

(51) International Patent Classification:
B05D 3/06 (2006.01) **B05C 9/12** (2006.01)(21) International Application Number:
PCT/US2010/024218(22) International Filing Date:
15 February 2010 (15.02.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/157,928 6 March 2009 (06.03.2009) US
12/705,685 15 February 2010 (15.02.2010) US(71) Applicant (for all designated States except US): **GM GLOBAL TECHNOLOGY OPERATIONS, INC.** [US/US]; 300 Renaissance Center, P.O. Box 300, Detroit, MI 48265-3000 (US).(72) Inventors: **FAN, Hua-Tzu**; 29212 Chelsea Crossing, Farmington Hills, MI 48331 (US). **KUO, Hong-Hsiang**; 6560 Parkview Drive, Troy, MI 48098 (US).(74) Agent: **CICHOSZ, Vincent, A.**; CICHOSZ AND CICHOSZ, PLLC, 129 E. Commerce Street, Milford, MI 48381 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: METHOD AND APPARATUS FOR PAINT CURING

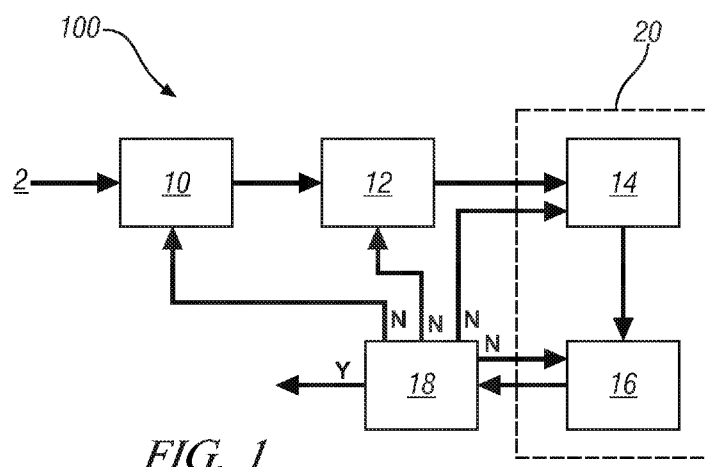


FIG. 1

(57) Abstract: A method for curing a paint coating applied to a workpiece includes applying radiant light energy to cure the paint coating on surfaces of the workpiece within a line of sight of a radiant light energy source, and applying ambient air to the workpiece to cure the paint coating on surfaces of the workpiece not within the line of sight of the radiant light energy source.

METHOD AND APPARATUS FOR PAINT CURING

TECHNICAL FIELD

[0001] This disclosure is related to automotive paint application and automotive paint curing.

BACKGROUND

[0002] The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.

[0003] During the assembly of an automobile, it is desirable to provide the automobile body a high quality finish. The quality of the finish improves the marketability of the automobile as well as protects the automobile body from elements.

[0004] The paint baking process during automobile assembly is a major energy consuming process in an automotive assembly paint shop. A typical topcoat oven used for paint baking has three major functions: (1) controlling volatile organic compound (VOC) emissions and solvent odors by driving out paint solvents or water; (2) achieving appearance quality where the top coat oven helps paint flow and level during film formation; and (3) providing durability by promoting cross-linking to cure the paint. However, topcoat ovens are large, ranging in size to about 470 feet long, thus increasing manufacturing costs and limiting space in the automotive assembly paint shop. Additionally, operation of a topcoat oven is associated with a high energy

consumption rate per year. It is recognized that operation of topcoat ovens are second only to spray booths in the highest consumption of energy at the automobile paint shop. A typical automotive assembly paint shop utilizes two to three topcoat ovens.

SUMMARY

[0005] A method for curing a paint coating applied to a workpiece includes applying radiant light energy to cure the paint coating on surfaces of the workpiece within a line of sight of a radiant light energy source, and applying ambient air to the workpiece to cure paint coating on surfaces of the workpiece not within the line of sight of the radiant light energy source.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] One or more embodiments will now be described, by way of example, with reference to the accompanying drawings, in which:

[0007] FIG. 1 schematically illustrates a paint application process in accordance with an exemplary embodiment of the present disclosure;

[0008] FIG. 2 schematically illustrates the chemical composition of a paint coating that can be cured by both efficient radiant light energy and low bake systems in accordance with the present disclosure;

[0009] FIG. 3 illustrates a graphical depiction of an electromagnetic spectrum in order of increasing wavelength in accordance with the present disclosure;

[0010] FIG. 4 illustrates a graphical depiction illustrating energy emissions of near infrared light, short wavelength infrared light and medium wavelength infrared light in accordance with the present disclosure;

[0011] FIGS 5a-5d illustrate pictorial diagrams of the chemical reactions during the curing of a workpiece utilizing various curing methods that include near infrared light, ultraviolet light, medium-wave infrared light and induction heating in accordance with the present disclosure; and,

[0012] FIG. 6 illustrates a pictorial diagram of the chemical reaction during the curing of a workpiece utilizing ambient air at an ambient cure station in accordance with the present disclosure.

DETAILED DESCRIPTION

[0013] Referring now to the drawings, wherein the showings are for the purpose of illustrating certain exemplary embodiments only and not for the purpose of limiting the same, FIG. 1 schematically illustrates a paint application process 100 in accordance with an exemplary embodiment of the present disclosure. The exemplary paint application process 100 includes a coating station 10, a heat flash station 12, a curing process 20 and an inspection station 18. The curing process 20 includes a radiation cure station 14 and an ambient cure station 16. In operation, an unfinished workpiece 2 is presented to the coating station 10 where a fresh coat of paint is applied to the workpiece 2. Upon exiting the coating station 10, the painted workpiece 2 is first presented to the heat flash station 12 and then to the radiation cure station 14 and the ambient cure station 16 of curing process 20 to substantially cure

the workpiece 2. Upon completion of the curing process 20, the substantially cured workpiece 2 is examined at the inspection station 18.

[0014] An exemplary coating station 10 includes a paint spray booth where a fresh coat of paint is applied to the workpiece 2. An exemplary workpiece 2 is an automobile wherein a fresh coat of paint is applied to interior and exterior surfaces of the automobile. However, the workpiece 2 is not limited to automobiles. The fresh coat of paint includes a paint material having a chemical composition enabling the paint coating to be cured by both efficient radiant light energy (i.e., the radiation cure station 14) and low bake systems (i.e., the ambient cure station 16). It is desirable that the paint coating be substantially resistant to scratches and chips, meet appearance and exposure standards and be adaptable to existing application processes (i.e., a spray booth).

[0015] Referring to FIG. 2, the chemical composition of an exemplary paint coating 200 is illustrated in accordance with an exemplary embodiment of the present disclosure. The paint coating 200 can be cured or hardened by both efficient radiant light energy (i.e., the radiation cure station 14) and low bake systems (i.e., the ambient cure station 16). Efficient radiant light energy can include ultraviolet light, near infrared (NIR) light, and conventional infrared light having short, medium and long wavelengths. Likewise, low bake systems can include ambient air at ambient temperature or can additionally blow warm or hot air to help facilitate the curing process and decrease tack free times. The paint coating 200 cross-links polymer segments 204 and silica segments 202, wherein each end of each polymer segment 204

is linked to a silica segment 202 utilizing a cross-linking material 206. The silica segments 202 are hard segments that provide scratch resistance, whereas the polymer segments 204 are soft and flexible segments that provide structural integrity while substantially preventing cracking during the curing process 20. It should be appreciated that the exemplary paint coating 200 not be limited to a chemical composition including the cross-linking of polymer and silica segments 204 and 202, respectively, but can include any chemical composition capable of being cured by both low bake systems and efficient radiation energy.

[0016] As mentioned above, after a fresh coat of paint is applied to the workpiece 2 at the coating station 10, the workpiece 2 is sent to the heat flash station 12. The heat flash station 12 includes a heated flash process to drive out solvents and water from the paint coating 200. Driving out solvents and water from the paint coating substantially reduces volatile organic compound (VOC) emissions and solvent odors from the paint coating 200 before curing at the radiation cure station 14 and the ambient cure station 16. Heated flash stations 12 are known in the art and will not be discussed in great detail herein.

[0017] As discussed above, topcoat ovens can be impractical due to size and cost constraints as well as the high energy consumption required for operating topcoat ovens. Many ideas and concepts have emerged to try to reduce or eliminate the need for paint ovens. These ideas generally fall into two categories: (1) low bake paint systems and (2) efficient radiant light energy cure systems. However, low bake paint systems and efficient radiant light energy cure systems used alone to cure a workpiece have shortfalls that

prevent these systems and processes from replacing the topcoat oven. For example, low bake paint systems eliminate the need for a topcoat oven, however, exterior surfaces may attract airborne dust during a longer than desirable cure time and tack-free time. Radiant light energy cure systems allow for a fast cure time, however, reaching surfaces not in the line of sight of a radiant light energy source providing the radiant light energy requires the use of additional equipment or steps such as robotic arms and plasma chambers to reach surfaces not in the line of sight of the radiant light energy source. The exemplary curing process 20 illustrated in FIG. 1, and disclosed herein, utilizes the radiation cure station 14 (i.e., radiant light energy cure systems) and the ambient cure station 16 (i.e., low bake paint systems) to substantially cure the workpiece 2 without encompassing the drawbacks associated with only utilizing one of the of the systems discussed above.

[0018] Referring to FIG. 3, a graphical depiction of an electromagnetic spectrum 300 is illustrated in order of increasing wavelength (λ). The electromagnetic spectrum includes gamma rays 30, x-rays 32, ultraviolet radiation 34, visible light 36, infrared (IR) light 38 and radio waves 40. Ultraviolet light 34 includes a wavelength range between 10 nanometers and 0.38 microns. Near infrared (NIR) light 42 having a wavelength between 0.8 and 1.5 microns, overlaps portions of the visible light spectrum 36 and the IR light spectrum 38. Whereas the IR light spectrum 38 includes short and medium wavelengths 44 and 46, respectively, having wavelengths in the ranges of 1.2 and 2.0 microns, respectively. It is appreciated that short-wave

IR light 44 overlaps into the visible light 36 spectrum at wavelengths between 1.0 and 1.2 microns.

[0019] Referring to FIG. 4, a graphical depiction illustrating energy emissions versus wavelength of NIR light 42, short-wave IR light 44 and medium-wave IR light 46 are illustrated in accordance with the present disclosure. The axis of ordinate denotes energy emissions ($\text{MW}/\mu\text{m}^2$) and the axis of abscissa denotes wavelength (μm). It is appreciated that NIR light 42 emits a higher amount of energy than short-wave IR light 44 and medium-wave IR light 46, and as will become apparent, the cure time is substantially shorter when utilizing NIR light 42 (or ultraviolet light 34) than it is for short- and medium-wave IR lights 44 and 46, respectively.

[0020] As will be discussed in greater detail herein, when radiant light energy (i.e., ultraviolet light 34 or NIR light 42) is applied to the surface of a paint coated (i.e., paint coating 200 shown in FIG. 2) workpiece 2, molecules within the paint are cross-linked during a chemical reaction and thereby achieve a hardened and substantially cured state. Radiant energy in the form of light (i.e., ultraviolet light 34 or NIR light 42) is particularly advantageous over topcoat ovens for curing a workpiece 2 surface because light energy provides for reduced energy consumption, while attaining very high gloss levels in the paint coating. The entire cross-linking of the paint coated (i.e., paint coating 200 shown in FIG. 2) workpiece 2 takes place in seconds when utilizing ultraviolet light 34 or NIR light 42, as opposed to minutes or hours in the thermal baking processes (i.e., topcoat oven). Cross-linking of the paint coated workpiece 2 takes place in minutes when utilizing shortwave IR 44 or

medium-wave IR 46. In addition to reduced energy consumption, a lead benefit to the fast cure times produced by utilizing ultraviolet light energy 34 or NIR light energy 42, is the elimination or drastic reduction in airborne dust collection associated with slow tack free times of the painted workpiece 2 prior to being substantially cured.

[0021] Referring to FIGS 5a-5d, pictorial diagrams illustrating the chemical reactions during the curing of a workpiece 2a-2d utilizing various curing technology methods to cure the painted workpiece 2a-2d is shown, in accordance with the present disclosure. The curing technologies illustrated include NIR light 42 (FIG. 5a), ultraviolet light 34 (FIG. 5b), medium-wave IR light 46 (FIG. 5c) and induction heating (FIG. 5d).

[0022] Referring to FIG. 5a, NIR light 42 is projected from a NIR lamp 542 onto a paint coating 29a applied to a substrate surface 52a of a workpiece 2a. The paint coating 29a includes a plurality of paint molecules 204a disposed therein. The NIR lamp 542 projects NIR light 42 in a straight line to surfaces within the line of sight 50a of the NIR lamp 542. In an exemplary example, the NIR lamp 542 is shaped and sized to cure a workpiece 2 the size of a full automobile. In an alternative embodiment, a plurality of NIR lamps 542 can be utilized to cure the workpiece 2a, wherein each NIR lamp 542 can be configured to cure a portion of the workpiece 2a. As shown, radiation within the NIR light 42 is substantially absorbed by the paint coating 29a. The absorption of the NIR light 42 provides for fast and homogenous penetration of the NIR light 42 into the paint coating 29a to substantially cure a surface of the workpiece 2a in the line of sight 50a of the NIR lamp 542 without heating

the substrate surface 52a as in the case of conventional infrared light radiation (i.e., medium-wave IR light 46 shown in FIG. 5c). As demonstrated by the high energy emissions in FIG. 4, the bandwidth of NIR light 42 can accomplish cure times at or near 70 seconds. It is appreciated that the paint coating 29a can include the chemical composition of the paint coating 200 (see FIG. 2) that can be cured or hardened by both NIR light 42 and low bake systems (i.e., the ambient cure station 16).

[0023] Referring to FIG. 5b, ultraviolet light 34 is projected from an ultraviolet lamp 534 onto a paint coating 29b applied to a substrate surface 52b of a workpiece 2b. The paint coating 29b includes a plurality of paint molecules 204b and a plurality of photo initiators 205b disposed therein. The ultraviolet lamp 534 projects ultraviolet light 34 in a straight line to surfaces within the line of sight 50b of the ultraviolet lamp 534. In an exemplary embodiment, the ultraviolet lamp 534 is shaped and sized to cure a workpiece 2b the size of a full automobile. In an alternative embodiment, a plurality of UV lamps 534 can be utilized to cure the workpiece 2b, wherein each UV lamp 534 can be configured to cure a portion of the workpiece 2b. When the paint coating 29b receives the ultraviolet light 34, the plurality of photo initiators 205b disposed within the paint coating 29b initiate a chemical chain reaction to promote cross-linking between the plurality of paint molecules 204b and thereby substantially cure a surface of the workpiece 2b in the line of site 50b of the UV lamp 534. This chemical chain reaction within the paint coating 29b can accomplish cure times in seconds. It is appreciated that the paint coating 29b can include the chemical composition of the paint coating

200 (see FIG. 2) that can be cured or hardened by both ultraviolet light 34 and low bake systems (i.e., the ambient cure station 16).

[0024] Referring to FIG. 5c, medium-wave IR light 46 is projected from an IR lamp 546 onto a paint coating 29c applied to a substrate surface 52c of a workpiece 2c. The paint coating 29c includes a plurality of paint molecules 204c disposed therein. The IR lamp 546 projects the medium-wave IR light 46 in a straight line to surfaces within the line of sight 50c of the IR lamp 546. In an exemplary embodiment, the IR lamp 546 is shaped and sized to cure a workpiece the size of a full automobile. In an alternative embodiment, a plurality of IR lamps 546 can be utilized to cure the workpiece 2c, wherein each IR lamp 546 can be configured to cure a portion of the workpiece 2c. Additionally, the substrate surface 52c is heated via conduction and only the top surface of the paint coating 29c is heated by the medium-wave IR light 46. Heating the top surface of the paint coating 29c and the substrate surface 52c via conduction can accomplish cure times in the paint coating 29c at or near 25 minutes. It is appreciated that the paint coating 29c can include the chemical composition of the paint coating 200 (see FIG. 2) that can be cured or hardened by both medium-wave IR light 46 and low bake systems (i.e., the ambient cure station 16).

[0025] NIR light 42 and ultraviolet light 34 are preferred methods of curing a surface within the line of sight of the radiant light energy source (i.e., lamps 542 or 534) due to decreased cure and tack free times compared to medium-wave IR light 46.

[0026] Referring to FIG. 5d, induction heating is applied to cure a paint coating 29d applied to a metallic substrate surface 52d of a workpiece 2d. The paint coating 29d includes a plurality of paint molecules 204d disposed therein. The substrate surface 52d is electromagnetically heated by a plurality of induction coils 54 around the substrate surface 52d, wherein the heat is absorbed by the paint coating 29d to substantially cure the paint coating 29d. The workpiece 2d can be substantially cured in seconds. In an example, induction heating can be utilized to substantially cure a paint coating applied to a roll-bar for application on a vehicle, wherein the roll-bar is electromagnetically heated by induction coils and the paint coating absorbs the heat so substantially cure the paint coating.

[0027] Referring back to FIG. 1, the workpiece 2 enters the radiation cure station 14 of the exemplary curing process 20 upon exiting the heat flash station 12. Exemplary embodiments envisioned of the radiation cure station 14 include the application of ultraviolet light 34 or NIR light 42 discussed by methods described in FIGS. 5a and 5b. Alternative forms of radiant light energy contemplated to cure the workpiece include shortwave and medium-wave IR 44 and 46, respectively; however these forms of radiant light energy are less preferred due to increased tack free and cure times. In addition to radiant light energy, alternative forms of energy to cure the workpiece 2 include induction heating (FIG. 5d), hydrogen bombardment and electron beams. It should be appreciated that any combination of the above forms of energy may be used in combination to assist in the curing of the workpiece 2.

[0028] As discussed above, both ultraviolet and NIR light energy 34 and 42, respectively are limited to curing surfaces of a workpiece 2 that are within the line of sight of the radiant light energy source (i.e., UV lamp 534 or NIR lamp 542) because light travels in a straight line. For example, interior surfaces of an automobile that include door frames or the back side of a trunk lid cannot be cured if the radiant light energy (i.e., ultraviolet light 34 or NIR light 42) is blocked by other panels of the automobile. It is known to mount lamps for projecting ultraviolet light 34 or NIR light 42 on robotic arms or to utilize plasma ultraviolet light 34 chambers to reach interior or hidden surfaces of the workpiece 2. However, these solutions can increase cost and slow down process cycle time for substantially curing the workpiece 2. The exemplary curing process 20 disclosed herein utilizes the radiant cure station 14 to promote cross-linking on a surface of the painted workpiece 2 by projecting radiant light energy (i.e., ultraviolet light 34 or NIR light 42) on exterior surfaces of the workpiece 2, and thus, achieving reduced energy consumption and fast cure times on the exterior surfaces of the workpiece 2. Whereas, the exemplary curing process 20 additionally utilizes the ambient curing station 16 to cure interior surfaces, or surfaces not in the line of sight of the radiant light energy source (i.e., UV lamp 534 or NIR lamp 542), to cure the workpiece 2. It is appreciated that slow tack free times associated with ambient curing are less susceptible to airborne dust collection on interior surfaces of the painted workpiece 2 as opposed to exterior surfaces.

[0029] Once exterior surfaces of the workpiece 2 within the line of sight of the radiant light energy source (i.e., NIR lamp 542 or UV lamp 534 shown in

FIGS. 5a and 5b, respectively) are substantially cured at the radiant cure station 14, the workpiece 2 enters the ambient cure station 16. Utilizing ambient air at ambient temperature, the ambient cure station 16 cures surfaces of the workpiece 2 that were not cured at the radiation cure station 14. Curing the workpiece 2 at ambient temperature is advantageous because interior surfaces and other surfaces that were not accessible at the radiation cure station 14 get cured while avoiding the use of expensive equipment (i.e., robotic arms and plasma chambers). In an alternative embodiment, the ambient cure station 16 can blow warm or hot air to help facilitate the curing process and decrease tack free times.

[0030] Referring to FIG. 6, a pictorial diagram of the ambient cure station 16 illustrating the chemical reaction during the curing of a workpiece 2e utilizing ambient air 60 is shown, in accordance with the present disclosure. Paint coating 29e applied to a substrate surface 52e of the workpiece 2e is cured by cross-linking the plurality of paint molecules 204e with the ambient air 60 over a period of time. For example, full cure of the paint coating 29e can occur in about 12 to 16 hours utilizing ambient air 60. Tack free time is established at or near 20 to 30 minutes. However, because interior surfaces are not directly exposed to airborne dust, the workpiece 2e is not as susceptible to having dirt-in-paint defects. It is appreciated, that the paint coating 29e can include the chemical composition of the paint coating 200 (see FIG. 2) capable of being cured or hardened by both efficient radiant light energy (i.e., the radiation cure station 14) and ambient air 60 at the ambient cure station 16.

[0031] Referring to FIGS. 1, 5 and 6, it is appreciated that the exemplary curing process 20 in association with the paint coating 200 (see FIG. 2) enables exterior surfaces of a workpiece 2a-2d to be cured within seconds, and surfaces not easily accessible (i.e., interior surfaces) at the radiant cure station 14 to be cured by ambient air 60 at the ambient cure station 16. Thus, the exemplary curing process 20 eliminates or substantially reduces the collection of airborne dust and dirt-in paint on appearance critical exterior surfaces due to slow tack free time, while the ambient cure system 16 eliminates the need for expensive equipment and additional steps to cure paint on less-appearance critical interior surfaces or other surfaces not within the line of sight of the radiant light energy source (i.e., UV lamp 534 or NIR lamp 542).

[0032] Upon exiting the exemplary curing process 20, the substantially cured workpiece 2 enters the inspection station 18. At the inspection station 18, the substantially cured workpiece 2 is inspected for scratches, blemishes and defects in the workpiece 2. If the finish of the workpiece 2 meets industry standards the workpiece 2 exits the paint application process 100. If the finish of the workpiece 2 does not meet industry standards (i.e., defects are found in the finish of the workpiece 2 or workpiece is not substantially cured), the workpiece 2 may be sent back to the coating station 10, the heat flash station 12, the radiation cure station 14 or the ambient cure station 16 to fix any defects found in the finish of the workpiece 2 at the inspection station 18. For example, the finished workpiece 2 can be an automobile where it is determined that portions of the inside door frame were not painted. The

unpainted portions of the inside door frame can be touched up and left to cure in the ambient cure station 16 until being substantially cured.

[0033] The disclosure has described certain preferred embodiments and modifications thereto. Further modifications and alterations may occur to others upon reading and understanding the specification. Therefore, it is intended that the disclosure not be limited to the particular embodiment(s) disclosed as the best mode contemplated for carrying out this disclosure, but that the disclosure will include all embodiments falling within the scope of the appended claims.

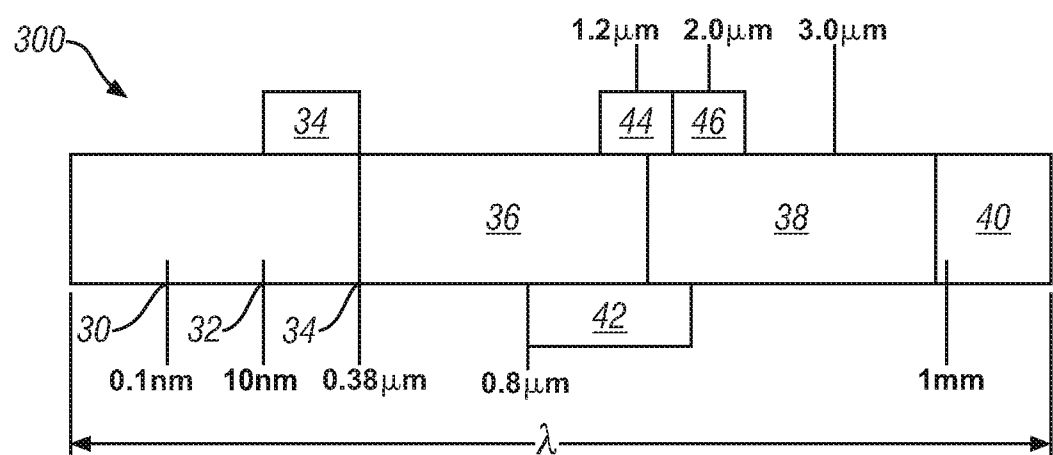
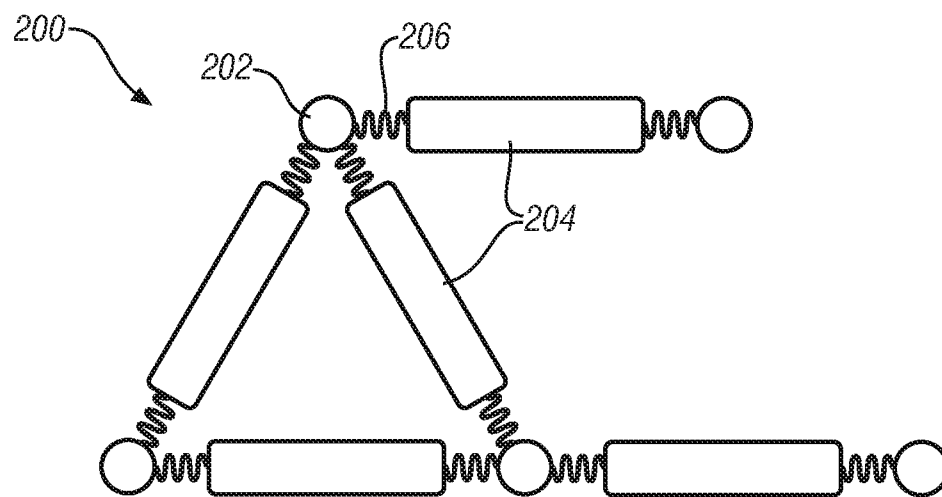
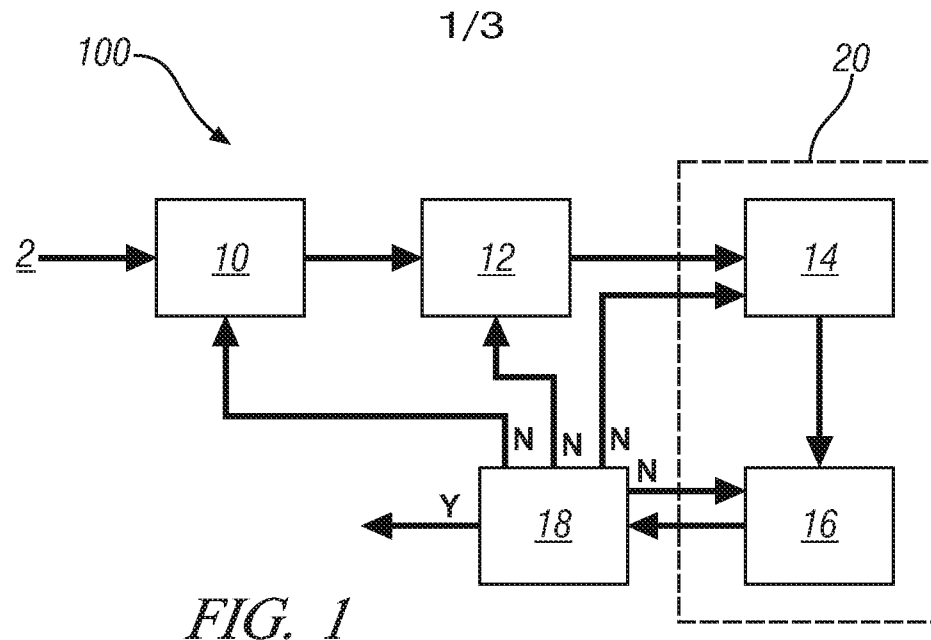
CLAIMS

1. Method for curing a paint coating applied to a workpiece, comprising:
applying radiant light energy to cure said paint coating on surfaces of
said workpiece within a line of sight of a radiant light energy source;
and,
applying ambient air to said workpiece to cure said paint coating on
surfaces of said workpiece not within said line of sight of said radiant
light energy source.
2. The method of claim 1, wherein said radiant light energy source projects
radiant light energy in a straight line.
3. The method of claim 1, wherein said radiant light energy comprises
ultraviolet light radiation.
4. The method of claim 1, wherein said radiant light energy comprises near
infrared light radiation.
5. The method of claim 1, wherein said radiant light energy source
comprises an ultraviolet lamp.
6. The method of claim 5, wherein said workpiece comprises an
automobile.

7. The method of claim 1, wherein said radiant light energy source comprises a plurality of ultraviolet lamps, each lamp for curing a portion of said workpiece.
8. The method of claim 1, wherein said radiant light energy source is a near infrared lamp.
9. The method of claim 8, wherein said near infrared lamp is sized and shaped to cure a workpiece the size of an automobile.
10. The method of claim 1, wherein said radiant light energy source comprises a plurality of near infrared lamps, each lamp for curing a portion of said workpiece.
11. The method of claim 1, wherein said paint coating is curable by both near infrared light radiation and ambient air.
12. The method of claim 1, wherein said paint coating is curable by both ultraviolet light radiation and ambient air.
13. The method of claim 12, wherein said paint coating comprises photo initiators to promote cross-linking between polymer molecules and silica molecules in response to said ultraviolet light radiation.

14. The method of claim 1, wherein said paint coating is tack free in less than 25 minutes at ambient temperature.
15. The method of claim 1, wherein said paint coating is substantially cured in less than 16 hours at ambient temperature.
16. Method for providing a finish to a vehicle body in an automotive assembly paintshop, comprising:
 - applying a fresh coat of paint on said vehicle body;
 - providing a heat flash process to drive out solvents and water in said fresh coat of paint on said vehicle body; and
 - utilizing a curing process to cure said paint on said vehicle body, the curing process comprising:
 - applying radiant light energy to cure said paint coating on surfaces of said vehicle body; and
 - applying ambient air to cure said paint coating on surfaces of said vehicle body not cured by said radiant light energy.
17. The method of claim 16, wherein applying radiant light energy to cure said paint coating on surfaces of said vehicle body comprises exterior surfaces of said vehicle body within a line of sight of a radiant light energy source.

18. The method of claim 16, wherein surfaces of said vehicle body not cured by said radiant light energy comprise interior surfaces of said vehicle body not within a line of sight of a radiant light energy source.
19. Apparatus for providing a finish to a vehicle body in an automotive assembly paint shop, comprising:
a paint station for applying a fresh coat of paint on said vehicle body;
a heat flash station for providing a heat flash process to drive out solvents and water in said fresh coat of paint on said vehicle body;
and
curing stations for curing the fresh coat of paint on said vehicle body, the curing stations comprising:
a radiation cure station for applying radiant light energy to cure said paint coating on surfaces of said vehicle body within a line of sight of a radiant light energy source; and
an ambient cure station for applying ambient air to said vehicle to cure said paint coating on surfaces of said vehicle body not within said line of sight of said radiant light energy source.
20. The apparatus of claim 19, wherein said paint station is a spray booth.



2/3

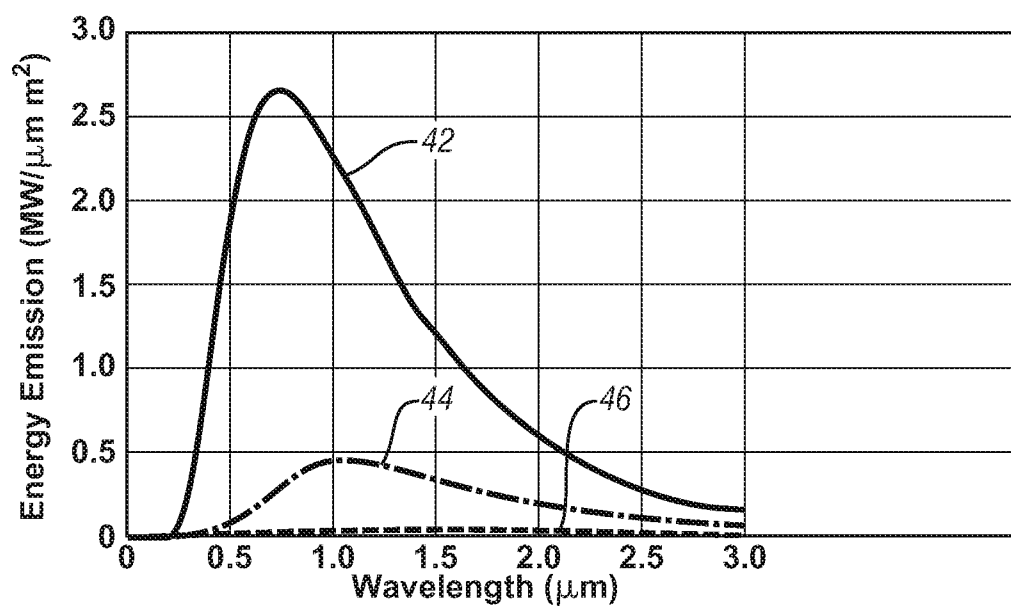


FIG. 4

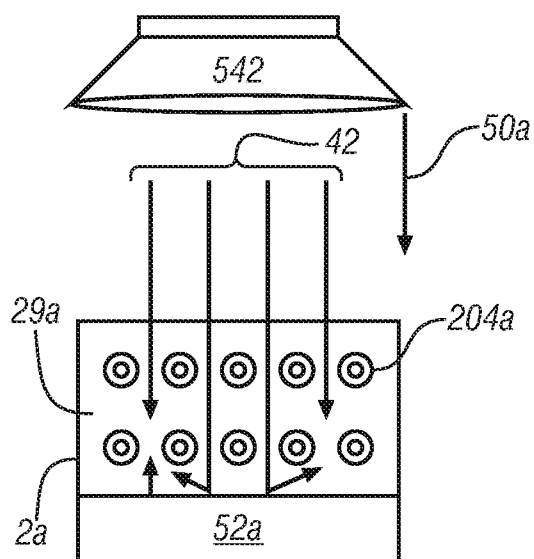


FIG. 5a

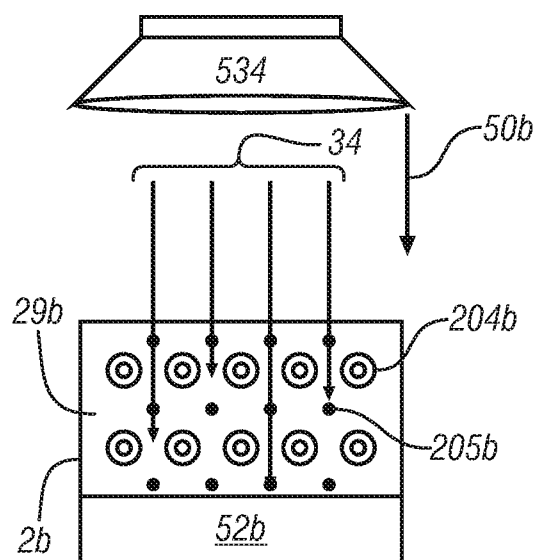


FIG. 5b

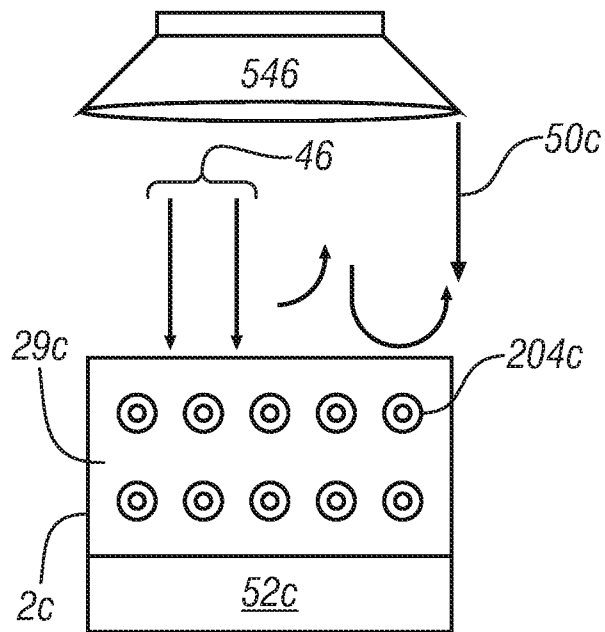


FIG. 5c

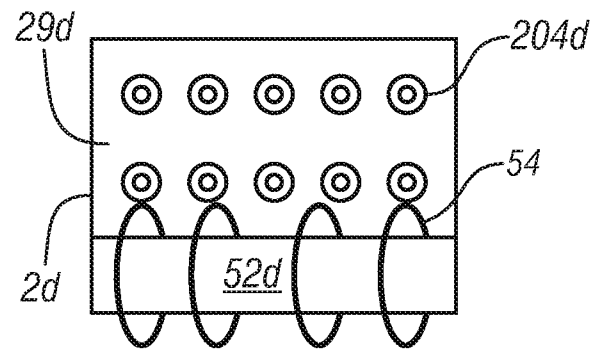


FIG. 5d

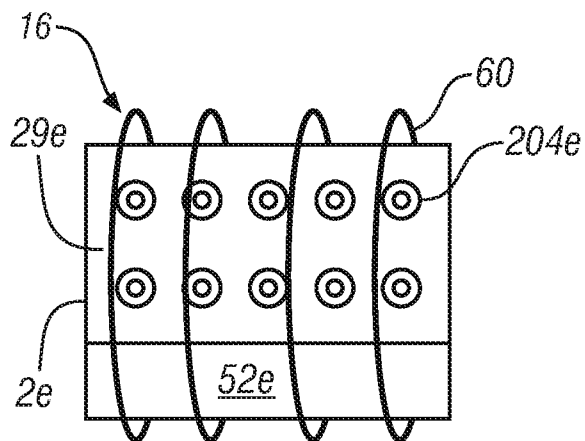


FIG. 6