Dec. 25, 1962 S. C. PEEK, JR., ETAL 3,070,723

PROJECTION LAMP

Filed Jan. 21, 1960

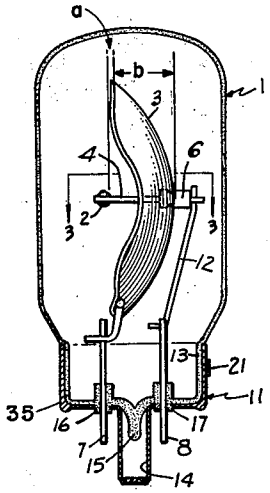

fig. 1

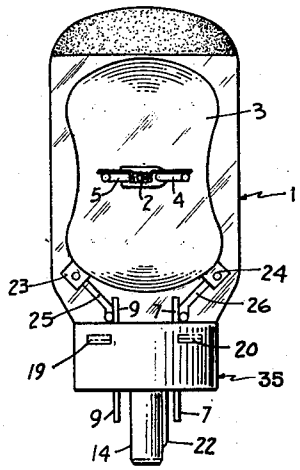

fig. 2

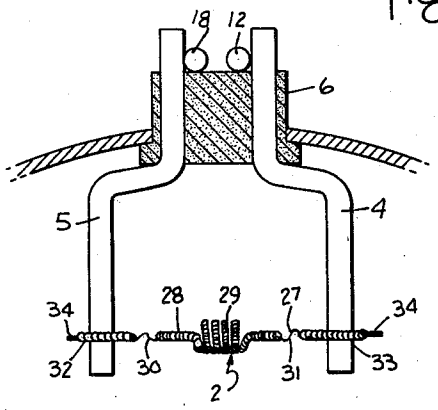

fig. 3

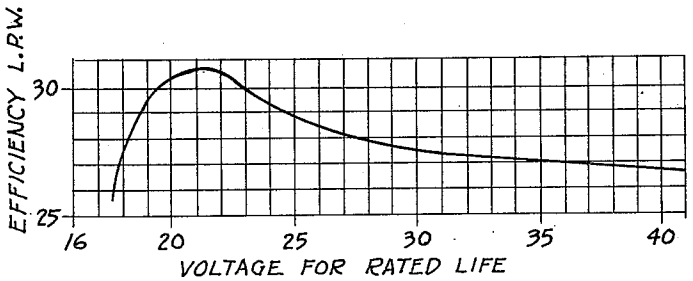

fig. 4

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PROJECTION LAMP

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This invention relates to incandescent lamps for projection purposes, that is, for projecting a beam of light. Such lamps are used, for example, in moving picture and slide projectors. In their most recent forms, such lamps include a metallic reflector in close proximity to an incandescent filament which has the form of a coiled-coil.

We have discovered that the most efficient form of coil for such lamps is one that operates at between about 20 and 23 volts, and particularly at about 21.5 volts, and that a coil designed for a voltage greater or smaller than that will not be as efficient. Efficiency in such lamps is a factor of great importance because a high efficiency means that a given amount of light is produced at a lower watt input to the lamp, thereby causing less heating effect on the film or slide and requiring a smaller blower for cooling the lamp.

The efficiency of the coil can be further increased by "pulling out" one turn on each side of the coil between the main coil and the supporting lead-in wires. This appears to reduce the temperature gradient along the ends of the coil, thereby reducing preferential etching due to the temperature gradient.

In addition, it facilitates control of the total effective filament length by insuring that said length is terminated at a particular turn. The end turns of the filament, beyond the pulled out turn, have a mandrel or so-called "spud" inside them, thereby both short-circuiting them and facilitating their attachment to a support wire. The mandrel or spud terminates at about the middle of the axial length of the pulled-out turn, and insures that the termination occurs at that particular turn, and not one on either side of it, as could easily be the case if the mandrel were inserted into the closely-wound coil without the pulled turn. The importance of fixing the exact turn at which the effective length of the coil terminates (that is, the turn at which the shorting effect of the spud begins) is indicated by the fact that a variation of one turn can make a life difference of 7%.

The projection lamp is generally designed for vertical operation with the base down, that is, with the base at the bottom. If the lead-in wires to the filament extend transversely to the lamp axis in the region in which the filament is attached to them, it is found that having the legs of the filament extend outward from the top of the coil, that is, from the part of the coil furthest from the base, rather than from the axis of the coil, or the bottom or side, the operation is much better. We find that under such circumstances, the sag in the turn will bend them outward from each other, and not closer together, thereby preventing short-circuiting or overheating. The legs of the coil are preferably attached to the top of the lead-in wires.

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

FIGURE 1 is a profile view, partly in section, of one embodiment of a lamp according to the invention;

FIGURE 2 is a front view of the same lamp;

FIGURE 3 is an enlarged view, partly in section, of the structure of the filament and its supports; and

FIGURE 4 is a graph showing the variation in light output with filaments of different voltages.

In FIGURE 1, an enclosing tubular glass envelope 1 contains the incandescible coiled filament 2 and the polished metal reflector 3 in position to reflect light from said filament. The reflector can be paraboloidal, with the filament substantially at the focus, if a parallel beam of light is desired; but for use in a slide or motion picture projector, the reflector is generally made ellipsoidal with the filament at the nearer focus of the ellipse.

The reflector and filament are made in a unitary structure, with the lead-in wires 4, 5 which support the filament extending through a ceramic insulating bushing 6 fixed to reflector 3 through an opening therein. In this way the filament and reflector can be fixed in position with respect to each other before being fixed in position in the envelope 1. The latter has four stiff wire contact prongs 7, 8, 9 (the one which would be 10 is not shown), sealed through the bottom or base 11 of the envelope 1.

A metal cap 35 fits around the base 11, extending up the cylindrical wall 13 of envelope 1 and containing the downwardly-extending hollow projection 14 which protects the sealed exhaust tube 15. Each contact prong 7, 8, 9 (and 10 not shown) has the glass "beads" 16, 17, sealed around it, and the metal cap 35 has holes through which said beads pass.

The cap 35 carries three spaced projections 19, 20, 21 which cooperate with fingers in a socket to align the bulb therein. One said socket is shown in copending application Serial No. 553,367, filed December 15, 1955, by William H. Morgan, Jr., for a Lamp Positioner. The projection 14 has the key 22, as shown in FIG. 2, extending parallel to the axis of the envelope, to aid in aligning the lamp in a socket.

The lead-in wires 4, 5 extend directly only a short distance behind the bushing 6, the connecting wire 12 being connected to wire 4 at the back of bushing 6 and extending downward at an angle to be connected near its end to lead-in wire 8. The connecting wire 12 is bent crosswise to lead-in wire 8 to make a more effective supporting connection. Lead-in wire 10, not shown, would be similarly connected to a support wire 18 between lead-in wire 5 and a contact prong.

The reflector 2 has two eyeletted tabs 23, 24 and a short support wire 25, 26 is welded across the tab and welded also to the contact prongs 7, 9. This helps align the reflector in the bulb and keeps it in position.

By running the lead-in wires 4, 5 through closely-fitting holes in the ceramic backing 6 arcing between the lead-in wires on filament burnout is prevented, and a fuse to prevent such arcs is unnecessary. The narrow hole through which the arc must pass in the ceramic 6 snuffs it out.

The filament 2 and its supports, 4, 5, are shown in more detail in FIG. 3. The supporting wires 4, 5 extend through the ceramic bushing 6 and are bent outwardly as they emerge from said bushing on the concave side of the reflector. This bending together with the welding of connecting wires 12, 18 to lead-in wires 4, 5 at the other end of the ceramic 6, helps keep the filament and reflector in permanent alignment.

The filament 2 itself is a coiled-coil having a tungsten wire 27 coiled into a primary coil 28 of small diameter with the middle length of the primary coil itself again coiled to form a coiled-coil 29 of larger diameter. The turns 30 and 31 are pulled out to a greater distance than the remainder of the coil for reasons previously explained. Each end portion 32, 33 of the coil has a mandrel 34, generally called a "spud," fitted tightly inside it to facilitate welding or other connection to the lead-in wires 4, 5 and also to short the ends of the coil to keep them from being heated as much as the

remainder of the coil. For convenience in drawing, the spud is terminated at the beginning of the pulled-out turn, but in practice it will be desirable to have it near the middle of the turn, so that variations in the exact amount of insertion will not have much effect.

As an example of a coil according to the invention, the portion **32** would be about 6 turns long, and the portion **28** would be about 8 turns long, with five secondary turns in the coiled-coil portion **29**. The latter portion has 30 turns per inch, and the spud **34** is a tungsten pin 0.030 inch in diameter. The primary coil was wound to 64 turns per inch on a 10-mil mandrel. The average primary coil diameter was 26.7 mils.

In the specific embodiment here described, the reflector had an elliptical curvature according to the following curve

$$y^2=2(0.880)x-0.650x^2$$

where y is the vertical coordinate and x the horizontal coordinate when the reflector is positioned in the bulb as shown in FIG. 1 and the base is down, that is, at the bottom of the envelope.

The side of the coiled-coil filament nearest to the reflector is positioned 0.070 inch in front of the plane of the outer edges of the reflector, and that plane is 0.450 inch from the apex of the reflector, that is, from the apex of the reflector curve where it would pass through ceramic **6** if that ceramic were not there. These distances are shown as *a* and *b* respectively in FIG. 1.

In operation, a voltage of about 21.5 volts is connected between the filament contact prong **8** and the corresponding prong (not shown) to the other side of the filament. The contact prongs **7** and **9** are left "floating," that is, not connected to anything, because if they are connected to either side of the line, the reflector will blacken by conduction through the gas to the other end of the voltage supply line.

The graph of FIG. 4 shows the lamp efficiency in lumens per watt (L.P.W.) at the screen of a projector, plotted against the voltage at which the filament must be operated to obtain the rated life of 15 hours. (The life in a projector lamp is customarily of that value in order to obtain high efficiency.) The filaments used were different for each voltage, but the wattage and overall dimensions of the filament were the same.

In other words, a series of filament coiled-coils were made, each coil being of 0.200 inch axial length and 0.085 inch outside diameter, each coil having the same number of secondary turns but differing in wire size. The number of primary turns was changed slightly to accommodate the different wire sizes. The lamps were all used in the same movie projector for 8 mm. film and the coil was made of the above size to insure that the objective lens would be completely filled with useful light for all coils tested. The lumens per watt at the screen on which the lens were focussed were then measured.

In that way, the best coil for efficiency was found to be one that gave the rated life at 21.5 volts. All other coils were less efficient.

When the coil is designed for a voltage of about 100 volts or more, it can no longer be made of such dimensions as to fit within the 0.200 inch by 0.085 inch dimensions given above, and a coil for direct operation on a 115-volt line will have only about sixty percent of its turns within a rectangle of the dimensions given above. The light from the remaining turns will therefore not be useful in filling the usual projection lens with which the lamp would normally be used.

The tungsten wire of which the coil is wound had, in the specific example cited earlier in the present application, a diameter of about 8.48 mils. When wound in the manner described, the finished coiled-coil will have a diameter of about 0.085 inch.

What we claim is:

1. An incandescent projection lamp comprising a sealed enclosing bulb, an ellipsoidal reflector inside said bulb, and a coiled-coil tungsten filament in said bulb, said filament being of about 0.2 inch axial length and about 0.085 inch outside diameter adapted to attain its operating temperature at between about 20 and about 23 volts and being approximately at the focal point of said reflector nearest to said reflector.

2. An incandescent projection lamp comprising a sealed enclosing bulb, an ellipsoidal reflector inside said bulb, and a coiled-coil tungsten filament in said bulb, said filament being of about 0.2 inch axial length and about 0.085 inch outside diamter adapted to attain its operating temperature at about 21.5 volts and being approximately at the focal point of said reflector nearest to said reflector.

3. An incandescent projection lamp comprising a sealed enclosing bulb, an ellisoidal reflector inside said bulb, and a coiled-coil tungsten filament in said bulb, said filament being of about 0.2 inch axial length and about 0.085 inch outside diameter designed to take about 150 watts at 21.5 volts and being approximately at the local point of said reflector nearest to said reflector.

4. An incandescent projection lamp comprising a sealed enclosing bulb, an ellipsoidal reflector inside said bulb, and a coiled-coil tungsten filament at the approximate focus of said ellipsoidal reflector nearest to said reflector and being of about 0.2 inch axial length and about 0.085 inch outside diameter in said bulb, said filament having an opearting resistance between about 2.7 and 3.5 ohms.

5. An incandescent projection lamp comprising a sealed enclosing bulb, an ellipsoidal reflector inside said bulb, and a coiled-coil tungsten filament at the approximate focus of said ellipsoidal reflector nearest to said reflector and being of about 0.2 inch axial length and about 0.085 inch outside diameter in said bulb, said filament having an operating resistance of about 3.1 ohms.

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