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INDUCTION LAMP

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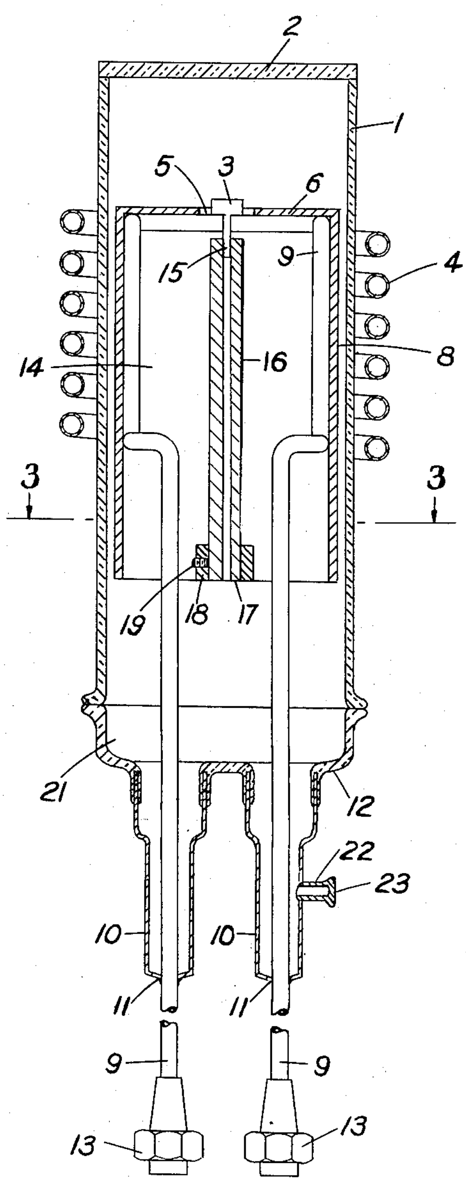

Fig. 2

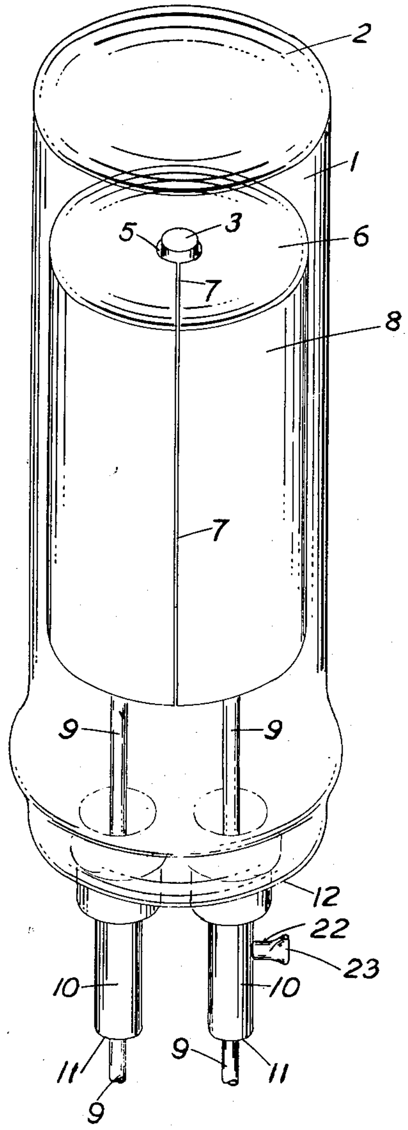

Fig. 1

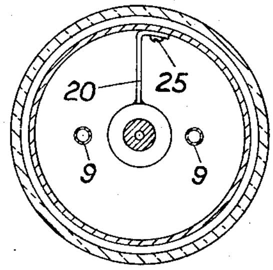

Fig. 3

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INDUCTION LAMP

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9 Claims. (Cl. 313—35)

This invention relates to electric lamps, and especially to lamps in which light is emitted by an incandescent body.

Such lamps have previously been either of the point-source arc-heated type or of the wire filament type, neither of which is satisfactory for use when a uniformly illuminated field is desired for projection devices, film printers and the like.

At present, incandescent lamps are generally used for such purposes, the lamp having a series of parallel filaments arranged side-by-side in a plane. In an optical system, the image produced by such a series of filaments is obviously non-uniform in brightness, and in order to reduce the non-uniformity, the system has to be defocussed, that is, the image is focussed at a point other than that at which the light is to be used. For example, in a film printer, the so-called "fi'm gate" is the position at which the light is desired, but the image of the filament has to be focussed at a position beyond the ga'e, so that the image is sufficiently out of focus at the gate to blur it and give a more uniform light pattern.

Such defocussing, however, entails a considerable loss of light. For reasonable uniformity, the loss can be as much as 73% in a conventional projector system, leaving only about 27% of the light available at the film gate. Thus the major portion of the light is lost. For an incandescent filament source, therefore, the ratio of the amount of light available to the amount which can actually be used is about 3.7. A light source with the same total light output and the proper size and shape with uniform brightness could deliver 3.7 times as much light at the film gate. If the source were circular in shape and the film gate square, about 40% of the light would be lost in the part of the image outside the circumscribed square, but such a source would still deliver 2.2 times as much light as a fi'ament source.

In addition to the loss from the amount of defocussing required, there is an additional loss with incandescent filament sources due to their inability to fill the lens of the optical system completely, because of the non-uniformity of the source. The nearer this filling is achieved, the greater will be the light output from the system. A source of uniform brightness will accordingly give a considerable gain in effective light output over that from sources hitherto used.

An object of the present invention is to achieve such gains in effective light output by providing a luminous source of proper characteristics.

In particular, the invention provides a light source of uniform brightness throughout the surface designed for exposure to a lens. This is achieved by using as the light source an inductively-heated body of refractory material. For convenience, I refer to said body as a "target."

The use of an inductively heated target of cons:derable area will give more uniform illumination over a wide field, and the refractory material used can be, for example, hafnium carbide, tantalum carbide, niobium carbide, or the like, or a mixture thereof. Such m^terials have higher melting points and lower vapor pressures than tungsten, and can consequently be operated at extremely high temperature, which gives a more uniform illumination of the target because the radiation loss becomes the main heat loss from the target and conduction losses from the support become comparatively small. The increased temperature gives higher intrinsic brightness and better color distribution.

The target can be heated inductively from a coil placed around it and carrying radio frequency current. A field concentrator between the coil and the target is very effective in improving the efficiency of energy conversion to the target. For example, I have used a concentrator in the form of a metal cylinder closed at one end except for an opening in which the target is placed. The cylinder is slotted longitudinally a'ong its side, the slot extending radially into the closed end, in order to eliminate any direct loop around the intensifier itself, transverse to the field.

I have found that by water cooling the concentrator the metal'ic vapor from the target can be collected on the concentrator and kept from depositing on the gl^ss of the tube, thereby preventing the drop in light output which such a deposit on the glass would cause.

Because the temperature at which the target is operated is above the melting or softening points of o'herwise suitable supporting materials, especially if the target is of a metal carbide, the best material for supporting the target is the material of the target itself. For that reason, the back of the target piece is machined to a reduced diameter for a short distance to form a supporting extension for the target, which extension will project back a short distance from the effective target until a region of lower temperature is reached, in which region it can be joined to a somewhat less refractory support.

A region of low enough temperature will be reached at a short distance in back of the plane of the disc of the concentrator, where the field is weaker and the length of the heat-conducting path sufficient to reduce the temperature. By making the supporting extension of the target of smaller diameter than that of the target itself, the conductive heat losses are kept low. Such extension can be the sole support for the target itself.

The front of the bulb or the end from which the light is taken, is preferably flat, and a so-called "optical flat" sealed to the glass at that end is generally desirable.

In order to prevent undue loss of material from the target by evaporation, a gaseous atmosphere is used at considerable pressure. The gas used shou'd be essentially inert with respect to the target material, in order to prevent deleterious chemical reaction therewith. For example, the rare gases such as argon or krypton can be used, either individually or in mixtures with each other. The gas and the parts of the device can be encased in an hermetically sealed bulb which is transmissive of the radiations which are desired to be emitted from the bulb. These radiations are generally in the visible or ultraviolet region.

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, shown in Fig. 2, 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 suported 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 suported by the hollow metal tubes **9, 9** which are attached to the copper thimbles **10, 10** at the external ends **11, 11** thereof, said coper 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."

As shown in Figure 2, 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 copending aplication of Frithjof N. Hansen, filed of even date herewith. 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 3/8 inch back from said target itself. The diameter of the target **3** itself was 5/16 inch.

The bottom end of projecting support **15** is fitted into a zirconia supporting tube **16** at a considerable distance, about 1/4 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 suported 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.

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.

What I claim is:

1. An electric lamp for use in a high-frequency electromagnetic field, said lamp comprising a target of refractory material, and a magnetic field concentrator around said target.

2. An electric induction lamp comprising a magnetic field concentrator including an annular metal disc having a central opening, and a target of refractory material in said opening and spaced from the walls thereof.

3. An electric lamp comprising a target of extremely refractory material, a support of less refractory material, and an intermediate support of said extremely refractory material of smaller cross-sectional area than that of said target and attached to the back only of said target, said support of tantalum carbide extending between said target and said first-mentioned support.

4. An electric lamp comprising: a target of a refractory material selected from the group consisting of tantalum carbide, hafnium carbide, niobium carbide and mixtures thereof; a support of less refractory material; and an intermediate support of smaller cross-sectional area than said target and of the same material as said target and integral therewith, said intermediate support extending between the back of said target and said first-mentioned support.

5. The combination of claim 4, and a magnetic field concentrating disc having a central opening, said target being set in said opening and spaced therefrom, said intermediate support extending for a distance beyond the plane of said disc and away from the main light-emitting surface of said target.

6. An electric induction lamp comprising a glass envelope, an induction target therein, a metal disc around said target, and a hollow metallic tube attached to and in thermal contact with said disc, said tube being capable of carrying a cooling fluid therethrough to cool said disc, whereby material evaporated from said target is collected on said disc and the glass envelope is kept free of discoloration from such material.

7. An electric lamp comprising a light-emissive heated body which gives off light-absorbing material, a gas-filled, light-transmitting envelope enclosing said body and through at least a portion of which light from said body must pass, and liquid cooling means within said envelope for collecting said light-absorbing material to keep it from depositing on the portion of the envelope through which said light passes.

8. An electric lamp for use in a high-frequency electromagnetic field, said lamp comprising a target of refractory material, a magnetic field concentrator around said target, and a glass envelope enclosing said concentrator and said target.

9. An electric induction lamp comprising a magnetic field concentrator including an annular metal disc having a central opening, and a target of refractory material in said opening and spaced from the walls thereof, and a glass envelope enclosing said concentrator and said target.

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