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INCANDESCENT LAMP WITH VIBRATION DAMPING SUPPORT FOR FILAMENT

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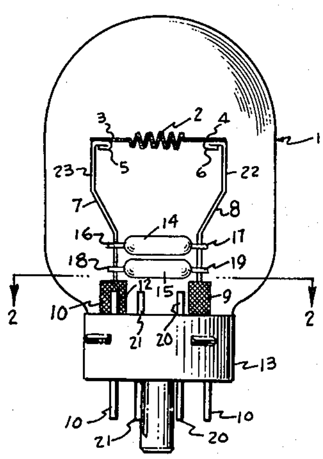

fig. 1

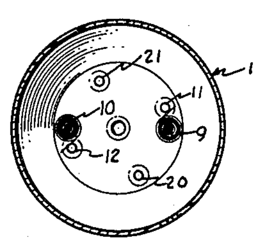

fig. 2

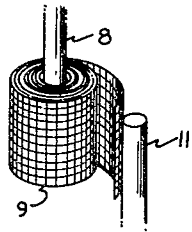

fig. 3

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INCANDESCENT LAMP WITH VIBRATION DAMPING SUPPORT FOR FILAMENT

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This invention relates to incandescent lamps. Such lamps generally comprise an electrically-incandescible body, such as a filament, in a sealed enclosing envelope of a light-transmitting material such as glass.

The incandescible body has generally been of tungsten, the brightness and efficiency of the lamp being therefor no greater than that obtainable at the melting point of tungsten, which is about 3300° C.

A much higher brightness can be obtained by making the incandescible body of a more refractory material, but if it is to be heated by passage of current through it, the material must be also electrically conductive. Tantalum carbide is a conductive material more refractory than tungsten and has been suggested for use as an incandescible body in an incandescent lamp.

Tantalum carbide, however, is hard and brittle, so it cannot be drawn into wire, and even if it could be so drawn, would be practically impossible to form into a coil.

The suggestion has therefore been made that a coiled filament be made of tantalum metal, mounted on suitable support and lead-in wires in a lamp envelope, and then transformed to tantalum carbide in situ by being heated to a suitable temperature in the presence of a carburizing gas, generally a hydrocarbon such as methane. A small amount of the latter is preferably used in an atomsphere of another gas such as hydrogen.

However, a tantalum carbide coil is extremely brittle, and will be shattered if the envelope containing it is dropped even an inch or two onto a hard surface. High speed motion pictures of the shattering taken at a rate of 3000 pictures per second, show that the entire destruction of the filament takes place between the instant one picture is taken and the instant the next is taken, that is, in no more than 1/3000 of a second. One picture shows the filament intact, the next shows it destroyed. The shattering impulse is therefore of high frequency, or of very short duration.

Since the shocks which destroy the coil are of the high frequency type, it is essential to damp out any such vibrations and prevent their transmission to the coil. Attaching shock absorbers to the lead-in wires, for example, by running extensions from the lead-in wires to small containers of glass wool or other damping substances, can be helpful in this respect. At the same time, the mount can be made heavy enough to avoid high frequency resonance.

We have discovered, however, that the filament can be better protected against shock by placing the shock absorbing material in series connection with the lead-in wires, both electrically and mechanically, for example, by making part of the lead-in wire of suitable spring material, provided that the losses in the spring are sufficient to damp out the vibration instead of transmitting it.

A helical spring can be placed in series with the lead-in wires to damp out the vibration and prevent its transmission to the filament by that route. However, the wires would have to be rather rigid if they were to maintain and support the filament in precise position and their effectiveness might not be as great as desired. Moreover, the length of spring required would result in an appreciable voltage drop, between one end of the spring

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and the other, with consequent reduction in lamp efficiency. A smaller proportion of the applied voltage would get to the tantalum carbide coil.

We have discovered that more effective shock protection for the filament can be obtained if the spring placed in series, electrically and mechanically, with the lead-in wires is of the spiral type. The spring can be of suitable metal strip, but will be far more effective if made of wire mesh, for example, nickel mesh, of considerable width. Such mesh, being made of a multitude of woven wires, can stretch somewhat in two directions, and the friction losses at the multitude of points where the wires cross in the mesh, will help to damp out the vibrations, particularly those of high frequency. The wires will slide over one another in various directions at the intersections, since they are merely woven together and the wires are not welded together at the cross-over points.

If the lead-in wires are vertical the plane of the mesh can be vertical, the material being wound into a spiral about a vertical axis. The wires extending upwardly toward the filament can be attached to the mesh at the center of the spiral, with the lead-in wires below the spring being welded to the outside end of the spiral.

Merely placing shock-absorbing means in series with the filament, or in contact with the support wires, will not be fully effective if each support wire extending from the spring to the filament is independent of the other, because then any small shock which did get through the absorbing means might move one support wire one way and the other wire the other way, stretching the coil or compressing it.

In order to avoid the latter and make the filament mount, above the springs, a stiff firmly fixed unit, as well as to augment its weight and thereby decrease its transmissivity of high frequency vibrations, we fix the support wires firmly in position with respect to each other by means of insulating struts mechanically connected, for example, between them. These struts can, for example, be glass beads with wires extending from their ends and welded to the support wires, but in that case two such struts should be used to fix the wires rigidly in a definite relationship. However, instead of using two struts, a wider strut can be used, so that it will hold each wire at at least two spaced points on that wire, or along a sufficient length of the wire to insure rigidity.

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

FIGURE 1 is a profile view of the invention; and

FIGURE 2 is a plan cross-section on plane 2—2; and

FIGURE 3 is a perspective view of the mesh spring.

In FIGURE 1, the sealed glass envelope **1** contains the coiled-coil filament **2** of tantalum carbide wire, the coil being welded at its ends **3**, **4** to the ends **5**, **6** of the support wires **7**, **8** which in turn are welded, respectively, to the inside edges of the spiral mesh springs **9**, **10** in a direction transverse to the length of the mesh. The lead-in wires **11**, **12**, respectively, are welded to the outside edge of the springs **9**, **10** and extend through the glass to act as contact prongs outside of the envelope **1**; that is, they are hermetically sealed through the envelope **1** at its bottom, as shown in the drawing. The usual metal cap **13**, for example as shown in co-pending United States patent application Serial No. 553,367 filed December 15, 1955, by William Morgan, Jr., is cemented to the bottom portion of the envelope **1**.

To make the mount more stiff and rigid, the glass beads **14**, **15** are provided. The wires **16**, **17**, **18**, **19** extend out of the ends of the beads **14**, **15** and are welded to the support wires **7**, **8** to act as stiffening struts.

For proper positioning of the lamp in the usual socket, extra contact prongs and lead-in wires **20**, **21** are provided. These may, if desired, be connected, respectively, to lead-in wires 11, 12 to help carry the current, or may be left electrically unconnected. The connection between one of said wires 20, 21 and the lead-in wires can be made through a fuse, as in United States Patent 2,859,381 issued November 4, 1958, to O. H. Biggs and S. Gray.

The lamp envelope contains a filling of argon containing 8% hydrogen and 0.3% carbon tetrachloride, the latter gas being used to improve the maintenance of light output in the lamp during life, and the hydrogen combination being present to insure that the tantalum carbide filament will remain in the carburized form throughout its life. The argon is added to improve the life of the lamp by reducing evaporation from the filament, and to increase the efficiency by reducing the cooling of the filament. The filling is at a pressure of about 800 mm.

The support wires 7, 8 can be of nickel and are 0.045 inch in diameter. The ends 5, 6 are of tantalum, the latter preferably extending down to the beads 22, 23 at which point the result can be achieved by welding a tantalum wire to the support wires 7, 8 at those points. The glass beads 14, 15 are about 9 mm. long and about 5 mm. in diameter. The insert wires 16, 17, 18, 19 can be of about 0.040 inch in diameter.

The spiral configuration of spring 9 is shown in FIGURE 2. The inside lead-in wires 7, 8 are shown welded to the inside end of the spring 9 at or near, and parallel to, its axis. The nickel wire mesh has 60 wires to the inch lengthwise, and 40 per inch across its width; that is, it is a so-called 60–40 mesh. The wires are about 0.005 inch in diameter.

The tantalum carbide filament 2 is formed from a coiled-coil of 0.007 inch diameter tantalum, the minor coil having an inside diameter of 0.010 inch and the major coil an inside diameter of 0.030 inch.

The filament is made by doubly-coiling a wire of metallic tantalum, or suitable alloy thereof (the alloy known as "Tantaloy," containing about 7.5% tungsten, is satisfactory), then welding it to the support wire ends 3, 4 mounting it in a lamp envelope and then carburizing it by passing enough current through it to raise it to a temperature between about 2000° C. and 2600° C. in an atmosphere of hydrogen containing about ⅛ of 1% to ¼ of 1% of methane gas, the total gas pressure being about atmospheric, that is, about 800 mm. of mercury. However, we prefer to use hydrogen saturated with xylol at room temperature, xylol being a hydrocarbon.

During the carburizing, the coil increases about 24% in volume and this tends to distort the shape of the coil considerably especially when the filament is a coiled-coil. The distortion can be reduced by carburizing in a series of steps. For example, the coil can first be heated at about 2250° C. for about 1½ minutes, then pumped out, that is exhausted of gas, and refilled with the same gas mixture. The gas mixture used can be 100 mm. of hydrogen saturated with xylol, as above, and 700 mm. of reasonably pure hydrogen.

The above heating, exhausting and filling process can be repeated about five times, and then the gas filling can be changed to 800 mm. of mercury pressure of hydrogen saturated with xylol at room temperature, the hydrocarbon content being thus increased. The temperature is then raised to 2380° C. for about half a minute, and then raised slowly to 2500° C. in about one and one half minutes. This is repeated about four times, and then the lamp can be exhausted and filled with the final filling gas that is to be present in the lamp. This can be the gas filling mentioned for that purpose in describing FIGURE 1.

The above process will result in a tantalum carbide coil with less distortion than that obtained with quick, one-step conversion. However, the coil will still sag somewhat before the fifth step is reached.

The sagging can be entirely prevented if the coil is to be carburized in a horizontal position by painting the upper half of the coil surface with a suspension of colloidal graphite in water, for example, the suspension known as "aquadag." The effectiveness of this coating is apparently due to the depletion of the carbon in the hydrocarbon gas as the latter rises from the top to the bottom of the hot coil by convection. Whatever be the reason, the effect of applying the carbon is dramatic. It completely ends the sagging.

The above is particularly true of coils in which the minor and major windings are in the same direction, for example, both clockwise. Coiling the major and minor windings in opposite directions appears to enhance the sagging.

The mesh spring 9 is about 1⅜ inch long and 7/16 inch wide, wound in a coil of about three turns to an outside diameter of about one-quarter inch. The dimensions can be varied, as long as the damping effect of the spring is sufficient.

Various modifications of the specific example given will be apparent to those skilled in the art without departing from the spirit and scope of the invention. The specific dimensions, gas pressures and compositions given have, however, proven very effective for a 200 watt lamp to be operated at about 38 volts. If longer life is desired, the percentage of hydrogen in the gas filling of the final sealed lamp can be raised, for example, to about 15%, at some sacrifice of efficiency. The amount of carbon tetrachloride can also be varied, quantities between about 0.3% to about 0.8% being especially effective, and other substance to increase the light output can be used instead.

The filament 2 described above is especially useful in projection lamps, where high brightness and efficiency is of great importance, and can be used for example in the filament in the projection lamp of co-pending applications, Serial No. 701,414 filed December 9, 1957, and Serial No. 707,952 filed January 9, 1958, respectively. In such lamps the filament support wires are held in a ceramic button set in a reflector, and that button can serve as the means for holding the wires rigid. Lead-in wires to the filament or support wires for the reflector extend from four lead-in wires in the envelope, and damping springs would need to be used in all four.

The structure described can be used with filaments of brittle materials other than tantalum carbide.

By an "incandescible" material in the foregoing specification is meant one which can be made incandescent.

The amount of graphite used on the upper half of the filament described was 1.4 mg.

The temperatures given in the specification were measured on an optical pyrometer.

What we claim is:

1. An incandescent lamp comprising a filament of refractory electrically-conductive material, a support wire for each end of said filament, insulating stiffening means mechanically connecting said support wires to form a rigid, stiff structure, a damping spring at one end of each support wire, and a lead-in wire mechanically connected to each damping spring.

2. An incandescent lamp comprising a filament of refractory electrically-conductive material, a support wire for each end of said filament, insulating stiffening means mechanically connecting said support wires to form a rigid, stiff structure, spiral damping springs at the ends of said support wires, and lead-in wires mechanically connected to said damping springs.

3. An incandescent lamp comprising a filament of refractory, electrically conductive material, a support wire for each end of said filament, insulating stiffening means mechanically connecting said support wires to form a rigid, stiff structure, wire-mesh spiral damping springs at the ends of said support wires, and lead-in wires mechanically connected to said damping springs.

4. An incandescent lamp comprising an enclosing envelope, a filament of refractory material, a stiff rigid mounting for said filament, and at least one spring of

high damping characteristic attached between said mounting and said envelope.

5. An incandescent lamp comprising a sealed enclosing envelope, lead-in wires sealed therethrough, a filament of refractory conductive material, a stiff, rigid mounting for said filament, said mounting including electrical connections from said filament, and a spring of high damping characteristic between each lead-in wire and the mounting.

6. An electric incandescent lamp comprising a sealed light-transmitting envelope; lead-in wires extending therethrough; a damped spring attached to each of said lead-in wires; a support wire extending from each damped spring; means holding said support wires in fixed relationship to each other to form a stiff, rigid support for a filament; and a filament of refractory, conductive material connected between the otherwise free ends of said support wires.

7. An electric incandescent lamp comprising a sealed light-transmitting envelope; lead-in wires extending therethrough; a damped spring attached to each of said lead-

in wires; a support wire extending from each damped spring; means holding said support wires in fixed relationship to each other to form a stiff, rigid support for a filament; and a filament of tantalum carbide between the otherwise free ends of said support wires.

8. An electric incandescent lamp comprising a sealed light-transmitting envelope; lead-in wires extending therethrough; a spiral spring of wire mesh attached to each of said lead-in wires for damping high frequency vibrations; a support wire extending from each damped spring; means holding said support wires in fixed relationship to each other to form a stiff, rigid support for a filament; and a filament of tantalum carbide between the otherwise free ends of said support wires.

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