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DETERIORATION RESISTANT REFLECTOR

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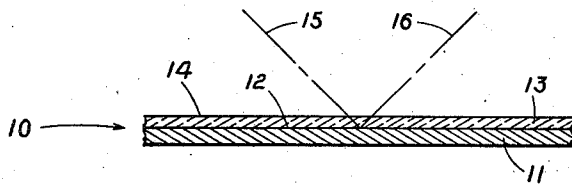


Fig. 1

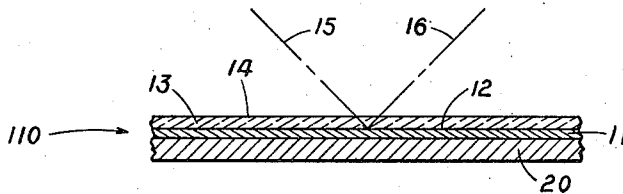


Fig. 2

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DETERIORATION RESISTANT REFLECTOR

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4 Claims. (Cl. 88—105)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

This invention deals with reflecting metal surfaces protected against deterioration through corrosion or mechanical injury by a fused-on, transparent colorless or control vitreous enamel coating. The invention comprises (a) the enameled reflecting metal and processes for making it; (b) reflectors made from such enameled metal and processes for making them; and although it deals particularly with metal reflectors having silver surfaces, is applicable also to other metal reflectors.

Metal reflectors with silver surfaces, because of their high reflection factor for light from tungsten or similar lamps, are very efficient while new, but tarnish films and corrosion products formed on the silver by impurities in the air reduce this efficiency unless these corroding impurities are excluded. Transparent lacquers applied to the silver for this purpose are useful in some degree. However, many lacquers deteriorate slowly under ordinary conditions of service and very rapidly when exposed to extreme conditions such as the high humidity at seacoast locations or to the high temperatures of powerful lamps, so they are no longer effective in protecting the reflecting metal surface. There is often difficulty also in cleaning lacquered reflectors without marring the lacquered surface.

With the foregoing and other objects in view, the invention consists in the construction, combination and arrangement of parts hereinafter described and illustrated in the drawing, in which, Fig. 1 is a sectional view of one form of the reflector of this invention; and

Fig. 2 is a sectional view of a slightly modified form of this invention.

This invention employs fused-on transparent vitreous enamel coatings of controlled color instead of lacquers to cover the silver-reflecting surface and in so doing produces coatings better adapted than lacquers to withstand extremes of heat or cold, as well as the action of moisture, salt spray or air contaminants. The surface of such vitreous enameled reflectors is also not easily scratched or marred by cleaning.

Certain types of enameled reflectors now in use employ the surface of opaque enamels to reflect and diffuse the light, whereas reflectors protected by transparent enamel made according to this invention reflect the light specularly

from the metal surface through the transparent enamel layer. The enamel coating applied to reflectors made by this invention must therefore be transparent, uniformly thin, and free from the waviness, gas bubbles and discontinuities found in many commercial vitreous enameled articles. In obtaining this kind of enamel coating on a silver surface the processes described below have been found effective. Another distinction between ordinary enameled metal articles and the kind herein described is that the usual pretreatment of a commercial metal article for receiving an enamel coat, namely, pickling or sandblasting, produces a surface having a low reflection factor for light, and hence one unsuited for making reflectors.

The various steps in making a reflecting sheet having an enameled silver surface are now described:

The metal

Flat sheets of pure silver, preferably finished by cold rolling passes, and free from surface imperfections such as cavities, fissures, seams and blisters, are preferred. The minimum thickness of the sheet that may be used must be determined by trial with the enamel to be applied so that the enamel coating applied to the sheet will not "craze" (develop cracks) on cooling or subsequent heating. The thickness of the enamel coating is also a factor, a thin layer having less tendency to develop cracks than a thicker one. If the sheet thickness is not less than .03", little difficulty with "crazing" is to be expected. Before applying the enamel the silver surface of the sheet must be polished to a high specular reflection factor by usual silver polishing methods, then cleaned by washing with a solvent like toluol or carbon tetrachloride, and repolished by clean soft polishing cloths. If the sheet cannot be immediately enameled it must be protected from tarnishing until it can be enameled.

The enamel chosen for the coating should be one that can be applied in a temperature range well under the melting point of silver (it has been found that a range of 500° C. to 850° C. gives good results). The enamel layer when applied to the silver surface must have a high transmission factor for light (or other radiation to be reflected) and have a smooth, even, glossy surface hard enough not to be easily scratched dur-

ing cleaning. The enamel type should be chosen to be as resistant as possible to moisture, sea air or contaminants in air such as dust or sulphur-containing gases. Without limiting myself to these compositions, I cite as examples of the enamel that may be applied to silver, the following:

Parts by weight melted enamel

SiO ₂	PbO	Na ₂ O	K ₂ O	B ₂ O ₃
20	45-60	5-20	0-15	15
30	60	5	0	5
35	30-45	5	0-15	15
60	30	5-12.5	0	7.5-15

Variations in enamel properties may be obtained by changing the relative proportion of these oxides. Thus, the melting point may be lowered by increasing the lead oxide, but if the best resistance to atmospheric weathering is required, the lead oxide must not be too high. Resistance to weathering may be improved by increasing the potassium oxide, and some lowering of fusion temperature may also be secured by using mixed oxides of sodium and potassium.

Method of applying the enamel to silver-reflecting surfaces

The polished sheet, cleaned as described, is placed, polished side up, on a flat slab of metal or other material (such as fused silica) that will not oxidize seriously or deform when heated or cooled in the temperature range specified. The slab carrying the sheet to be enameled is heated electrically or in any other way that will not tarnish the silver by fuel gases. While the temperature is coming up, small pieces (free from enamel dust) of the enamel are spread evenly over the silver surface. When these pieces have softened sufficiently, but before they begin to flow, a roller made of hardened steel (preferably an alloy steel very resistant to oxidation and rusting) is passed over them in such manner that the enamel pieces are made to coalesce and the enamel is then rolled out into a thin even coating free from gas bubbles, cavities and bumps or waviness; the temperature may be raised or lowered during this operation, as indicated. In some cases it is advantageous after this rolling operation to raise the temperature to a point where the enamel begins to flow away from the edges of the sheet and hold this temperature a while. As soon as the appearance of the enamel coating is satisfactory, the sheet is cooled; in some cases this is done by taking the sheet off the heated slab and cooling it quickly in air; in other cases a slower rate of cooling is advantageous.

Sheets made in this way may be used as stock for pressing out reflectors, as described herein, or for other purposes. Or, if desired, the sheets thus made may be transferred from the hot slab to steel rolls and reduced in section, while maintained at suitable temperatures. By choosing the temperature range of rolling, enamel thickness and silver thickness may be reduced at the same or at different rates. A backing sheet of base metal, such as steel, nickel, or copper may be welded onto the silver-enameled sheet during these rolling steps, if desired.

Example of reflecting silver surface made in the laboratory

Flat sheets of pure silver approximately $\frac{1}{8}$ " thick were polished and cleaned; the specular reflection factor (for light from a tungsten lamp)

before enameling was 0.90. The sheets were placed on a thick plate of stainless steel heated electrically. Enamel particles were placed on the silver surface and lightly rolled by a hand-operated steel roller when they were in the right temperature interval (600°-800° C.) until an adherent, thin, even coating was formed. The enameled sheet was then cooled quickly in air. The specular reflection factors of several enameled sheets made this way varied between 0.82 and 0.86.

Reflectors made from enameled sheets

Blanks of the enameled sheets are pressed, while hot enough for the necessary plasticity of metal and coating, into accurately-machined molds having the contour of the reflector desired. The pressed shapes, after controlled cooling or annealing, are backed with a sufficient thickness of an electro-deposited metal, such as iron or nickel, by spraying or fusing on the backing metal.

As specific examples of specular reflectors made according to this invention, there is shown at 10 a reflector consisting of a foundation metal 11 made of pure silver or other selected foundation metal, having the proper specular reflecting surfaces on its polished and cleaned specular reflecting surface 12. A vitreous transparent enamel coating 13, placed on the specular surface 12 according to this invention, likewise has a smooth, even surface 14 thereon, through which an incident ray of light 15 may penetrate to be specularly reflected as at 16. In the form of invention shown in Fig. 2, the specular reflector 110 has had its foundation metal 11 welded on or otherwise secured to a backing sheet 20, according to the method of this invention above described, to reinforce the same, the reflector 110 being otherwise identical with that shown at 10.

It will also be understood that enameled sheets or reflectors made by such methods may be useful as reflectors for various kinds of radiation other than visible light from the tungsten or other lamps ordinarily employed with silver-surfaced reflectors.

Other modifications and changes in the proportions and arrangements of the parts may be made by those skilled in the art without departing from the nature of the invention, within the scope of what is hereinafter claimed.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

Having thus set forth and disclosed the nature of this invention, what is claimed is:

1. A deterioration resistant reflector comprising a foundation metal of pure silver having a thickness on the order of .03" or more, said silver having a reflecting surface, and a thin transparent vitreous enamel coating fused on said reflecting surface, said enamel being of the group having oxides of silicon and of lead as its major constituents and oxides of sodium and of boron as its minor constituents having a working range well under the melting point of pure silver.

2. A deterioration resistant reflector comprising a foundation metal of pure silver having a thickness on the order of .03" or more, said silver having a reflecting surface, and a thin transparent vitreous colorless enamel coating fused on said reflecting surface, said enamel being of the group having oxides of silicon and of lead as its major constituents and oxides of sodium and of boron as its minor constituents having a work-

ing range well under the melting point of pure silver.

3. A deterioration resistant reflector comprising a foundation metal of pure silver having a thickness on the order of .03" or more, said silver having a reflecting surface, and a thin transparent vitreous colored enamel coating fused on said reflecting surface, said enamel being of the group having oxides of silicon and of lead as its major constituents and oxides of sodium and of boron as its minor constituents having a working range well under the melting point of pure silver.

4. A deterioration resistant reflector compris-

ing a foundation metal of pure silver having a thickness on the order of .03" or more, said silver having a reflecting surface, a thin transparent vitreous enamel coating fused on said reflecting surface, said enamel being of the group having oxides of silicon and of lead as its major constituents and oxides of sodium and of boron as its minor constituents having a working range well under the melting point of pure silver, and a backing sheet on which said foundation metal is secured.

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