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(54) **AMBER VEHICLE LAMP**

AMBER FAHRZEUGLAMPE

PHARE DE VEHICULE DE COULEUR AMBRE

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(56) References cited:
US-A- 5 126 620 **US-A- 5 667 888**

- **PATENT ABSTRACTS OF JAPAN vol. 1997, no. 09, 30 September 1997 (1997-09-30) & JP 09 124976 A (KOITO MFG CO LTD;NIPPON KAKO TORYO KK), 13 May 1997 (1997-05-13)**
- **PATENT ABSTRACTS OF JAPAN vol. 013, no. 176 (E-749), 25 April 1989 (1989-04-25) & JP 01 006354 A (MATSUSHITA ELECTRONICS CORP), 10 January 1989 (1989-01-10)**
- **DATABASE WPI Derwent Publications Ltd., London, GB; AN 1985-058731 XP002174672 "lamp for color display unit" & JP 60 014749 A (MATSUSHITA ELECTRONICS CORP), 25 January 1985 (1985-01-25)**

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EP 1 010 191 B1

Description

1. Technical Field

[0001] The invention relates to electric lamps and particularly to electric lamps used in vehicles. More particularly the invention is concerned with a polymer coating for a vehicle signal lamp.

2. Background Art

[0002] Amber vehicle lamp bulbs are commonly used as signal lamps in motor vehicles. Historically amber bulbs were made with a cadmium doped glass to produce the amber color. For environmental reasons, cadmium has become an unacceptable material. There is now a market need for an environmentally sound alternative. Various color coated lamps have been developed, and their initial color can be acceptable. Given the specified expected ambient operating conditions for a vehicle, the bulb surface may have a temperature ranging from -40 to 350 degrees Celsius, so durability is difficult to achieve. In fact, the color, or the adherence of the existing coatings, or both have not been particularly good over time. Elapsed time for an automotive signal lamp can appear to be relatively long, while in fact the actual "on" time can be relatively short. A signal lamp may be on for only minutes in the day of a vehicle's operation, so the apparent life of the lamp may appear to be a year or more, when in fact the lamp has only been on cumulatively for only a few tens or even several hundred hours or so. In longer use, known coatings have been found to peel, or turn into a dust that falls off the bulb. Similarly the color may fade. The lamp color then departs from the required specification. There is then a need for an amber bulb coating material that meets standard color specifications, and has a durable life.

The Japanese patent application with the publication number 09124976 discloses a color coating agent for turn signal lamps of automobiles by blending a pigment mixture of red iron oxide pigment (hematite) having a particle diameter of less than 0. 1 mm and a yellow pigment made up of one or more of indolinones, quinacvidones and metal complex azo pigments.

Disclosure of the invention

[0003] A durable amber colored lamp may be formed from a lamp bulb having a coating formed according to claim 1.

Brief Description of the Drawings

[0004]

FIG. 1 shows a perspective view of a preferred embodiment of an amber vehicle lamp.

FIG. 2 shows a perspective view of a preferred alternative embodiment of an amber vehicle lamp.

FIG. 3 shows a perspective view of another preferred alternative embodiment of an amber vehicle lamp.

FIG. 4 shows a cross sectional view of a coated lamp envelope, partially broken away.

FIG. 5 shows a chart of the effects over time of fading on the color coordinates.

Best Mode for Carrying Out the Invention

[0005] FIG. I shows a perspective view of a preferred embodiment of an amber vehicle lamp. Like reference numbers designate like or corresponding parts throughout the drawings and specification. The amber vehicle lamp 10 is assembled from a lamp bulb with a coating 12 comprising a clear silicone-polyester resin, red iron oxide, and a yellow anthraquinone. A silane coupling agent may be optionally included in the polyester resin. FIG. 2 shows a perspective view of a preferred alternative embodiment of an amber vehicle lamp. FIG. 3 shows a perspective view of another preferred alternative embodiment of an amber vehicle lamp. FIG. 4 shows a cross sectional view of a coated lamp envelope, partially broken away. The amber coating 12 covers substantially all of the light transmitting region of the glass 14 of the bulb.

[0006] The preferred incandescent light bulb is an spherical bulb with a press seal known generally in the industry as an S-8. The bulb has a diameter of about 1 inch, and is made of a SG10 type glass, but other glasses, including unleaded glasses, may be used. The filament is supplied with electricity through two leads sealed through the press seal. Similar, two filament, four lead bulbs are also commonly made, and may be similarly coated. A base is attached to the press seal region to provide a convenient mechanical coupling and electrical connection for the bulb. Several base designs are known. The particular choice of the base design is felt to be matter of design choice.

[0007] Coated on the exterior of the bulb is an amber colored coating 12 that, apart from the amber color is substantially transparent. The amber color coating includes a clear silicone-polyester polymer and colorant combination including red iron oxide, and yellow anthraquinone. The preferred coating has a weight ratio composition of 5.0 percent yellow iron oxide, 5.0 percent yellow anthraquinone with the remainder being the silicone-polyester resin. Optionally, a silane coupling agent, of 0.5 weight percent silane may be included in the silicone-polyester.

[0008] The preferred clear resin is a high silicone content polymer, and in particular, high silicone silicone-polyester type polymer resin. The Applicants use a high silicone content polymer available as Silikoftal HTT from Tego Chemie Service GmbH.

[0009] The preferred silane material (optional) includes silicone-polyester linkages. The Applicants have used a known silane with polyester linkages comprising

gamma-methacryloxypropyltrimethoxysilane available as Z-6030 from Dow Corning Corporation. The silane material may be applied separately, or mixed with the silicone-polyester resin. One recent test procedure indicates that while the coating composition that includes the silane material can achieve an existing specification, the same composition without the silane results in greater durability. The composition with the silane included is now considered a less preferred alternative.

[0010] A solvent is mixed with the colorants, silane (optional) and resin in sufficient quantity to form a fluid coating material with a viscosity convenient for the chosen form of application. Dipping the lamp is one convenient method of applying the coating. The Applicants prefer spraying, so the mixture needs to be diluted with the solvent sufficiently to result in a sprayable fluid. The preferred polymer solvent is acetone but others may be used, such as methoxypropylacetate.

[0011] The preferred colorant material is a mixture of a yellow iron oxide and an anthraquinone. The preferred anthraquinone is Filester yellow RNB, available from Ciba Specialty Chemicals and has a more particular chemical formula of 9,10-anthraceneedione, 1,1'-{(6-phenyl-1,3,5-triazine-2,4diyl)diimino}bis. The colorants are prepared to provide particle sizes of 0.01μm or less. The very small size particle size enables a transparent bulb, that still has an amber color.

[0012] The yellow iron oxide colorant may be dispersed in a media mill using solvent, and milled to the small size. The anthraquinone may be dispersed separately, again using a media mill, and milled to the small size (particle sizes of 0.01μm or less). The two colorants are then combined in the mill, and then milled together. The two colorants are then thoroughly mixed. The silane (optional) and silicone-polyester resin are then added by using a planetary mixer. A solvent is added to achieve the desired viscosity for the chosen form of application. The resulting mixture, immediately after mixing, does not necessarily show the proper amber color. Nonetheless, the resulting mixture is ready for application to the clean glass lamp surface.

[0013] The Applicants coat previously manufactured, clear lamp bulbs. The chosen bulb is known as a 3157 S-8 wedge. The bulbs are held by their bases so the bulb portions face down, and the bases and electrical connections are shielded from any spray. This leaves the light transmissive portion of the bulb exposed. The exposed glass portions of the bulb are then sprayed, bulb side up, with the coating mixture at ambient temperature, leaving a thin fluid coating. Alternatively, the exposed glass portions may be dipped (bulb down) in the coating material, and any excess coating material may drip off. In either case, the viscosity is such that the coating material as applied leaves a uniform thin layer which may be approximately 0.0127 millimeters (5.0 10^{-4} inches). Measured variations were about 0.0015 millimeters (5.9 10^{-5} inches). This thickness is sufficient to allow light to exit the bulb with an amber color that meets the ECE specification for vehicle amber signal lamps.

[0014] The coated bulb is then baked at 250 to 300 degrees Celsius for 15 minutes in a dust free atmosphere to form an amber colored polymer layer. During the baking process a number of events occur. The colored coating layer is bonded to the glass. The yellow iron oxide changes from FeOOH to Fe_2O_3 and which in combination with the yellow anthraquinone pigment gives the desired amber color. The silicone polyester polymer is cross linked around the colorant particles to entrap them in a complex network of resin material. The baking also drives off any residual solvent.

[0015] The resulting coated bulbs were tested and found to have the following characteristics: The bulb had a thin hard, transparent amber coating. The amber color meets the SAE and ECE color coordinate requirements for vehicle amber signal lamps. In particular, when the bulb is on, it producer an amber color light with color coordinate (X,Y) within the 1931 CIE chromaticity region wherein a) 0.398 (the red boundary) is equal to or less than Y, b) Y is also equal to or less than 0.429 (the green boundary), and c) 0.993 - X is equal to or less than Y (the white boundary). Coated bulbs (with silane) under test have been operated continuously for over 840 hours. This is 70 percent of the rated life of 1200 hours for a 3157 S-8 wedge bulb. Coated bulbs (with silane) have been found to have complete coating adherence and a color maintenance of 96 percent measured by spherical integration methods. Coated bulbs (with silane) are expected to have a color maintenance of 94.3 percent at 100 percent of rated bulb life.

[0016] FIG. 5 shows a chart of the effects over time of fading on the color coordinates. In this test, the bulbs were exposed to normal operating environment of 90 flashes per second for 1315 hours. The initial color coordinates were approximately, (0.579, 0.415), and after 1315 hours the color had shifted to approximately (0.573, 0.422). Both the initial and the final coordinates were within the EC (region 16) and SAE (region 18) defined regions for amber. The coated bulbs, with silane and without silane, were tested according to a schedule of 24 hours of the lamp being on under varying conditions of heat, and humidity. In summary, during the test, the temperature was varied from -40 to 80 degrees Celsius, with the humidity reaching as much as 93 percent. Meanwhile, the lamps were turned on and off according to a schedule. The coated lamps were to achieve a B10 (90 percent success, 10 percent failure) of 10 cycles (10 days). The bulbs with silane passed with a B10 of about 10 or 12 cycles. The bulbs without the silane achieved a B10 of 18 cycles. The coated bulb has proven to have a better amber color, and a longer color maintenance than any other coated product known to the applicants. The disclosed operating conditions, dimensions, configurations and embodiments are as examples only, and other suitable configurations and relations may be used to implement the invention.

[0017] While there have been shown and described

what are at present considered to be the preferred embodiments of the invention, it will be apparent to those skilled in the art that various changes and modifications can be made herein without departing from the scope of the invention defined by the appended claims.

Claims

1. An amber color coated incandescent light bulb (10) comprising:

an incandescent light bulb with a light transmissive glass envelope,
the envelope coated with an amber color coating (12) including:

a clear silicone-polyester polymer; and
colorant including red iron oxide,

characterized in that
the colorant further includes yellow anthraquinone, and
the red iron oxide has a particle size less than 0.01 μm.

2. The light bulb in claim 1, wherein the color has an amber color within the 1931 CIE chromoticity region defined by 0.398 = < y = < 0.429 and 0.993 - x =< y.

3. The light bulb in claim 1, wherein the anthraquinone has a chemical formula of 9,10-anthraceneedione, 1,1'-{(6-phenyl-1,3,5-triazine-2,4 diyl)diimino}bis-.

4. The light bulb in claim 1, wherein the yellow anthraquinone has a particle size less than 0.01 μm.

5. The light bulb in claim 1, wherein the silicone-polyester polymer is a clear polysiloxane polyester resin.

6. A method of making an amber coated lamp bulb comprising the steps of:

a) providing a lamp bulb with a glass region to be coated;
b) providing a mixture of a yellow iron oxide, and a yellow anthraquinone, the mixture having an average particle size of no more than 0.01 μm, to result in a clear colored coating;
c) mixing the yellow iron oxide, and yellow anthraquinone mixture with a clear silicone-polyester resin;
d) further including in the mixture a polymer solvent being in sufficient quantity to form a fluid coating material with a viscosity convenient for application;
e) coating the glass region to be coated with the coating material to a thickness sufficient to allow passage of light out from the lamp bulb; and
f) heating the coated lamp to a sufficient temperature, and for a sufficient time period to cure the resin, to substantially remove the solvent and, to form a colored polymer layer on the lamp.

7. The method in claim 6, wherein the silicone-polyester resin includes Silikoftal HTT.

8. The method in claim 6, wherein the silicone-polyester resin includes acetone as a solvent.

9. The method in claim 6, wherein the silicone-polyester resin includes methoxypropylacetate as a solvent.

10. The method in claim 6, wherein the polymer solvent includes acetone in sufficient quantity to form a fluid coating material with a viscosity convenient for spraying.

11. The method in claim 6, wherein the coating material is sprayed on the glass region to be coated.

12. The method in claim 6, wherein the coating material is applied to a uniform thickness of 0.0127 millimeters (0.0005 inches).

13. The method in claim 6, wherein the lamp is heated from 250 to 300 degrees Celsius for 15 minutes in a dust free atmosphere.

14. The method in claim 6, wherein the mixture comprises equal weight amounts of yellow iron oxide and a yellow anthraquinone, and
the yellow anthraquinone has a chemical formula of 9,10-anthraceneedione, 1,1'-{(6-phenyl-1,3,5-triazine-2,4diyl)diimino}bis-.

15. The method of claim 6, wherein the mixture of the yellow iron oxide the yellow anthraquinone, and the clear silicone-polyester resin includes a silane, being gamma-methacryloxypropyltrimetoxysilane,
the silicone-polyester resin is gamma-methacryloxypropyltrimeth, and
the coating material has a weight composition of 0.5 percent silane, 5.0 percent yellow iron oxide, 5.0 percent yellow anthraquinone, and the remaining weight being the silicone-polyester resin.

Patentansprüche

1. Eine mit gelber Farbe beschichtete Glühbirne bzw. -lampe (incandescent light bulb) (10) umfassend:

eine Glühbirne mit einer lichtdurchlässigen Glasumhüllung,

wobei die Umhüllung mit einer gelben Farbbeschichtung (12) beschichtet ist, umfassend:

ein durchsichtiges Silikon-Polyester Polymer; und
Färbemittel einschließlich rotes Eisenoxid,

dadurch gekennzeichnet, dass
das Färbemittel des Weiteren gelbes Anthrachinon umfasst und
das rote Eisenoxid eine Teilchengröße von weniger als 0,01 μm aufweist.

2. Glühbirne nach Anspruch 1, wobei die Farbe eine gelbe Farbe innerhalb des 1931 CIE Chromatizitätsbereichs aufweist, definiert durch 0,398 = < y = < 0,429 und 0,993 - x = < y.

3. Glühbirne nach Anspruch 1, wobei das Anthrachinon eine chemische Formel von 9,10-Anthracendion, 1,1'{(6-Phenyl-1,3,5-triazin-2,4diyl)diimino} bis- aufweist.

4. Glühbirne nach Anspruch 1, wobei das gelbe Anthrachinon eine Teilchengröße von weniger als 0,01 μm aufweist.

5. Glühbirne nach Anspruch 1, wobei das Silikon-Polyester Polymer ein durchsichtiges Polysiloxanpolyesterharz ist.

6. Verfahren zur Herstellung einer mit gelber Farbe beschichteten Glühbirne umfassend die Schritte:

a) Bereitstellen einer Glühbirne mit einem zu beschichtenden Glasbereich;
b) Bereitstellen einer Mischung aus gelben Eisenoxid und einem gelben Anthrachinon, wobei die Mischung eine mittlere Teilchengröße von nicht mehr als 0,01 μm aufweist, um zu einer durchsichtigen, gefärbten Beschichtung zu führen;
c) Mischen des gelben Eisenoxids und der gelben Anthrachinonmischung mit einem durchsichtigen Silikonpolyesterharz;
d) des Weiteren Hinzufügen eines Polymerlösungsmittels in die Mischung in einer ausreichenden Menge, um ein flüssiges Beschichtungsmaterial mit einer für die Aufbringung geeigneten Viskosität zu bilden;
e) Beschichten des zu beschichtenden Glasbereichs mit dem Beschichtungsmaterial mit einer Dicke, die ausreichend ist, um den Durchtritt von Licht aus der Glühbirne zu ermöglichen; und
f) Erwärmen der beschichteten Lampe auf eine ausreichende Temperatur und für einen ausreichenden Zeitraum, um das Harz zu härten, um das Lösungsmittel im Wesentlichen zu entfernen und um eine gefärbte Polymerschicht auf der Lampe zu bilden.

7. Verfahren nach Anspruch 6, wobei das Silikonpolyesterharz Silikoftal HTT umfasst.

8. Verfahren nach Anspruch 6, wobei das Silikonpolyesterharz Aceton als ein Lösungsmittel umfasst.

9. Verfahren nach Anspruch 6, wobei das Silikonpolyesterharz Methoxypropylacetat als ein Lösungsmittel umfasst.

10. Verfahren nach Anspruch 6, wobei das Polymerlösungsmittel Aceton in einer ausreichenden Menge umfasst, um ein flüssiges Beschichtungsmaterial mit einer geeigneten Viskosität zum Sprühen zu bilden.

11. Verfahren nach Anspruch 6, wobei das Beschichtungsmaterial auf den zu beschichtenden Glasbereich aufgesprüht wird.

12. Verfahren nach Anspruch 6, wobei das Beschichtungsmaterial mit einer gleichmäßigen Dicke von 0,0127 mm (0,0005 inch) aufgebracht wird.

13. Verfahren nach Anspruch 6, wobei die Lampe zwischen 250 bis 300 °C für 15 Minuten in einer staubfreien Atmosphäre erwärmt wird.

14. Verfahren nach Anspruch 6, wobei die Mischung gleiche Gewichtsmengen an gelben Eisenoxid und einem gelben Anthrachinon umfasst, und
das gelbe Anthrachinon eine chemische Formel von 9,10-Anthracendion, 1,1'-{(6-Phenyl-1,3,5-triazin-2,4diyl)diimino}bis- aufweist.

15. Verfahren nach Anspruch 6, wobei die Mischung des gelben Eisenoxids, des gelben Anthrachinons und des durchsichtigen Silikonpolyesterharzes ein Silan umfasst, welches Gamma-Methacryloxypropyltrimetoxysilan ist,
das Silikonpolyesterharz ist Gamma-Methacryloxypropyltrimeth ist, und
das Beschichtungsmaterial eine Gewichtszusammensetzung aus 0,5 % Silan, 5,0 % gelbes Eisenoxid, 5,0 % gelbes Anthrachinon aufweist und das restliche Gewicht Silikonpolyesterharz ist.

Revendications

1. Ampoule d'éclairage à incandescence revêtue d'une couleur ambre (10), comprenant :

une ampoule d'éclairage à incandescence ayant une enveloppe en verre transmettant la lumière,

l'enveloppe revêtue d'un revêtement de couleur ambre (12) comprenant :

un polymère silicone-polyester transparent ; et
un colorant incluant de l'oxyde de fer rouge,

caractérisée en ce que
le colorant comprend de plus une anthraquinone jaune, et
l'oxyde de fer rouge a une taille de particule inférieure à 0,01 μm.

2. Ampoule d'éclairage selon la revendication 1, dans laquelle la couleur est une couleur ambre dans la région de chromaticité CIE 1931 définie par 0,398 = < y = < 0,429 et 0,993 - x = < y.

3. Ampoule d'éclairage selon la revendication 1, dans laquelle l'anthraquinone a la formule chimique 9,10-anthracèneedione, 1,1'-{(6-phényl-1,3,5-triazine-2,4-diyl)diimino}bis-.

4. Ampoule d'éclairage selon la revendication 1, dans laquelle l'anthraquinone jaune a une taille de particule inférieure à 0,01 μm.

5. Ampoule d'éclairage selon la revendication 1, dans laquelle le polymère silicone-polyester est une résine de polysiloxane polyester transparente.

6. Procédé pour fabriquer une ampoule d'éclairage, pourvue d'un revêtement ambré, comprenant les étapes consistant à :

a) se procurer une ampoule d'éclairage présentant une zone en verre à revêtir,
b) se procurer un mélange d'oxyde de fer jaune, et d'anthraquinone jaune, le mélange ayant une taille moyenne de particule qui n'est pas supérieure à 0,01 μm, le résultat étant un produit de revêtement coloré transparent ;
c) mélanger le mélange d'oxyde de fer jaune, et d'anthraquinone jaune avec une résine de silicone-polyester transparente ;
d) inclure de plus dans le mélange un solvant pour polymère en une quantité suffisante pour former un matériau de revêtement fluide ayant une viscosité adaptée pour l'application;
e) revêtir la zone en verre à revêtir, à l'aide du matériau de revêtement jusqu'à une épaisseur suffisante pour permettre le passage de lumière hors de l'ampoule d'éclairage ; et
f) chauffer l'ampoule revêtue jusqu'à une température suffisante, et pendant une période de temps suffisante pour durcir la résine, afin d'éliminer de manière substantielle le solvant et former une couche de polymère colorée sur l'ampoule.

7. Procédé selon la revendication 6, dans lequel la résine de silicone-polyester inclut du Silikoftal HTT.

8. Procédé selon la revendication 6, dans laquelle la résine de silicone-polyester comprend de l'acétone en tant que solvant.

9. Procédé selon la revendication 6, dans lequel la résine de silicone-polyester comprend du méthoxypropylacétate en tant que solvant.

10. Procédé selon la revendication 6, dans lequel le solvant pour polymère comprend de l'acétone en quantité suffisante pour former un matériau de revêtement fluide ayant une viscosité adaptée à une pulvérisation.

11. Procédé selon la revendication 6, dans lequel le matériau de revêtement est pulvérisé sur la zone en verre à revêtir.

12. Procédé selon la revendication 6, dans lequel le matériau de revêtement est appliqué jusqu'à une épaisseur uniforme de 0,0127 millimètre (0,0005 pouce).

13. Procédé selon la revendication 6, dans lequel l'ampoule est chauffée à 250-300 degrés Celsius pendant 15 minutes dans une atmosphère exempte de poussière.

14. Procédé selon la revendication 6, dans lequel le mélange comprend des quantités en poids égales d'oxyde de fer jaune et d'anthraquinone jaune, et l'anthraquinone jaune à la formule chimique 9,10-anthracèneedione, 1,1'-{(6-phényl-1,3,5-triazine-2,4-diyl)diimino}bis-.

15. Procédé selon la revendication 6, dans lequel le mélange d'oxyde de fer jaune, d'anthraquinone jaune et de résine de silicone-polyester transparente comprend un silane, qui est le gamma-méthacryloxypropyltriméthoxysilane,
la résine de silicone-polyester est le gamma-méthacryloxypropyltriméth, et
le matériau de revêtement a une composition en poids de 0,5 pourcent de silane, 5,0 pourcent d'oxyde de fer jaune, 5,0 pourcent d'anthraquinone jaune, et le poids restant étant la résine de silicone-polyester.

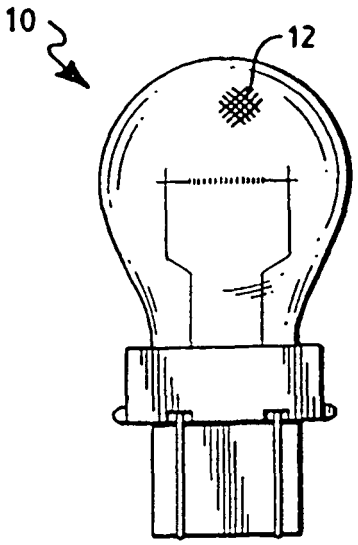

FIG. 1

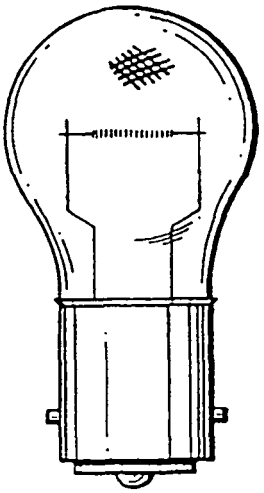

FIG. 2

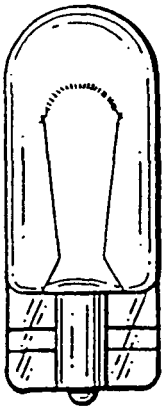

FIG. 3

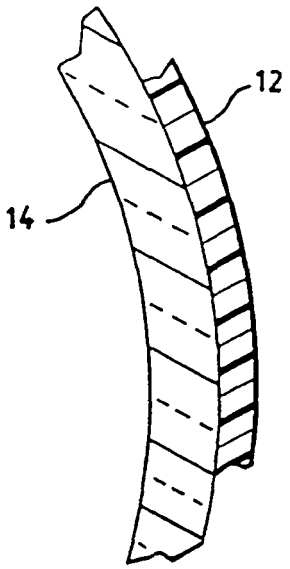

FIG. 4

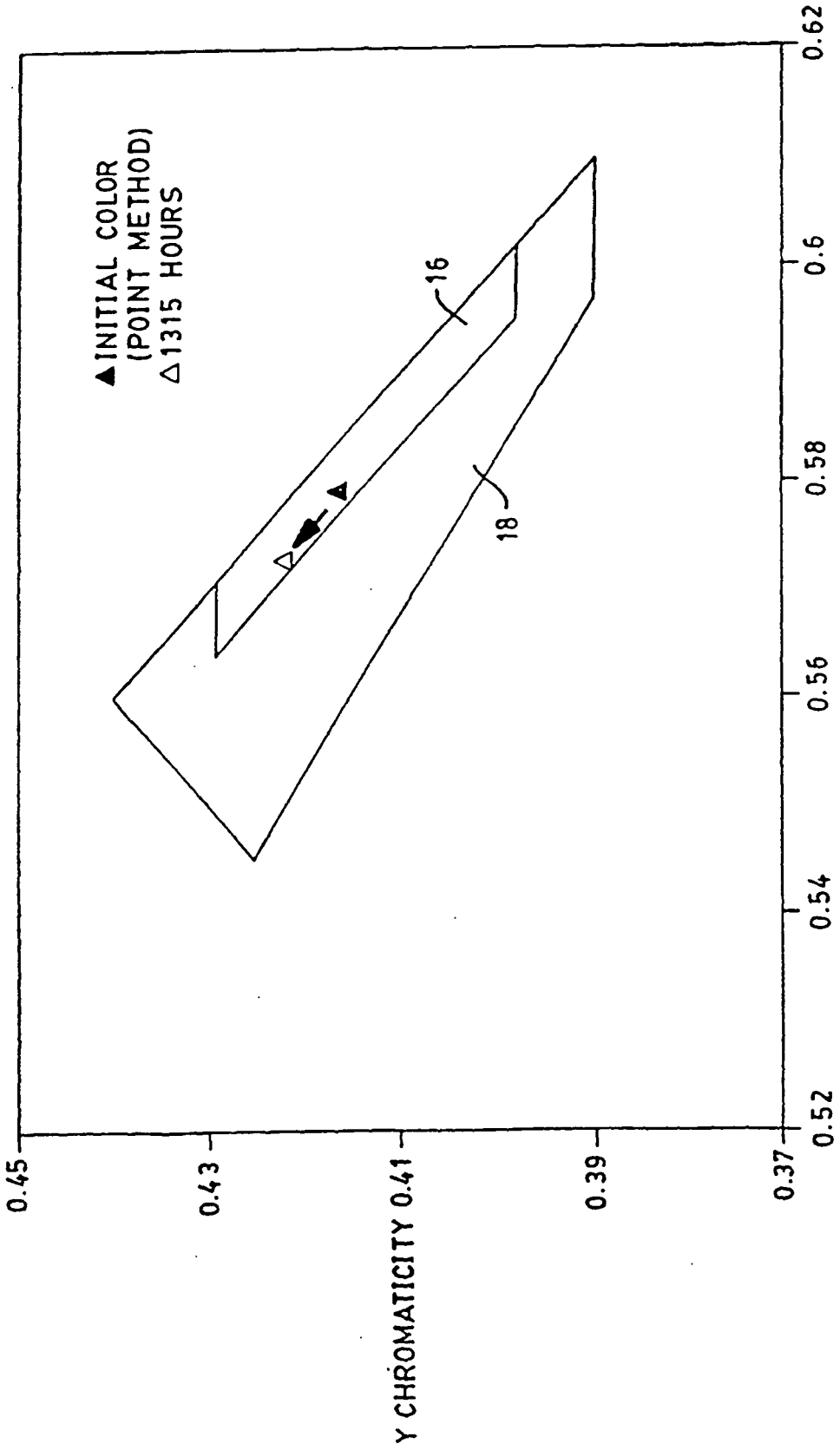
▲INITIAL COLOR
(POINT METHOD)
△1315 HOURS
16
18
0.45
0.43
0.41
0.39
0.37
Y CHROMATICITY
0.52
0.54
0.56
0.58
0.6
0.62
X CHROMATICITY

FIG. 5