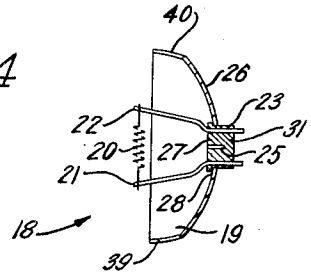
April 18, 1961 J. M. HARRIS ET AL 2,980,818

PROJECTION LAMP

Filed Jan. 9, 1958

Fig. 4



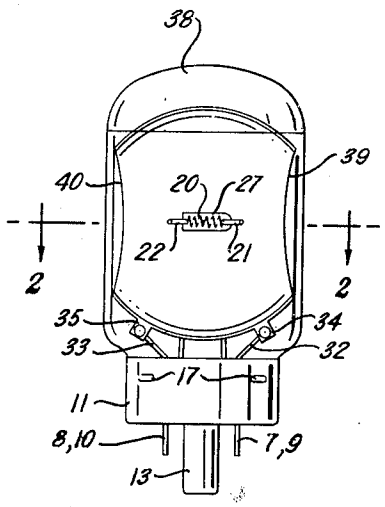


Fig. 2

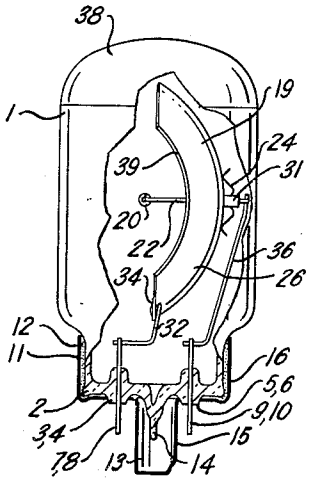


Fig. 1

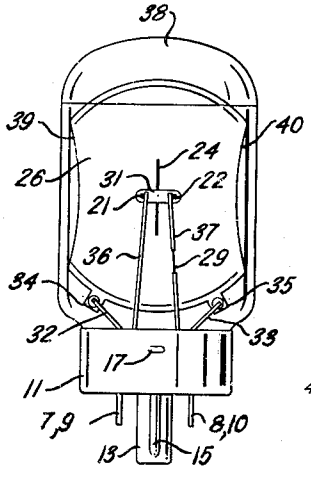


Fig. 3

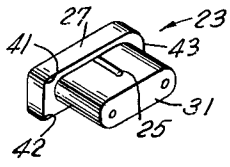


Fig. 5

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2,980,818

PROJECTION LAMP

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Filed Jan. 9, 1958, Ser. No. 707,952

4 Claims. (Cl. 313—113)

This invention relates to electric incandescent lamps and especially to lamps designed for use in moving picture projection devices or in other devices requiring a high concentration of light energy on a limited area.

Such lamps have been made for use with an external reflector, or with a metallic reflector deposited on the inside of the glass bulb of the lamp. When an external reflector was used, it had to be made large compared with the dimensions of the lamp, in order to reflect a sufficient amount of the light in the desired direction. This necessitated a large enclosure for the projecting system, with consequent cumbersomeness and expense. In addition, there was the difficulty of properly aligning the lamp filament with the reflector, since the lamp has to be made detachable for replacement purposes, and of cooling the lamp.

Eliminating the external reflector and using a reflecting surface deposited on the interior or exterior surface of the lamp bulb provided a more compact unit, but introduced the additional difficulty of forming the glass bulb to a special and very precise shape. The shape could not be controlled precisely enough with the usual methods available for molding glass bulbs. Furthermore, the reflector would be on the lamp bulb and the filament on the lamp mount, so the proper positioning of filament and reflector was difficult to control accurately when the flare of the mount was sealed to the open end of the bulb. The alignment had to be fixed with precision while the seal was still hot and plastic, and before it solidified. A cap then had to be affixed to the lamp and aligned.

The above difficulties can be avoided by making the lamp with an internal reflector, separate from the bulb, and supported solely from the same mount which supports the filament. For example, a glass piece can be ground to the desired concave curvature on one side and the concave portion coated with reflecting metal; the reflector can then be supported from wires set into the glass piece or attached to the lead-in wires to the filament.

We have discovered, however, that a more rugged and optically effective lamp, as well as a less expensive one, can be made with the separate reflector shaped from a metal sheet to the desired curvature, and placed inside the bulb and in reflecting relationship to the filament.

Although a mirror of metal deposited on a carefully ground and polished piece of glass may be slightly more efficient than a metal mirror, we have found that a mirror pressed out of a metal sheet to proper shape, then polished and silvered (if the metal out of which it is pressed is not itself silver) will give very high reflectivity. For example, a mirror of pressed and polished copper, plated with nickel and then silvered, has given a reflectivity of about 95%. Even an extremely good hand-tooled metal-on-glass mirror could not give much more than that, and machine-ground glass pieces coated with silver give only about 85% reflectivity. Thus the metal mirror will be most effective under actual manufacturing conditions.

Moreover, the use of an elliptical mirror is often desired in projection lamps. Such a mirror cannot be made satisfactorily by machine, so a machine-made metal-on-glass mirror must necessarily be spherical. An elliptical mirror can be made on a glass base by hand, but only in a tedious manner and at considerable expense.

An elliptical mirror can, however, be readily pressed out of soft sheet metal at less than ½ of 1% the cost of making an elliptical mirror out of a glass base.

We have further discovered that the metal mirror must be supported in such a way that it is not electrically connected to either of the filament lead-in wires; it must be electrically "floating" with respect to the lead-in wires, that is, insulated from both of them. Connecting the mirror to one of the lead-in wires might seem possible, but we find that with such a connection the mirror becomes quickly discolored by electrolysis through the gas. This is particularly true with lamps used on ordinary commercial power line voltages, such as the usual 110 volts.

We have discovered, however, that the filament can be very effectively mounted from an insulating ceramic piece fixed to the metal reflector, the piece preferably being set into the reflector at the back thereof. The support wires for the filament are held firmly by the ceramic piece, through which they extend.

The filament and reflector then form an integral structure, properly aligned with respect to each other in a manner completely independent of the other parts of the lamp.

The filament-reflector combination can then be mounted as a unit on support wires extending up from a glass wafer which acts as a header or stem to seal off the enclosing bulb. Two of these support wires can be the lead-in wires to the filament, since the ceramic piece or button holds the filament supports fast to the reflector, as explained above.

Because the reflector, being inside the bulb, can be placed close to the filament, it can be made quite small without sacrificing light output in the desired direction. However, the filament must then be positioned and maintained quite precisely in position. To reduce sagging or changes in the filament itself to a minimum, it is wound to its final form on a mandrel, and then set by passing a current through the mandrel to bring the filament to a temperature of about 2000° C., as shown in copending application Serial No. 674,364, filed July 26, 1957, now U.S. Patent 2,863,359, by Wilfrid G. Matheson. The mandrel is then removed.

In addition, the ceramic button which holds the filament supports must be held firmly but resiliently against movement in the reflector. We have discovered that this can be achieved by shaping the button so that it can be held back against the face of the reflector at three points, and providing a spring urging the button back.

A portion of the button can extend through a slot in the reflector, and a spring can bear against the back of the reflector and against the rear of the button, to urge the forward part of the button against the face of the reflector. The button can be in the form of a flat sleeve where it passes through the slot, to prevent rotation, and the forward part of the button can be in the form of a flange on the sleeve. The flange can be substantially rectangular in outer dimension, with one short side of the rectangle straight to provide two points of contact, one at each corner of the short side, and the other short side curved to provide only one point of contact at the middle of the arc of the curve.

In that manner, the ceramic support which holds the filament supports is fixed firmly in place in a given plane with respect to the reflector, and held firmly against rotation in said plane, yet can yield temporarily against a sudden shock, for example, against the shock of being dropped.

Other objects, features and advantages of our invention will be apparent from the following description, taken in conjunction with the attached drawing in which:

Fig. 1 is a side profile view partly cut away, of one embodiment of a lamp according to the invention;

Fig. 2 is a front profile view of the same embodiment;

Fig. 3 is a back profile view;

Fig. 4 is a sectional view on lines 2—2 of the same device, and

Fig. 5 is an enlarged view of the insulating button through which the lead-in wires extend through the reflector.

In the figures, the tubular glass bulb **1** is sealed at one end to a glass wafer **2**, having the nubs **3**, **4**, **5**, **6**, through which lead-in pins **7**, **8**, **9**, **10** extend. The metal cap **11** is fixed to bulb **1** by cement **12**, and extends over the bottom of the wafer **2**, the cap **11** having holes through which nubs **3**, **4**, **5**, **6** extend. A cylindrical projection **13** from cap **11** extends around the sealed exhaust tube **14**, and has the usual key **15** for alignment when placed in a socket such as that shown in copending application Serial No. 553,367, filed December 15, 1955, by William H. Morgan, Jr.

The outside surface **16** of cylindrical cap **11** is tapered inward toward the bottom of the lamp, to facilitate insertion in a socket such as that mentioned. The taper is about 1.5°, and is sufficient to allow insertion of the cap **11** into such a socket freely enough to allow rotation until the key **15** is inserted into the keyway of the socket, whereupon the cap **11** can be pushed further into the socket and held therein by the projections **17** extending outward in three positions around the cap circumference.

The reflector and filament assembly **18** comprises a sheet metal reflector **19**, the filament **20** held by lead-in and support wires **21**, **22**, one such wire being at each end of said filament, and the ceramic button **23** through which the lead-in wires **21**, **22** extend and in which they are firmly held, and the wire spring **24**, which extends through the slot **25** in ceramic button **23**, bearing between the end of the slot and the back **26** of reflector **19**, to urge the flange **27** against the face **28** of reflector **19**.

The ceramic button **23** comprises the flat sleeve **31**, shown as being approximately rectangular in shape but with its short sides rounded in Figure 3, which extends through the reflector **19** through a slot therein shaped to a sliding fit for said sleeve, and the flange **27**, also approximately rectangular in shape but having one of its short sides straight or flat in shape and the other rounded, at least on the back of the flange, to form a group of three points **41**, **42**, **43** which bear against the face of reflector **19** around the slot therein to fix the position of the button **23** in reflector **19**.

The reflector and filament are thus held firmly but resiliently together in proper relationship, and can be attached as a unit to the wafer **2**, by support wires **32**, **33**, welded to tabs **34**, **35** on reflector **19**, and also by lead-in wires **36**, **37** which are welded to the electrically-conducting filament suport wires **21**, **22** and act as further supports. The support wires **32**, **33**, **36**, **37** are welded at their bottom ends to the lead-in contact pins respectively, thereby providing a firmly-fixed shock-resistant mount.

The lamp is filled with nitrogen at a pressure of about 1000 millimeters of mercury to reduce evaporation from the filament **20**, which can be a coiled-coil of tungsten wire. The top **38** of the bulb **1** is coated with a ceramic glaze, preferably of a color such as black or blue, to increase the radiation of heat from the top of the lamp to prevent overheating of the glass.

The exhaust tube **14** can be sealed by methods now well-known in the art, for example as shown in copending United States patent application Serial No. 594,305, filed June 27, 1956, now U.S. Patent 2,837,880, by Alexander Rosenblatt et al., assigned to the same assignee as the present application.

In order to get as large a useful reflecting surface into a given size tubular bulb, the perimeter of the reflector is made non-circular, that is the reflector has two sides **39**, **40**, "cut off" to a slightly bowed configuration, as shown in the figures. The reflector can be cut off on each side in a plane at about 15° to the plane of the front of the reflector.

If the filament is made long in comparison to its diameter and placed so that its ends are nearest the cut-off or bowed sides of the reflector, as shown in the figures, the amount of light directed toward the bowed ends will be minimized and the resultant combination will be the most effective reflector-filament structure for insertion into a bulb of given diameter.

In the specific embodiment herein described, the reflector was substantially ellipsoidal, that is, a surface of revolution of the curve

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

about the "y" axis, the linear dimension in the curve being the inch.

The curve described is enough different from an exact ellipsoid to give a maximum of diffuse reflected light at a film gate about 1¾ inches from the plane of the front of the reflector.

The filament was set about 0.520 inch from the apex of the face of the reflector.

A reflector of spherical surface, with the filament about half-way between the center of curvature and the surface can also be used, but will give a smaller amount of light at the film gate.

A true ellipsoid is also effective, but in order to avoid an image at the film gate, should be used with the filament, or the film gate, or both, slightly off-focus.

The lamp can, of course, be used for other purposes than the illumination of a film gate, and for some of those, an image may be desired.

The lead-in wire **37** has the fuse wire **29** therein, the latter being a nickel wire of reduced diameter, about 0.12 mm., and about 3 mm. long. The other lead-in and support wires **21**, **22**, **32**, **33**, **36**, **37** are about 0.050 in. in diameter. The lead-in pins **7**, **8**, **9**, **10** are of so-called "Dumet" wire, that is a well-known copper-coated nickel-iron alloy wire, about 0.025 inch in diameter, where they pass through the glass, for a length of about 0.175 inch and of nickel, or of a nickel-iron alloy known as "Alloy 52," just as they emerge from the glass. The pin is of copperweld wire, that is of copper-coated steel, on its portion external to the lamp. The copperweld wire, Dumet wire and nickel wire are butt-welded together at their joints.

The ceramic button **23** has a width of about 0.150 inch, and the semi-circle of its curved end has that dimension for its diameter. The distance between the squared end and the curved end (taken to the apex of the curve) is 0.400 inch. The axial thickness of the flange is about 0.045 inch. The width of the flat sleeve portion is about 0.110 inch and the length, taken between the apexes of the curves at each end, is 0.360 inch, and the axial distance along the sleeve is 0.205 inch. The slot is 0.170 inch long, from the front face of the button, the bottom of the slot being rounded to a radius of about 0.012 inch, and the slot is about 0.024 inch wide. The holes through which the wires **21**, **22** extend are 0.051 inch in diameter, to make a tight fit with 0.050 inch diameter wires, and about 0.250 inch apart between centers. The corners at the squared end are actually rounded to about 0.015 inch radius, a very small radius.

The button **23** can be of any good refractory material; we have used, for example, a ceramic manufactured by Clowes Ceramics, Chattanooga, Tennessee, and known as "Steatite" 4450–50, composed of 86% talc, 8% feldspar and 6% ball clay.

The reflector can be made of a copper sheet, of a grade free from any appreciable scratches on the reflecting side. The copper pins can be cut out to the desired shape and

pressed between a concave and convex die of such shape to give the desired curvature. The copper is then polished, nickel-plated, polished again and then coated with a silver reflecting surface by evaporation of the silver thereon in a manner known to the art.

The bulb has a diameter of about 1½ inches, being known in the industry as a T–12 bulb, of lime glass, and the diameter is reduced to about 1$\frac{3}{32}$ inch at the neck portion inside cap 11.

The alignment of filament and reflector with each other is, as previously explained, independent of the rest of the lamp. However, the direction of the beam, that is the direction in which the reflector-filament unit faces, is determined by the position in which it is held by the support wires. The alignment of the beam can be done by adjusting the support and lead-in wires, or by fixing their shape and position, on the glass wafer 2 before the wafer is sealed to the bulb, and the cap 11 cemented onto the bulb in a proper position to align the bulb properly in a socket of the type mentioned.

The filament was about 2.0 mm. in outside diameter and about 7 millimeters long, being a coiled coil as shown in the example in a patent application Serial No. 674,364, filed July 26, 1957, now U.S. Patent 2,863,359, by Wilfrid G. Matheson. A filament long on comparison to its diameter is most effective with the reflector described.

We have found that the shock-resistance of the filament can be greatly increased by pulling out the end turn at each side to a slightly greater pitch than that of the remainder of the coil, making the whole coil about 8.5 millimeters long between the support wires 21, 22.

No condensing lens is necessary with the device of our invention, when used in a motion picture projector.

In a lamp having a reflecting surface deposited on the inside of the glass bulb, the metallic vapors from the filament tend to deposit on the reflector, blackening it and reducing its reflective power. When the reflector is spaced from the bulb, however, the convection currents will carry the vapors upward and away from the reflector, so that they will eventually deposit on the glass bulb. A considerable part of the vapor will deposit on the part of the bulb behind the reflector where it does not reduce the light output.

The specific example for which dimensions are given is for operation at about 150 to 160 watts at a line voltage of about 110 to 115 volts, under which conditions it gives about as much illumination at the film gate as a 500-watt lamp with an external reflector, thereby requiring a smaller amount of cooling and permitting the use of a smaller reflector.

Various modifications of the device described can be made by a person skilled in the art without departing from the spirit and scope of the invention.

What we claim is:

1. An incandescent lamp comprising an hermetic sealed bulb having a light-transmitting portion, a concave reflector of sheet metal supported inside said bulb and spaced therefrom, a metallic filament inside the same bulb, and means holding said filament in reflecting relationship to said reflector and insulating it therefrom, said filament being placed between the concave reflector and the light-transmitting portion of the bulb.

2. The combination of claim 1, in which the means holding the filament is a pair of support wires set into an insulating button in said reflector.

3. An incandescent lamp comprising a sealed light-transmitting bulb, a reflector of sheet metal inside said bulb, a metallic filament inside said bulb, electrically-conducting support wires for said filament, a ceramic button in which said support wires are held, said button being shaped to have three points which can be brought into contact with said reflector to position the button precisely therein, and means urging said button against said reflector at said three points.

4. An incandescent lamp having a tubular bulb having a light-transmitting portion, a filament in said bulb, said filament being a coiled coil having a substantially straight longitudinal axis and a diameter small compared with the length of the coil, a concave reflector of sheet metal inside said bulb with the axis of said reflector perpendicular to the axis of the bulb and directed to reflect light from said filament through said light-reflecting portion, said reflector and said filament being supported solely from one end of the bulb by rigid lead-in and support wires sealed through said end of said envelope to act as contact prongs.

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