

Sept. 17, 1940.

C. A. LAISE

2,214,742

INCANDESCENT LAMP AND MANUFACTURE THEREOF

Filed March 23, 1935

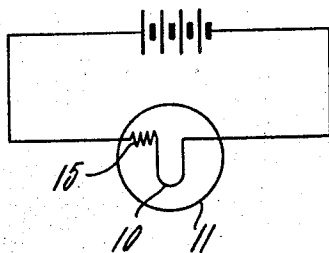


Fig. 1.

Fig. 2a.

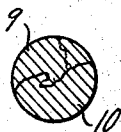


Fig. 2.

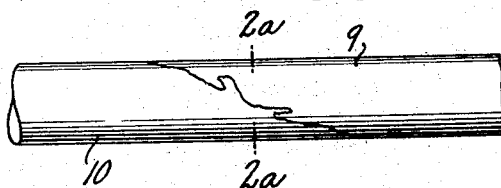
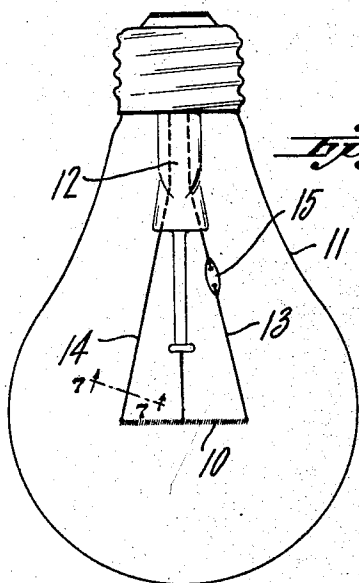


Fig. 3.

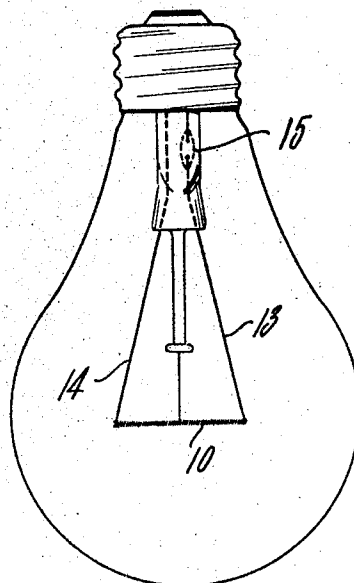


Fig. 4.

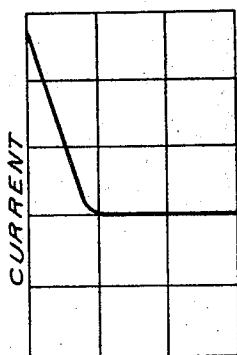


Fig. 5.

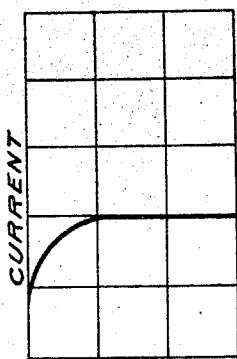


Fig. 6.

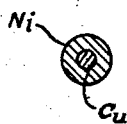


Fig. 7.

INVENTOR.  
CLEMENS A. LAISE  
BY *Charles Holland*  
ATTORNEY.

## UNITED STATES PATENT OFFICE

2,214,742

INCANDESCENT LAMP AND MANUFACTURE  
THEREOFClemens A. Laise, Tenaffy, N. J., Fidelity Union  
Trust Company, executor of said Clemens A.  
Laise, deceased

Application March 23, 1935, Serial No. 12,567

4 Claims. (Cl. 176—16)

This invention relates generally to improvement in high efficiency incandescent lamps, and especially to lamps of the character that utilize metallic filaments as light emitting elements. An important feature of the invention concerns a novel electrical circuit, preferably embodied in the lamp structure itself, which is adapted to produce a higher efficiency combined with longer life than is possible to attain with the lamps of the are as heretofore known. The invention is particularly concerned with the construction of such a lamp and circuit and method of making the same, which is especially well adapted for use in lamps produced in conformity with the principles herein set forth.

The expression "high efficiency lamp" as used in the present application needs a certain definition. It is probably true that this term has been in use since the early days of the lamp art. It is certainly true that with the introduction of metallic filaments, the lamps utilizing these filaments became known as "high efficiency lamps." The term, however, had meaning only in comparison with carbon lamps and other lamps of lesser efficiency. With the appearance of the tungsten filament lamp, the term acquired a new meaning and when this was followed by the gas-filled lamp with a coiled tungsten filament, it was thought that a lamp of this type was the "high efficiency lamp."

Developments of recent years have, however, shown still higher efficiencies are possible. For, whereas in former times each increase in efficiency was attained by use of an improved filament material or by use of a more suitable gaseous atmosphere, it has lately been the aim to use the same gaseous atmosphere and the same filament material but to attain greater efficiency by applying more exact engineering principles to the lamp construction.

In the lamp art, efficiency consists in obtaining the greatest amount of lumens per watt consistent with a sufficiently long life to satisfy commercial and practical needs. As efficiency is increased, the life of the lamp is shortened, other things being equal. In the lamp art of the past, however, the highest possible efficiency was rarely attained for the reason that such a lamp was not well adapted to sustain the shock of turning the current on or off. A metal filament is most conductive when cold; but as the temperature increases, the resistance also increases. There is, therefore, at the instant of switching on, a sudden surge of current through the filament which

produced a shock sufficient in many cases to rupture the filament.

It is an object of the present invention to provide a lamp capable of attaining the highest possible efficiency and which at the same time will be capable of preventing the surge and consequent shock due to the switching on of the current.

It is a further object of the invention to provide a lamp of the high efficiency described that will have a long commercial life. The elimination of the initial surge, of course, is the primary reason for this longer life, not only because with the elimination of the surge the shock is also eliminated, but also because a frequently observed phenomenon accompanying the surge, especially when the filament is highly concentrated, is the formation of an arc across the leads and the concomitant destruction of the filament at the point of junction with the leads.

It is a still further object to provide a lamp of high efficiency having lead wires of small diameter and hence with only slight cooling effect upon the filament. In lamps of the present art, the cooling effect of the leads is sufficient to cause relatively large differences in temperature with the highest temperatures midway between the leads. When such differences of temperatures exist, the filament frequently ruptures or fuses at the exceedingly hot midway point.

To accomplish these objects of the invention, a specially designed circuit is provided in the lamp.

The preferred elements of the circuit above suggested comprise a filament of the physical and mechanical structure hereinafter described; a resistance element having resistance characteristics opposed to those of the filament and sufficient to balance the initial current surge; and leads of small diameter and high conductivity. Such a circuit is represented diagrammatically in Fig. 1 of the annexed drawing. In Figs. 2 and 2<sup>a</sup> are illustrated cross-sectional and longitudinal sectional views of the filament; Figs. 3 and 4 illustrate different ways in which the circuit and filament may be incorporated in a standard type of lamp; Fig. 5 shows a current-time curve of the initial operation of an ordinary lamp; and Fig. 6 shows the current-time curve of a lamp constructed in accordance with the invention. Fig. 7 is an enlarged section taken along the line 7—7 of Fig. 3 showing the construction of the lead wires.

The above described elements will be described seriatim. First, the filament. The filament of

the lamp of this invention may be of the general type described and claimed in my Patent No. 1,631,493, consisting of tungsten as a base with additions of boron nitride or boron-suboxide and potassium borate which have a scavenging effect. The metallic bar from which the filament is drawn is so treated that at the sintering or metalizing temperature a portion of the scavengers distills out and takes along with it detrimental impurities that may be present in the tungsten base. The amount of such scavenger additions is such that in the final filament the amounts remaining are very minute, being one-quarter of one per cent. or less.

The filament is composed of tungsten so treated that it has few sectional boundaries, if any, in relation to its length. The filament metal is relatively soft and pliable and the section boundaries interlock laterally and longitudinally of the wire in such a manner that the filament neither sags, offsets nor ruptures, and the intergranular cement being reduced to a minimum, the filament has little tendency to twist or distort after it has been shaped and set into suitable concentrated form.

One prime cause of brittleness in tungsten filaments of the granular type of the prior art, is the presence of foreign non-metallic substances in the grain boundaries. For instance, in the old pressed or squirted tungsten filaments, an organic binder was used which became carbonized during the process of manufacture and formed carbides in the crystal boundaries. In the drawn tungsten filament as first produced, additions of various substances, such as the oxides of calcium, aluminum or thorium, were added for the purpose of retarding the growth of crystals. This practice resulted also in compounds in the grain boundaries that tended to produce a brittle filament, particularly after a short period of use. In the later so-called non-sag tungsten filament additions are made to the metal that produce silicon compounds and probably also hydrides in the grain boundaries with a resulting brittleness after relatively short use.

All such intergranular substances act solely as cements holding the grains together and preventing the grains from coalescing and forming larger grains. In the filament of the present invention, however, the cementing material is composed of scavenging substances which are added to the tungsten powder from which the slugs are made and from which they are drawn down to filament diameters. After the addition of the scavenging material to the powder, the same is worked into slugs in the usual way and the conditions of manufacture and heat treatment so regulated that they have a grain count of approximately 15,000 to 20,000 grains per square millimeter.

The slugs are mechanically worked by swaging and drawing into wire and then concentrated into coils or coiled-coils or rolled into ribbon and corrugated or twisted into concentrated form. In making coiled coils of filament wire, the wire should be so wound that the magnetic effect due to the line of force generated about it will not cause short circuiting.

When making coils or coiled-coils, mandrels of nickel or nichrome or other refractory metals soluble in acids may be used and the coil or coiled-coil is heated on the mandrel preferably in an atmosphere of wet hydrogen at temperatures ranging from 1000° C. to 1500° C. until a permanent set is imparted to the filament and the

wire has been relieved of all of its strain. Thus, there will be no readjustment of the coil after the mandrel is dissolved out.

I use wet hydrogen, a practice contrary to that of the present art in which dry hydrogen is used in such operations, for the reason that wet hydrogen tends to decompose carbides on the surface or in the grain boundaries of the filaments. If dry hydrogen is used, carbides are likely to form with the filament metal in the presence of carbon or carbon compounds. As a result of my process employing wet hydrogen, the pliability and ductility of the filament is not impaired as it would be if dry hydrogen were used.

The heat treated coil and mandrel are then cut to proper lengths to give the proper voltage of lamp and the mandrel is then dissolved in suitable acids such as nitric acid and sulphuric acid if nickel or nickel alloys are used as mandrel wire.

After the coil or other shape of filament treated in the above manner is mounted into the lamp, the lamp is sealed and exhausted or filled with gas and then flashed by connecting the lamp in series with a rheostat or nichrome resistance at about 125% over voltage that is 125% of the rated voltage of the filament for a period of about five minutes, so that the filament quickly attains the germinating temperatures and the grains coalesce or flow into each other, producing a light emitting medium with long interlocking sections which have little tendency to sag or distort. Such sections may consist of at least one turn and preferably several turns of coil, especially after the lamp has burned about one hour at its rated voltage.

During the flashing operation it is desirable to use twice the voltage of the greatest voltage of the lamp and so regulate the proper voltage in this temporary circuit so that about 125% drop takes place across the lamp and 75% in the balance of the circuit consisting of a suitable rheostat.

During the heat treatments above described, the scavenging materials tend to distill out, carrying with them substantially all impurities, including occluded hydrogen, that may be present in the grain boundaries. With these impurities eliminated, there is little obstruction to rapid grain growth and the formation in the filament of long sections and but few interlocking section boundaries. Instead of the particular scavenging materials mentioned, other refractory nitrides may be used with excellent effect, such as barium nitride or beryllium nitride.

In Figs. 2 and 2\* are illustrated enlarged sections of a straight filament composed of interlocking sections 9 and 10, which are representative of the filament structure above described.

It is apparent that this filament of few interlocking sections can be operated at a much higher efficiency or lumen output and longer life than a highly crystallized filament of many grain boundaries. Furthermore, it retains its shape after it is once permanently set or flashed by my special process in the lamp circuit of this invention, so that it does not droop, shrink, twist or short-circuit between the individual sections.

The shape of my light emitting filament may be a round cylindrical wire section, a square or oblong ribbon section, or may be in the form of a ribbon corrugated or twisted or in the form of a coil or a double coil or helical coil. For gas-filled lamps, especially of the higher voltage type, a concentrated form such as a coiled-coil is desirable. In every case, however, my principle of

treating the specially prepared filament body remains the same, namely, that the filament body containing boron scavengers, or the like, is subjected in my special circuit to a flashing or heat treating operation after the lamp is exhausted or even after it is based to produce the final structure in my light emitting element as previously set forth.

The second feature of my lamp is that the filament is preferably mounted upon lead wires of the general type described and claimed in the copending application of Clemens A. Laise and Jacob Kurtz, Serial No. 707,106, but the diameter of these lead wires, by virtue of the exceptional heat and current conductivity characteristics of the material thereof, may be made much smaller than that generally used in lamps of the present art of equivalent wattage and may be as small as 50% of the cross-sectional area of the lead wire of such generally used lamps.

The wire described and claimed in said copending application may be described generally as being composed of a nickel sheath and a copper core, the nickel constituting a relatively large proportion of the total wire and at least 10% thereof. In cross-section such a wire appears as indicated in the enlarged view of Fig. 7.

A third and very important feature of my invention is that the resistance or ballast disposed in the circuit is incorporated in one of the leads, either within the stem as indicated in Fig. 4, or without it as shown at 15 in Fig. 3; or it may even be arranged outside of the lamp.

The purpose of this ballast or resistance is to eliminate the sudden surge of current through my lamp. It may consist of a small choke coil or similar device which momentarily has a high resistance when connected across a difference of potential and then, as the current begins to flow, the resistance is practically eliminated so that the loss of power due to the presence of the same is practically negligible.

This coil or equivalent resistance may be imbedded in metallic oxide and may or may not be enclosed in a ceramic, or resinous, or Bakelite composition which holds it in place and insulates it both electrically and thermally. The conducting oxide may be iron oxide or other equivalent oxide or conducting material which has a high resistance when cold and becomes very conductive when heated up slightly.

The surge preventive in my invention is placed directly into the circuit of the incandescent lamp either inside of the bulb, which I prefer, or outside of the bulb. It may, however, also be placed into the lamp base or into a socket into which the lamp base fits.

The circuit of my improved lamp with the ballast included as surge-preventing medium is such that the initial resistance of the circuit is greater than the normal operating resistance of the circuit of the lamps now in use or so that the initial flow of current is less than the normal flow of current in the same lamp when operating at

its rated voltage. This is illustrated by the curves Fig. 5 which indicate the initial surge of the lamps of the present art, and Fig. 6 which indicate the initial performance of a lamp of the present invention.

The resistance or ballast is such that it does not cause substantial loss of power in the circuit during the normal operation but merely dampens, reduces and tends to prevent the initial surge of current when the circuit is first connected across a difference in potential. This elimination of sudden surge of current prevents or retards the sudden rupture of filament at the grain boundaries and also reduces possibility of arcing across the lead wires.

Figs. 5 and 6 above referred to are comparative curves with current plotted against time showing the effect of the circuit of the present invention. In Fig. 5 the initial surge of current introduced into an ordinary lamp is considerable but is quickly reduced to a constant value after a few seconds. In Fig. 6 the initial current introduced into a lamp constructed in accordance with the principles of the present invention is shown to rise gradually to a constant value after a few seconds and the usual surge is substantially avoided.

Having thus described my invention, what I claim is:

1. An incandescent lamp comprising in combination an envelope, a base, a coiled tungsten filament, lead wires connecting said filament to said base, said lead wires being of relatively small diameter and consisting of a nickel sleeve on a copper core and an electrical resistance in one of said leads said resistance having a negative coefficient of resistance.

2. An electric incandescent lamp comprising, in combination, an envelope, a base, a tungsten filament, relatively light composite lead wires consisting of a nickel sleeve on a copper core connecting said filament to said base and an electrical resistance in series with said leads said resistance having a negative coefficient of resistance.

3. An incandescent lamp comprising in combination a concentrated light-emitting body composed of tungsten having long interlocking grains, leads connected thereto having relatively slight cooling power, and a resistance element incorporated in one of said leads, said element consisting of a choke coil embedded in metallic oxide.

4. An incandescent lamp comprising in combination a concentrated light-emitting body composed of tungsten having long interlocking grains, leads connected thereto having relatively slight cooling power, and a resistance element incorporated in one of said leads, said element consisting of a choke coil embedded in metallic oxide imbedded in an electrical and thermal insulating body.

CLEMENS A. LAISE.

CERTIFICATE OF CORRECTION.

Patent No. 2,214,742.

September 17, 1940.

CLEMENS A. LAISE.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, line 9, for "are" read --art--; page 2, first column, line 21, for "sage" read --sags--; line 67, for "lien" read --line--; page 3, first column, line 45, for "seramic" read --ceramic--; and second column, line 38, claim 2, for "incandenscent" read --incandescent--; line 44, same claim, for "coefficience" read --coefficient--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of October, A. D. 1940.

(Seal)

Henry Van Arsdale,  
Acting Commissioner of Patents.