TUNGSTEN HALOGEN LAMP

Inventors: Emery G. Audesse, Salem; Robert M. Griffin, South Hamilton; Alexander Tartakoff, Beverly; John J. Gutta, Hamilton, all of Mass.

Assignee: Sylvania Electric Products, Inc.

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UNITED STATES PATENTS

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Primary Examiner—John Kominski
Attorney—Norman J. O'Malley, Laurence Burns and Joseph C. Ryan

ABSTRACT

A tungsten halogen lamp in hard glass in which the temperature gradient in the envelope is such that the top of the latter is at about 200°C and the remainder of the lamp hotter, so that the halogen will not only keep the glass bulb clear by means of the usual regenerative halogen cycle, but will also react with impurities in the tungsten to condense them out nonregeneratively on the top of the envelope, the lamp being operated base up. To insure the proper operation of the halogen cycle, the supporting conductors for the filament are made small enough to operate at incandescence at the designed current, in contrast to the much larger diameter used for supporting conductors in ordinary incandescent lamps, where the wires operate comparatively cool and have low resistance and voltage drop. The higher voltage drop in the incandescent supporting conductor is compensated for by designing the filament coil to operate at its desired temperature at lower voltage in an atmosphere of bromine and krypton.

5 Claims, 2 Drawing Figures
TUNGSTEN HALOGEN LAMP

BACKGROUND OF THE INVENTION

1. Field of Invention
This invention relates to incandescent electric lamps of the tungsten halogen type.

2. Brief Summary of Prior Art
In such lamps, the tungsten which is normally evaporated from the filament during operation combines with the halogen to form a gas phase, because of the high temperature, and the halide normally has a regenerating action, being used over and over again, because when it returns to the hot filament or lead-in wires the halide will decompose, depositing the tungsten on said filament or lead-in wires. This halogen cycle is well known, and lamps utilizing it have been on the market.

Such lamps have previously been made in quartz tubes or bulbs, because of the high temperature which was considered necessary for operation. It was believed that the temperature had to be high and uniform, and that the presence of a cool spot would cause impurities in the tungsten wire to combine with the halogen and reduce its effectiveness or clean it up from the lamp, as pointed out in U.S. Pat. No. 2,883,571 issued Apr. 21, 1959 to E. F. Friderich et al.

BRIEF SUMMARY OF INVENTION

Because of the great expense involved in using quartz, various efforts have been made to manufacture tungsten halogen lamps of a hard glass, such as a borosilicate, with the usual lamp construction of flare and bulb sealed together. These efforts appear to have been unsuccessful commercially. We have found, however, that by designing the lamp to have a particular temperature gradient from top to bottom, and by using tungsten lead-in wires of smaller diameter than is customary for the current they carry, so that they will be incandescent, a very effective lamp can be made for commercial use, such as in television or motion picture studios. The effectiveness of the lamp will be greatly increased by using a fill of krypton gas.

We have, moreover, found that with a lamp made according to our invention, the tungsten wire used in the lead-in conductors and the like need be only of the same purity as used in ordinary nonhalogen incandescent lamps, and does not need to be of the higher purity used in most quartz halogen lamps. A surface coating of oxide on the tungsten, for example, will not be deleterious. The reason for this appears to be that, although the top portion of our lamp operates above 200° C., so that the halogen does not condense out, it will still be cool enough, operating at say 205° C. so that halides formed with the impurities in or on the wires will condense out. In this way the halogen not only performs its usual function of regenerating the tungsten to keep the bulb wall clean, but also acts as a getter to clean up impurities in the wire and deposit them in the top of the bulb where they do not interfere with the light output. It is especially effective in removing any oxide coating on the wire by converting it to an oxy-halide which condenses out.

The quantity of halogen present in the bulb should be sufficient to allow the loss of some of it in cleaning up impurities without a reduction in quantity below that necessary to fulfill the regenerative action with the tungsten.

A further advantage of the borosilicate glass lamp is that the tungsten lead-in wires can be sealed directly through the glass, and do not require molybdenum ribbons in the seals.

We have discovered that in order to operate at temperatures satisfactory for glass, the bulb must be of much greater diameter than that used with a quartz halogen lamp, and since this means that the emitted light must travel a far greater distance through the halogen than with a quartz bulb, the most effective halogen for the lamp is bromine, rather than the more usual iodine, because the latter in vapor form is colored blue and would absorb a considerable part of the light.

We have also found that it is desirable to operate the press of the lamp somewhat close to but below its annealing temper-
Gaseous HBr in a lamp undergoes pyrolysis in the vicinity of the lighted filament thus forming free bromine which migrates to the vicinity of the wall of bulb 1 where it combines with tungsten which has evaporated from the coil. A volatile tungsten bromide (WBr₂) is thus formed, where x may have any one of several values such as 4, 5, 6 corresponding to the upper valences of tungsten. The bromide taking part in the regenerative cycle is WBrx. If any part of the bulb wall is at or below 200°C, the WBrx will condense in this region thus reducing the amount of bromine available to the regenerative cycle. If on the other hand the entire bulb wall is above 200°C, then the WBrx compound migrates back toward the filament coil. During this migration, the temperature will ultimately reach and exceed 1,400°C thus causing the WBrx to undergo pyrolysis. The free tungsten will either migrate back to the bulb wall or deposit on some tungsten part.

The free bromine will either migrate back likewise, toward the bulb wall or to some tungsten part whose temperature is below 1,400°C. The bromine will combine with the tungsten part to form a tungsten bromide compound (WBrx). If the part temperature is below 200°C then the WBrx compound will remain as a solid condensate on the tungsten part thus reducing the amount of bromine available to the regenerative cycle. If, on the other hand, the part temperature is above 200°C (but below 1,400°C) then the WBrx compound will volatilize and diffuse to the vicinity of the coil where pyrolysis occurs thus forming free bromine and tungsten again. The important point here is that this latter bit of tungsten was released to the lamp atmosphere not by thermal emission from the filament coil but by chemical attack on some other tungsten part. It would not have been freed if the tungsten part temperature were above 1,400°C where bromine attack is impossible or below 200°C where the WBrx would have been held as a solid condensate. Unfortunately, this WBrx condensate is also undesirable in that it permanently ties up a portion of bromine thus reducing the effective life of the bromine regenerative cycle.

In summation it may be said that the effective life of the hydrogen bromide regenerative cycle is directly effected by the operating temperature of the tungsten parts, as follows:

a. Temperature less than 200°C: shortens cycle life by progressively tying up available bromine in the form of solid WBrx condensates on the tungsten part.

b. Temperature between 200°C and 1,400°C: shortens cycle life by chemical release of additional tungsten molecules which ordinarily would have remained on the tungsten part and out of the regenerative cycle.

c. Temperature above 1,400°C: increases cycle life by inhibiting chemical attack by the bromine and by acting as a place of deposit for evaporated tungsten.

One other point should also be made. Temperatures in the region of 1,400°C are very important with respect to tungsten parts in operating lamps. In this temperature region, the ratio of tungsten lost by thermal emission to that which is gained by deposit on the part, is very close to unity. The result is that the net contribution of tungsten molecules to the lamp atmosphere by tungsten parts operating at or near 1,400°C is substantially zero. Thus, the life of the halogen regenerative cycle is increased. In FIG. 1, the approximate temperatures of different portions of the bulb lamp 1, the lead-in wires 4, 5, and the support wire 25 are indicated. The bulb wall temperatures were measured with the lamp operating base up in a suitable fixture, which was a scoop-type fixture designed for the ordinary 1,000 watt incandescent lamp in a PS52 bulb. The “PS” means “pear-shaped” and the 52 means that the maximum bulb diameter is 52/8 inches, that is 6½ inches). In this fixture, it is generally best to have the bulb with its axis vertical or not more than 45° from vertical, with the base up. In some newer type “scoop” fixtures, where the bulb is axial with the reflector, the bulb can be operated effectively even horizontally.

Because of the gettering action of the bromine with the temperature gradient shown, cleaning of the filament and tungsten parts with acid is not necessary, and the lamps can accordingly be made on regular incandescent lamp machinery, with provision for adding the bromine at some place on the machine. This greatly reduces the cost of making the lamp. Although a specific embodiment of the invention has been described, various changes and modifications will be apparent to a person skilled in the art upon reading the present specification, and the scope of the invention is limited only by the claims.

What we claim is:

1. A tungsten halogen incandescent lamp having a light transmitting envelope, a coiled tungsten filament therein, a filling of inert gas therein, and a quantity of a halogen therein, the size of the envelope being such that the temperature at the top of the envelope is about 200°C and the temperature at the bottom about 400°C.

2. The lamp of claim 1, in which the envelope is tubular and of borosilicate glass.

3. The lamp of claim 1, in which the tungsten of the filament contains impurities with which the halogen will react to form a halide, which will condense out on the inside surface of the envelope near the top thereof.

4. The lamp of claim 3, in which the amount of halogen is sufficient to react with the impurities and leave enough to maintain the regenerative action of the halogen with the tungsten evaporated from the filament.

5. The lamp of claim 4, and a ceramic disc between the filament and the top portion of the envelope to cool said top portion.