Jan. 30, 1940. W. J. HITCHCOCK 2,188,298

SEAL FOR EVACUATED DEVICES

Filed July 2, 1937

Fig. 3.

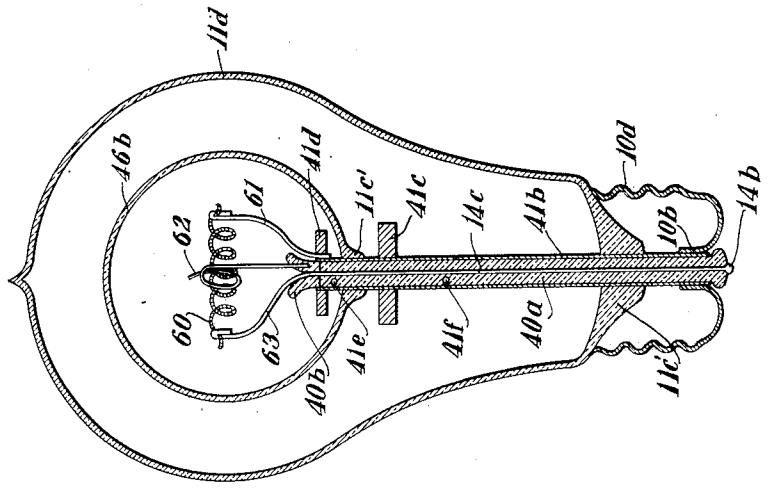



Fig. 4.

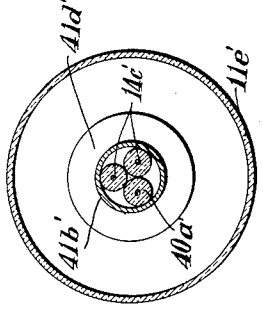



Fig. 2.

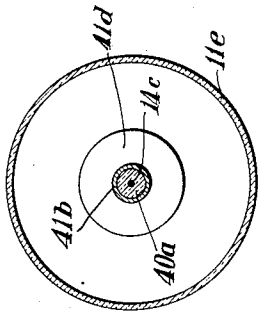
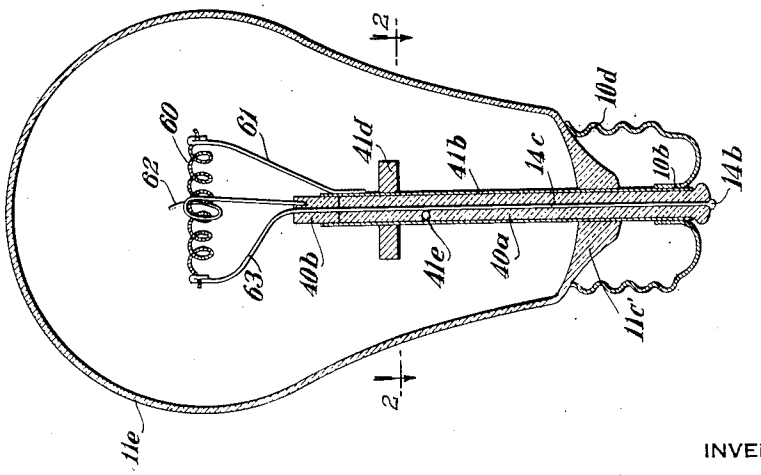



Fig. 1.




INVENTOR

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2,188,298

## SEAL FOR EVACUATED DEVICES

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Application July 2, 1937, Serial No. 151,588

7 Claims. (Cl. 176—16)

The present invention relates particularly to tight joints between glass and metal for sealing off lamps and other devices from the atmosphere in a fashion eliminating flares. In the case of incandescent lamps, and such lamps as described in my United States Patent No. 2,166,781 for Electric lamp, of which this present application is a continuation in part, it relates particularly to arrangements whereby lamps may be sealed off at any reasonable pressure desired, even at two different pressures within one external envelope, or a pressure greater than that of the atmosphere, even after the complete assembly of the lamp except for its base and without the need for any flare. The general principles of the invention are also applicable to exhausting and sealing radio tubes and similar electronic devices depending on the emission of electrons under the action of light or electrical discharges in gases. In some such cases, it may be desirable to substitute a metal bulb for the glass bulbs that are described below.

The principle underlying the present invention resides in the design or arrangment of the metallic conductors and insulating glass parts of such devices so that their seals will allow of an outwardly directed net gas pressure even when warm, or of an inwardly directed gas pressure, and may be made after sealing the outermost conductor to the bulb. An important feature of the present invention is that the seals may be made by high frequency heating if desired, and more than one seal may shut off a space from contamination by the atmosphere so that its freedom from such contamination does not depend on the excellence of one seal alone.

In the case of incandescent lamps particularly, an important feature of the present invention is that it lessens the length of wire necessary in such leads as those of an incandescent lamp, which are ordinarily thin nickel wires extending from the stem to the filament and are analogous to the leads 61 and 63 of the drawing and which are necessary to keep the filament well away from any surface of considerable area, such as the wall of the bulb itself, that might blacken due to evaporation of tungsten from the filament and decrease the light output of the lamp as one conductor, through most of its length, is a metallic cylindrical tube fitted over glass tubing that contains the other leading-in conductor. The two conductors are insulated from each other by the glass, which may be melted down upon them to form a seal, and rigid support, at any reasonable pressure, including pressures within the bulb greater than atmospheric, which is not possible in making a glass tip as under greater internal pressure than that of the atmosphere the soft hot glass of a glass tip blows out into the atmosphere, opens, and allows the gas contained within the bulb to escape. As mentioned, the heat for making this seal may be furnished by high frequency electrical eddy currents, especially if the outer cylindrical conductor has been provided with an electrically well conducting enlargement, or enlargements.

As leading-in conductors, assembled in this fashion, may be sealed into glass bulbs without the provision of any other stem whatsoever (in the fashion known as a pinch seal and common with neon sign lamp cathodes or at the tops of radio tube bulbs) and may consist of more than two conductors, as will be shown more particularly below, and may serve as a rigid support for a variety of apparatus internal to such bulb and its external base; the principles of the invention are applicable to many different types of evacuated devices that ordinary require a glass stem but will be made sufficiently clear to those skilled in the art by examples in the form of incandescent lamps to which the accompanying drawing refers.

In the purely diagrammatic drawing—

Figure 1 is a vertical section of an incandescent lamp.

Figure 2 is a section taken on the line 2—2 of Figure 1 looking in the direction of the arrows.

Figure 3 is a vertical section of a similar incandescent lamp except it has been provided with a double walled or outer bulb.

Figure 4 is a sectional view of a modified form of sealing means adapted for use with more than two leading-in conductors but otherwise generally similar to Figure 2.

Figures 1, 2, and 3, illustrate the application to incandescent lamps of the simplest form of the seal of my invention. No flare, or other stem, is required as such leading-in conductors as are required may be sealed in in the same fashion as the cathodes of neon sign lamps. No basing cement is needed as it suffices to solder a base to the externally projecting portion of the outermost conductor. Since the length of this is a fixed quantity, coils may be accurately positioned with regard to the base and bulb; a matter that has some application to headlight, projector, automobile, and other lamps used in conjunction with reflectors and lenses. Lamps may be sealed off from the atmosphere while their internal gas pressure is greater than that surrounding their bulbs, minimizing difficulty with arcs even in the

case of high voltage and coiled coil lamps burning in the 84 to 96% argon-nitrogen mixture and making it more practical to use incandescent lamps as sources of ultra-violet light. Coiled coil lamps are more shock resistant than with the long support wires of the usual mount.

Referring to Figures 1 and 2, these illustrate an incandescent lamp with a single walled bulb 11e having a coiled coil filament of tungsten supported in a pigtail 62 and by leads 61 and 63. The pigtail 62 is inserted by methods well known to the art in a glass section 40b which has been lightly fused to the wire 63 and a metallic tube 41b. Wire 61 is welded to the tube 41b which also carries a heavy collar 41d of some well conducting metal, such as nickel plated copper, either hard soldered to it, firmly united to it as by the plating process, or any other good tight fit upon it. The wire 63 continues through the length of the tube 41b and preferably consists of one length of any metal that will unit in a vacuum tight manner with the particular glass being used, although it may consist of several metals welded together only some of which will unite with glass, as is the practice with the present incandescent lamps now in commercial use. After the bulb 11e, which is preferably frosted, consists of soft glass, and has any of the usual shapes of such bulbs, has been fused to the tube 41b at the point 11c', the glass tube 40a is slipped over section 14c of the wire 63 and a ball is formed by heating with a gas flame at point 14b on wire 14c and the glass is thereby held in position while the lamp is exhausted. This is next done, care having been taken that the heating to form the ball has not sealed off the lamp from the pump. The lamp is exhausted through an orifice 41e in the tube 41b and through the length of this tube. If desired and if care is taken in fusing the bulb to tube 41b not to melt the glass 40a within it, as by very rapidly applying heat and using a temporary sleeve over tube 41b until the seal to the bulb is almost made, one length of glass may be left inside tube 41b from the beginning and there is no necessity to use two separate sections of glass tubing 40a and 40b.

After exhaust, the lamp is sealed off from the atmosphere and the pump, either by high frequency heating applied to the collar 41d melting the glass at the orifice 41e until it is firmly united with the metal of the tube 41b below the orifice and with that of the wire 14c, so that the atmosphere is excluded from the lamp, or by a gas flame applied as is usual with incandescent lamps having glass tubulations and tips below the seal 11c', or by both methods in conjunction. After the lamp is sealed off from the atmosphere, the brass base 10d is slipped over the tube 41b and soldered to it at the point 10b by further heating with a gas flame at the point 14b, or by high frequency heating, or by heating in an oven.

The operation of the lamp will be understood to be that of an incandescent lamp except where it is possible to seal the lamp off with a greater quantity of gas within it than that corresponding to atmospheric pressure at the temperature of the lamp while the seal is being made, it is thought that this will generally be done as it usually results in either a whiter or more efficient lamp at a fixed life or in a longer lived and whiter lamp at the same efficiency as formerly. It also results in a lamp having less tendency to arc than one having a lower gas pressure and other advantages mentioned above. In particular, when the lamp is filled with hydrogen rather than the common argon mixture with nitrogen, while the lamp is very inefficient due to the well known cooling action of the hydrogen, the rapidity of this cooling action on a fine filament or thin ribbon is such as to allow of the operation of the lamp in the transmission of facsimiles by radio or wire as fluctuations in light output will follow such rapidly varying currents.

A construction facilitating a much higher pressure than atmospheric is illustrated in Figure 3. This modification has further advantages over that of Figures 1 and 2 in that when both bulbs are frosted or of opal glass a much better diffusion of the light of the filament is obtained than is possible in a single walled bulb. Colors, or a film of cellulose lacquer, applied to the outer wall of the inner bulb are protected by the outer bulb, or the inner bulb may be of the somewhat expensive daylight blue glass, or other special glass, while the larger outer bulb is of ordinary glass. Furthermore as only the inner bulb need be filled with inert gas, or hydrogen, etc., there results considerable economy in the use of such gas that might even make the very rare gas Krypton a more practical material for use in incandescent lamps and somewhat reduces the expense of filling a lamp to a higher pressure than atmospheric. If desired the space between the bulbs 11d and 46b may be provided with inlets and outlets for water, oil, or other cooling fluid and most of the heat of the lamp carried away by circulating such fluid or gas. Handsome decorative effects may be obtained by permanently sealing off such fluids, especially glycerine and water mixtures, in the space between the two bulbs together with such things as bits of colored mica or glass that will circulate when the lamp is lit. Or this space may be permanently filled with hydrogen to cool the inner bulb especially when the lamp within the inner bulb is such a lamp as the recently developed ultra high pressure mercury lamps. The most important advantage; however, is that a fracture of the inner bulb while filled with a gas pressure above atmospheric is a less serious matter than it is when no outer bulb is present. This is not to say; however, that even a single bulb, such as that of Figure 1, may not be so protected by a coating of lacquer drying to a tough elastic outer wall covering substantially the whole exposed area of the bulb, or a wire guard, that it may be shattered with impunity while filled with pressures approximately twice atmospheric. A lacquer transparent to ultraviolet light and resistant to heat, such as cellulose acetate, is preferred.

In any case, the inner bulb 46b is evacuated as explained in connection with Figures 1 and 2, with similar numbers corresponding. The outer bulb 11d is then sealed to tube 41b and if this process is carried out while the inner bulb is still in connection with the pumps, the inner bulb is further sealed from the pump and the atmosphere. If the outer bulb is then in turn evacuated of air, preferably through a tip on the top of the bulb as was formerly common with incandescent lamps but if desired, through an orifice at 41f, which is shown together with a collar 41c by means of which the outer bulb may be sealed if desired; these processes may be carried out in a manner similar to that described in connection with the foregoing modification of the invention. Furthermore, if desired, the structure of the seal may be identical with that described in connection with my copending application Serial No.

83,571. It will be understood that the lamp operates much as described in connection with Figure 1.

Figure 4 illustrates a form of seal, generally similar to Figure 2, and having similar numbers corresponding to the numbers of Figure 2. Similarly to Figure 2, it is a section taken on the line 2—2 of Figure 1 looking in the direction of the arrows or in a like location in Figure 3. For clarity, the glass tubes 40*a'* have been shown unmelted but in sealing the lamp, as explained above, heat generated by electrical eddy currents flowing in the metallic flange 41*d'*, which is a separate tight fitting collar on the metallic tube 41*b'*, and is larger than the tube 41*b'*, melts the glass immediately within this collar, most of the rest of the tube 41*b'* staying relatively cool, and this glass flows down upon the unmelted glass to seal the channels shown within 41*b'*, the metallic tube. The glass does not completely fill the metal tube 41*b'* except at a level close to the lower level of the collar but below the orifices shown. The methods by which high frequency electrical currents may be caused to circulate in the flange 41*d'* are entirely similar to those well known in heating the interior parts of radio tubes. As mentioned above, if this method of heating is not used, the channels shown may be sealed by heat from a gas flame applied externally to the lamp, or both methods may be used. This method of sealing is common to all the figures and minor variations in it, such as pinching the lower end of the metallic tube after it has been heated by the gas flame, to more easily close the channels shown, will be obvious to all skilled in the art of sealing evacuated devices. It will, however, ordinarily be unnecessary to go to this trouble, as glass wets the metals or alloys used for the tube and the leading-in conductors and when fluid is drawn up into the tube by capillary attraction much as water is drawn up into a glass tube, and it entirely fills the tube at the place where the glass has been melted. It may be used instead of the seal of Figure 2 when two or more leading-in conductors 14*c'* are needed, as may be the case with an incandescent lamp S containing more than one filament or the lamps of my copending application Serial No. 83,571. In such cases the external metallic tube 41*b'* may or may not be used as a conductor of electricity. It may serve merely to carry the collar 41*d'* or as an electrostatic shield or to gather the lead wires within itself into a compact and strong bundle capable of supporting considerable weight. In all cases; however, these metallic tubes and leading-in conductors are made of materials which readily unite with glass to give seals through which no air leaks. Such materials are well known including in the case of soft glass the elements platinum and copper, copper having a borated surface and the composite material known as copperclad or Dumet. Also a series of alloys, appearing to be principally nickel, chromium, and cobalt and known under such trade names as "52 or 53 metal." These alloys are the same as those described in the magazine "Physics" for December 1934 by A. W. Hull and E. E. Burger under the title of Glass to metal seals and in the case of the alloy matching standard lead glass, the composition is Fe 37%, Ni 30%, Co 25%, Cr 8%.

The examples given are not to be taken as limiting the scope of the invention to the employment of its principles in incandescent lamps since the functions of the invention are applicable quite generally to many specific forms of devices whose operation depends upon freedom from contamination by the atmosphere.

I claim:

1. In an electric lamp, a translucent double walled bulb, a metallic tube extending through both walls of the said bulb and attached to at least one in a gas tight manner, a leading-in conductor of electric power to the interior of the said bulb included within the said metallic tube, and an electrical insulator included between the said tube and the said conductor and attached to them in a gas tight manner.

2. In an electrical device, an enclosure excluding the atmosphere, a metallic electrically conducting exhaust tube extending through the wall of the said enclosure and attached to it in a gas tight manner, at least one leading-in conductor of electric power extending through said tube to the interior of the said enclosure, an electrical insulator included between the said tube and the said conductor and attached to them in a gas tight manner, and apparatus consuming electric power in the interior of the said enclosure connected to at least two of the conductors constituted by the said at least one leading-in conductor and the said metallic exhaust tube.

3. In an electric lamp, a blub excluding the atmosphere and at least partially permeable to light, a metallic electrically conductive exhaust tube extending through the wall of the enclosure and attached to it in a gas tight manner, at least one leading-in conductor of electric power extending through said tube to the interior of the said bulb, an electrical insulator included between the said tube and the said leading-in conductor and attached to them in a gas tight manner, and a source of light connected to at least two of the conductors constituted by the said at least one leading-in conductor and the said metallic exhaust tube.

4. In an electric lamp, a bulb excluding the atmosphere and at least partially permeable to light, a metallic electrically conducting exhaust tube extending through the wall of the said bulb and attached to it in a gas tight manner, at least one leading-in conductor of electric power extending through said tube to the interior of the said bulb, an electrical insulator included between the said tube and the said conductor and attached to them in a gas tight manner, a metallic flange on the said tube, and a source of light connected to at least two of the conductors constituted by the said at least one leading-in conductor and the said metallic exhaust tube.

5. In an incandescent electric lamp, a bulb excluding the atmosphere and at least partially permeable to light, a metallic electrically conductive exhaust tube extending through the wall of the said bulb and permanently confining gas at a higher pressure than atmospheric within said bulb, at least one leading-in conductor of electric power extending through said tube to the interior of said bulb, an electrical insulator included between said tube and the said leading-in conductor and sealed to them in a gas tight manner, and a solid incandescent body connected to at least two of the conductors constituted by the said at least one leading-in conductor and the said metallic exhaust tube.

6. In an electric lamp, an envelope excluding the atmosphere and at least partially permeable to light, a metallic exhaust tube extending

through the envelope and attached to it in a gas tight manner, an electrically conductive flange on the exhaust tube within the envelope, material more fusible than the exhaust tube within the exhaust tube and permanently sealing the same at the flange, leading-in conductors of electric power to the interior of the said envelope, and a source of light in the interior of the said envelope connected to at least two of the conductors constituted by the said leading-in conductors and the said metallic exhaust tube.

7. In a permanently sealed incandescent electric lamp containing gas at greater than atmospheric pressure, a light transmitting double walled bulb having an inner wall of glass and a substantially complete tough elastic outer wall covering in contact with the glass, a metallic exhaust tube extending through the said inner wall and sealed to it, an internal seal of glass within the said metallic tube, and a source of light within the said inner wall connected to conductors of electricity extending from the exterior to the interior of the said double walled bulb.

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