April 15, 1941. J. H. RAMAGE 2,238,599

LEAD WIRE

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Fig. 1

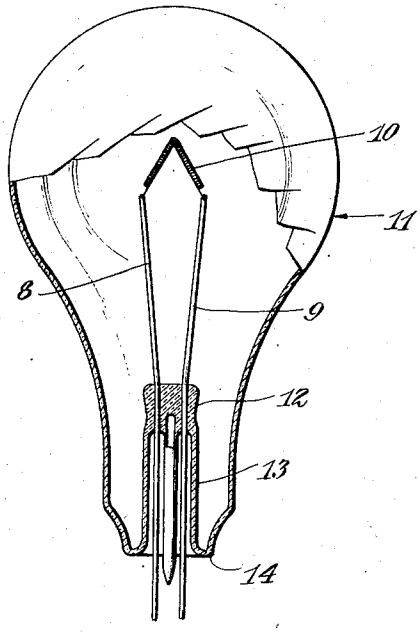
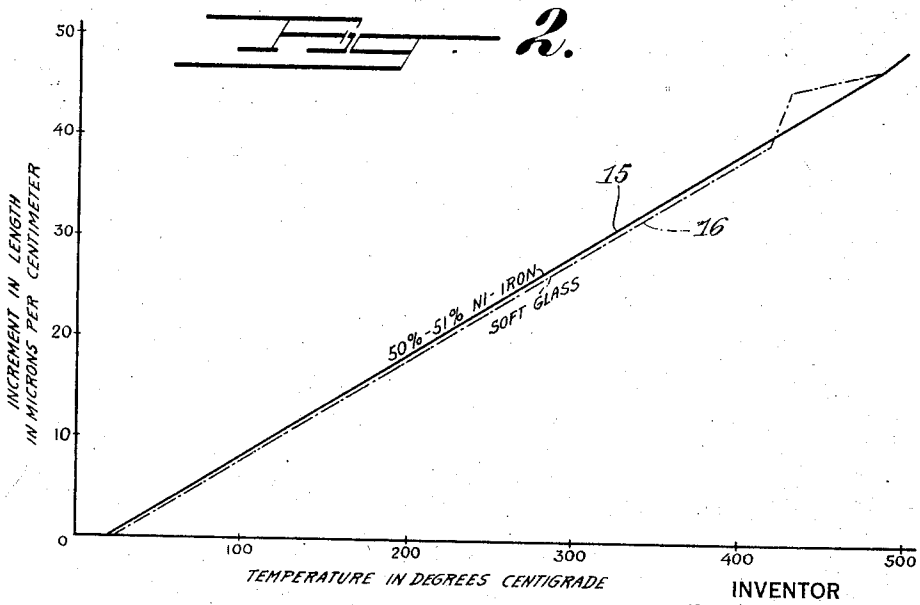



Fig. 2.

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2,238,599

## LEAD WIRE

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8 Claims. (Cl. 49—92)

This invention relates to wires of such character as to be capable of use as leading-in conductors through the wall of a glass envelope and more particularly to a leading-in wire for electrical devices.

Although the present invention may find various uses in connection with electrical devices where it is necessary to conduct current through the wall of a sealed container, it is particularly adapted for use as a leading-in wire for incandescent electric lamps.

It is well recognized that a problem exists in providing an electrical conductor having the proper coefficient of expansion so that, when sealed through the wall of a glass bulb, variations in the degree of expansion between the conductor and the glass will be reduced to a minimum or to such an extent as to prevent leakage.

It has been the practice for many years to use compound wires having a core of a base metal such as nickel-iron alloy and a covering or surface coating of platinum or copper.

The use of copper-clad leading-in conductors has come into extensive practice but the manufacture thereof is difficult and costly since a great deal of care must be taken in practicing the method of making such a wire. When applying to the core the cover must be hermetically tight and difficulty is experienced in obtaining the exactness and accuracy required in determining the diameter of the core and the cover.

It has been proposed to employ homogeneous wire of an alloy of chromium and iron which, however, did not give satisfactory results since it did not properly adhere to the standard lamp glass and made a comparatively poor seal. The known alloys of iron and nickel behave in a similar manner and also have a great tendency to form air bubbles and air passages to the extent that they are not usable without an outer coating of some glass wetting material such as platinum or copper.

When using copper-clad wires, that is, a nickel iron core with a copper sheath, it has been the practice to employ a copper clad section of such wire of sufficient length to constitute the seal through the wall of the envelope. To each end of this section of wire was welded another wire, one of said wires constituted the lead which connected with the external contact of the lamp and the other the conductor connected with the light source. This three-piece wire, which is known in the art as a three-piece weld, required a number of operations in its fabrication and, although it included only a small portion of the copper clad wire, it was, nevertheless, costly when compared with the other materials used in lamp manufacture.

It is an object of the present invention to eliminate the use of a copper-clad wire or a three-piece weld and provide what is termed a straight-through conductor in the form of a homogeneous leading-in wire including a combination of metals of such character as to meet the sealing-in requirements.

Another object of the invention is to provide a homogeneous wire which may be sealed through the wall of a bulb in the absence of air bubbles or voids between the glass and the wire when the wire is sealed through the glass wall.

A further object of the invention is to provide a leading-in wire including nickel, iron, and other ingredients in the form of an alloy which wets with the glass to which it is sealed.

A still further object of the invention is to provide a leading-in conductor in the form of a homogeneous wire from which the occluded gases have been removed.

Other objects and advantages of the invention will be apparent from the following description together with the accompanying drawing in which—

Fig. 1 is a side view of a lamp having lead wires which serve as supports for a filament and

Fig. 2 is a curve showing the relative expansion of the present lead wire and that of soft glass.

A wire of the character above described may be employed as lead wires 8 and 9 for a filament 10 of an incandescent electric lamp 11. The lead wire may be sealed through the wall of the bulb by means of a press 12 of what is known as soft glass. The press is part of a flare tube 13 sealed at 14 to the bulb neck in the usual manner.

It will be noted that the present wire extends through the press and is continuous to provide the support members for the filament, making it unnecessary to use an extra section for wetting to the glass.

In Fig. 2 of the drawing, the curve 15 in full lines indicates the expansion of the lead wire in increments in length in microns per centimeter at different temperatures. The curve 16 in dotted lines indicates the expansion of the glass measured by the same unit.

When using copper-clad nickel iron wire it was necessary to not only consider the longitudinal coefficient of expansion but the radial coefficient as well. The radial coefficient of expansion of

copper-clad wire known as Dumet is about the same as that of the present wire. The longitudinal coefficient of expansion of the copper-clad wire is different, with the result that strains are set up and fine cracks occur about the seal. Since the present wire and the glass in which it is sealed have the same coefficients of expansion in all directions as indicated by the curves, a more practical and effective result is obtained.

It has been found that when an alloy of about 50% of nickel and the remaining percentage of iron with several other ingredients, the proportions of which will hereinafter be given, is sealed to glasses which are known in the art as "soft glasses" an effective seal is obtained and such a seal is maintained through a range of temperatures greater than that possible with other known seal materials under the best conditions. A leading-in conductor may, in accordance with the present invention, be made in the form of an alloy including the following:

| | Per cent |
|---|---|
| Nickel, about | 50 |
| Carbon, less than | 0.1 |
| Manganese, from about | .3 to .5 |
| Silicon, less than | .15 |
| Cobalt | Free |
| Iron | Remainder |

The above proportions give a practical and satisfactory composition although slightly larger percentages of carbon and silicon will not change the alloy to such a degree as to make it impractical.

The above formula calls for a cobalt free alloy. By free is meant without the presence of cobalt in sufficient quantity to detrimentally affect the coefficient of expansion of the nickel when used for the purpose intended. It has been found that up to about one percent cobalt may be added to the nickel making what is termed 50 to 51 percent nickel. Preferably the nickel should contain the least amount of cobalt possible.

I have found by first removing the normally occluded gases from an alloy as given above, a leading-in conductor may be had which meets all practical requirements and is superior to and less costly than similar conductors as heretofore employed. For the purpose of removing the gases from the alloy, it is given a heat treatment at about 1000 to 1100 degrees centigrade in hydrogen. The time interval of treatment is dependent on the size of the material; that is, sufficient time should be given to raise the temperature throughout the alloy to the temperature zone in which it is treated.

The heat treatment frees the metal of gases so that when sealed in a glass wall no gas bubbles occur and the metal is in intimate and seal-tight contact with the glass. It has been found that the coefficient of expansion for an alloy given above follows that of such glass as potassium, lead and barium boro-silicate over a range of temperature from normal room temperature up to 450 degrees C.

A leading-in wire made in accordance with the present invention follows the coefficients of expansion of the glasses mentioned from room temperature to their annealing points, which is important in that residual strains can be removed from the glass without breaking the seal by the heat necessary for the annealing operation after the seal is made.

By reason of the present invention it is possible to make what is termed a straight-through lead wire having the necessary sealing properties and producible at relatively low cost without sacrificing any of the properties necessary to obtain an effective and practical result.

Although a preferred embodiment of the invention is shown and described herein, it is to be understood that modifications may be made therein by variations in the portions of the ingredients employed and that the invention is only limited to the ingredients and proportions given in the degree and manner pointed out in the accompanying claims.

What is claimed is:

1. An alloy comprising from 50 to less than 51% of nickel, less than 1% of cobalt, less than .1% of carbon, from about .3% to .5% of manganese, less than .15% of silicon, and the remainder iron, freed of normally occluded gases by heat treating in hydrogen at about 1000 to 1100° C., and having a coefficient of expansion substantially corresponding with that of soft glasses between room temperatures and about 450° C., whereby it is especially adapted for the manufacture of leading-in conductors for incandescent electric lamps, the bulbs of which are composed of soft glass.

2. An alloy comprising 50 to 51% of nickel and cobalt, the cobalt being less than 1% of the alloy, not more than 1% of other minor ingredients, and the remainder iron, freed of normally occluded gases by heat treating in hydrogen, and having a coefficient of expansion substantially corresponding with that of soft glasses between room temperatures and about 450° C., whereby it is especially adapted for the manufacture of leading-in conductors for incandescent electric lamps, the bulbs of which are composed of soft glass.

3. An alloy comprising 50 to 51% of nickel and cobalt, the cobalt being less than 1% of the not more than 1% of other ingredients, and the remainder iron, and having a coefficient of expansion substantially corresponding with that of soft glasses between room temperatures and about 450° C., whereby it is especially adapted for the manufacture of leading-in conductors for incandescent electric lamps, the bulbs of which are composed of soft glass.

4. An alloy comprising 50 to 51% of nickel and cobalt, and cobalt being less than 1% of the alloy, not more than 1% of other ingredients, and the remainder iron, and having a coefficient of expansion approximately within the range of that for soft glasses, whereby it is especially adapted for the manufacture of leading-in conductors for incandescent electric lamps.

5. An article comprising soft glass, and a leading-in conductor sealed thereinto, said conductor being a wire formed entirely of an alloy comprising 50 to 51% of nickel and cobalt, the cobalt being less than 1% of the alloy, not more than 1% of other ingredients, and the remainder iron, heat treated at a temperature of about 1000 to 1100° C. in hydrogen to avoid the formation of bubbles at the seal, and the proportions of the ingredients being such that its coefficient of expansion corresponds substantially with that for soft glass between room temperatures and about 450° C., thereby adapting it for the formation of a perfect seal in said glass.

6. An article comprising soft glass welded to an alloy of 50 to 51% of nickel and cobalt, the cobalt being less than 1% of the alloy, not more than 1% of other minor ingredients, and the remainder iron, freed of normally occluded gases by heat treating in hydrogen at about 1000 to

1100° C., whereby it has a coefficient of expansion substantially corresponding with that of said soft glass between room temperatures and about 450° C.

7. An essentially strain-free seal consisting of glass in fused combination with an alloy comprising 50 to 51% of nickel and cobalt, in which the cobalt is less than 1% of the alloy, not more than 1% of other minor ingredients, and the remainder of iron, freed of normally occluded gases by heat treating in hydrogen at about 1000 to 1100° C., whereby the thermal expansion characteristics of said glass and alloy are substantially coincident from room temperatures at least up to approximately the annealing point of the glass.

8. An article comprising soft glass welded to an alloy containing 50 to 51% of nickel and cobalt, the cobalt being less than 1% of the alloy, not more than 1% of other minor ingredients, and the remainder iron, said glass having a thermal expansion characteristic which substantially matches that of the alloy from room temperature at least up to the softening point of the glass.

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