

Sept. 21, 1948.

A. GREINER

2,449,650

INCANDESCENT LAMP AND METHOD OF MANUFACTURE

Filed Oct. 1, 1947

2 Sheets-Sheet 1

Fig. 1

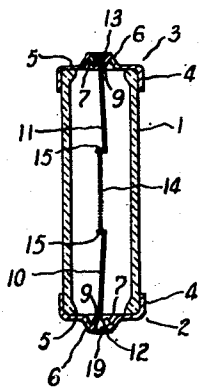


Fig. 2

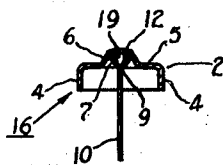


Fig. 3

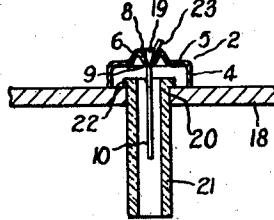


Fig. 4

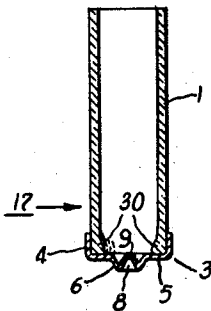


Fig. 5

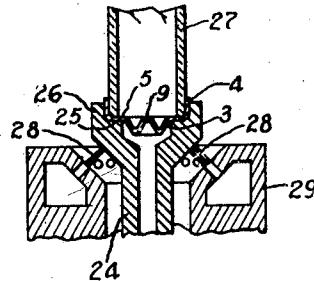


Fig. 6

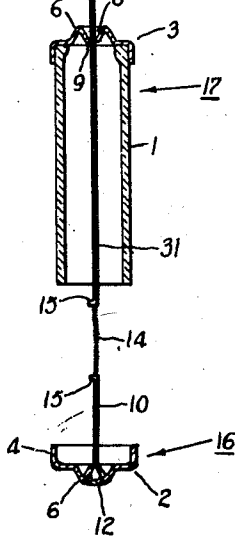
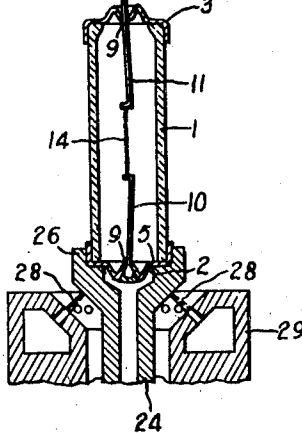


Fig. 7



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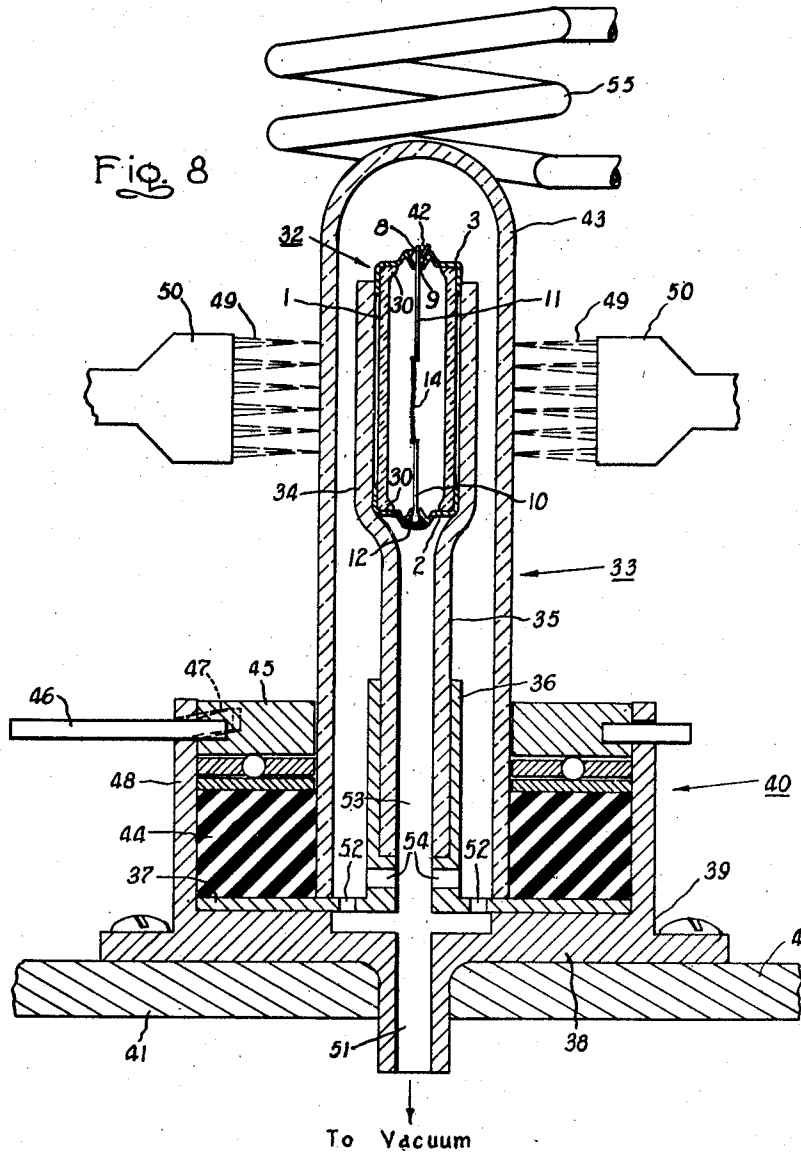
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INCANDESCENT LAMP AND METHOD OF MANUFACTURE

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,449,650

INCANDESCENT LAMP AND METHOD OF MANUFACTURE

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New York

Application October 1, 1947, Serial No. 777,239

9 Claims. (Cl. 176-29)

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My invention relates to electric incandescent lamps or similar devices and to a method of manufacturing the same. More particularly, my invention relates to electric incandescent lamps of the double-ended miniature type having terminal contact members at the opposite ends thereof. The lamp comprising my invention may be used for various purposes, such as for automobile dome or dash lighting, for electric iron and waffle iron indicator lighting, and in many other applications where a miniature sized lamp is required.

The production of a satisfactory low cost double-ended miniature incandescent lamp of simple construction has ever been a problem in the lamp manufacturing art. Prior proposed lamp constructions of this type have not been entirely satisfactory for various reasons, such as their unadaptability to machine manufacture, or their requirement for production methods which resulted in a high percentage of rejects due to faulty seals, etc., or the formation of so-called "gassy" lamps.

It is an object, therefore, of the present invention to provide a miniature double-ended electric incandescent lamp of simple construction which is readily adaptable to machine manufacture and which can be made inexpensively with a minimum percentage of rejects.

Another object of my invention is to provide an electric incandescent lamp of the above-mentioned character which is suitable for operation under conditions of high temperature.

Still another object of my invention is to provide a novel method of manufacturing an electric incandescent lamp of the above-mentioned character.

Further objects and advantages of my invention will appear from the following detailed description of a species thereof and from the accompanying drawings in which:

Fig. 1 is a longitudinal section, on an enlarged scale, of an electric incandescent lamp comprising my invention; Fig. 2 is a detail view, in section, of the terminal cap and lead-in wire assembly for one end of the lamp; Fig. 3 is a view illustrating one method of manufacturing the terminal cap assembly shown in Fig. 2; Fig. 4 is a detail view, in section, of the envelope and terminal cap assembly which is employed in the manufacture of the lamp according to the invention; Fig. 5 is a view illustrating one method of manufacturing the envelope and cap assembly shown in Fig. 4; Fig. 6 is a view illustrating the mounting of the filament on the lead-in conduc-

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tors of the lamp; Fig. 7 is a view illustrating the sealing of the terminal cap assembly to the envelope assembly to form the enclosure of the lamp; and Fig. 8 is a view illustrating the evacuation, and the sealing of the exhaust aperture, of the lamp.

Referring to Fig. 1, the electric incandescent lamp according to the invention comprises an evacuated tubular glass envelope 1 closed at its ends by identical metal end caps 2, 3 which are fusion-sealed to the envelope ends. The said end caps 2, 3 are preferably made of silver-plated iron containing a small percentage of carbon, e. g., .05 per cent, and they are provided with peripheral lip or side wall portions 4 which fit over the ends of the glass envelope 1 and are fusion-sealed to the outer wall surface thereof. As shown, the glass envelope 1 is also sealed at its rim ends to the base wall portions 5 of the end caps which base wall portions constitute, in effect, the end walls of the envelope itself. The glass envelope 1 is made of a suitable low-melting point glass which matches the expansion characteristics of the metal end caps 2, 3 and which readily wets and seals thereto. For sealing to silver-plated iron end caps such as are preferably employed, I have found a soft lead glass of the following approximate composition to be particularly suitable:

	Percent
SiO ₂ -----	45
PbO-----	35
Al ₂ O ₃ -----	2
Na ₂ O-----	3
K ₂ O-----	14
Li ₂ O-----	1

If desired, the lithium oxide in the above composition may be omitted.

The base or end walls 5 of the end caps 2, 3 are formed on their outer sides with circular bosses 6 provided with re-entrant inner wall portions or indentations 7 which extend inwardly of the envelope to form cone-shaped recesses 8 (Figs. 3-4) in the outer side of the cap end walls 5. At the bottom of the recesses 8, the end cap walls 5 are provided with apertures 9 through which lead-in wires 10, 11 extend into the envelope 1. The said lead-in wires 10, 11 are preferably made of the same silver-plated iron such as is used for the caps 2, 3 and they are electrically connected to and supported by the respective end caps by metallic fusible material or solder 12 and 13 disposed within the recesses 8 of the respective end caps 2 and 3. The lead-in wires 10, 11 project

into the envelope 1 longitudinally and approximately axially thereof with their inner ends spaced apart and bridged by a filament 14 of suitable refractory metal such as tungsten. The filament 14 may be either in the form of a fine linearly-extending coil or a straight length of tungsten wire, and it is preferably fastened to the lead-in wires by pressing or embedding its opposite ends into the metal of the lead-in wires. As shown, the lead-in wires 10, 11 are preferably formed with short laterally-bent inner end portions 15 to which the filament ends are fastened.

Referring now to Figs. 2-8 illustrating the steps involved in manufacturing the lamp according to the invention, a terminal assembly 16 as shown in Fig. 2 and an envelope assembly 17 as shown in Fig. 4 are first formed separately. The terminal assembly 16 comprises end cap 2 and lead-in wire 10 united by the solder mass 12, and it may be formed in the manner indicated in Fig. 3. As there shown, the end cap 2 is rested in an upright position, embossed side up, on an apertured support plate 18, and the lead-in wire 10, having one end flattened (as indicated at 19) to a width greater than the diameter of the aperture 9 in the end cap, is inserted and dropped through the cap aperture 9 until the flattened end 19 rests against the rim of the said aperture so as to be located within the cap recess 8. In such position, the lead-in wire 10 extends down through the opening 20 in the support plate 18. A quartz sleeve 21, extending through the opening 20 and having an outturned flange 22 resting on the support plate 18, maintains the lead-in wire 10 out of contact with the metal support plate 18 so as to prevent it from sticking thereto during the subsequent heating operation. With the cap 2 and lead-in wire 10 thus assembled in position on the support plate 18, a pellet 23 of a suitable silver solder having a melting point of around 800-900° C. or thereabouts, i. e., below the melting point (960° C.) of the silver-plating on the metal parts 2 and 10 but above the temperature which the lamp may attain during service, is placed in the recess 8 and the assembly then passed through a hydrogen furnace to melt the solder pellet and cause it to flow around the flattened end 19 of the lead-in wire and fill the recess 8, thus firmly securing the lead-in wire to the end cap. Because of the fact that the aperture 9 at the bottom of the recess 8 is substantially closed by the lead-in wire 10 projecting therethrough, and also due to the surface tension of the fluid solder, the latter does not flow down and out through the said aperture. Instead of soldering the wire 10 to the end cap 2, it may be secured thereto in any other suitable manner as by welding, for instance, in which case the aperture 9 in the end cap 2 would be omitted.

The envelope assembly 17 (Fig. 4), comprising the glass envelope 1 and the end cap 3 fusion-sealed together, may be formed in the manner indicated in Fig. 5. As there shown, the end cap 3 is placed, inward side up, in a stainless steel holder 24 having a recessed seat 25 in its upper or head end 26 for receiving and holding the said end cap in place. One end of a glass tube 27 is then introduced into the cavity of the end cap which is formed by the peripheral lip 4 thereon, with the glass tube resting of its own weight against the end wall 5 of the cap. The head 26 of the holder 24 is then suitably heated, as by gas fires 28 from a ring-type burner 29 surrounding the holder, to cause the lower end of the glass tube 27 to be softened by conduction of heat

thereto from the holder head 26 and the end cap 3. The heating operation is continued until the softened glass flows down partly onto the end wall 5 of the end cap 3 to thereby form the thickened glass seal portion 30 (Fig. 4). By heating the silver-plated end cap 3 by conduction, rather than by gas fires applied directly thereto, better control of the heating of the end cap and less likelihood of damage to the silver-plating thereon is obtained.

The completed terminal and envelope assemblies 16 and 17 are next positioned and held in spaced, aligned relationship with each other, as shown in Fig. 6, with the open end of the envelope 1 facing the inward side of the end cap 2. The two assemblies may be held in such position in a suitable holder (not shown) which may comprise one of the heads of a turret-type machine, for instance. An extended lead-in wire 31 (which may constitute the free end portion of a supply of such wire coiled on a supply spool 31') is then inserted first through the aperture 9 in the end cap 3 and then passed through the envelope 1 until it projects a short distance beyond the open end of the envelope, with its end aligned with and spaced a predetermined distance from the inner end of the lead-in wire 10 on terminal assembly 16. The wires 10, 31 may be firmly held, adjacent their facing inner ends, in such aligned and spaced relation by suitable gripping jaws (not shown) provided therefor on the above-mentioned machine head. The inner end portions of the wires 10, 31 are then bent in the same direction to extend more or less parallel to each other and provide the laterally bent inner end portions 15 spaced a predetermined distance apart. The filament 14 is then suitably fastened at its ends to the bent inner ends 15 of the wires 10, 31, as by pressing the filament wire into the metal of the said wires 10, 31. The above-described method of assembly of the terminal and envelope assemblies 16 and 17 with the filament 14 and lead-in wire 31 is not claimed herein, that being the invention of A. W. Seltz as disclosed and claimed in copending U. S. application No. 777,337 filed October 1, 1947, filed of even date herewith and assigned to the assignee of the present invention.

After the mounting of the filament 14 in place on the wires 10, 31, a quantity of red phosphorus or other getter material may be applied to the filament 14, after which the terminal and envelope assemblies 16, 17 are brought together as shown in Fig. 7 and the wire 31 then cut off at a point outwardly adjacent the end cap 3 to form the lead-in wire 11. The assemblies 16, 17 are then ready for sealing together. The lead-in wire 11 is kept from dropping through the aperture 9 in the end cap 3 and into the envelope 1 by the resistance of the filament 14 which possesses sufficient strength for such purpose. The sealing of the terminal assembly 16 to the envelope assembly 17 may be performed in the same manner and with the same sealing apparatus shown in Fig. 5.

The unitary lamp assembly 32 (Fig. 8) thus formed is then ready for the exhaustion (also gas filling, if desired) and the final sealing-off thereof, which operations may be conveniently carried out in an exhaust chamber 33 in the manner indicated in Fig. 8. As there shown, the lamp assembly 32 is placed and supported in an upright position, with its unsealed end cap 3 uppermost, within the enlarged upper end 34 of a vertically extending quartz tube 35 the lower end

of which fits into and is supported by a metal sleeve 36. At its lower end, the sleeve 36 is provided with an outturned flange 37 which rests on the bottom wall 38 of the housing portion 39 of a conventional type compression rubber chuck 40 mounted on a table 41. One or more pellets 42 of a suitable silver solder are then placed in the recess 8 of the end cap 3, after which a tubular quartz cover member 43 comprising the exhaust chamber 33 is placed over the tube 35 and the lamp assembly 32 therein, with its lower end resting on the flange 37 of the metal sleeve 36. The rubber compression ring 44 of the chuck 40 is then compressed, by inward movement of the compression collar 45 into the housing 39, to thereby press the rubber tightly against the outer wall surface of the quartz cover tube 43 and thus form an air-tight joint therebetween, the inward movement of the collar 45 being produced by rotating it by means of the operating arm 46 which rides in a spiral groove 47 provided in the side wall 48 of the chuck housing 39. The exhaust chamber 33 is then evacuated and the quartz cover tube 43 simultaneously heated in the region opposite the lamp assembly 32, as by gas fires 49 from burners 50, to thereby heat the lamp assembly during the exhaustion thereof, in conformance with usual lamp exhausting procedure. The chamber 3 is exhausted through a passageway 51 in the bottom wall 38 of the chuck housing 39, which passage-way is connected with the vacuum source and communicates with the interior of the exhaust chamber through apertures 52 in the sleeve flange 37 and also through the bore 53 and apertures 54 in the wall of the sleeve 36 itself.

When the required degree of vacuum is produced in the lamp assembly 32, the gas fires 49 are removed and an induction coil 55 moved down over the upper end of the quartz tube 43 so as to surround the same at a point approximately opposite the end cap 3 of the lamp assembly 32 therein. The coil 55 is then connected to a source of high frequency current. The resulting magnetic field set up by the coil 55 serves to heat the metal end cap 3 to red heat which in turn melts the solder pellet 42 by conduction of heat thereto, causing the solder to flow down into and fill the recess 8 and aperture 9 in the end cap and connect the lead-in wire 11 to the said cap, thus completing the manufacture of the lamp. Any excess portion of the lead-in wire 11 projecting outwardly beyond the solder 13 (Fig. 1) of the finished lamp is then cut off flush with the outer surface thereof.

The solders 12, 13 employed for sealing the aperture 9 in the end caps 2, 3 are preferably ones that do not contain any flux such as would be apt to contaminate the vacuum in the lamp and therefore produce a so-called "gassy" lamp. Also, they should not contain any constituents which vaporize at relatively low temperatures (such as are encountered when the lamp is heated during the exhaustion thereof) and which would deposit, when in such vaporized state, on the walls of the envelope 1 to form a light-impervious coating thereon. Like the solder 12 which is used in the fabrication of the terminal assembly 16, the solder 13 should have a melting point below that of the silver plating on the end cap 3 and lead-in wire 11 but above the temperature which the lamp is apt to attain when in service. Within this range of permissible fusion temperatures, however we prefer to employ a solder 13 having a fusion tempera-

ture in the lower portion of the range and which will flow freely so as to readily fill the aperture 9 and the recess 8 in the end cap 3. For this purpose, I have found a solder composition composed of silver, copper and phosphorus to be very satisfactory for sealing the aperture 9 in the end cap 3, the following approximate composition being particularly suitable:

	Percent
Ag -----	15
Cu -----	80
P -----	5

15 The phosphorus in such a solder material has a tendency to act both as a flux and as a getter for the lamp.

For the solder used in the fabrication of the terminal assembly 16, I prefer to employ a solder material 12 having a melting point below that of the silver-plating on the end cap 2 but well above the softening temperature of the glass of which the envelope 1 is made, so as to assure that the solder joint between the lead-in conductor 10 and end cap 2 of assembly 16 will not be disturbed during the subsequent sealing of the glass envelope 1 to the said assembly 16. For this purpose, I have found a solder composed approximately of 50% silver and 50% copper to be particularly satisfactory.

30 The lamp according to the invention is less expensive and can be produced with greater ease and less shrinkage than prior known lamps of this general type. The silver-plated iron end caps and the particular envelope glass composition employed in the preferred form of the invention match each other and seal together exceedingly well and, coupled with the particular form of seal structure disclosed wherein the metal of the end cap surrounds the glass at the seal so as to place the glass under compression, results in the formation of an exceptionally strong seal which can be made with a very low percentage of rejects and which is less subject to cracking during use of the lamp under conditions of high temperature than in the case of prior lamps of this type. Besides presenting a nice, clean appearance, the silver-plating on the end contact caps 2, 3 also provides a good electrical contact with the terminal contacts of the lamp socket.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric incandescent lamp comprising a sealed double-ended glass envelope having tubular end portions, a pair of metal end contact caps fusion-sealed to the ends of said envelope, each of said end caps having its end wall provided with an apertured indentation, a filament in said envelope, a pair of lead-in conductors connected to the ends of said filament and each extending outwardly through the aperture and into the indentation recess of a respective one of said end caps, and a quantity of metallic fusible material filling the recess and aperture in each end cap and securing the associated conductor thereto.

2. A miniature electric incandescent lamp comprising a sealed double-ended glass envelope having tubular end portions, a pair of metallic end contact caps fusion-sealed to the ends of said envelope and having inturned peripheral lip portions circumposed about and fusion-sealed to the walls of the said envelope end portions, at least one of said end caps having its end wall provided with an apertured indentation, a filament in said

envelope, a pair of lead-in conductors secured to said end caps and electrically connected to the ends of said filament, one of said conductors extending outwardly through the aperture and into the indentation recess of its associated end cap, and a quantity of metallic fusible material in said recess sealing the said aperture and securing the said one conductor to its associated end cap.

3. A miniature electric incandescent lamp comprising a sealed double-ended glass envelope having tubular end portions, a pair of metallic end contact caps fusion-sealed to the ends of said envelope and having intumed peripheral lip portions circumposed about and fusion-sealed to the walls of said envelope end portions, each of said end caps having its end wall provided with an apertured indentation, a filament in said envelope, a pair of lead-in conductors electrically connected to the ends of said filament and each extending outwardly through the aperture and into the indentation recess of a respective one of said end caps, and a quantity of metallic fusible material disposed within the recess of and sealing the aperture in each end cap and securing the associated conductor thereto.

4. An electric incandescent lamp comprising a sealed glass envelope, a silver-plated metal end cap fusion-sealed to the envelope and provided with an aperture therethrough, a filament in said envelope, a lead-in conductor connecting one end of the filament to the said end cap, and a quantity of metallic fusible material sealing the said aperture in the end cap, said material having a fusion temperature below the melting point of the silver-plating on the end cap but above the operating temperature which the lamp normally attains in its designed service.

5. An electric incandescent lamp comprising a sealed glass envelope, a silver-plated metal end cap fusion-sealed to the envelope and provided with an aperture therethrough, a filament in said envelope, a lead-in conductor connecting one end of the filament to the said end cap, and a quantity of metallic fusible material sealing the said aperture in the end cap, said material being composed principally of silver, copper and phosphorus.

6. An electric incandescent lamp comprising a sealed glass envelope, a silver-plated metal end cap fusion-sealed to the envelope and provided with an aperture therethrough, a filament in said envelope, a lead-in conductor connecting one end of the filament to the said end cap, and a quantity of metallic fusible material sealing the said aperture in the end cap, said material comprising approximately 15 per cent silver, 80 per cent copper and 5 per cent phosphorus.

7. An electric incandescent lamp comprising a

sealed double-ended glass envelope having tubular end portions, a pair of silver-plated metal end caps fusion-sealed to the ends of the envelope, at least one of said end caps having an aperture communicating with the interior of the envelope, a filament in said envelope, a silver-plated lead-in conductor connected to one end of the filament and extending outwardly through the aperture in the said one end cap, and a quantity of metallic fusible material sealing the said aperture and connecting the lead-in conductor therein to the said one end cap, said material having a fusion temperature below the melting point of the silver-plating on the end cap and lead-in conductor but above the operating temperature which the lamp normally attains in its designed service.

8. An electric incandescent lamp comprising a sealed double-ended glass envelope having tubular end portions, a pair of silver-plated metal end contact caps fusion-sealed to the ends of said envelope, each of said end caps having its end wall provided with an outward embossment having a central apertured indentation, a filament in said envelope, a pair of silver-plated lead-in conductors connected to the ends of said filament and each extending outwardly through the aperture and into the indentation recess of respective ones of said end caps, and a quantity of metallic fusible material filling the recess and aperture in each end cap and securing the associated conductor thereto, said fusible material having a fusion temperature below the melting point of the silver-plating on said end caps but above the operating temperature which the lamp normally attains in its designed service.

9. An electric incandescent lamp comprising a sealed double-ended glass envelope having tubular end portions, a pair of metal end caps fusion-sealed to the opposite ends of said envelope, a filament in said envelope, and a pair of lead-in conductors in said envelope connecting the ends of the filament to the end caps, said end caps consisting of silver-plated iron and having peripheral lip portions circumposed about and fusion-sealed to the walls of the said envelope end portions.

ALFRED GREINER.

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The following references are of record in the file of this patent:

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