June 22, 1937.

J. D. EDWARDS

2,084,327

COMPOSITE REFLECTOR

Filed Oct. 11, 1933

Fig. 1.

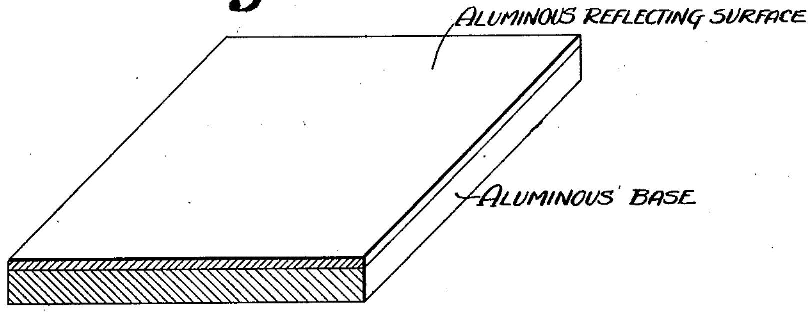


Fig. 2.

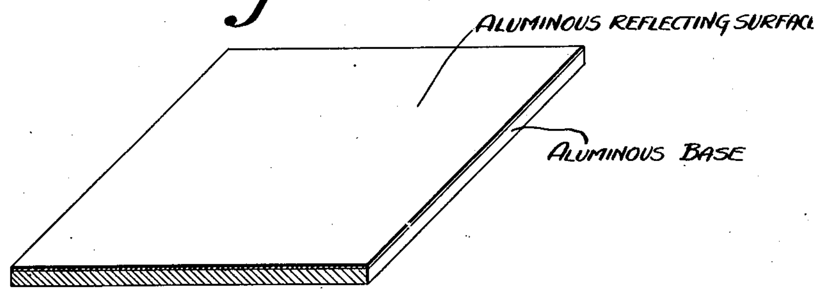
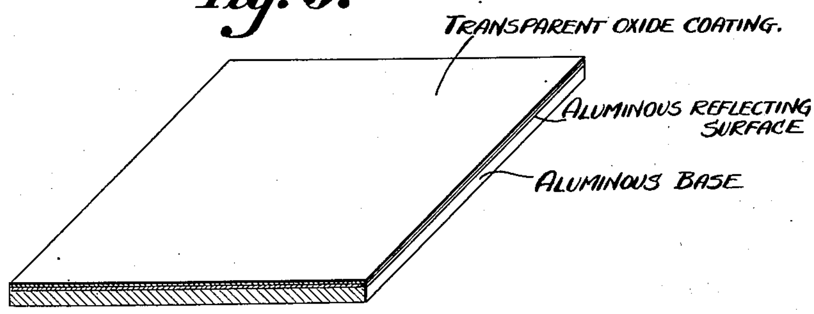


Fig. 3.



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2,084,327

COMPOSITE REFLECTOR

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10 Claims. (Cl. 88—105)

This invention relates to improved aluminum reflecting surfaces of uniform high reflectivity and provided with an artificial clear and transparent protective oxide coating.

Various attempts have been made to produce stable, corrosion-resistant reflecting surfaces on aluminum by providing an aluminum reflecting surface with an oxide coating. However, the many advantages incident to the provision of the reflecting aluminum surface with such oxide coatings are often offset by the fact that the oxide coatings developed on the surface show various markings, streaks, and lines. These markings are in general invisible on the metal surface before the oxide coating treatment but appear during the oxide coating treatment, and they are apparently directly related to the internal structure of the surface of the metal and the working process by which the article has been formed. For example, when a cup-shaped or hemispherical light reflector is formed by the usual drawing operation, the reflecting surface, after oxide coating, may exhibit "drawing lines" in the form of relatively non-reflective, concentrically arcuate streaks; or a flat aluminum reflecting surface may, upon being oxide-coated, develop definite lines directly traceable to the structure of the metal surface. Furthermore, the oxide coating produced upon the reflecting surface often has a cloudy and translucent appearance and may at times be colored. These defects materially reduce the reflectivity of the treated aluminum reflecting surface.

It is an object of the present invention to produce an article having a durable oxide-coated aluminous metal reflecting surface which is uniformly free from streaks and markings and in which the oxide coating is uniformly clear and transparent. It is another object of this invention to produce an article having a durable, uniformly reflecting oxide-coated aluminous metal reflecting surface of improved reflecting power. It is more particularly an object of this invention to produce a composite metallic article having an oxide-coated aluminous metal reflecting surface. Other objects will become apparent from the following description of the invention.

This invention is predicated upon the discovery that an article formed of a composite metal consisting of a metallic base portion and an aluminous metal surface portion having a reflecting surface, when produced by operations involving a reduction in thickness of the aluminous metal surface portion of at least 99.5 per cent, and treated to form thereon an oxide coating, does not exhibit the objectionable markings heretofore referred to, and upon the further discovery that if the surface portion consists of high purity aluminum, or an alloy thereof, an oxide coating may be produced which is clear and transparent and which does not detract materially from the reflectivity of the aluminum surface. Thus, a composite metal article may be obtained according to this invention having a durable, uniformly reflecting, oxide-coated aluminous metal reflecting surface having a greater and more uniform reflecting power than has heretofore been obtainable in oxide-coated aluminous metal reflecting surfaces.

The composite metal used in producing the improved articles of this invention may consist of any desired number of metal layers. It is generally preferable, however, to use a composite metal consisting of a relatively thick base portion from which the composite metal derives its principal structural properties, provided on one or more of its surfaces with a relatively thin aluminous metal (aluminum or aluminum base alloy) surface portion. The base portion may be of any aluminum or aluminum base alloy of the desired physical properties, which may be conveniently united with an aluminous metal sheet by a hot or cold working operation, such as by rolling or drawing.

In forming the composite metal, any of the known methods for forming such materials may be used. One method which has proved particularly satisfactory for forming a duplex metal having an aluminous metal base portion and a surface portion of another aluminous metal is to cast the base metal against the metal surface portion in sheet or other worked form as described in U. S. Patent 1,865,089 to E. H. Dix, issued June 28, 1932. Another satisfactory method is to bond the aluminous metal surface portion in sheet form with the aluminous metal base portion in sheet or slab form. The intermediate composite metal article thus formed must in any case be subsequently worked to produce a composite metal having an aluminous metal reflecting surface satisfactory for the purposes of this invention. The working of this intermediate composite metal has the effect of eliminating from the aluminous metal surface portion the internal metallic structure which causes the appearance of lines and streaks when the surface portion is subsequently artificially oxide-coated. The degree to which this objectionable metallic structure is removed is dependent upon the total amount of working given the aluminous metal surface portion both before and after formation of the composite metallic article.

It is considered essential that the composite metal be reduced at least 85 per cent by working the base metal and surface metal together as by reducing the composite article in a rolling operation. In general, sufficient total working of the aluminous metal surface portion to reduce its original thickness at least about 99.5 per cent including the working applied both before and during the formation of the composite metal will produce a satisfactory surface. It is preferable, however, to reduce the original thickness of the aluminous metal surface portion at least about 99.9 per cent for the best result.

Regardless of the exact composition of the aluminous metal surface portion of the composite metal, the markings resulting from the internal structure of the metal which appear upon subsequent oxidation of the surface may be avoided in the reflector by the use of a material such as above described. However, if the aluminous metal surface portion be formed of high purity aluminum, that is to say, aluminum of at least 99.7 per cent purity, or certain alloys of such high purity aluminum, the additional advantage is obtained that the oxide coating subsequently formed on the aluminum reflecting surface is clear, transparent and substantially colorless, so that an article having a durable reflecting surface of high reflecting power may be produced. In general, the presence of a total of 0.1 to 0.3 per cent of most of the usual alloying elements in the high purity aluminum does not materially affect the character of the oxide coating obtained, but amounts greater than this of such elements as silicon, iron and manganese may cause the oxide coating to be cloudy or colored. Certain elements, such as magnesium and zinc, when present in the high purity aluminum alloys in relatively large amounts, do not deleteriously affect the oxide coating formed. In the preferred form of this invention, therefore, the article is formed from a composite aluminous metal comprising a relatively thick aluminous metal base portion having the structural properties desired in the finished article and a relatively thin worked aluminous metal surface portion consisting of aluminum of 99.7 per cent purity, or a high purity aluminum alloy containing not more than 0.1 to 0.3 per cent of the usual impurities such as silicon, iron and manganese, and containing not more than 0.3 per cent of copper in addition thereto. Magnesium and zinc may be present in relatively large amounts as alloying constituents.

The type of reflecting surface desired, whether diffuse or specular, may be produced on the aluminous metal surface portion of this composite metal article by any of the processes known in the art. The production of a diffuse reflecting surface may be accomplished by mechanical or chemical treatment; care should be taken in this treatment, however, not to remove a substantial thickness of the surface coating or expose the base metal. Particularly uniform and bright diffuse reflecting surfaces are obtained by the chemical etching of a composite aluminous metal in which the surface portion is formed of a high purity aluminum alloy containing 0.06 to 0.3 per cent of copper and free from graphitic silicon, in accordance with the invention described in copending U. S. Patent No. 1,999,042, of Junius D. Edwards, Cyril S. Taylor, and Welker W. Wentz, issued April 23, 1935. Specular reflecting surfaces may be produced by various types of buffing and polishing operations. For example, particularly good specular reflecting surfaces are obtainable by a roll polishing operation in which the rolling is carried out with rolls having highly polished surfaces and in which the metal surface is given a light etching treatment between successive roll passes. Good specular reflecting surfaces are also obtainable by the use of buffing operations, but it is generally necessary or desirable to treat surfaces prepared in this manner in order to brighten them prior to the formation of the oxide coating on them. This brightening may be accomplished by an anodic treatment in a fluoborate electrolyte as described in the copending U. S. application No. 683,344, of Ralph B. Mason, filed August 2, 1933.

The clear, transparent oxide coating may be produced on the aluminous metal reflecting surface by anodic treatment in various known electrolytes, such as sulfuric acid, or a mixture of sulfuric acid and oxalic acid. For this purpose it is preferable to carry out the anodic oxidation in sulfuric acid, since coatings of substantial thickness which are colorless and clear may be obtained, and this result is desirable in order to obtain the maximum of protection for the reflecting surface with a minimum of reduction in the reflectivity of the aluminous metal surface. Good protective oxide coatings which are of substantial thickness and which are clear, colorless and transparent may, for example, be obtained by making the aluminous metal reflecting surface the anode in an electrolytic cell containing a 15 per cent solution of sulfuric acid as the electrolyte and passing a current having a current density of 12 amperes per square inch of anode surface for 10 minutes at about 70° F.

In the accompanying drawing is shown, in Figs. 1, 2, and 3, the improved article of this invention in three successive stages of development. Fig. 1 shows a composite metal in sheet form comprising a relatively thick metallic base portion and a relatively thin aluminous metal reflecting surface portion. In Fig. 2 is shown the same composite metal after a reduction in thickness preparatory to further treatment for the production of an oxide coating on the aluminous reflecting surface. Fig. 3 shows a completed article manufactured according to this invention, comprising a composite metal having a relatively thick metal base portion, and a relatively thin aluminous metal surface portion, which has been reduced at least 99.5 per cent in thickness in forming the composite article, and which has a bright reflecting surface provided with a clear, transparent oxide coating free from lines or markings of any kind.

Having thus described the invention, I claim:

1. A composite metal article having a durable aluminous metal reflecting surface characterized by the absence of structural markings, comprising an aluminous metal base portion and an aluminous metal surface portion provided with a clear, transparent, protective, artificial oxide coating, said surface portion having a metallic structure obtained by working together the base portion and the surface portion and producing a total reduction in the thickness of the surface portion of at least 99.5 per cent.

2. As an article of manufacture, a composite metal reflector having a reflecting surface which is characterized by the absence of structural markings and comprising an aluminous metal

base portion and an aluminous metal surface portion provided with a clear, transparent, protective, artificial oxide coating, said composite metal having the structure obtained by reducing its thickness at least 85 per cent by working together the base portion and the surface portion, and the aluminous metal surface portion having a metallic structure obtained by working together the base portion and the surface portion and producing a total reduction in its thickness of at least 99.5 per cent.

3. As an article of manufacture, a composite metal reflector the reflecting surface of which is characterized by the absence of structural markings, comprising an aluminous metal base portion and a high purity aluminum surface portion containing not more than 0.3 per cent of impurities and provided with a clear, transparent, protective, artificial oxide coating, said surface portion having a metallic structure obtained by working together the base portion and the surface portion and producing a total reduction in the thickness of the surface portion of at least 99.5 per cent.

4. As an article of manufacture, a composite metal reflector the reflecting surface of which is characterized by the absence of structural markings, comprising an aluminous metal base portion and a high purity aluminum surface portion containing not more than 0.3 per cent of impurities and provided with a clear transparent protective, artificial oxide coating, said composite metal having the structure obtained by reducing its thickness at least 85 per cent by working together the base portion and the surface portion, and the aluminous metal surface portion having a metallic structure obtained by working together the base portion and the surface portion and producing a total reduction in its thickness of at least 99.5 per cent.

5. As an article of manufacture, a composite metal reflector having a reflecting surface which is characterized by the absence of structural markings and comprising an aluminous metal base portion and an aluminous metal surface portion provided with a clear, transparent, protective, artificial oxide coating, said composite metal having the structure obtained by reducing its thickness at least 85 per cent by working together the base portion and the surface portion, and the aluminous metal surface portion having a metallic structure obtained by working together the base portion and the surface portion and producing a total reduction in its thickness of at least 99.9 per cent.

6. A composite metal reflector having a durable aluminous metal reflecting surface characterized by the absence of structural markings, comprising an aluminous metal base portion and a high purity aluminum surface portion containing not more than 0.3 per cent of the elements silicon, iron and manganese in combination, said surface portion having a highly reflecting surface provided with a clear, transparent, protective, electrolytic oxide coating, said surface portion having the metallic structure obtained by working together the base portion and the surface portion and producing a total reduction in the thickness of the surface portion of at least 99.5 per cent.

7. The method of preparing a composite metal reflector which comprises providing a composite metal ingot having an aluminous metal base portion and an aluminous metal surface portion, working the ingot to produce a total reduction in the thickness of the aluminous metal surface portion of 99.5 per cent, brightening the aluminous metal surface portion of the reduced article, and applying a clear, protective artificial oxide coating to the brightened surface.

8. The method of preparing a composite metal reflector which comprises providing an ingot of high purity aluminous metal, reducing the thickness of the ingot to form a slab, casting aluminum alloy base metal against said slab to form a composite metal ingot having a high purity aluminous metal surface portion, working said composite metal ingot to reduce its thickness at least 85 per cent and to bring the total reduction in thickness of the surface portion up to at least 99.5 per cent, treating the surface portion to produce thereon a highly reflecting surface, and electrolytically applying a clear, protective oxide coating to said surface.

9. The method of preparing a composite aluminous metal reflector having a durable aluminous metal reflecting surface characterized by the absence of structural markings, which comprises preparing high purity aluminum containing not more than 0.3 per cent of the elements silicon, iron and manganese, and not more than 0.3 per cent of copper, casting an ingot therefrom, reducing the thickness of the ingot to form a high purity aluminum slab, casting an aluminum alloy base portion against said slab to form a composite aluminous metal ingot having a high purity aluminum surface portion, working said composite metal ingot to reduce its thickness at least 85 per cent and to bring the total reduction in thickness of the high purity aluminum surface portion up to at least 99.5 per cent, brightening the surface of the high purity aluminum surface portion, and electrolytically applying a clear, protective oxide coating to the brightened surface in an electrolyte containing sulfuric acid.

10. The method of preparing a composite metal reflector which comprises providing a composite metal ingot having an aluminous metal base portion and an aluminous metal surface portion, working the ingot to effect a total reduction in thickness of the aluminous metal surface portion of at least 99.5 per cent, brightening the aluminous metal surface portion of the reduced article, and applying a clear, protective, artificial oxide coating to the brightened surface.

JUNIUS D. EDWARDS.