

Aug. 7, 1962

W. E. THOURET
ARC LAMP WITH SELF-BALLASTED ARC TUBE
AND IMPROVED LUMEN MAINTENANCE

3,048,741

Filed Aug. 24, 1960

3 Sheets-Sheet 1

Fig. 1B.

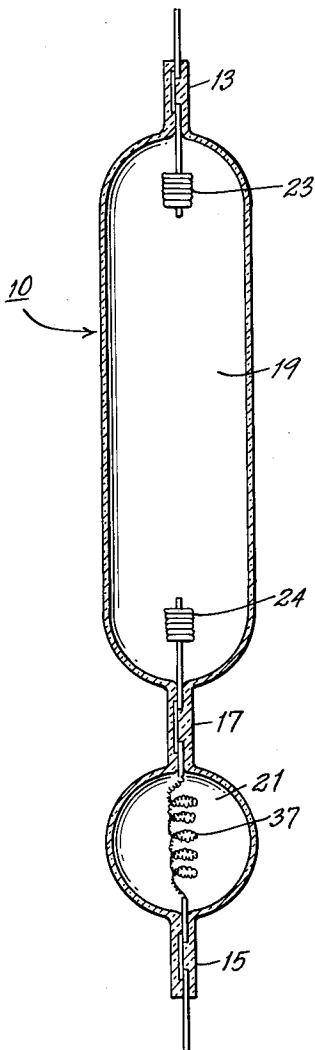


Fig. 1A.

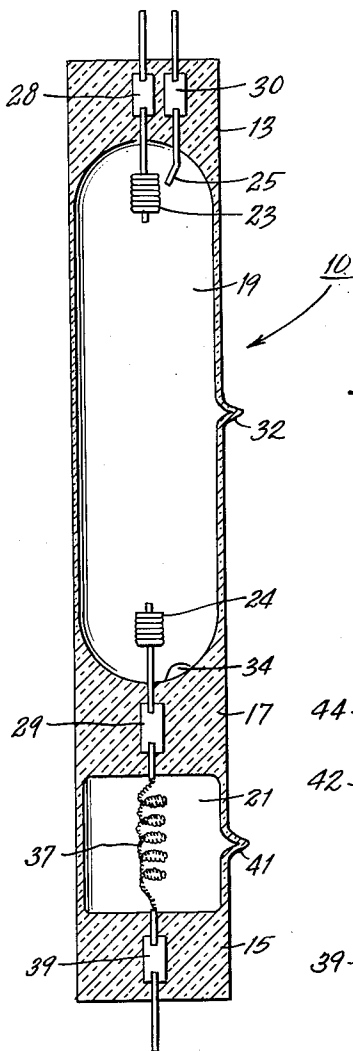
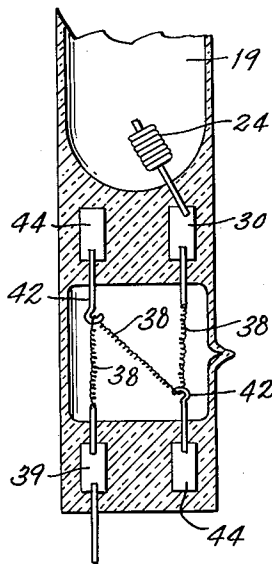


Fig. 3.



INVENTOR.
WOLFGANG E. THOURET
BY *Darby & Darby*
ATTORNEYS

Aug. 7, 1962

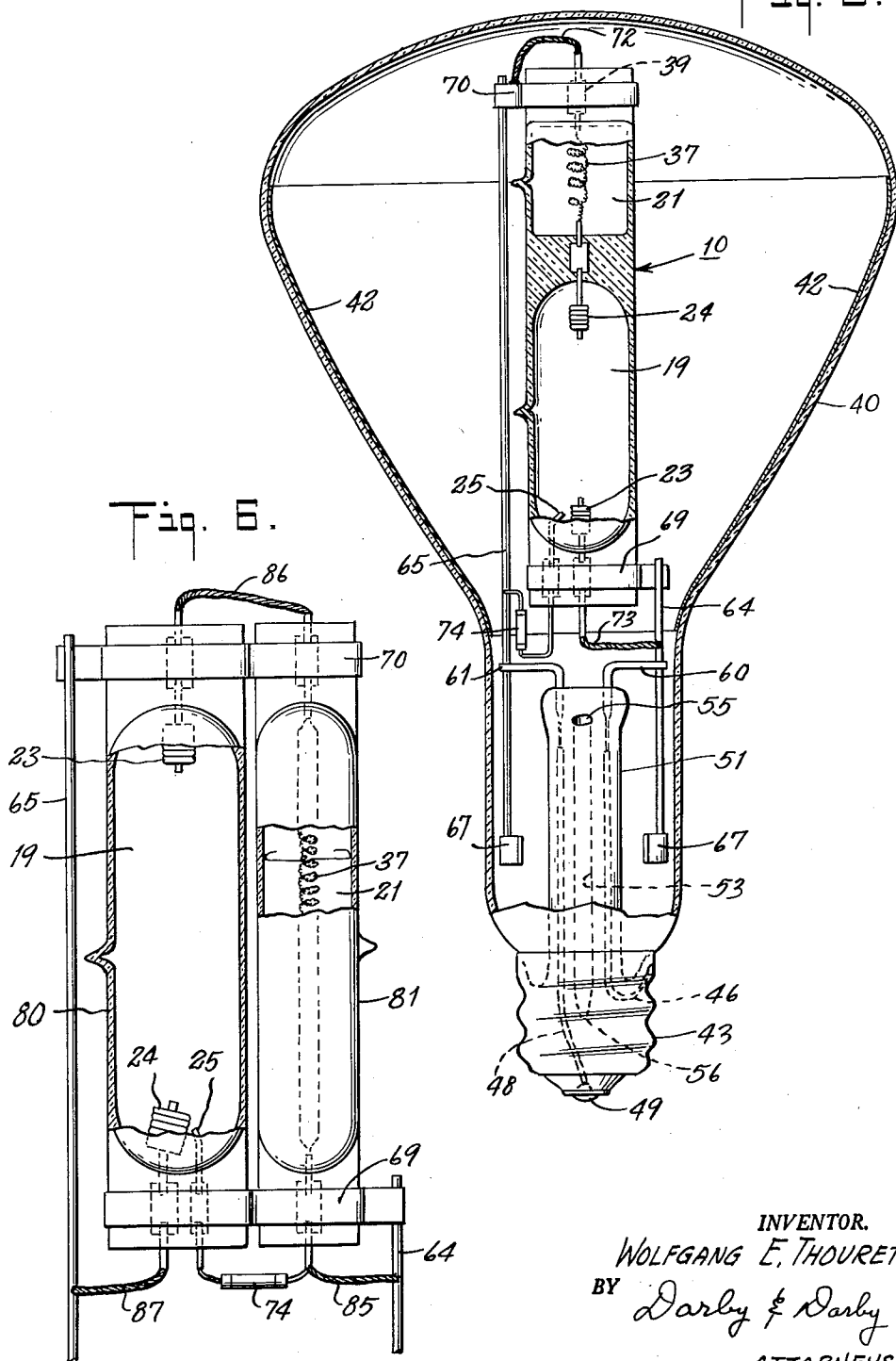
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Fig. 2.



INVENTOR.
WOLFGANG E. THOURET
BY *Darby & Darby*
ATTORNEYS

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Fig. 5A.

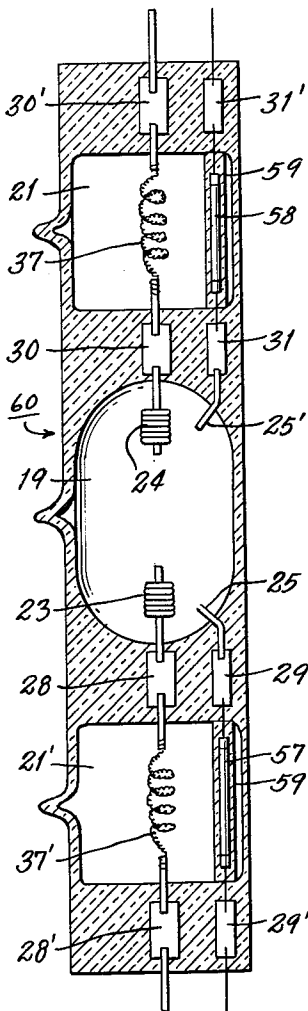


Fig. 5B.

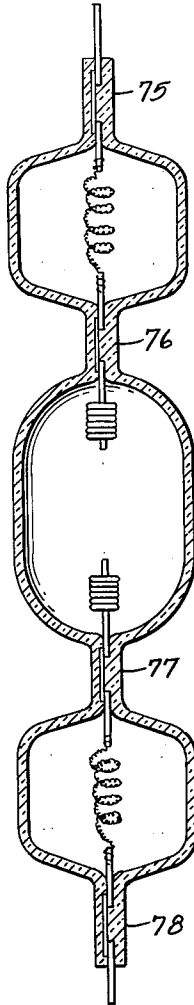


Fig. 4A.

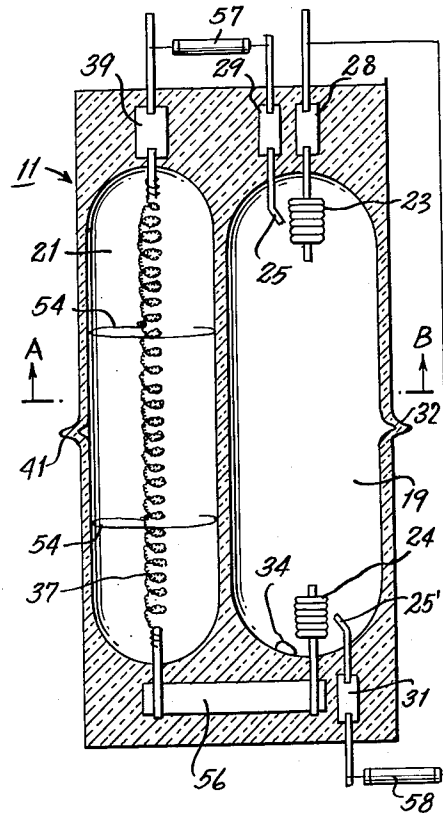
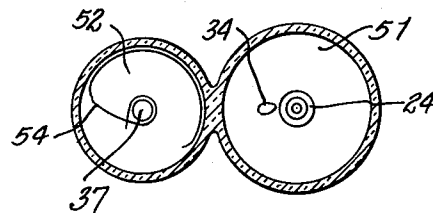


Fig. 4B.



INVENTOR.
WOLFGANG E. THOURET
BY *Darby & Darby*
ATTORNEYS

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ARC LAMP WITH SELF-BALLASTED ARC TUBE AND IMPROVED LUMEN MAINTENANCE

Wolfgang Emery Thouret, North Bergen, N.J., assignor
to Duro-Test Corporation, North Bergen, N.J., a corporation of New York

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This invention relates to arc lamps and more particularly to self-ballasted arc lamps of the mercury vapor type having improved lumen maintenance.

High pressure mercury vapor lamps of the self-ballasted type are well known in the art. These lamps are usually formed of a separate arc tube of quartz glass, or other high refractory transparent material, which houses the mercury pool and the starting and arc electrodes. The arc tube or chamber operates in conjunction with a tungsten filament which is electrically connected in series with the arc tube. The tungsten filament serves as an incandescent stabilizing ballast for the mercury arc discharge and the combination of the tungsten filament and the arc tube can be operated directly from a conventional electrical power supply source without the use of external transformers, inductive reactors, or other similar external ballasting means.

Heretofore, arc lamps of this type have been constructed with the arc tube and the tungsten filament ballast arranged together within an outer quartz or glass envelope or bulb, with the filament being exposed to the atmosphere inside the envelope. The envelope is filled with an inert gas such as argon, nitrogen, or a mixture of both, at approximately atmospheric pressure and the inert gas serves as an atmosphere for operation of the tungsten filament.

Mercury vapor arc lamps have relatively long lives. As an example, the operating life of the above-described type of self-ballasted mercury arc lamp in many instances ranges up to 12,000 or 15,000 hours. In the lamp, the mercury vapor arc discharge has a very high luminous efficiency and the incandescent ballast filament contributes only a very small percentage to the lamp's total lumen output. The ballast filament can therefore be designed to have long life characteristics so it will last as long as the mercury arc lamp, without impairing the overall lumen output of the lamp to any noticeable degree.

In general, the lumen maintenance of self-ballasted mercury vapor lamps is not as good as the lumen maintenance of mercury vapor lamps utilizing external ballast devices. This is so because the tungsten ballast filament within the outer lamp envelope evaporates during the operation of the lamp. The evaporated tungsten deposits or condenses both on the inner surface of the outer envelope and on the outer surface of the arc tube and blackens both of these surfaces. Since the light produced in the arc discharge tube has to pass through both of these surfaces the lumen output of the lamp falls off proportionately to the operating time due to the blackening of the surfaces. Thus, the lumen output of an average self-ballasted lamp with exposed filament ballast may drop to 65-70% of initial lumen output after 10,000 hours of use while the lumen output of an externally ballasted lamp drops only to about 85% of the initial lumen output during the same period of operating time.

The present invention is directed to a lamp of the self-ballasted type which has improved lumen maintenance substantially the same in accordance with the invention, instead of leaving the tungsten ballast filament exposed to interact with the inner wall of the lamp envelope and the outer surface of the arc tube, the tungsten ballasting element is enclosed in its own vacuum-tight chamber or

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envelope. The chamber for the tungsten ballasting filament is filled with an atmosphere of argon-krypton, or other rare gas suited for tungsten filament burning, to which is added a small percentage of a halogen or halogen compound. The halogen or halogen compound is preferably of chlorine, iodine or bromine. Tungsten filament lamps with halogen or halogen compound scavengers have nearly 100% lumen maintenance throughout their life due to the presence of the halogen or halogen compound acting in combination with the relatively high operating temperature of the lamp wall. In this type of lamp, a halogen cycle occurs in which the evaporated tungsten particles from the filament that reach the tube wall combine with halogen particles to form a tungsten-halogenide compound. This compound has a relatively high vapor pressure at the envelope wall temperature and evaporates back into the envelope where it disassociates in the neighborhood of the filament and redeposits tungsten back onto the filament. The re-deposited tungsten not only increases the filament life but also prevents blackening of the inner wall of the envelope.

Since the tungsten filament is housed in a separate chamber evaporated tungsten is prevented from reaching the inner surface of the lamp outer envelope or the outer surface of the arc tube. Blackening of these two surfaces is thereby eliminated. Further, the halogen or halogen compound scavenger inhibits blackening of the inner wall of the filament chamber thereby improving the lumen maintenance of the filament ballast so that it can be designed to operate for 12,000-15,000 hours with a lumen output above 85% of its initial lumen output. All of these features contribute to producing an arc lamp with improved lumen maintenance.

It is therefore an object of this invention to provide a self-ballasted arc lamp which has a substantially constant lumen output throughout its useful life.

Still another object of this invention is to provide a self-ballasted arc lamp in which the filament ballast and the arc elements are housed in separate chambers.

Yet another object of this invention is to provide a self-ballasted arc lamp of the mercury vapor type in which the tungsten filament ballast and the arc lamp elements are housed in separate chambers made from a single tube.

Other objects and advantages of the present invention will become more apparent upon reference to the following specification and annexed drawings in which;

FIGURE 1A is an elevational view taken partly in section of a single tube with the arc lamp and the filament ballast chambers;

FIGURE 1B is an elevational view taken partly in section of the tube of FIGURE 1A rotated by 90°;

FIGURE 2 is a plan view taken partly in section of the structure of FIGURES 1A-1B as used in a complete arc lamp;

FIGURE 3 is an elevational view taken partly in section of a filament chamber utilizing a modified type filament;

FIGURE 4A is an elevational view partly in cross-section of another embodiment of the invention in which the separate chambers are formed from a special tube;

FIGURE 4B is a cross-section of the structure of FIGURE 4A taken along lines A-B;

FIGURE 5A is an elevational view taken partly in cross-section of another embodiment of the invention utilizing three chambers;

FIGURE 5B is an elevational view taken partly in cross-section of the embodiment of the invention shown in FIGURE 5A rotated by 90°; and FIGURE 6 is an elevational view taken partly in section of still another embodiment of the invention including its lamp mounting elements.

While the present invention is to be described with reference to an arc lamp of the mercury vapor type, it should be realized that its principles may be extended to other lamps, for example, sodium vapor. Therefore, the description of the mercury vapor lamp is to be considered as being merely illustrative insofar as the principles of the invention are concerned.

Referring to FIGURES 1A and 1B, the arc and ballast elements for a self-ballasted arc lamp are shown housed in a tube 10. The tube 10 is manufactured from a single straight piece of tubing of a suitable high-refractory transparent material, such as quartz glass. The tube is sealed off at the ends 13 and 15 and at an intermediate section 17 to form an arc chamber 19 and a filament ballast chamber 21.

The arc chamber 19 has mounted therein the arc electrodes 23 and 24 and the auxiliary starting electrode 25. Each of the electrodes 23, 24 and 25 has connected to its a respective lead-in connector 28, 29 and 30. The lead-in connectors 28, 29 and 30 are preferably of ribbon shape and are made of a suitable material such as molybdenum. The lead-in connectors 28 and 30 are pressed into the end 13 of the tube and the connection 29 is pressed into the intermediate section 17 in a conventional manner thereby forming the arc chamber 19. The electrodes 23, 24 and 25 are also pressed into the tube in a conventional manner. It should be realized that these arc electrodes 23 and 24 may first be mounted in a suitable boss or holder of vitreous material and the holder then fused to the tube.

The arc chamber 19 has an exhaust tube or tubulation 32 which is tipped off after the chamber is exhausted and then filled with a suitable amount of starting gas such as argon. If argon is used, an amount is placed in the chamber to establish a pressure of about 20 mm. of mercury. The chamber 19 also has a small amount of mercury 34 which produces the luminous discharge.

Connected to the end of the ribbon lead-in connector 30 which extends into the filament chamber 21 is one end of a filament 37 which is preferably of the coiled-coil type and is made of tungsten. The other end of the filament is connected to a ribbon lead-in connector 39. The lead-in connector 39 is pressed into the end 15 of the tube so that a separate chamber 21 for the filament ballast is formed between the pressed areas 15 and 17. The filament chamber 21 has an exhaust stem or tubulation 41 through which the chamber 21 is first evacuated and then filled with one to several atmospheres of argon, krypton or other inert fill gas, and a small percentage of halogen or a halogen compound. The tubulation 41 is then tipped off to form a seal. The halogen or halogen compound performs the function described above, namely, to prevent the blackening of the inner wall of the chamber 21 by the tungsten evaporated from the filament.

The double-chamber, self-ballasted tube 10 shown in FIGURES 1A-1B can be mounted into an outer bulb or envelope by means of a mounting structure such as that shown in FIGURE 2. The tube 10 is mounted in an outer bulb 40 which may be made of glass, quartz, or other suitable vitreous material. The inside of the bulb 40 can be clear, frosted or coated with a light diffusing substance. In the preferred embodiment shown, the inside of the bulb 40 has a phosphor coating 42 which reacts to the wavelength of the light produced by the arc discharge. In the mercury vapor type of lamp, ultraviolet radiation is produced in the chamber 19 in addition to visible light. The ultra-violet radiation is converted into additional visible light by the phosphor coating to increase the luminous efficiency of the lamp. The composition of the phosphor coating may also be selected to modify or change the color rendition properties of the light given off by the arc lamp.

The lamp of FIGURE 2 has a metal screw type base 43 to which is connected a conductor 46 at the side

thereof and a conductor 48 to a button contact 49 which is electrically insulated from the base. The bulb 40 is continuously molded at its bottom and terminates in a support stem 51. The bottom of the bulb 40 is secured to the inside of the screw base 43 by a suitable sealing compound.

The stem 51 is formed with a tubular aperture 53, which terminates in an opening 55 at the top of the stem 51 to communicate with the interior of the bulb 40. The tubular aperture 53 has a tubulation 56 at its end through which the inside of the bulb 40 is exhausted and then filled with a suitable fill gas, if desired. After filling the bulb with gas, stem 56 is then tipped-off to vacuum-seal the bulb 40.

Conductors 46 and 48 are pressed into the stem 51 and the respective L-shaped conductors 60 and 61, of a slightly heavier diameter, are connected to them. Connected to each of the conductors 60 and 61 are respective conductor rods 64 and 65. Each of the rods 64 and 65 has connected thereto at its end adjacent the base of the bulb a curved metallic element 67.

A bracket 69 in the general shape of the pressed end 13 of the tube 10 is fastened to the upper end of the rod 64 by a spot weld or some other suitable process. The rod 65 has attached to its upper end a similarly shaped bracket 70. The two brackets 69 and 70 hold the tube 10 rigidly within the bulb 40.

The ribbon lead-in 39 for the filament 37 is connected to one side of the voltage source through lead-in conductor wire 48, conductor 61, rod 65, and a wire 72. Electrode 23 is connected to the other side of the voltage source through conductor wire 46, conductor 60, rod 64 and a wire 73. Therefore, the filament 37 and the arc electrodes 23 and 24 are connected in series across the power supply. The auxiliary starting electrode 25 receives its energizing potential through a dropping resistor 74.

When current is applied through the loads 46 and 48 the auxiliary electrode 25 ignites the arc between the two electrodes 23 and 24 and the tungsten filament 37 serves as ballast in the well-known manner. However, it should be realized that none of the tungsten which evaporates from the filament 37 can be deposited onto the inner wall of the bulb 40 or onto the outer wall of the arc chamber 19. It should also be realized, that the lumen maintenance of the tungsten filament in the chamber 21 is substantially increased due to the use of the halogen or halogen compound which prevents blackening of the inner wall of chamber 21. Therefore, since blackening of the wall surfaces is prevented by the use of the separate chamber for the tungsten filament ballast, and the halogen or halogen compound scavenger improves the lumen maintenance of the tungsten filament, the total lumen maintenance of the lamp is substantially improved.

FIGURE 3 shows another type of tungsten filament which may be utilized with the tube 10 of FIGURES 1A-B or with the other embodiments of tubes disclosed herein. In FIGURE 3, instead of using a single coiled-coil tungsten filament, a filament having three sections 38 arranged in an N shape is utilized. The filament sections 38 are supported by the hooks 42 which are secured in the tube envelope by the extra pressed-in flat pieces 44. The hooks 42 are insulated from the lamp operating circuit.

FIGURES 4A-4B show another embodiment of a self-ballasted double chamber tube. In this embodiment, similar elements used in the tube 10 of FIGURES 1A-1B have been designated with the same reference numerals. The tube 11 of FIGURES 4A-4B is made from a special piece of tubing which is preferably of quartz and has two bores 51 and 52. The right hand bore 51, which is the larger of the two, is used for the arc cham-

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ber 19 and the left hand bore is used for the filament-ballast chamber 21.

A single tungsten filament 37 in the chamber 21 is supported by two tungsten wire spirals 54. The filament 37 is held in the inner turn of the spiral and the outer turn of the spiral presses against the inside wall of the chamber 21. The ends of the tungsten filament 37 are connected to the ribbon lead-in connectors 39 and 56. The chamber is also filled with a halogen or halogen compound scavenger.

The arc chamber 19 has the arc electrodes 23 and 24 and two auxiliary starting electrodes 25 and 25'. Starting electrode 25 is connected to the opposite arc electrode 24 through a starting resistor 57, lead-in connector 39, the filament 37 and connector 56. Starting electrode 25' is connected to the opposite arc electrode 23 through the lead-in connector 31, starting resistor 58 and connector 28.

The self-ballasted tube shown in FIGURES 4A and 4B has several advantages. First of all, the manufacturing process is simplified because sealing-in of the ribbon connectors and the formation of both chambers can take place in one press operation.

Further since both chambers of the tube are arranged parallel to each other, good blending of the light produced by the chambers is provided.

The tube 11 of FIGURE 4 may be mounted in a lamp in the manner shown in FIGURE 2, by a simple modification of the mounting brackets 69 and 70.

FIGURES 5A and 5B show a triple-chamber self-ballasted tube 60 having an arc chamber 19 and two filament chambers 21 and 21'. In this embodiment, the filament is split into two sections 37 and 37', the sections being placed in a respective chamber 21 and 21' on each side of the arc chamber 19. This arrangement has the advantage of achieving optimum blending of the light from the arc and from the ballast filaments because of the symmetric placement of the tungsten filament chamber at each end of the arc chamber.

In the triple-chamber tube 60, the filaments 37 and 37' are of the coiled-coil type and do not require separate supports because of their relatively short lengths. Starting resistors 57 and 58, for the respective auxiliary electrodes 25 and 25', are each placed in a respective chamber 21' and 21 in order to simplify connections and mounting of the complete triple-chamber tube within the outer bulb. The starting resistors 57 and 58 are mounted within quartz tubes 59 and are entirely isolated from the atmosphere in the tungsten-filament-halogen ballast chambers 21 and 21'. The ends of the upper tube 59 are sealed in the pressed portions 75 and 76 of the tube 60 and the end of the lower tube 59 are sealed in the pressed portions 77 and 78. Lead-in connections 21' and 31' are connected to the respective resistors 57 and 58.

Sealed into the end portions 75 and 78 of the tube 60 are the respective connectors 30'—31' and 28'—29'. Connectors 30—31 and 28—29 are sealed into the respective intermediate portions 76 and 77. The tungsten filaments 37 and 37' and the arc electrodes 23 and 24 are connected in series by the ribbon connectors 30', 30, 28 and 28'. Potential is applied to the filaments and the arc electrodes by the leads connected to the ribbon lead-ins 28' and 30. The ribbon leads 31', 31, 29 and 29' are a part of the auxiliary starting circuit and connect the auxiliary starting electrodes 25 and 25' with the starting resistors 57 and 58 and the potential source.

Mounting of the triple-chamber tube 60 may be accomplished in a manner similar to that shown in FIGURE 2. As pointed out, optimum blending of the light from the arc source and the ballast filaments is achieved by the symmetric arrangement of the two filament chambers 21 and 21' on either side of the arc chamber 19.

FIGURE 6 shows another embodiment of the invention which utilizes two separate tubes 80 and 81 for the arc chamber 19 and the filament chamber 21. Each of

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the chambers 19 and 21 is formed in the manner previously described, with the filament chamber 21 containing a halogen or halogen compound. The two tubes 30 and 31 are mounted parallel to each other by brackets 69 and 70 which are attached to the respective conducting rod supports 64 and 65. These are mounted within an outer envelope as shown in FIGURE 2. The series ballast connection is made through conducting rod 64, wire 85, filament 37, wire 86, electrodes 23 and 24, wire 87, and back to the rod 65. The starting resistor 74 is connected from the wire 85 to the auxiliary starting electrode 25.

By using the parallel mounting arrangement for the two tubes 80 and 81 improved light blending is achieved, much in the same manner as with the embodiment of FIGURES 4A—4B. The arrangement of FIGURE 6 has the additional advantage of using two tubes 80 and 81, which may be worked with separately, as desired.

Although a particular structure has been described, it should be understood that the scope of the invention should not be considered to be limited by the particular embodiment of the invention shown by way of illustration, but rather by the appended claims.

I claim:

1. In a self-ballasted arc lamp the combination comprising a first chamber, said first chamber having mounted therein arc electrodes for producing a light of relatively high intensity, a second chamber, said second chamber having mounted therein an incandescent filament for operation as a ballast element for said arc electrodes, said first and second chambers being sealed-off from each other to prevent interaction between the materials forming the elements in the respective chambers and a quantity of a halogen element within said second chamber to prevent blackening of its inner wall by the incandescent filament material thereby producing a lamp having improved lumen maintenance.

2. A self-ballasted arc lamp as set forth in claim 1 wherein said incandescent filament is made of tungsten and the halogen element in said second chamber is a constituent of a halogen compound.

3. In a self-ballasted arc lamp the combination comprising an outer lamp envelope, a first chamber mounted within said envelope, said first chamber having mounted therein arc electrodes for producing a light of a relatively high intensity, a second chamber mounted within said envelope, said second chamber having mounted therein an incandescent filament containing tungsten for operation as a ballast element for said arc electrodes, said first and second chambers being sealed-off from each other to prevent material from the incandescent filament from interacting with the outer wall of the first chamber and the inner wall of the envelope, a quantity of a substance within said second chamber for preventing evaporated filament material from darkening the inner wall of the second chamber and means for electrically connecting said arc electrodes to said ballast element.

4. In a self-ballasted arc lamp the combination comprising an outer lamp envelope, a single bore tube of transparent vitreous material mounted within said envelope, said tube being formed with first and second chambers, arc electrodes mounted within said first chamber for producing light of relatively high intensity, an incandescent filament ballast element for said arc electrodes mounted within said second chamber, said first and second chambers being sealed-off from each other to prevent material from the filament from interacting with the outer wall of the tube or with the inner wall of the envelope, a quantity of a substance within said second chamber for preventing evaporated filament material from darkening the inner wall of the second chamber and means for connecting said ballast element to said arc electrodes.

5. A self-ballasted arc lamp as set forth in claim 4 wherein said filament is of tungsten and is of the coiled-coil type.

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6. A self-ballasted arc lamp as set forth in claim 5 wherein said tungsten filament is mounted in an N shape within said second chamber.

7. In a self-ballasted arc lamp the combination comprising an outer lamp envelope, a tube of transparent vitreous material having two side-by-side bores mounted within said envelope, said bores being sealed-off at the ends thereof to form first and second chambers, arc electrodes mounted within said first chamber for producing light of relatively high intensity, an incandescent filament ballast element for said arc electrodes mounted within said second chamber, said first and second chambers being sealed-off from each other thereby preventing material from the filament from interacting with the outer wall of the tube or with the inner wall of the envelope, and means for connecting said ballast element to said arc electrodes.

8. A self-ballasted lamp as set forth in claim 7 wherein said incandescent filament contains tungsten and said second chamber contains a quantity of a substance for preventing evaporated filament material from darkening the inner wall of the second chamber.

9. In a self-ballasted arc lamp the combination comprising an outer lamp envelope, a single bore tube of transparent vitreous material mounted within said envelope, said tube being pressed at the ends and at two

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areas intermediate the ends to form first, second and third chambers, said second chambers being between said first and third chambers, arc electrodes mounted within said second chamber for producing light of relatively high intensity, incandescent filament ballast elements for said arc electrodes mounted within said first and third chambers, said first, second and third electrodes being sealed-off from each other thereby preventing material from the filaments in the first and third chambers from interacting with the outer wall of the tube or with the inner wall of the envelope, and means for electrically connecting said filament ballast elements to said arc electrodes.

10. A self-ballasted lamp as set forth in claim 9 wherein said incandescent filaments in said first and third chambers contain tungsten and said first and third chambers contain a quantity of a substance for preventing evaporated filament material from darkening the inner walls of said chambers.

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