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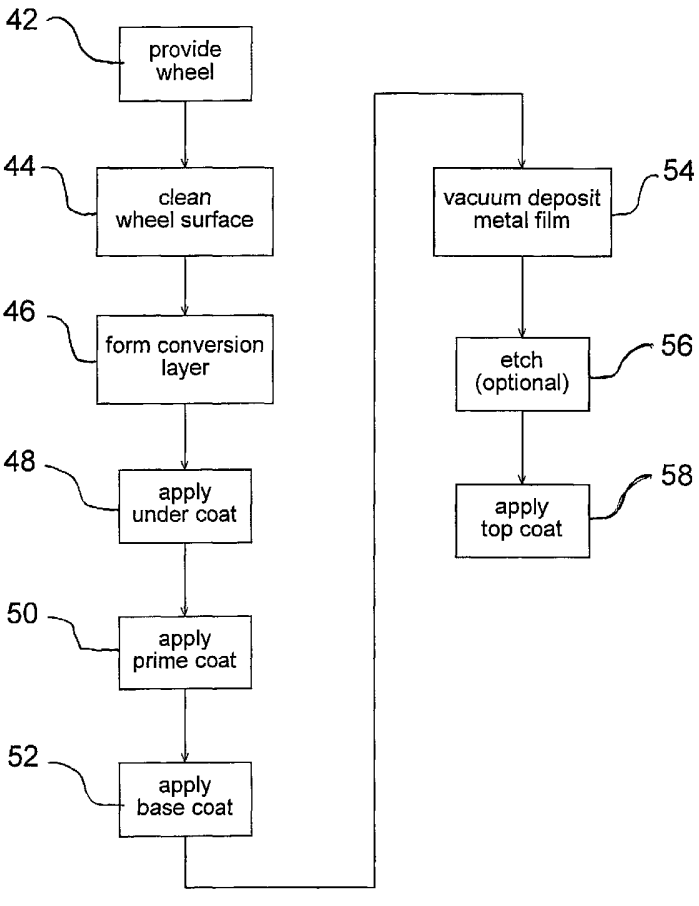
(54) Title: BRIGHT SURFACE COATING FOR A VEHICLE WHEEL



(57) Abstract: A multi-layer coating for a vehicle wheel includes a layer of undercoat material adjacent to the surface of the wheel that fills any surface imperfections. Intermediate urethane layers are deposited upon the undercoat layer. A metal film is vacuum deposited over the intermediate layers to provide a smooth bright appearance for the wheel.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

BRIGHT SURFACE COATING FOR A VEHICLE WHEEL

Background of Invention

[001] This invention relates in general to decorative surface coatings for vehicle wheels and in particular to a bright surface coating for vehicle wheels and a process for forming the bright surface coating.

[002] Vehicle wheels have a circular wheel disc attached to an annular wheel rim. The wheel disc includes a central wheel hub having a pilot hole and plurality of wheel mounting holes formed therethrough. A plurality of circumferentially spaced spokes typically support the wheel hub within the wheel rim. The wheel rim is adapted to support a pneumatic tire.

[003] In the past, vehicle wheels typically have been formed entirely from steel. However, one piece wheels formed from light weight metals, such as aluminum and magnesium or alloys thereof, are becoming increasingly popular. In addition to weighing less than conventional all-steel wheels, such light weight wheels can be manufactured having a pleasing esthetic shape. Weight savings also can be achieved with two piece wheels fabricated by attaching a wheel disc formed from a light weight metal alloy to a steel wheel rim. Alternately, a two piece wheel can be fabricated by attaching a wheel disc formed from a light weight metal to a wheel rim that also is formed from the same light weight metal. Light weight one piece wheels and light weight components for two piece wheels are typically formed by conventional methods, such as gravity or low pressure casting.

[004] Regardless of how the wheel is formed, the wheel disc outboard surface is often machined to form a smooth surface. The outboard surface is then provided with a coating having a high luster. One such know coating is formed by a

conventional chrome plating process. A conventional chrome plating process involves a complex series of discrete steps during which multiple layers of metal are electro-chemically deposited upon the wheel surface.

[005] Prior to chrome plating, the wheel surface is cleaned of any oil and dirt, which could inhibit adhesion of metal deposits to the wheel surface. The chrome plating begins with immersion of the portion of the wheel to be chrome plated in chemical bath that contains nickel in solution. During immersion, an electric potential is applied between the wheel and the solution causing a thin layer of nickel to be electro-chemically deposited upon the wheel surface. The nickel layer, which is typically referred to as a prenickel layer, enhances the adhesion of the successive layers to the wheel surface. However, the prenickel layer tends to have a relatively uneven surface. Therefore, a copper layer is usually electro-chemically deposited over the prenickel layer, usually by immersion of the wheel surface in another chemical bath that contains copper in solution while an electric potential is applied between the wheel and the solution. The copper fills in uneven portions of the prenickel layer, forming a smooth surface. To further enhance the surface smoothness, the copper layer is buffed, or polished. Then a second nickel layer, which is typically referred to as a semi-bright nickel layer, is formed over the copper layer by electro-chemical deposition. The semi-bright nickel layer provides corrosion resistance. Next, a layer of nickel that contains sulfur is electro-chemically deposited over the semi-bright nickel layer as a sacrificial corrosion layer. A final bright layer of nickel is then electro-chemically deposited over the sacrificial nickel layer to provide reflectivity and brightness to the wheel surface.

[006] The layers of nickel and copper provide a base upon which the chromium layer is electro-chemically deposited. First, a pre-chromium layer of discontinuous chrome, or pixie dust, is deposited over the bright nickel layer.

Then a layer of chromium is electro-chemically deposited over the pre-chromium layer to prevent nickel fogging. The preceding description of a chrome plating process is meant to be illustrative of the process and it will be appreciated that the details can vary.

[007] Because each layer is formed by immersing the wheel surface in a chemical bath containing a solution of the particular metal to be deposited upon the wheel surface with an electric potential applied between the wheel and the chemical bath, each layer is chemically bonded to the preceding layer to provide a durable and attractive decorative coating. While the chrome plating process has been described above as an electro-chemical deposition process, the process is typically referred to as electro-plating.

[008] As an alternate to the complex chrome plating process described above, it also is known to provide a high gloss finish to an aluminum wheel by vacuum depositing indium, or an alloy of indium, onto the wheel surface. The vacuum deposited indium, when properly topcoated, provides a bright, shiny appearance that very closely duplicates a chemically deposited, or electro-deposited, chrome plated surface.

[009] Referring now to the drawings, a known multi-layer coating that includes a layer of vacuum deposited indium is illustrated in Fig. 1 by an enlarged cross sectional view of a portion of a vehicle wheel. In Fig. 1, a portion of an aluminum wheel 10 having an outer surface 12 is covered by a multi-layer coating 14. The multi-layer coating 14 includes a standard conversion coating layer 16 of a chemical or electrochemical treatment such as a chromate coating. The conversion coating layer 16 is covered by primer coat layer 18 formed from an urethane resin. The primer coat layer 18 is, in turn, covered by a base coat layer 20 of a suitable urethane polymer.

[010] The base coat layer 20 is covered by a metal film layer 22 of vacuum metalized indium metal islands. Alternately, the film layer 22 can be formed from an indium alloy. Finally, a top coat 24 formed from a protective dielectric material, such as clear polyurethane, covers the metal film layer 22. The process for forming the multi-layer coating 14 is often referred to as a metalization process and is more fully described in U.S. Patent No. 5,290,625, which is incorporated herein by reference.

Summary of Invention

[011] This invention relates to a bright surface coating for vehicle wheels and a process for forming the bright surface coating.

[012] The above described processes form a smooth shiny surface that is esthetically pleasing in appearance. However, the chrome plating process is very complex and, accordingly, expensive. Also, due to the complexity and specialized nature of the chrome plating process, it is usually necessary to ship the wheels to a chrome plater for the application of the surface finish, which further increases manufacturing time and expense.

[013] The alternate surface finishing process described above that utilizes a metalization process is much simpler to apply; however, a very smooth surface is required to obtain a finish that is similar to chrome plating because the vacuum deposited metal film mirrors the surface upon which it is deposited. It has been found that the urethane primer coat described above does not sufficiently level the wheel surface Accordingly, in order to achieve the desired glossy surface finish, it is often necessary to polish the surface before applying the metalization process. Polishing adds to the manufacturing expense and may require shipping the wheels to a separate facility for polishing. Additionally, some of the aesthetically pleasing wheel designs include complex shapes that

make complete polishing of the surface difficult. Accordingly, it would be desirable to provide an improved process for forming a decorative bright surface coating upon a vehicle wheel.

[014] The present invention is directed toward a bright multi-layer surface coating for a vehicle wheel. The multi-layer coating includes an undercoat layer covering at least a portion of the wheel surface with the undercoat layer filling any surface imperfections to provide a smooth surface. In the preferred embodiment, the undercoat layer is formed from an acrylic material. Alternately, the undercoat layer can be formed from a polyester material instead of an acrylic material. The multi-layer coating also includes a layer of primer material that covers the undercoat layer. The multi-layer coating further includes a layer of base coat material that covers the primer layer. A vacuum deposited metal film covers the base coat layer so that the wheel surface has a bright appearance. The invention also contemplates that the multi-layer coating includes a protective layer of clear coat material that covers the metal film as a top coat.

[015] The present invention also contemplates a process for forming a bright multi-layer surface coating for a vehicle wheel. The process includes providing a vehicle wheel. A layer of undercoat material is applied to at least a portion of a surface of the wheel with the undercoat layer filling any surface imperfections to provide a smooth surface. In the preferred embodiment, the undercoat layer is formed from an acrylic material. Alternately, the undercoat layer can be formed from a polyester material instead of an acrylic material. A layer of primer material is applied over the undercoat layer. A layer of base coat material is then applied over the primer layer and a metal film is vacuum deposited over the base coat layer. Subsequent to depositing the metal film, a protective layer of a clear coat material is deposited over the metal film.

[016] Various objects and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiment, when read in light of the accompanying drawings.

Brief Description of Drawings

[017] Fig. 1 is a enlarged cross sectional view of a wheel surface coating in accordance with the prior art.

[018] Fig. 2 is a enlarged cross sectional view of a wheel surface coating in accordance with the present invention.

[019] Fig. 3 is an enlarged cross sectional view of an alternate embodiment of the wheel surface coating shown in Fig. 2.

[020] Fig. 4 is an enlarged cross sectional view of another alternate embodiment of the wheel surface coating shown in Fig. 2.

[021] Fig. 5 is a flow chart for a process for depositing the surface coating shown in Fig. 2 upon a wheel surface.

Detailed Description

[022] Referring again to the drawings, there is illustrated in Fig. 2 an improved multi-layered coating 26 for a wheel surface in accordance with the present invention. Components shown in Fig. 2 that are similar to components shown in Fig. 1 have the same numerical identifiers.

[023] As shown in Fig. 2, a portion of an aluminum wheel 10 having an outer surface 12 is covered by a multi-layer coating 26 that includes a vacuum deposited indium layer. The multi-layer coating 26 includes a standard conversion coating layer 16 of a chemical or electrochemical treatment such as a

chromate coating. A suitable chromate conversion coating is Parker Amchem Alodine 1200S.

[024] The present invention contemplates covering the conversion layer 16 with a coating of a polyester or an acrylic material, which forms an undercoat layer, labeled 28 in Fig. 2, between the conversion layer 16 and the remaining coating layers. In the preferred embodiment, an acrylic material is used for the undercoat layer 28. The undercoat layer 28 can have a thickness within a range of from 1.0 to 10.0 mils, with a thickness range of from 1.0 to 5.0 mils being desirable and a thickness range of from 1.0 to 2.0 mils being preferable. In the preferred embodiment a powder form of the undercoat material is sprayed onto the wheel with an electric potential established between the powder spray head and the wheel surface to enhance the adhesion of the powder to the wheel surface. However, the undercoat material may also have a water or solvent base. Additionally, the invention contemplates that either a clear coat or a pigmented material can be used to form the undercoat layer 28.

[025] The polyester or acrylic material used in the undercoat layer 28 is formulated differently than the urethane material used for the prior art primer coat 18 and provides a smoother surface. The inventors have found that the prior art urethane primer coat is not effective to fill, or smooth, variations in wheel surface heights that exceed one mil. In the preferred embodiment, an acrylic coating with a glass plate flow rate within the range of 150 to 170 mm is used to form the undercoat layer 28. The acrylic coating flow rate is less than the flow rate of the prior art urethane primer coat material. The alternate polyester material that can be used to form the undercoat layer 28 has similar properties. Accordingly, the acrylic or polyester undercoating layer fills the low areas of the wheel surface to produce a uniformly smooth surface for the subsequently applied layers.

[026] The inventors also have found that the acrylic or polyester undercoat layer 28 applied to the surface of the chromate conversion coating provides a sufficiently smooth surface that it is not necessary to polish the wheel surface. The inventors have determined that application of acrylic or polyester coatings as an undercoat layer costs less than polishing the wheel. Therefore, the present invention provides substantial cost savings. Additionally, the present invention can be readily applied to wheel designs having complex shapes that may preclude polishing portions of the wheel surfaces.

[027] The undercoat layer 28 is covered by a layer of primer coat 18 of a urethane resin having a typical thickness of form 0.1 to 2.0 mills. The primer coat layer 18 is, in turn, covered by a base coat layer 20 of a suitable urethane polymer having a typical thickness of from 0.1 to 2.0 mils. The undercoat, primer coat and base coat layers 28, 18 and 30 provide a dielectric or electrically insulative surface for receiving the vacuum deposited metal.

[028] The base coat layer 30 is covered by a film layer 22 of vacuum metalized indium metal islands. Alternately, the film layer 22 can be formed from an indium alloy. The etched vacuum metallized indium islands typically have a thickness of 25 to 2,000 angstrons. Sputtering and thermal evaporation are preferred commercial methods for laying down the metal film layer 22. Alternately, ion plating, induction heating or electron beam evaporation methods also may be utilized to form the film layer 22. Details of the process are included in U.S. Patent No. 4,431,711, which is incorporated herein by reference.

[029] In the preferred embodiment, the valleys separating the indium islands in the metal film layer 22 are etched during a 60 to 90 second time period by an etching solution. In the preferred embodiment, a 10 percent sodium hydroxide solution is utilized as the etchant. The etching enhances the adhesion of the top

coat; however, the invention also can be practiced without etching the film layer 22.

[030] Finally, a top coat layer 24 formed from a protective dielectric material, such as a clear urethane or an acrylic polymer, covers the metal film layer 22. The top coat layer 24 has a typical thickness of from 0.1 to 2.0 mils. The top coat 24 layer encapsulates the islands of the metal film 22 to "fix" the electrical conductivity of the metal film 22 and thereby substantially increases the corrosion resistance of the metal film 22. The top coat layer 24 also provides protection against mechanical damage to the surface finish of the multi-layer coating 26.

[031] The applicants have found that the invention provides an improved bright finish by decreasing the textured appearance that results from the inadequate leveling properties of the paints used in the prior art primer coat. The applicants also have found that additional layers of undercoating further enhance the surface gloss of the finish. Accordingly, a first alternate embodiment of the invention is illustrated generally at 30 in Fig. 3, where components that are similar to components shown in Fig. 2 have the same numerical identifiers. In Fig. 3, the undercoat 28 is a first layer of undercoat. A second undercoat layer 32, formed from an acrylic coating material, is deposited upon the wheel surface between the first undercoat 28 and the urethane primer coat 18. The applicants have observed that the two undercoats 28 and 32 provide a smoother wheel surface that results in a glossier wheel finish than the finish obtained with a single undercoat layer. While the preferred embodiment has been described with the second undercoat 32 being formed from an acrylic coating material, it will be appreciated that the second undercoat also may be formed from a polyester coating material.

[032] Similarly, a second alternate embodiment of the invention is illustrated generally at 34 in Fig. 4, where components that are similar to components shown in Fig. 3 have the same numerical identifiers. In Fig. 4, a third undercoat layer 36 formed from an acrylic coating material is deposited upon the wheel surface between the second undercoat 32 and the urethane primer coat 18 to achieve the desired surface appearance and to control the surface texture. The applicants have observed that the three undercoats 28, 32 and 36 provide an even smoother wheel surface that results in an even glossier wheel finish than the finish obtained with two undercoat layers. While the preferred embodiment has been described with the third undercoat 36 being formed from an acrylic coating material, it will be appreciated that the third undercoat also may be formed from a polyester coating material.

[033] The present invention also contemplates a process for forming an improved multi-layer coating that is illustrated by the flow chart shown in Fig. 5. In functional block 42, a wheel formed from an aluminum alloy is provided. The wheel surface is cleaned of oil and grease in functional block 44. The cleaning typically includes immersion of the wheel in a solvent bath that removes any oil and grease that would inhibit adhesion of the coating layers to the wheel surface. The wheel is then rinsed by immersion in a water bath or by spraying with a high pressure jet.

[034] A conversion coating layer is chemically or electro-chemically deposited upon the wheel surface in functional block 46, as described in the above referenced U.S. Patent No. 5,290,624. Next an undercoat layer is applied to the wheel surface over the conversion coating layer in functional block 48. In the preferred embodiment, the wheel is rotated while an acrylic material is sprayed onto the wheel surface to form the undercoat layer. The wheel is then placed in a curing oven to fully cure the coating. While the preferred embodiment uses an

acrylic material for the undercoat layer, it will be appreciated that a polyester material also may be utilized for the undercoat layer. After curing the undercoat layer, additional layers of undercoat may be applied (not shown) to provide a smoother surface and corresponding glossier finish; however, such additional undercoat layers are optional. The additional undercoat layers can be formed from either acrylic or polyester materials.

[035] A layer of primer coat formed from an urethane resin is applied over the undercoat layer in functional block 50. The wheel is rotated while the primer materail is sprayed onto the wheel surface. The wheel surface is air flashed at room temperature to remove solvents and then cured for a time period as recommended by the manufacturer at a temperature also recommended by the manufacturer. Next a layer of base coat formed from an urethane polymer material, such as, for example, an urethane enamel, is applied to the wheel surface over the primer coat layer in functional block 52. The applied base coat layer is air flashed to allow the solvents to evaporate and then the wheel is again cured for a time period as recommended by the manufacturer at a temperature also recommended by the manufacturer.

[036] A layer of metal film is applied to the wheel surface over the base coat layer in functional block 54. Once the wheel has cooled to room temperature, the surface of the wheel is vacuum metalized with thermally evaporated indium or an alloy thereof. In the preferred embodiment, the wheel is placed in a vacuum chamber that is pumped down to 5×10^{-5} Torr and then backfilled with argon to 7×10^{-4} Torr. The wheel is rotated within the vacuum chamber while indium or an alloy of indium is sputtered or thermally evaporated onto the wheel surface. Alternately, ion plating, induction heating or electron beam evaporation methods may be utilized to form the metal film layer. Details of the process are included in the above referenced U.S. Patent No. 4,431,711. While the vacuum

within the chamber is described above as 7×10^{-4} Torr, the metalizing also can be completed at other vacuum levels, such as, for example, up to 5×10^{-3}. Also, the backfilling of the vacuum chamber with argon can be omitted.

[037] In functional block 56, the metal film surface is etched to improve the adhesion of the top coat; however, this step is optional and can be omitted. In the preferred embodiment, etching involves rinsing the metal film surface with a ten percent sodium hydroxide solution for 60 to 90 seconds in a temperature range of 150° to 160° F. The metal film surface is then rinsed twice with water and finally with deionized water. The etching process is more fully described in U.S. Patent No. 5,284,679, which is incorporated herein by reference.

[038] Finally, a top coat layer of clear plastic is applied over the metal film in functional block 58. Clear acrylics and urethanes are preferred for forming the top coat layer. The top coat layer can be applied by spraying the coating material onto the metal film surface as the wheel is rotated. After being applied, the top coat layer is cured in a curing oven.

[039] The principle and mode of operation of this invention have been explained and illustrated in its preferred embodiment. However, it must be understood that this invention may be practiced otherwise than as specifically explained and illustrated without departing from its spirit or scope. For example, while the preferred embodiment of the invention has been illustrated and described for a multi-layer coating applied to an aluminum wheel, it will be appreciated that the multi-layer coating also can be applied to wheels formed from other materials to include alloys of magnesium and steel. Additionally, the invention also can be utilized to form a bright surface finish on vehicle components other than wheels.

Claims

What is claimed is:

1. A decorative surface coating for a vehicle wheel comprising:

a metal vehicle wheel having a surface;

a layer of undercoat material deposited over at least a portion of said wheel surface, said undercoat layer filling any surface imperfections in said wheel surface to provide a smooth surface;

a layer of primer coat material deposited over said undercoat layer;

a layer of base coat material deposited over said primer coat layer; and

a layer of a vacuum deposited metal film deposited over said base coat layer, whereby said wheel surface has a bright appearance.

2. The surface coating according to claim 1 wherein said undercoat layer is formed from an acrylic material.

3. The surface coating according to claim 1 wherein said undercoat layer is formed from an polyester material.

4. The surface coating according to claim 1 further including a protective layer of clear coat material deposited over said metal film.

5. The surface coating according to claim 4 further including a conversion coating layer deposited between said wheel surface and said undercoat layer.

6. The surface coating according to claim 5 wherein said metal film layer includes indium.

7. The surface coating according to claim 5 wherein said primer coat layer and said base coat layer are formed from an urethane material.

8. The surface coating according to claim 5 wherein said undercoat layer is a first undercoat layer and further wherein the surface coating includes a second undercoat layer deposited between said first undercoat layer and said primer coat layer.

9. The surface coating according to claim 8 wherein said second undercoat layer is formed from an acrylic material.

10. The surface coating according to claim 8 wherein said second undercoat layer is formed from an polyester material.

11. The surface coating according to claim 8 further including a third undercoat layer deposited between said second undercoat layer and said primer coat layer.

12. The surface coating according to claim 11 wherein said third undercoat layer is formed from an acrylic material.

13. The surface coating according to claim 11 wherein said third undercoat layer is formed from an polyester material.

14. A process for forming a decorative coating upon the surface of a vehicle wheel comprising the steps of:

(a) providing a wheel having a surface;

(b) applying a layer of undercoat material to at least a portion of the wheel surface, the undercoat material filling any surface imperfections to provide a smooth surface;

(c) applying a layer of primer coat material over the undercoat layer;

(d) applying a layer of base coat material over the primer coat layer; and

(e) vacuum depositing a metal film over the base coat layer whereby the wheel surface has a bright appearance.

15. The process according to claim 14 wherein the undercoat layer applied in step (b) includes an acrylic material.

16. The process according to claim 14 wherein the undercoat layer applied in step (b) includes a polyester material.

17. The process according to claim 14 further including, subsequent to step (d) applying a protective layer of clear coat material over the metal film.

18. The process according to claim 17 further including, prior to step (b), applying a conversion coating layer to the wheel surface.

19. The process according to claim 18 wherein the metal film deposited in step (d) includes indium.

20. The process according to claim 18 wherein the primer coat layer applied in step (c) is formed from an urethane material.

21. The process according to claim 20 wherein the base coat layer applied in step (d) is formed from an urethane material.

22. The process according to claim 18 wherein the undercoat layer applied in step (b) is a first undercoat layer and further wherein step (b) includes applying a second layer of undercoat material over the first undercoat layer.

23. The process according to claim 22 wherein the second undercoat layer is formed from an acrylic material.

24. The process according to claim 22 wherein the second undercoat layer is formed from a polyester material.

25. The process according to claim 22 wherein step (b) also includes applying a third layer of undercoat material over the second undercoat layer.

26. The process according to claim 25 wherein the third undercoat layer is formed from an acrylic material.

27. The process according to claim 25 wherein the third undercoat layer is formed from a polyester material.

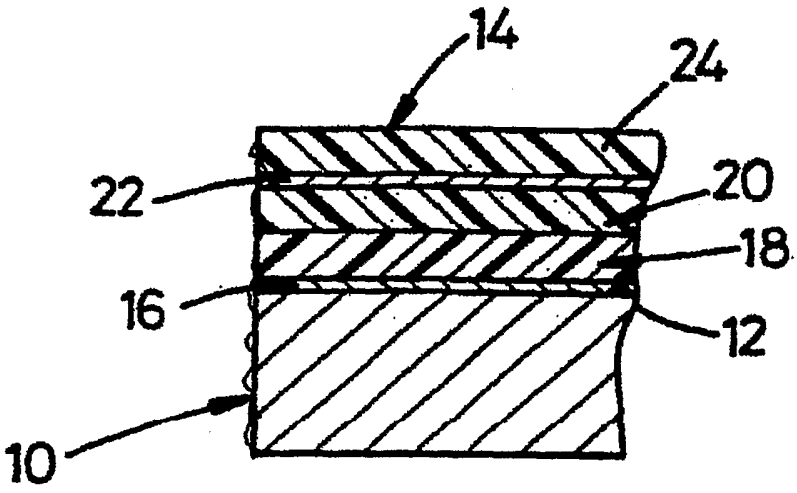

FIG. 1
(PRIOR ART)

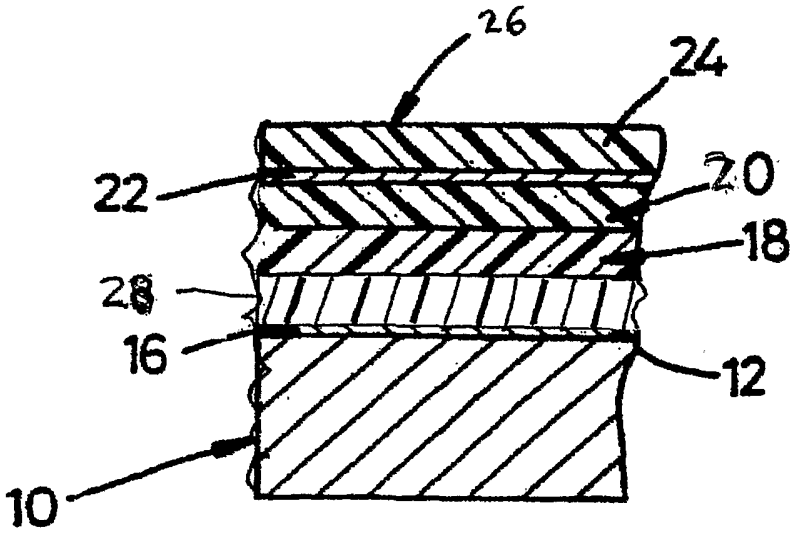

FIG. 2

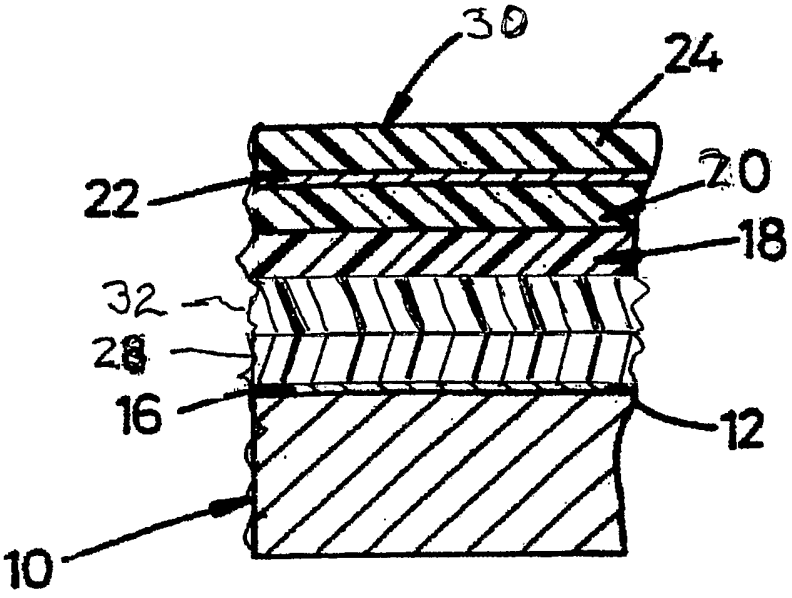

FIG. 3

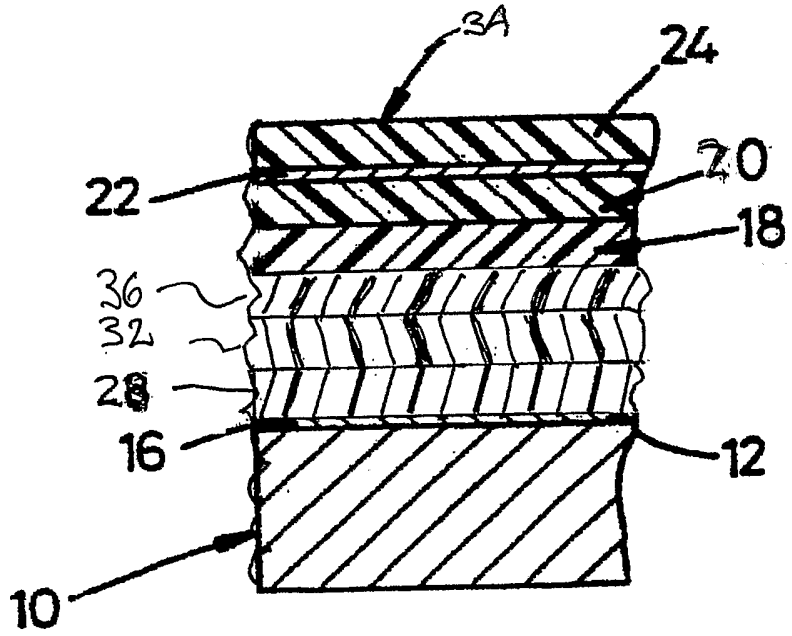

FIG. 4

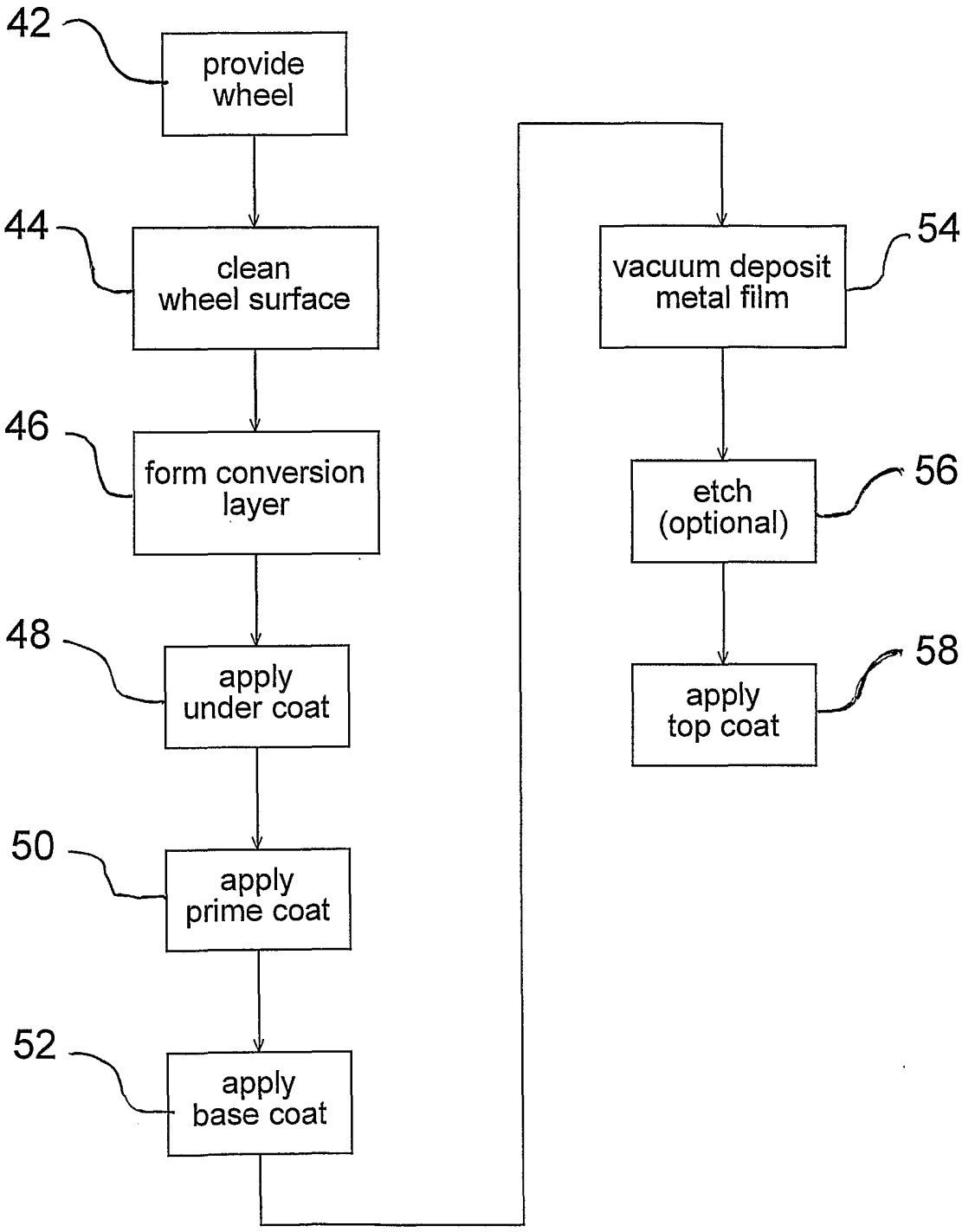
42
provide wheel
44
clean wheel surface
46
form conversion layer
48
apply under coat
50
apply prime coat
52
apply base coat
54
vacuum deposit metal film
56
etch (optional)
58
apply top coat

FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 03/23949

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B32B15/08 B44C3/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B44C B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 290 625 A (EISFELLER RICHARD C ET AL) 1 March 1994 (1994-03-01) cited in the application column 3, line 17 -column 4, line 27 ---	1-27
A	EP 0 599 487 A (DAVIDSON TEXTRON INC) 1 June 1994 (1994-06-01) cited in the application page 4, line 57 -page 7, line 11 ---	1-27
A	US 4 431 711 A (EISFELLER RICHARD C) 14 February 1984 (1984-02-14) cited in the application column 7, line 1 - line 38 ---	1-27

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 November 2003	28/11/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Patosuo, S

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 03/23949

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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