continuing after the short period necessary to remove the crystals, a relay could be used in series with the voltage source and the gap, the relay being of a type which cuts off the voltage as soon as a predetermined current passes and keep it off for a period sufficient to allow the vapors formed by the discharge to be dispersed and for the concentrator to cool.

Other objects, features and advantages of the invention will be apparent from the following specification, taken in connection with the accompanying drawings, in which:

Fig. 1 is a view of a lamp according to the invention;

Fig. 2 is a schematic view of apparatus according to the invention; and Fig. 3 is a top view of the lamp of Fig. 1.

In Figure 1, the glass envelope **1** includes the plane glass disc **2**, of a type generally called an optical flat, through which light from the cylindrical target **3** can emerge when the latter is heated by the passage of a high frequency current in coil **4**, which is external to the lamp and not an integral part thereof. The target **3** is set in the central opening **5** of an annular metal disc **6**, and is of smaller diameter than said opening. The disc **6** has the radial slot **7** so that there will not be a complete conductive turn in which current can flow by induction. The disc **6** acts as a closure member for one end of the cylindrical metal shell **8**, which extends longitudinally back in the envelope **1**, preferably for a distance equal to the length of the coil **4** and in register therewith. The slot **7** extends from disc **6** longitudinally down the wall of cylinder **8**, to prevent the cylinder's acting as a complete conductive turn, that is, as a so-called "shorted" turn. The disc **6** and shell **8** act to concentrate the magnetic field in the vicinity of the target.

The tubes **9, 9** should not extend across the slot **7** at any point, for if they did, they would short circuit it. In cases where liquid cooling is not desired, the concentrator disc **6** and shell **8** can be supported in some other manner than by tubes **9, 9**, for example by being supported from the glass walls of envelope **1**.

The cylinder **8** is supported by the hollow metal tubes **9, 9** which are attached to the copper thimbles **10, 10** at the external ends **11, 11** thereof, said copper thimbles being sealed to the bottom wall **12** of the glass envelope **1** in a manner customary in the art of such seals, which are generally called "Housekeeper seals."

The hollow tubes **9, 9** terminate in the customary type of metal connectors **13, 13** used for sealing copper tubing together. Inside the envelope **1**, the tubes **9, 9** extend around and across the inner wall **14** of cylinder **7**, being attached thereto by soldering or in some other convenient manner.

The hollow tubes **9, 9** are not electrical lead-in conductors, but are merely conductors for the circulation of a cooling liquid such as water. If the water supply is grounded, however, the tubes **9, 9** and the cylinder **8** and disc **6** to which they are thermally connected, will also be at ground potential.

The thickness of target **3** is greater than that of the disc **6**, and the target **3** is placed so that part of it extends above the plane of the top of said disc as shown in the co-pending application Serial No. 520,767 of Frithjof N. Hansen, filed July 8, 1955. In one example, the target thickness was about 3/32 inch and the disc thickness about 1/16 inch. The disc was about 2 inches in diameter, and beyond the 3/32 inch thickness of the target itself, the target piece was machined down to a diameter of about 1/16 inch to provide a projecting support **15** for the main portion of the target **3**, said support extending about ⅜ inch back from said target itself. The diameter of the target 3 itself was $\frac{5}{16}$ inch.

The bottom end of projecting support **15** is fitted into a zirconia supporting tube **16** at a considerable distance, about ¼ inch in one example, from the main target **3**, in order to reduce heat losses. The zirconia tube extends downward along the axis of cylinder **7**, and its lower end **17** is held in collar **18** by set screws **19**, supported from the lower end of cylinder **7** in the bracket **20**, held to the wall of said cylinder by the screw **5**, as shown in Figure 3, although it can be held in other suitable manner if desired. Other refractory materials than zirconia can be used, the zirconia being given as an example.

The whole internal unit or "mount" is thus supported from the Housekeeper seal thimbles **10**, **10**, set in the glass base of "header" **20**. The seals to the thimbles **10**, **10** can therefore be made before the glass header **21** is sealed to envelope **1**, the sealing being accomplished in a manner well-known in the art.

Before sealing header **21** to envelope **1**, a lead-in wire **24** to target **3** is sealed through said header **21**. A glass bead **25** is formed around the wire **24** where it goes through the header **21**. It is generally convenient to seal a glass tube to the header as if it were an exhaust tube, and then seal the wire **24** through said tube to form the bead **25**. Because of the high voltage to be used, the wire **24** can merely be pressed against target **3** for good contact; or a small gap can even exist between the end of wire **24** and target **3**.

After sealing the header **21**, to envelope **1**, the lamp can be exhausted in a manner usual in the art, through the metal exhaust tube **22** which is brazed to the side of one of the thimbles **10**. The tube can then be filled with argon at about 1½ atmospheres absolute pressure, for example, and the exhaust tube **22** then sealed off to complete the lamp. The exhaust tube **22** being of metal, for example copper, can be flattened together at one part of its length to seal the lamp from the exhaust system, and then cut off at the flattened part. Such seals are well-known in the art.

In operation, one of the tubes **9** is connected to a water inlet by connector **13**, and the other tube **9** is connected to a water outlet by its connector. Water, or other cooling fluid, is then circulated through the tubes **9**, thereby keeping the disc **6** and shell **8** cool. A high frequency source of say 4 megacycles although other frequencies can be used, is connected to coil **4**, through which high frequency current will accordingly flow. The magnetic field inside said coil is concentrated, by disc **6** and shell **8**, around the refractory target **3**, which is accordingly heated by the currents induced in it. The target **3** becomes very hot, its temperature rising to about 3600° K. if sufficient energy is supplied.

The light from the front surface of target **3** then travels through the optical flat **2** to the plane in which it is to be used.

During operation, the material of target **3** will be vaporized, depositing on the concentrator disc **6** around the opening **5** therein, and tending to reduce or bridge the gap between the concentrator disc **6** and the target **3** by formation of crystals. A circuit for removing such crystals is given in Figure 2. The concentrator disc **6** is connected to one terminal **27** of a condenser **28** and the target **3** to the other terminal **29**, through resistor **25** and switch **26**. Connection to the concentrator disc **6** is made through cooling tube **9**, and to the target **3** through the lead-in wire **24**.

The positive end of condenser **28** generally goes to the target **3**, because the concentrator disc **6**, being ordinarily connected to a water-cooling system, is thereby grounded, and the negative side of the oscillator circuit for feeding coil 4 is generally also grounded. The condenser **28** can then be charged from the voltage used to supply the plate circuit of the oscillator. The condenser **28** can be permanently connected across the direct current supply, if desired, preferably through a voltage divider **30**, **31**, and then discharged across the gap at various intervals by closing switch **26**. A resistor **25** can be used to limit the discharge current from the condenser. Such a current limitation keeps the relay contacts from sticking.

A condenser voltage of about 1000 volts can be used with the lamp described, with a condenser **28** of about 30 microfarads and a resistor **26** of about 10 ohms. The switch **27** can be of the relay-actuated type because of the high voltage. These values are not critical, however, and other values can be used with good results. The voltage across the input terminals **32**, **33** to the voltage divider **30**, **31** can be about 4000 volts, for example, in the embodiment described.

If it is desired to keep voltage across the gap at nearly all times, so that a discharge will pass as soon as the crystals narrow the gap to a predetermined value, the voltage will have to be disconnected almost as soon as it is applied, to prevent the resultant arc or spark from continuing for a period sufficient to wear away the target. The arc being stopped, and the gap cleared, the eventual reapplication of voltage will not produce another arc; at least not until crystals again narrow the gap.

To achieve this result, the switch **26** can be a normally closed relay, with its actuating coil connected in series with the gap, that is its actuating coil could be in the same circuit as resistor **25**, or in series therewith, and the switch **26** should preferably be of a type which recloses slowly, giving the arc time to de-ionize.

The resistance **31** of the voltage divider **30**, **31**, will prevent shorting of the power line **32**, **33** by the discharge across gap **5**. It can be made of high enough resistance to prevent feeding the arc across gap **5** directly from the line. In the example described, the resistance **30** is about 200,000 ohms and **31** is about 500,000 ohms.

What we claim is:

An induction lamp comprising a light-transmitting envelope, an annular concentrator disc within said envelope, a target of refractory material inside but spaced from the inside of said disc, and electrical connections from said concentrator and said disc sealed through said envelope.

References Cited in the file of this patent

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