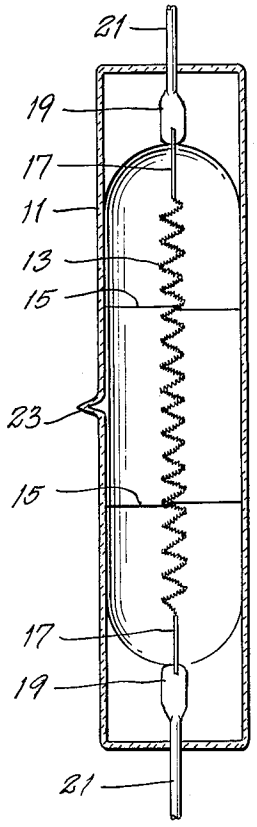
May 28, 1963 J. SHURGAN 3,091,718

CONSTANT LUMEN MAINTENANCE LAMP

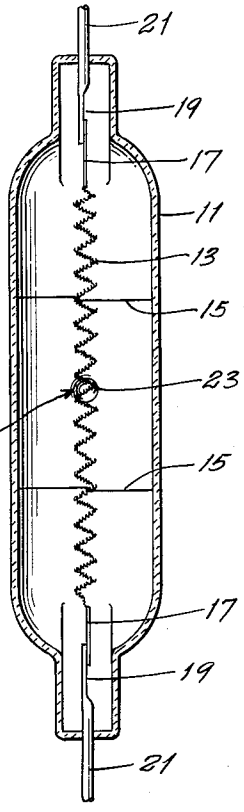
Filed July 8, 1960

Fig. 1A.



LAMP IS FILLED WITH FILL GAS + A GAS SELECTED FROM THE GROUP OF
1. HYDROGEN IODIDE
2. HYDROGEN BROMIDE
3. HYDROGEN CHLORIDE
OR THE GROUP OF
1. BROMINE VAPOR IN A CARRIER GAS
2. CHLORINE IN A CARRIER GAS

Fig. 1B.



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United States Patent Office 3,091,718 Patented May 28, 1963

3,091,718

CONSTANT LUMEN MAINTENANCE LAMP

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Filed July 8, 1960, Ser. No. 41,621
3 Claims. (Cl. 313—222)

This invention relates to the manufacture of lamps and more particularly to a lamp to which a gaseous scavenger is added for the purposes of preventing the blackening of the lamp wall, increasing filament life, and for maintaining a substantially constant lumen output during the life of the lamp.

In the past, incandescent lamps having tungsten filaments have been manufactured which utilize elemental iodine in an iodine cycle to remove evaporated tungsten from the wall of the bulb. The iodine cycle serves the purpose of preventing wall blackening, caused by the evaporation of the tungsten filament by redepositing the evaporated tungsten on the filament.

In the iodine cycle type of lamp referred to above a small quantity of molecular iodine (I_2) in solid form is introduced into the lamp during the process of manufacture. During the operation of the lamp, tungsten is transferred from the filament to the lamp wall by normal evaporation and diffusion, or by the water cycle. The molecular iodine (I_2) which is introduced into the lamp during the process of manufacture is changed into iodine atoms (I) by the pyrolysis of the molecular iodine in the vicinity of the filament. The iodine atoms diffuse to the lamp wall and under the proper conditions react with the adsorbed tungsten (W) forming volatile tungsten iodide (WI_2) which diffuses to the filament. The tungsten iodide (WI_2) is then decomposed at the filament by the heat of the filament resulting in the redepositing of tungsten on the filament and the production of iodine atoms which then diffuse to the lamp wall to repeat the cycle.

The iodine cycle in the above type of lamp depends on the reaction

$$W+2I \leftrightharpoons WI_2$$

where the forward reaction predominates at the lamp wall and the reverse reaction at the filament. A small amount of tungsten iodide is also formed in the gas phase due to a reaction between tungsten in the diffused form W(g) and iodine atoms (I) or molecular iodine (I_2) with a molecule of the inert lamp fill gas removing the excess energy. The gaseous tungsten iodide also serves the aforementioned purpose.

In general, lamps using an iodine cycle show a high lumen maintenance; i.e. the lumen output of the lamp remains substantially constant throughout the life thereof and does not decrease with filament age. However, many manufacturing and engineering difficulties are encountered in producing this type of lamp. One such difficulty involves the introduction of controlled amounts of molecular iodine into the lamp. When molecular iodine is used it deposits along the introductory system in amounts dependent on the wall temperature at the point of deposition. The amount of iodine actually introduced into the lamp will be dependent on the vapor pressure of iodine at the temperature used. Thus, to control the amount of iodine introduced, the temperature of the introductory system walls and lamp must be carefully controlled. Furthermore, the iodine must be introduced into an evacuated lamp, before the addition of fill gas, for otherwise the thermal diffusion time required for the thorough mixing of the fill gas and iodine vapor becomes uneconomic for manufacturing purposes. In addition, the intimate contact between molecular solid iodine and the walls of the

introductory and exhaust system leads to corrosion problems. The possibility of physical blocking of the introductory and exhaust systems by solid iodine is an additional problem.

The present invention relates to the manufacture of a lamp which has all the advantages of the iodine cycle without using molecular iodine, which interferes with the normal manufacturing cycle. In accordance with this invention, a gaseous halogen or halogen compound (gaseous scavenger) is introduced into the system by itself or in combination with a carrier gas and/or the lamp fill gas. By using a gaseous halogen or halogen compound it is possible to realize all the advantages of the iodine cycle. In addition, the lamp may be manufactured with a readily controlled and measured concentration of halogen or halogen compound, without heating the walls of the introductory system and carefully controlling this temperature. The manufacture of the lamp of the present invention may be carried out by conventional lamp manufacturing machinery and processes. The manufacturing processes may also be carried out in one operation, if the lamp fill gas is mixed with, or contains the gaseous halogen or halogen compound. Furthermore, there is no possibility of blocking the introductory and exhaust systems, since elemental iodine is not used. Also, the corrosion problem is substantially reduced in comparison with the use of solid iodine, since the concentration of gaseous halogen or halogen compound at the walls is much less than for solid iodine.

It is therefore an object of this invention to produce a lamp which has a substantially constant lumen output during its life.

Another object of this invention is to produce a lamp having a constant lumen output wherein the blackening of the lamp wall is prevented by a gaseous scavenger.

Yet a further object of this invention is to provide a process for introducing a halogen scavenger into the lamp to prevent blackening, the halogen scavenger being gaseous.

Still another object of this invention is to provide a lamp into which a gaseous halogen compound is introduced in order to prevent blackening.

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

FIGURE 1A shows a plan view of an incandescent lamp; and

FIGURE 1B shows the lamp of FIGURE 1A rotated by 90 degrees.

Referring now to FIGURES 1A and 1B, one type of incandescent lamp with which the present invention may be utilized, is shown. This lamp is of the type which has a tubular envelope **11** which is made of a suitable vitreous material such as quartz, and which is preferably clear. A tungsten filament **13**, which is shown as being of the coiled type, is supported within the envelope **11** by two supports **15**. The supports **15** are also formed of a suitable heat resistant material, such as tungsten, and are preferably spiral in shape. The supports **15** hold the filament **11** at the innermost turn of the spiral and the outer turn of the spiral presses against the inside of the envelope **11**, thereby supporting the filament **13** within the envelope.

The coiled filament **13** terminates at each end thereof in a solid wire **17** by means of which current is supplied to the filament **13**. Each of the wires **17** is preferably a solid piece of tungsten. A lead-in connector **19** is connected to each of the lead-in wires **17** by suitable process such as welding, etc. The lead-in connectors **19** are preferably of a flattened out shape, as shown, and may be formed with the edges thereof tapered or feathered, as is well known in the art. The lead-in connectors **19**

are also formed of a suitable material such as molybdenum, etc. The lead-in connectors **19** are shaped at the end opposite the lead-in wire **17** with a lead-in wire **21** which extends out through the envelope **11** and to which the terminals of the current source for the lamp filament **13** are connected.

In order to secure the filament structure within the envelope **11** and to form a vacuum seal for the lamp, the end of the tungsten wire **17**, the connector **19** and part of the lead-in **21** are sealed into the end of the envelope by a pressing operation. The ends of the tubular lamp envelope are therefore narrowed down and a vacuum seal is provided.

A tubulation **23** is provided through which the lamp is first exhausted and then filled with the fill gas and the gaseous halogen or halogen compound scavenger. After the filling operation is completed, the tubulation **23** is tipped off to provide a complete vacuum seal for the lamp.

In the lamps previously described wherein solid molecular iodine is introduced into the lamp, the iodine deposits on the inside wall of the lamp and also on the tubing and other parts of the system used for exhausting and filling the lamps. This interferes with the evacuation of the lamp and also causes corrosion problems in the exhaust system.

In accordance with the present invention and to overcome the manufacturing problems and disadvantages of the lamp using molecular iodine, a gaseous halogen or halogen compound is introduced into the lamp through the tubulation **23** after the lamp has been evacuated. This may be accomplished in a number of ways. The gaseous scavenger may be mixed with the fill gas prior to the introduction of the mixture into the lamp or else the fill gas and the scavenger may be introduced into the lamp separately. The gaseous halogen or halogen compound may also first be mixed with a small quantity of inert gas, called a carrier gas, and then the pre-mixture may be further mixed with the fill gas prior to introduction of the composite mixture into the lamp. The pre-mixture and the fill gas may also be introduced into the lamp separately.

With respect to the fill gas and carrier gas usuable with the invention, any inert gas such as argon, other rare gas, nitrogen, or any gas not precluded by conventional lamp manufacture may be utilized.

Suitable gaseous halogen compound scavengers which may be utilized with the present invention include gaseous halides, such as hydrogen bromide, hydrogen chloride and hydrogen iodide. Other gaseous halogens which may be utilized are bromine vapor in a carrier gas and chlorine in a carrier gas. In a preferred embodiment of the invention, the halogen compound hydrogen iodide is utilized.

When using gaseous halides such as hydrogen bromide, hydrogen chloride and hydrogen iodide, the halides are preferably mixed with the fill gas before the introduction of the mixture into the lamp. The gaseous halide and the fill gas may also be introduced into the lamp separately. If desired, the gaseous halide may first be mixed with the carrier gas to form a pre-mixture and then the pre-mixture may be introduced into the lamp as part of a composite mixture of fill gas, or separately from the fill gas.

When bromine vapor or chlorine gas is used, it is preferably first mixed with a quantity of a carrier gas. The pre-mixture may then be mixed with the fill gas before introduction into the lamp or the pre-mixture and the fill gas may be separately introduced into the lamp.

The amount of gaseous scavenger introduced should be such as to maintain a partial pressure in the lamp in the range between 1.0 mm. and 40.0 mm. of mercury pressure and including the extremes thereof. In a preferred form of the invention a partial pressure of about 8.0 mm. is maintained.

With a gaseous scavenger introduced into the lamp all of the advantages of the iodine cycle are obtained. During operation of the lamp, when a gaseous halide is used as the scavenger, the gaseous halide is partially decomposed by thermal energy at the filament into hydrogen and the corresponding halogen (bromine, chlorine or iodine). The evaporated tungsten combines at the lamp wall to form tungsten halide which is volatile at the operating temperature of the lamp wall. From this point on, a conventional type iodine cycle occurs in which the tungsten halide evaporates from the bulb wall and is decomposed at the filament by thermal energy. The tungsten is then redeposited on the filament and the halogen is regenerated into the system.

It should be noted that once iodine or other halogen is formed at the lamp filament by the decomposition of the gaseous halogen compound scavenger it may enter into one or both of the following reactions:

$$H_2+X_2 \rightarrow 2HX$$
$$H+X \rightarrow HX$$

where H is hydrogen and X represents the halogen. The reformed halide is then decomposed by thermal energy from the filament into the elemental halogen, restarting the cycle over again.

When the lamp envelope is made of quartz, the hydrogen formed in the decomposition of the gaseous halide may diffuse through the quartz bulb wall leaving free elemental halogen in the lamp to operate in a conventional iodine type cycle. It should be noted however that even when some hydrogen remains in the lamp, that the advantages of the iodine type cycle are still retained while the difficulties encountered in introducing a scavenger in molecular form into the lamp are overcome.

When bromine vapor or chlorine gas in a carrier gas mixture is utilized as the scavenger, it operates in the manner previously described with respect to the molecular iodine. However, it should again be realized that since the scavengers are of gaseous form, the difficulties in introducing the molecular halogen directly into the lamp are not encountered.

When bromine or chlorine are utilized as the scavenger, either in the form of bromine vapor or gaseous chlorine or in the form of hydrogen bromide or hydrogen chloride, the operating temperature of the lamp bulb must be made higher in order to effect the desired cycle. This does not pose any problems since the temperature may be increased by any of several techniques, for example, increasing power input, modifying the geometry of the lamp bulb, etc.

Therefore it has been seen that a novel lamp has been described which has a high lumen maintenance. The high lumen maintenance is accomplished by the introduction of a gaseous scavenger, in the form of a gaseous halogen or a gaseous halogen compound into the lamp, along with or separately from the lamp fill gas. This procedure overcomes the disadvantages encountered when elemental iodine or other halogen in molecular form is introduced in the system.

While the invention has been described with respect to a conventional type of tubular, coiled filament quartz lamp, it should be realized that it is not limited thereto since it may also be used with other types of lamps, for example: lamps having glass envelopes or envelopes of other vitreous material; lamps of different envelope shapes and geometries; lamps utilizing straight or coiled filaments in different configuration; etc.

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.

What is claimed is:

1. In a lamp comprising a metallic filament within an envelope, a gaseous compound within said envelope selected from the group consisting of hydrogen chloride,

hydrogen bromide and hydrogen iodide, said envelope formed of a material containing silica which has substantially the same or greater permeability to hydrogen as fused silica, thereby the hydrogen is able to diffuse out through said envelope upon disassociation from said gaseous compound.

2. An improved lumen maintenance lamp comprising a metallic lamp filament sealed within a substantially air-tight envelope of vitreous glass material which has substantially the same permeability to hydrogen as fused silica material, said filament having leads connected thereto which are adapted to be connected to a source of power for heating said filament, said envelope containing a quantity of a gaseous compound selected from the group consisting of hydrogen iodide, hydrogen chloride and hydrogen bromide, said envelope being permeable to hydrogen whereby the hydrogen is able to diffuse out through said envelope upon disassociation from said gaseous compound.

3. In a lamp comprising a metallic filament within an envelope, a halogen compound within said envelope, said compound containing a halogen scavenger which is to be retained in said envelope and an element which is to be expelled from said envelope, said envelope formed of a material which is relatively highly permeable to said unwanted element and relatively impermeable to said halogen scavenger whereby said unwanted element diffuses out through said envelope upon disassociation from said compound.

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