April 16, 1935. S. C. LANGDON 1,998,088

METAL BACKED REFLECTOR

Filed Feb. 5, 1932

Fig. 1

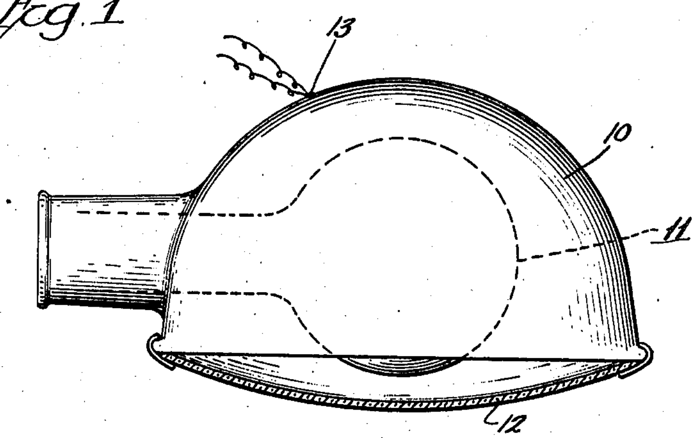



Fig. 2

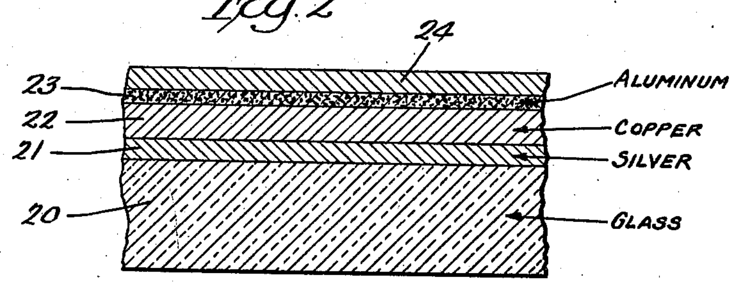
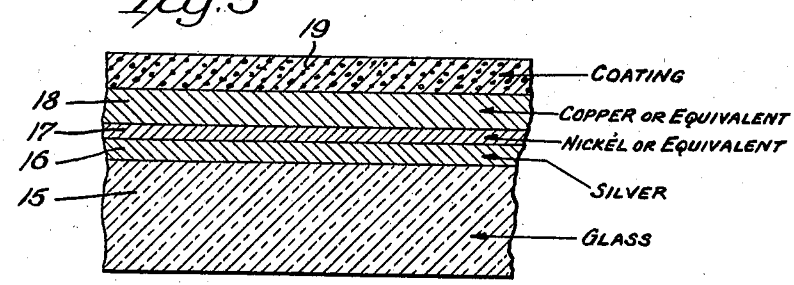



Fig. 3




Inventor:
Seth C. Langdon
E. N. Lundy
Atty.

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# UNITED STATES PATENT OFFICE

## 1,998,088

## METAL BACKED REFLECTOR

Seth C. Langdon, Evanston, Ill.

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9 Claims. (Cl. 88—1)

The present invention relates to metal backed reflectors, such as glass, particularly those which are used in connection with electric light bulbs, or illuminating Geissler tubes, and the like, for purposes of illumination, as in rooms, windows and like places, or electric arcs as in searchlights and the like, or merely for ordinary mirrors.

Mirrors and reflectors have long been made using a silver film on the back of the glass as the medium for the reflecting surface. Pure silver has been employed for this purpose because it has an extremely high reflecting efficiency in the visible light range, and because methods of depositing the silver on the glass are well known and highly developed. To protect the silver film it has been a custom to deposit upon the silver film a covering coat of copper. This has been done largely and readily by depositing methods in a well known manner either chemical or electro-chemical. A protection is thus formed against injury by mechanical action and against corrosion of the silver by gases, and for conduction of heat away from the mirror.

The copper protected silver films have developed certain defects in usage. When the reflectors of copper coated silver are not in use, as when they are in storage, their life without defects is much greater than when the reflectors are in use for lighting purposes. In use they are subjected to the heat of the lamp or arc and this heat causes the defects to appear sooner. The defects may not always be of the same character. Sometimes the silver film is blistered.

It may become dull and lose its sheen by the formation of a "blush", and there may be a mottling in areas of substantial size. Sometimes there is neither blistering nor blushing, nor mottling, but the surface loses its characteristic silver appearance, remains polished, but assumes a tinge of color more characteristic of copper than of silver.

In my copending application, Serial No. 568,899, filed October 15, 1931, I have disclosed my discovery of the cause of these defects. It has been found by study and experiment that the copper in the protective coating and the silver of the film merge in some way sufficient to destroy the surface of the pure silver film at the junction with the glass. I have not determined whether the copper enters the silver coating without the silver entering the copper film, or whether one or both of the metals migrate from their original positions.

In said application I have disclosed the placing of a metal different than copper, such as nickel, against the silver film, and have particularly disclosed a partitioning layer of such a metal between the silver and the backing metal, which backing metal is preferably copper.

In the prior art form, having copper on silver, and in my improved forms having on the silver a metal less reactive than copper to the silver, I have found that the life of the silver film is prolonged as the working temperature of the reflector is lowered.

It has been a practice to coat the back of metal backed reflectors with a finishing material having an attractive appearance. Aluminum powder has been used in such a way that the exposed surface is essentially an aluminum surface or thin film of its oxide. One reason for choosing aluminum is that its appearance remains substantially unchanged. The exposure, and the heat in use, do not cause any substantial discoloration. I have discovered that such a finishing material is about the poorest material that can be used, when used in that way. I have also discovered how it may be used, largely for its appearance, without a great disadvantage of an essentially aluminum surface.

The present invention deals with emissivity, or the radiation of heat from the back of the reflector by electromagnetic waves. I have discovered that the presence of an external coating of aluminum powder, as it is used in the prior art referred to, raises the working temperature of the reflector, and that if the coating is omitted and copper metal exposed, the working temperature is lowered. I have also discovered that merely covering such an aluminum coating with a more highly emissive substance will produce a lower working temperature. I have also discovered that when a varnish, even though it be transparent, is placed over the aluminum coating, a lower working temperature results. Numerous discoveries of this nature to effect the same result are hereinafter disclosed.

The primary object of the invention is to provide an exposed surface, preferably a finishing coat, on a metal back reflector, which surface effectively carries heat away from the reflector by radiation.

One object of the invention is the provision of a finished surface having the silvery appearance of aluminum, and a higher emissivity than an aluminum surface.

Another object is the provision of a varnish surface on a reflector.

Another object is the provision of a metal oxide surface on a reflector.

Another object is the provision of a black surface on a reflector.

Various other and ancillary objects and advantages of the invention will be apparent from the following description and explanation of the invention which is given hereinafter in reference to the exemplary embodiments of the invention shown in the accompanying drawing in which:

Figure 1 illustrates a lamp and reflector as it may be used in practice, and as it has been used in making the tests hereinafter disclosed.

Figure 2 represents a reflector structure, in cross section showing a form having copper on silver, in which form the effect of heat is very pronounced.

Figure 3 represents a reflector structure having metal other than copper against the silver, which form is more durable, and less sensitive to temperature.

In the drawing a lamp reflector 10 positioned to reflect downwardly has been mounted as shown. It has a bulb lamp 11 therein, a blue glass lens 12 over the front, and a testing thermocouple 13 fixed in the surface to record the temperature of the reflector body. In making tests, the reflector and thermocouple have been undisturbed. The lamp has been changed to use lamps of several powers, thereby to effect a series of different working temperatures.

The structure of the reflector is illustrated generally in Fig. 3. There is a glass body 15, a silver reflective film 16, a nickel or equivalent metal layer 17 united to the silver, a backing metal 18, such as copper, and a surface material 19. The surface material may be an oxide surface of the metal 18, or an added adherent coating, or a series of successive coatings. Whatever it may be it is not primarily the body of the material above the metal 18, but the surface which is exposed for the emission of radiant energy, which is the important factor in this invention.

In Fig. 2 a similar reflector is shown having glass 20, a silver reflective film 21, a copper backing metal 22, an aluminum powder coating 23, and a transparent varnish 24. The coating of Fig. 3 may be the same as that in Fig. 2 and the coating in Fig. 2 may be the same as any to be described for Fig. 3, without any departure from this invention. The reflector of Fig. 2 is more sensitive to heat than the reflector of Fig. 3. The use of an exposed aluminum powder surface on the metal structure of Fig. 2 is far more detrimental to it than the same coating is on the metal structure of Fig. 3, and therefore the addition of the varnish coat 24 to the aluminum coated article of Fig. 2 is far more advantageous and beneficial to the life of the reflector of Fig. 2 than the same addition is to an aluminum coated structure of Fig. 3.

In practice of this invention I prefer to use the reflectors like Fig. 3, made according to my copending application Serial No. 568,899, filed October 15, 1931, because by so doing, I use two features which contribute to the life of the reflector. However, the present invention may be used with the prior art reflectors having copper on silver, or merely on silver alone.

In order to make clear the nature of the invention a series of tests will be described, which exemplify the fact that it is the exterior and exposed surface which is important in controlling temperature of the reflector. Numerous materials have been employed and are briefly described.

*Gold bronze.*—This is the commercial form of surface-oxidized copper bronzing powder known as "bronze". It may be used dry, or in a varnish, as a bronze paint.

*Carbon black.*—Any commercial form of carbon black, dry, or carried in a varnish vehicle.

*Aluminum powder.*—Ordinary polished aluminum powder known as "silver". This is referred to as "dry" in which case it is dusted on as a powder for natural adherence. It is also referred to as "fresh" varnish, in which case it is made up fresh in a varnish vehicle. Where an age is specified, such mixture has been aged for that period before applying.

*Enamels.*—Commercial black, green, and ivory colored paint enamels are referred to.

*Varnish.*—Any varnish such as the common drying varnishes, or the synthetic resin varnishes, like phenol condensation products. All are substantially equivalent because they are organic substances, which is material to their functions. The varnish used as such is the same varnish used in admixture with the aluminum powder, bronzing powders, and carbon black.

Because I have found the "gold" bronze is stable to heat, and is efficient as a coating I have taken it, as used in an aged varnish, as a standard for reference. I have made such a coating on the metal backed silver reflector, and with a 200 watt lamp, have allowed the system of Fig. 1 to arrive at an equilibrium temperature determined to be 380° F. Thereafter, I coated it with carbon black in varnish over the oxidized copper without otherwise disturbing the system, and determined an equilibrium temperature of 365° F. The increased emission due to carbon black lowered the temperature 15°.

In the following table this is expressed as "−15". When there is an increase over the reference temperature of 380° F. it is given without the minus sign, as a positive number.

Following the application of carbon black, numerous additions were made without removal of previous coatings.

The results have been as follows:

*Table I*

| Item | Temperature change | Material employed at surface |
|---|---|---|
| 1 | 0 | "Gold" bronze, one day old. |
| 2 | −15 | Carbon black, in varnish. |
| 3 | 70 | Aluminum, freshly mixed. |
| 4 | 22 | "Gold" Bronze, freshly mixed. |
| 5 | −5 | Varnish. |
| 6 | 44 | Aluminum powder, dry. |
| 7 | 3 | Varnish. |
| 8 | 60 | Aluminum 48 hours old. |
| 9 | 64 | Aluminum, freshly mixed. |
| 10 | 0 | "Gold" bronze, one day old. |
| 11 | 64 | Aluminum, freshly mixed. |
| 12 | −12 | Black enamel paint. |
| 13 | −16 | Green enamel paint. |
| 14 | −16 | Ivory enamel paint. |
| 15 | −16 | Varnish. |
| 16 | 40 | Aluminum, dry. |
| 17 | 0 | Varnish. |
| 18 | 20 | Green pigment, dry. |
| 19 | 30 | Aluminum, dry. |
| 20 | ------------ | Aluminum, freshly mixed (reading made two days later, see item 21). |
| 21 | 50 | Above, after standing two days. |
| 22 | 0 | "Gold" bronze, one day old. |
| 23 | 20 | "Gold" bronze, dry. |
| 24 | 30 | Aluminum, dry. |
| 25 | 50 | Aluminum, freshly mixed. |
| 26 | −12 | Black enamel paint. |
| 27 | 6 | "Gold" bronze, one day old. |
| 28 | 6 | "Gold" bronze and carbon black, mixed. |

From the foregoing, it is apparent that the surface, and not the entire substance of the coating material, is the important factor in temperature control. The materials may be listed generally in the order of their decreasing efficiency to cool the reflector.

*Table II*

| | |
|---|---|
| Group A | Varnish, clear<br>Enamels, green and ivory<br>Carbon black, in varnish<br>Black enamel<br>"Gold" bronze, in varnish, one day old |
| Group B | Green pigment<br>"Gold" bronze dry<br>"Gold" bronze, freshly mixed |
| Group C | Aluminum, dry, freshly mixed in varnish, and aged in varnish. |

Where the varnish which is transparent is used, it is probable that the emissivity is somewhat controlled by the underlying material. Where the substance is transparent it must transmit some radiation from material beneath the surface, and it must also absorb some of the radiation emitted by the underlying material. Hence there must be some variation where transparent materials are employed. There are such variations indicated in the Table I. Generally the varnish used clear is high. The enamels present substantially the same surface as clear varnish. In consequence varnish and varnish base coatings give high emissivity.

The group B above includes freshly made "gold" bronze, while the aged "gold" bronze paint is included as group A. The mixing of metal powders into varnish vehicles to form bronzing paints is attended with a factor concerning the aging. Aluminum powder is very light compared to oxidized copper powder and the aluminum powder in a varnish tends more to float and leaf when applied and to project as metal particles from the vehicle. This is especially true in fresh mixtures. In aging, the wetting of some aluminum powders by the varnish is apparently not very much increased, depending on some characteristic of the powder. Acordingly, the aluminum paints generally give a partially metal surface, and the emissivity is partly that of aluminum metal.

Copper bronze powders are essentially nonmetallic at the surface, but are oxides. They are wet better by the varnish, and are heavier.

A fresh mixture therefore dries with more copper oxide particles projecting from the surface. An aged mixture on application more readily permits bronze particles to settle away from the surface. The table shows that freshly mixed gold bronze paints make hotter lamps than aged mixtures (items 4, 1, 10 and 22). Item 4 and item 23 are comparable, showing that a freshly mixed "gold" bronze paint has characteristics more like copper oxide itself used dry. These various uses of gold bronze show the contribution of the surface of the varnish.

The items 17 and 16 show how a clear varnish put over a dry aluminum metal powder, reduces the temperature 40° F.

It is well known that oxides have higher emissivity than the corresponding metals. The copper oxide has a much higher efficiency than aluminum metal. The reflectors may be backed with metals, such as copper, and any backing metal may be oxidized to increase the emissivity. The addition of a varnish over metal, such as aluminum will also increase emissivity. Varnishes or varnish base coatings are preferred over the metal because of their smoother character, their better appearance, and because of the greater ease of cleaning them. Where a silver appearance is desired, aluminum powder may underlie the varnish. Where a gold or bronze appearance is desired, a copper oxide bronze may underlie the varnish. Other pigments, or metal powders may be used under or in the varnish, such as the enamels above referred to. Varnishes, such as those formed by heat reactions, like the phenol-condensation products, and especially the transparent ones, are preferred.

The data derived in studying the detailed results of this invention are not limited to the temperature produced in a reflector by one lamp. Different lamps have been employed and the same order of relationship has been found with less difference as the workng temperature is lowered. I have used a 200 watt lamp, a 150 watt lamp and a 100 watt lamp, in the same reflector, and made comparative tests. Using aluminum as freshly mixed paint, and "gold" bronze as aged paint, the following working temperatures obtain:

*Table III*

| Watt | Aluminum | Gold | Difference |
|---|---|---|---|
| 200 | 426° F. | 368° F. | 58° F. |
| 150 | 353° F. | 310° F. | 43° F. |
| 100 | 249° F. | 227° F. | 22° F. |

The above table indicates a substantial benefit by using an aged bronze paint over a fresh or an aged aluminum paint. It should be noted that the difference is due to the varnish constituent of the "gold" paint being effective as a heat emitter, which it cannot be in the aluminum paint.

In order to illustrate the fact that the results described are dependent upon the character of the material, particularly with reference to aluminum, the following series of results are given, using materials heretofore listed, and the following additional material:

*Unpolished aluminum powder.*—A form distinguishable from the polished form, and one which does not leaf and float in varnish.

Otherwise, the tests have been made as described with reference to Table I.

*Table IV*

| Item | Temperature F. | Succession of materials employed |
|---|---|---|
| 1 | 450° | Aluminum, freshly mixed. |
| 2 | 406° | Clear varnish. |
| 3 | 467° | Unpolished aluminum in varnish. |
| 4 | 417° | Clear varnish. |
| 5 | 383° | Black enamel. |
| 6 | 456° | Aluminum, freshly mixed. |
| 7 | 411° | Clear varnish. |
| 8 | 380° | Black enamel. |
| 9 | 393° | "Gold" bronze. |
| 10 | 378° | Clear varnish. |
| 11 | 397° | Unpolished aluminum in varnish. |
| 12 | 452° | Polished aluminum in varnish. |
| 13 | 396° | Clear varnish. |
| 14 | 414° | Unpolished aluminum dusted on dry. |
| 15 | 368° | Varnish, with lamp black dusted on dry. |

The above Table IV shows a consistent reverse order of average efficiencies, as follows:

*Table V*

456° F. Polished aluminum in varnish
408° F. Clear varnish over aluminum
397° F. Unpolished aluminum in varnish
393° F. "Gold" bronze in varnish
382° F. Black enamel
378° F. Clear varnish over gold bronze.
368° F. Lamp black dusted on.

It is significant that aluminum paints have two degrees of efficiency depending upon the character of the aluminum. The polished or unpolished character of the aluminum determines whether the aluminum particle floats and projects from the varnish, or whether it settles within the varnish, making the paint present a substantially varnish surface. Unpolished aluminum is comparable to the copper base bronze powders. Therefore, it is to be understood that either a gold or an aluminum paint may be used, with substantially the same results, depending on the kind of aluminum that is used in the paint.

The present invention may be practiced in various ways which fall within the scope of the appended claims which define the invention.

I claim:

1. A light reflector adapted to withstand heat, comprising a glass reflector body, a reflective film of silver on said body, a metal backing layer metallically united to said film, and material on said backing comprising on the exterior a transparent varnish and beneath the varnish a visible metallic powder.

2. A light reflector adapted to withstand heat, comprising a glass reflector body, a reflective film of silver on said body, a metal backing layer metallically united to said film, and material on said backing comprising on the exterior a transparent varnish and beneath the varnish a visible aluminum powder.

3. A light reflector adapted to withstand heat, comprising a glass reflector body, a reflective film of silver on said body, a metal backing layer metallically united to said film, and material on said backing comprising on the exterior a transparent varnish and beneath the varnish a visible copper oxide powder.

4. A light reflector adapted to withstand heat, comprising a glass reflector body, a reflective film of silver on said body, a copper layer metallically united to said silver layer, an aluminum powder layer on said copper, and a varnish over said aluminum.

5. A light reflector adapted to withstand heat, comprising a glass reflector body, a reflective film of silver on said body, a copper layer metallically united to said silver layer, and an exposed varnish base coating united to said copper, said coating being such as to present at least a skin layer of the unadulterated varnish base.

6. A light reflector adapted to withstand heat comprising a glass reflector body, a reflective film of silver on said body, a metal backing layer metallically united to said film, and material applied to said metal layer including as the exposed coat a dried film of varnish containing beneath the surface thereof unpolished aluminum powder which has settled into the varnish of said film and away from the surface.

7. A light reflector adapted to withstand heat, comprising a glass reflector body, a reflective film of silver on said body, a copper layer metallically united to said silver layer, a metal powder layer directly over said copper, and a varnish directly over said metal powder layer.

8. A light reflector adapted to withstand heat, comprising a glass reflector body, a reflective film of silver on said body, a copper layer metallically united to said silver layer, a metal powder layer directly over said copper, and a transparent varnish directly over said metal powder layer.

9. A light reflector adapted to withstand heat, comprising a glass reflector body, a reflective film of silver on said body, a copper layer metallically united to said silver layer, an aluminum powder layer directly over said copper, and a transparent varnish coat directly over said aluminum powder layer.

SETH C. LANGDON.