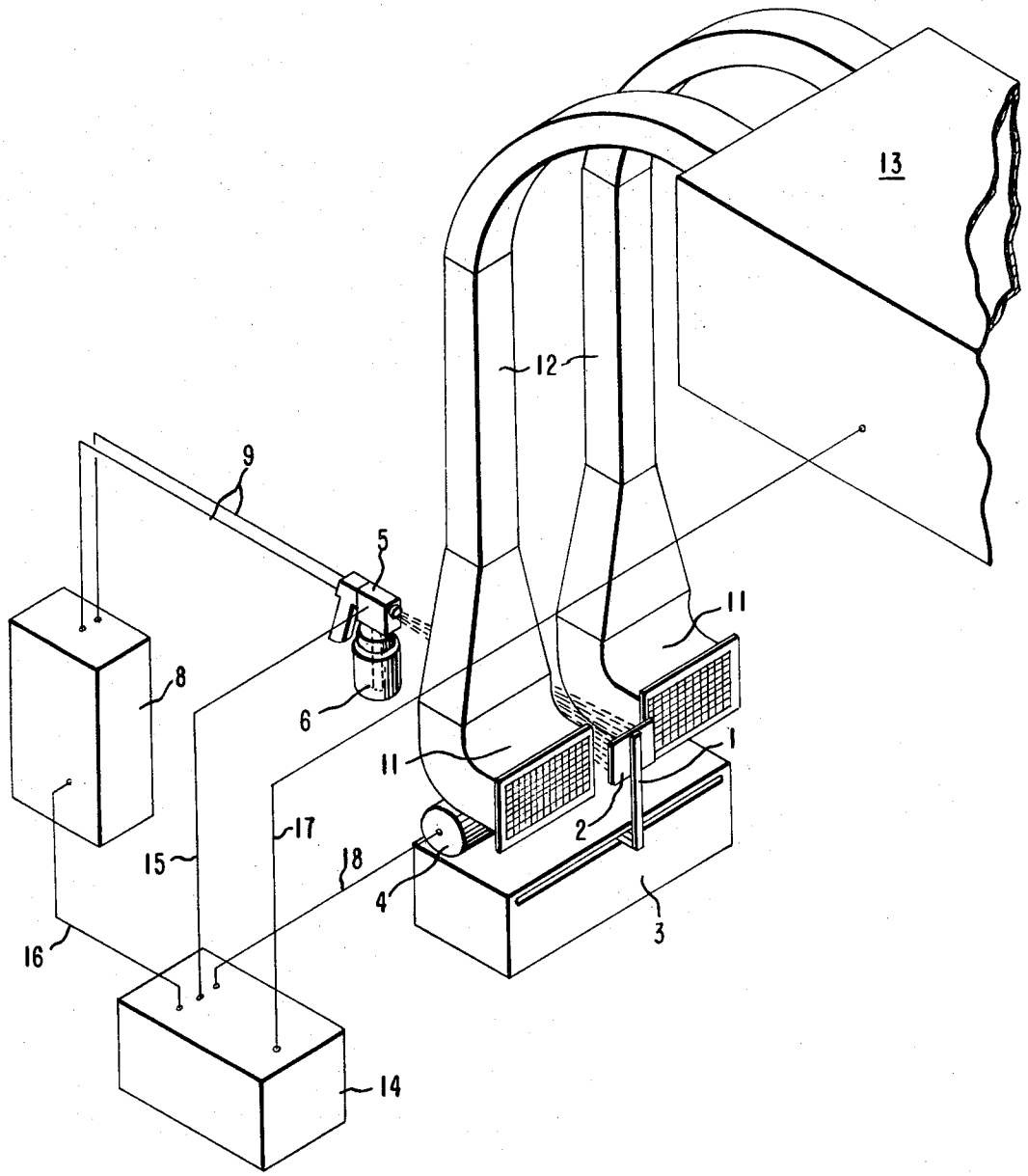
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METHOD FOR PRODUCING VISUALLY REPRODUCIBLE COATINGS ON SUBSTRATES

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INVENTORS
WEBSTER H. EDWARDS
EARL A. MILLER
THOMAS A. SCULLY
ROY H. VINING
DAVID WITTMAN

BY John E. Griffith ATTORNEY

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METHOD FOR PRODUCING VISUALLY REPRODUCIBLE COATINGS ON SUBSTRATES

Webster H. Edwards, Springfield, Pa., Earl A. Miller, Arlington Heights, Ill., and Thomas A. Scully, Glenolden, Roy H. Vining, Haverford, and David Wittman, Wallingford, Pa., assignors to E. I. du Pont de Nemours and Company, Wilmington, Del.

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ABSTRACT OF THE DISCLOSURE

An apparatus and method for reproducibly spray painting a substrate whereby the texture of a spray painted surface can be uniformly duplicated regardless of time, location or climatic conditions to produce a substrate which can be used to quality control paint color based on an instrumental comparison of the painted substrates.

BACKGROUND OF THE INVENTION

The paint industry has always been troubled by the problem of color control in the production of paints with reference to a standard color. The conventional mode of color control during production has been the visual shader, i.e. a trained person who would coordinate the addition of pigments to achieve the desired color effects.

Those who work in the art have tried to spray paint test panels with a standard color paint and with a production sample so they could be compared for color similarity via a trained color shader and/or instrumental means. This technique proved unsatisfactory due to the many variables—caused by climatic conditions, spray technique, etc.—which caused significant variances in color shades which were not due to a faulty pigment composition in the sample paint. Refined attempts have been made to solve this problem by spraying in air-conditioned rooms. Use of an air-conditioned room eliminates some of the environmental variables though this procedure is expensive due to the high cost of equipment required to condition large volumes of air which would have to be duplicated at various plant locations for production purposes.

Paints containing metallics are even more sensitive to the spray technique variable and to climatic conditions. Another variable was introduced with metallic paints—the effect on color caused by the variable orientation of the metal flakes in the paint film. In order for a system to be effective, it had to control the spray technique variables, the climatic condition, and prevent the random and unregulated setting up of the metal flakes on the paint film.

SUMMARY OF THE INVENTION

This invention relates to an apparatus for spray painting a substrate in order to produce a paint film on the substrate which is not significantly affected by changes in spray technique due to human variables, climatic conditions or the random setting up of metal flakes in the film. By reducing the effect of the variables which could alter the color of the film, it is possible to spray paint a test panel which exhibits the true shade of the paint unaltered by any variance caused by factors other than the pigment makeup of the paint. This enables the operator to predict by instrumental means what and how much pigment should be added to bring the batch of paint into a color match shade.

This invention also eliminates most of the variables which can materially affect the visual appearance of the

sprayed paint due to the "two-tone" or "flop" effect exhibited by metallic containing paints.

DESCRIPTION OF THE INVENTION

The apparatus of this invention was developed in order to reproducibly spray paint a panel which could be used to instrumentally color control paint production and shading by comparing it with a panel similarly sprayed with a standard color paint. In order to effectively color control paint production against a standard color, the two panels which would be compared (either instrumentally or visually) had to be uniformly coated with a paint film unaffected by factors other than pigment composition.

It has been learned through years of work by those in the art that a number of parameters affect the spray reproducibility of color panels. These parameters affect two major physical properties of the paint film:

(1) the wetness of the deposited film, and
(2) the rate of solvent evaporation from this film.

Further study was directed toward the isolation of the specific parameters contributing to these two major properties.

The following parameters were determined to be influential in the reproducibility of spray painting surfaces.

(1) The type of spray gun used:

(a) Cap, needle, and tip used
(b) Fan pattern of the spray
(c) Fluid flow rate of the paint

(2) Panel or substrate sprayed:

(a) Gun to panel distance
(b) Position of panel in fan pattern
(c) Panel speed through the spray
(d) Temperature of the panel

(3) Flash time (time lapse between subsequent spraying).

(4) Bake temperature of the film.

(5) Compressed air used in gun:

(a) Pressure of the air
(b) Temperature of the air

(6) Paint sample:

(a) Reduction to sprayable viscosity
(b) Temperature of paint
(c) Agitation of paint
(d) Solvent used in reduction

(7) Environment:

(a) Temperature
(b) Humidity
(c) Air flow rate

Of all the aforementioned parameters, the environment temperature, humidity, and rate of air flow past the panel were the most important contributors to panel variability (i.e. color) and the least susceptible to positive control. It should be noted that most of the remaining variables can be regulated under normal operating conditions.

DESCRIPTION OF THE DRAWING

The drawing shows a panel holder **1** having fastening means, not shown, whereby an unpainted panel **2** may be attached to the panel holder. The panel holder **1** is connected to reciprocating means **3**, preferably motor **4** driven, which will move the panel **2** and panel holder **1** through a spray pattern emitted from a spray gun **5**. The spray gun **5** supported by conventional means such as a stand, clamp, etc· (not shown) uses a conventional cap, tip and needle, not shown, and draws paint from a paint source **6** through conduit means connecting the spray gun

5 and the paint source 6. Compressed air is also supplied to the spray gun 5 from a compressed air source 8 through conduit means 9.

Air ducts 11 are situated on each side of the spray pattern emitted from the spray gun 5 whereby the panel 2 and panel holder 1 will pass in front of the air ducts 11 in its reciprocating movement. The air ducts 11 are connected through conduit means 12 to heating and blowing means 13 which force air 13 through the conduit 12 to the air ducts 11.

The entire apparatus is controlled by a sequencer 14 which can be mechanical or electrical, preferably electrical and capable of controlling the sequence of operation of the spray gun 5, reciprocating means 3, and the means 13 for heating and directing air to the air ducts 11. The sequencer 14 is electrically connected: to the spray gun 5 via electrically conducting wire means 15, to the compressed air source 8 via electrically conducting wire means 16, to the heating and blowing means 13 via electrically conducting wire means 17, and to the reciprocating means 3 and motor 4 via electrically conducting wire means 18.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The spray gun 5 is mechanically adjusted and is not subject to external variables so long as the adjustment settings are maintained. However, these adjustments have a marked effect on the wetness of the film and must be carefully selected in order to obtain a desirable spray pattern. Any conventional spray gun is satisfactory as long as the spray pattern it generates conforms to criteria subsequently described. A preferred spray gun is the De Vilbiss AGA–502 with a 30 cap and an AGA–4016–E tip and needle.

The aforementioned gun, cap, tip and needle can be adjusted to give a preferred fan pattern having a uniform elliptical shape approximately 10 to 10½ inches in height at a distance of 12 inches from the gun. Obviously, the nature of the fan pattern should vary with the size and shape of the substrate or test panel 2 to be sprayed. The preferred test panel is 4 inches x 6 inches in size thereby allowing the preferred fan to uniformly cover the entire panel which assures uniform distribution of the paint film.

The fluid flow rate through the spray gun of a sample of paint reduced with a solvent should be regulated because any variance directly affects the applied film wetness thereby changing its appearance. The exact rate of fluid flow is not essential so long as it is kept constant for all applications. A preferred fluid flow rate for a thermoplastic acrylic lacquer such as Lucite ® is about 320 to 360 grams of solvent such as ethylene glycol monoethyl ether acetate per minute. A fluid flow rate range of 200 to 400 grams of solvent per minute may be desirable depending upon what type of paint system is being used. The nature of the paint source 6 is relatively unimportant. An exception to this is a situation where the paint is reduced with a highly volatile solvent and a number of spray applications are to be made over a prolonged period of time. In such case, in order to avoid an undesirable rise in viscosity due to solvent loss, a covered paint source should be used.

It should be noted that the adjustments made to the spray gun such as fluid flow rate, fan pattern, etc. are accomplished by test spraying a pure solvent through the apparatus, after which the adjustments are secured to eliminate any inadvertent deviations. The fluid flow rate of the reduced paint need not be 320 to 360 grams/minute as this rate has been determined with a selected solvent and the resultant fluid flow rate of paint is sufficient for most applications. Consistency is the important factor for all related applications irrespective of the location of the apparatus.

The compressed air source 8 can be any conventional apparatus normally used to supply air to the spray gun. The extract air pressure is not critical so long as it is kept constant and is sufficient to form an effective fan pattern. A preferred air pressure is about 55 lbs. plus or minus 2 lbs.

The panel 2 can be any substrate capable of being spray painted. A preferred panel is a 4 inch x 6 inch primed aluminum panel. Selection of the size and type of panel is merely a matter of convenience based on the magnitude of the operation. The choice of size should be governed so as to allow the selected spray pattern to adequately cover the entire panel with a uniform paint film thickness.

The gun to panel distance should be kept constant, once established, as fluctuations in this distance will change the thickness of the paint film deposited on the panel. The preferred distance is about 12 inches. This distance is normally sufficient to allow the paint film to develop an "orange peel" or textured effect (discussed later) on the panel which provides a physician basis for standardization of sprayed panels in order that they may be accurately compared for color using visual or instrumental means. The spray gun to panel distance can be varied to compensate for any inaccuracy in the setting of any other component in the system. Therefore, it can be said the gun to panel distance is the master control of the apparatus whereby compensation can be made for minor inaccuracies in other adjustments or for any unusual climatic conditions.

The panel holder 1 is attached to reciprocating means 3 which move the panel through the spray pattern at a constant speed at an angle normal to the direction of the spray pattern. A reciprocating means can be utilized whereby the panel moves back and forth in a straight line or where the panel moves in a circular path. The essential aspect of the reciprocating means is that it be capable of carrying the panel through the spray pattern and also in front of the air ducts 11.

The reciprocating means is preferentially motor driven so as to facilitate regulation of the panel through the spray pattern at a constant speed. The speed of the panel through the spray pattern is about 800 to 1200 inches/minute, preferably about 22 inches/minute.

The panel should be so situated on the panel holder so that the center of the spray pattern is focused on the center of the panel as it passes through the spray pattern. The panel can be attached to the panel holder by any conventional fastening means such as clamps, bolts, magnets, tape and the like. These panel attachments can optionally be equipped with a heat exchanger to maintain the temperature of the panel at approximately the temperature of the air being emitted from the air ducts 11. If a constant panel temperature is not maintained during some operations, a temperature gradient could affect the viscosity of the paint and consequently affect the appearance of the paint film. Generally, the temperature of the panel is maintained by exposure to the ambient temperature of the spray area.

The air ducts 11 can be any size or shape so long as they are capable of blanketing the panel with air at a controlled temperature. The air ducts should be set so that the direction of the air is normal to the plane of the panel plus or minus 10° or 90° from the normal plus or minus 10°. Any conventional conduit means 12 such as pipes, tubing, etc. is suitable for directing air from the heating and blowing means to the air ducts.

A sequencer 14, either mechanical or electrical, is preferably used to control all of the aforementioned components. The sequencer should be capable of regulating the operation of the spray gun, and the duration thereof, the operation of the heating and blowing means and the duration thereof, and the operation of the reciprocating means and the duration thereof.

The aforementioned apparatus is designed to produce a panel uniformly coated with a film of paint. An identical apparatus should be capable of duplicating the color and physical appearance of the initial panel using the

same paint by duplicating all the settings used in the original apparatus.

This visual similarity can best be determined by spraying a panel under conditions whereby the texture of the dried paint film resembles an "orange peel" pattern. This gives the operator a physical property which he can match without having to be color trained. Once this "orange peel" pattern has been duplicated, any color variance from a standard is due to the improper pigmentation of the paint (assuming the quality of the pigment is the same).

For optimal control, the following procedure should be followed. The reciprocating means **3** with panel holder **2** and panel **1** attached is activated simultaneously with the heating and blowing means **13** and the spray gun **5**. The panel will pass (1) through the spray pattern produced by the spray gun, (2) in front of an air duct **11** where it will be blanketed by heated air from the heating and blowing means **13**, and (3) pass back through the spray pattern. This cycle can be repeated until a desired amount of coats are applied to the panel to produce substantially "complete hiding" (no part of the panel surface remains unpainted). At this time, the panel is allowed to "flash"—i.e. it is brought in front of an air duct for a predetermined amount of time in order that the blanket of hot air helps the solvent to evaporate from the paint film. The spray gun is not operative during the flash period.

It may be desirable to prepare the sequence to repeat the entire aforementioned procedure for some paint systems which have difficulty in achieving complete hiding of the panel with a minimum amount of coats.

The temperature, humidity, and flow of the controlled air are individually selected for each paint system in order to enhance drying of the paint into a tight "orange peel" film. A preferred temperature is about 160–180° F. at a rate of flow of 400 ft./min. for lacquer systems and about 140° F. at 250 ft./min. for air dry enamels. By using elevated temperatures, such as 120–250° F., the humidity content of the air is reduced to a point where it is no longer influential.

The atmosphere of controlled air surrounding the "flashing" panel is one of the most important concepts of the invention. The wet film thickness and drying rate of the film must be controlled within very narrow limits so that the aluminum particles which arrive on the panel in a turbulent state can orient into a position closely parallel to the plane of the panel substrate. If the spray or deposited film is too dry, the particles will remain in the random position at which they hit the panel and if the spray or film is too wet, thermal currents within the film will cause flooding. Each of these conditions would have a marked effect on the appearance of the dried film and on any instrumental measurements that may be attempted in order to characterize the paint. The controlled air directed to the "flashing" panel causes the aluminum flake to set up quickly in a desired uniform alignment without undue random orientation.

The rate of solvent loss from the applied paint film on the panel is another important concept and is a function of environmental conditions of which temperature is the most critical element. To properly control the rate of drying it is necessary to maintain the temperature of the environment surrounding the applied film of the panel while it is "flashing" (while the solvent is evaporating or "flashing" off). The most reproducible results are obtained by maintaining a temperature in excess of any spray room temperature with the preferred temperature range being the aforementioned 160–180° F. for lacquer and about 130–150° F. for air dry type enamels. The heating device and integrated blowing apparatus can be regulated to direct air at the desired temperature through the ducts (**11**) to the panel.

The rate of air flow should be sufficient to adequately dry the film and will necessarily vary for different systems. A preferred air flow rate is about 200 ft./minute for air dry enamels and 400 ft./minute for air dry lacquers.

The temperature, humidity, and rate of flow are all regulated to maximize efficient and controlled drying of the film.

The sample paint which is to be sprayed should be reduced to a desired viscosity using the same reducing agent (solvent) in all related applications. The viscosity should be such that the paint can be effectively sprayed. Once this viscosity has been established it should not be varied.

The temperature of the reduced paint sample should also be regulated and kept constant. A preferred temperature for most systems is about 75–85° F. as extreme temperatures will affect viscosity and thereby the rate of flow to the panel.

The paint sample may be agitated during application but it should be noted that agitation may cause an increase in viscosity due to vaporization of the solvent. If agitation is desired on a prolonged spraying operation, a closed system should be evaluated which would inhibit solvent loss as previously discussed.

The rate of evaporation of the solvent is one of the most important factors determining film wetness. The type solvent should be consistent so that the film dries at the same rate for all panels so sprayed. The rate of evaporation of the solvent is a factor determining the spray gun to panel distance, "flash" time, temperature and rate of flow of the duct directed air, etc. Solvents suitable for the use are those conventional to the paint industry such as xylene, toluene, ethylene glycol monoethyl ether acetate, and the like. A single solvent system is preferred so as to facilitate viscosity control.

The end product of this method of controlled environment spraying is a panel exhibiting a surface film texture closely resembling the external appearance of an orange peel. The operator of the apparatus can determine wetness or dryness of the film merely by checking the degree of "orange peel." A dry film is indicated by a very tight or concentrtaed "orange peel" pattern whereas, a wet film is characterized by a loose peel effect or no pattern at all. This method allows the operator to only have to match one variable after all the aforementioned adjustments have been matched, in order to produce a panel which can be used to match against other panels from other locations. Careful regulation of gun to panel distance is the master control to achieve the desired "orange peel" effect once all the other factors have been controlled. Once the degree of "orange peel" has been duplicated, the panel can be manually or instrumentally checked to determine whether there has been a color match between the panel sprayed with a sample batch of paint compared with a standard panel prepared from paint which is used as a color standard.

UTILITY

The apparatus and method of this invention enables a substrate to be spray painted and be unaffected by external factors which affect color except for the pigment composition of the paint. The variances due to improper pigmentation can be instrumentally measured by devices such as colorimeters and spectrophotometers. Readings derived from these instrumental measurements can be used to accurately predict amounts of pigment that can be added to bring the paint to a color match as compared with a standard color.

The apparatus and method of this invention has a preferred utility of being used in conjunction with the invention disclosed in copending U.S. patent application Armstrong et al., Ser. No. 26,269 filed Apr. 7, 1970.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following examples illustrate the various aspects of the invention in greater detail. However, it should be

recognized that they are only illustrative. Variations from what is disclosed will undoubtedly occur to those skilled in the art, but will nevertheless be embraced by the inventive concept. All parts are by weight.

EXAMPLE 1

The following adjustments were made to the apparatus of this invention in order to spray panels with an air dry lacquer:

(1) The air pressure was set at 55 lbs./inch^2 to a De Vilbiss AGA–502 spray gun.

(2) The fluid flow rate to the spray gun equipped with a 30 cap and an AGA–4016–E tip and needle was set at 320–360 grams of ethylene glycol monoethyl ether acetate per minute.

(3) A 10 inch vertical fan pattern at a distance of 12 inches was obtained from the spray gun.

(4) The heating and blowing means was a blower built by Buffalo Forge Works adjusted to produce a stream of air at a rate of 400 ft./min. at a temperature of 132° F. through the air ducts.

(5) The reciprocating means and panel holder was a Spramaytion panel carrier adjusted to move a 4 x 6 primed aluminum panel through the spray pattern at 822 inches per min. The panel traveled ¾ inches in front of the air ducts with the air ducts being situated 3 inches from the center line of the spray pattern on each side of the spray pattern.

The entire system was controlled by an internally designed automatic sequencer. The sequence followed was 4 passes through the spray (coats of paint)/2 minutes flash in front of the air ducts—4 passes/1 minute flash—4 passes/1 minute flash—4 passes/1 minute flash—and 4 passes/1 minute flash. The coated panel had a textured surface resembling an orange peel in nature.

EXAMPLE 2

An air dry enamel was applied to a panel using the procedure of Example 1 except that the temperature of the air through the ducts was from 170–180° F. The sequence for this application was 6 passes/3 minute flash—6 passes/3 minute flash—6 passes/3 minute flash—6 passes/3 minute flash—6 passes/3 minute flash—and 1 pass/2 minute flash.

A coated panel having a textured effect resembling an orange peel resulted.

The invention claims:

1. A method of producing visually reproducible coatings on substrates comprising repeatedly passing the substrates along a fixed path through a spray pattern emitted from a spray gun, said spray pattern being generated by supplying the spray gun with compressed air and coating material at constant pressures, said spray gun and the path of the substrate being fixed relative to each other, and directing a stream of heated air over said substrate through said spray pattern, said repeated passing being continued until an "orange peel" coating is obtained.

2. The method of claim **1** wherein said stream of heated air is at a temperature of from about 120°–250° F.

3. The method of claim **2** wherein said stream of heated air is at a velocity of from about 200–400 feet/minute.

4. The method of claim **3** wherein said substrate travels at a speed of about 800–1200 inches/minute.

5. The method of claim **4** wherein said substrate remains in said stream of heated air after the final pass through said spray pattern until said substrate is dry.

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ALFRED L. LEAVITT, Primary Examiner

J. H. NEWSOME, Assistant Examiner

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