United States Patent [19]

Harrison et al.

[11] **3,927,833**

[45] **Dec. 23, 1975**

[54] **APPARATUS FOR FORMING MULTIPLE-COMPONENT COMPOSITE STRUCTURES**

[75] Inventors: **David Harrison; Raul T. Sainz,** both of Miami, Fla.

[73] Assignee: **Ransburg Corporation,** Indianapolis, Ind.

[22] Filed: **July 25, 1975**

[21] Appl. No.: **599,139**

Related U.S. Application Data

[62] Division of Ser. No. 464,994, April 29, 1974.

[52] **U.S. Cl.** **239/306;** 239/325; 239/336; 239/422; 239/DIG. 8

[51] **Int. Cl.²** **B05B 7/08;** B05B 7/14; B05B 7/24

[58] **Field of Search** ..... 239/336, 306, 422, DIG. 8, 239/325, 8–10, 80, 85, 414, 415, 416.1; 117/27, 105.5; 118/308–311

[56] **References Cited**

UNITED STATES PATENTS

2,255,189	9/1941	Robinson et al.	239/422 X
2,821,890	2/1958	Wilson	239/422 X
3,034,732	5/1962	Winn	239/336 X
3,038,750	6/1962	Nielson	239/325 UX
3,096,225	7/1963	Carr et al.	239/325 X
3,399,834	9/1968	Bradley	239/10
3,542,296	11/1970	Bradley	239/DIG. 8
3,777,981	12/1973	Probst et al.	239/336 X
3,788,555	1/1974	Harrison et al.	239/422 X
3,797,750	3/1974	Liedberg	239/336
3,829,016	8/1974	Scharfenberger	239/336 X

Primary Examiner—Robert S. Ward, Jr.
Attorney, Agent, or Firm—Merrill N. Johnson

[57] **ABSTRACT**

A method and apparatus can be used to form complex laminates and other such structures with economical use of resins. This apparatus and method provides a mixed spray of a plural component liquid resin and curing agent with granular and fiber material entrained in the mixed spray. The apparatus includes a plurality of resin and curing agent spray means and granular and fibrous material dispensing means associated with the curing agent and resin spray means. The plurality of sprays are adapted to intersect and mix externally of the apparatus prior to deposition upon a surface. One or more granular materials can be entrained in a gaseous medium and mixed with the liquid spray so as to provide a mixed spray of multiple component materials. Reinforcing chopped fibers such as glass may be introduced into this mixed spray from a chopper located above the array of powder and liquid sprays.

6 Claims, 6 Drawing Figures

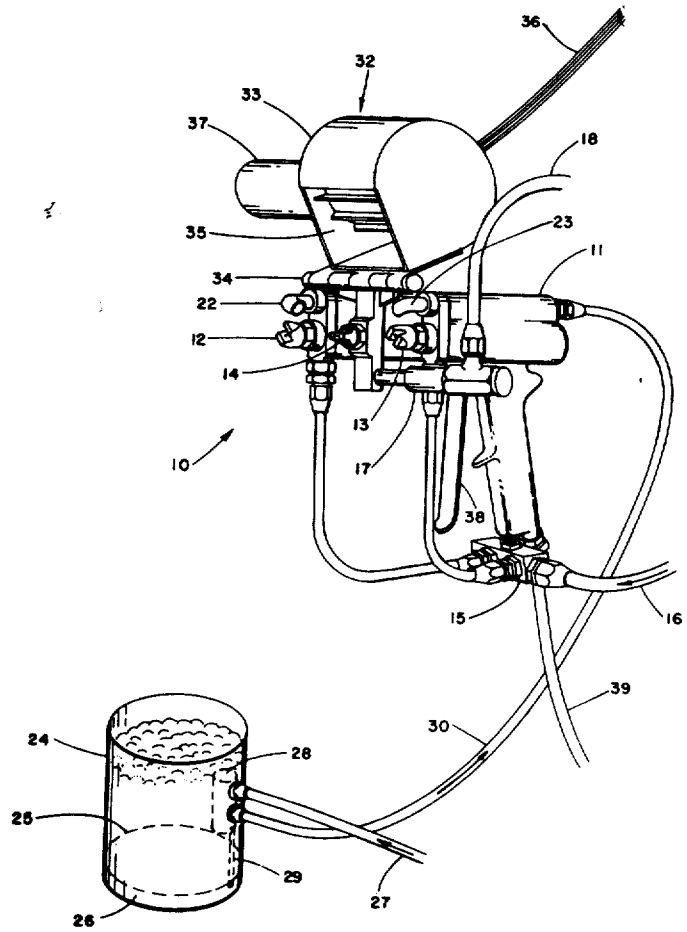


Fig. 1

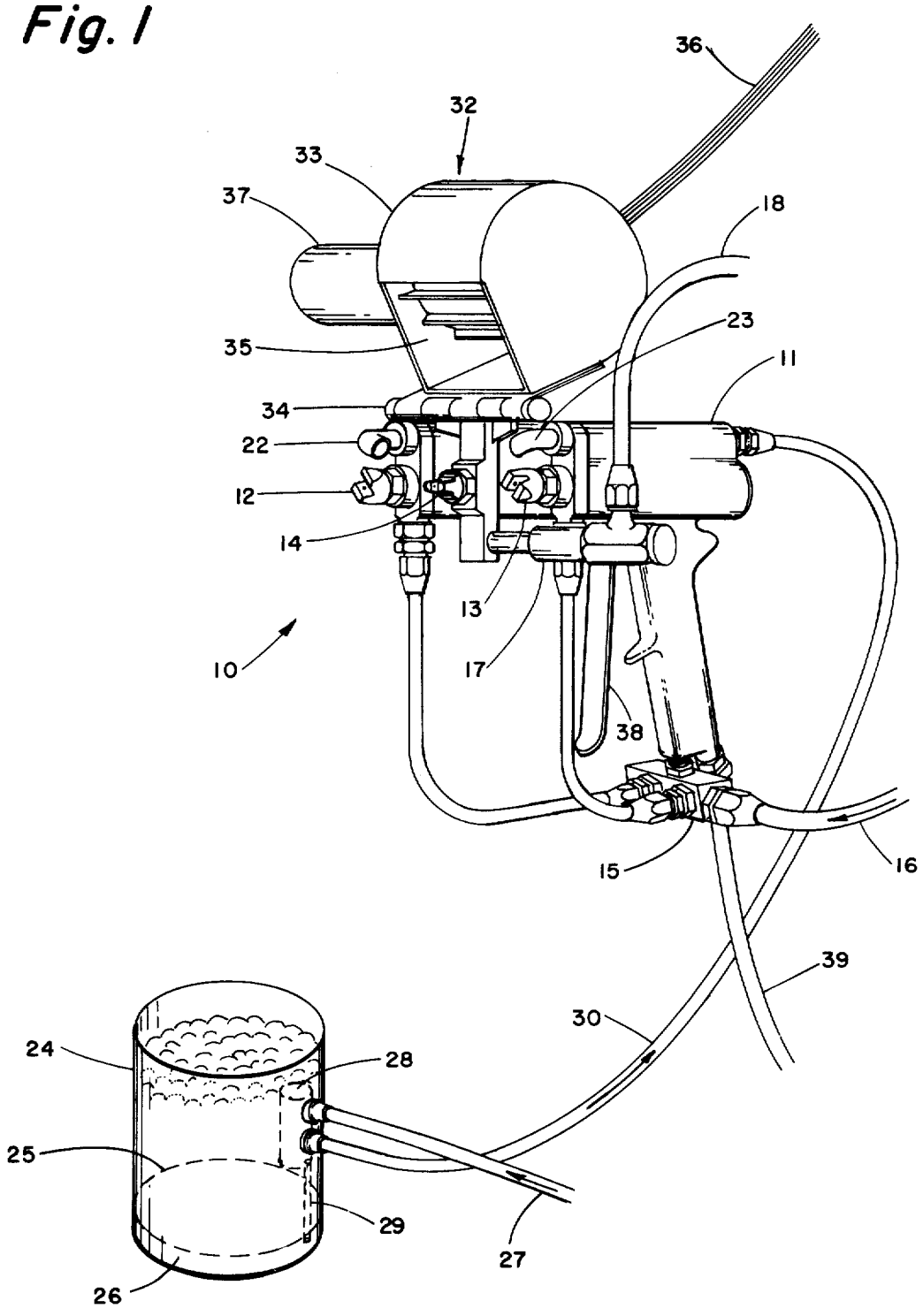

36
32
33
37
18
23
35
11
34
22
12
14
13
17
10
38
15
16
39
30
24
28
25
29
27
26

Fig. 2

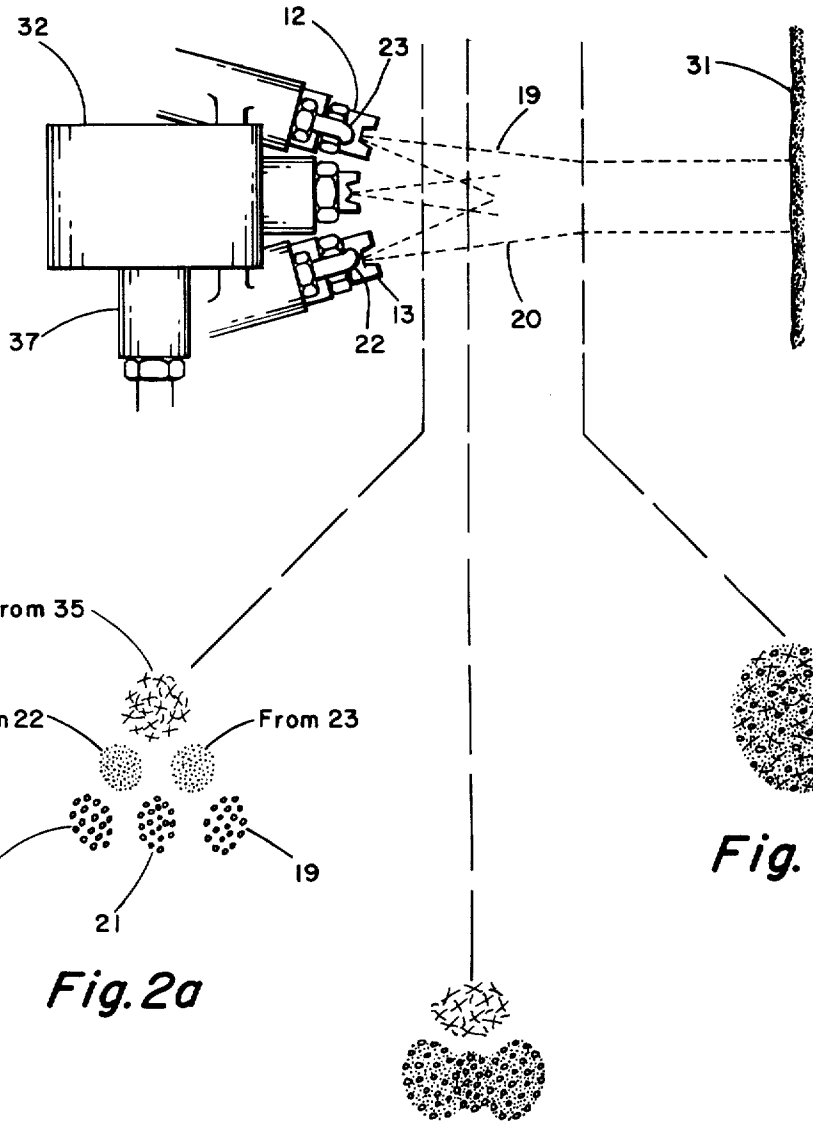


Fig. 2a

Fig. 2c

Fig. 2b

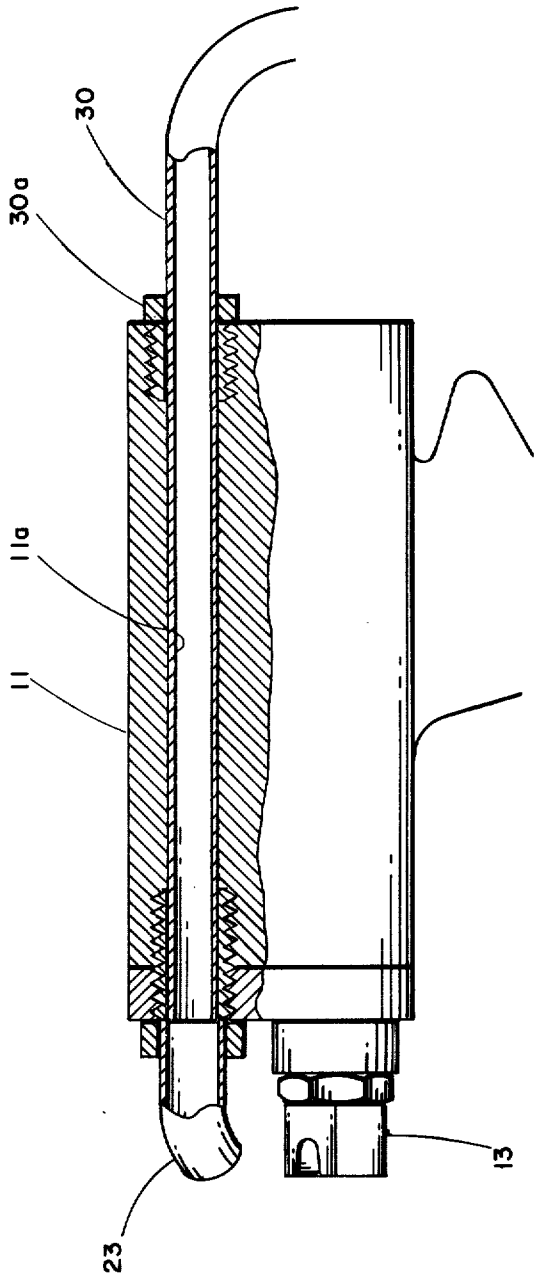


Fig. 3

APPARATUS FOR FORMING MULTIPLE-COMPONENT COMPOSITE STRUCTURES

This is a division of application Ser. No. 464,994, filed Apr. 29, 1974.

The present invention relates to a method of and an apparatus for forming multiple-component composite structures. Such structures may include laminates having a plurality of distinct layers, each layer being composed to have different physical properties. In addition, such structures may be made having no distinct interface, but having gradually changing material constituents, or gradually changing material proportions. Particulate and fibrous materials are mixed into catalyzed resin and the use of particulate and fibrous material provides special physical and chemical properties and saves expensive resins while imparting such properties. This invention includes a method of and an apparatus for providing a spray, including a plural component material with a multiplicity of entrained filler and reinforcing materials, and more particularly, includes an apparatus for and a method of providing a commingled spray, including a plural component material with granular material and with chopped fiber glass wetted by the liquid component prior to deposition.

Multiple-component composite structures which may be formed with this invention include, for example, rigid laminates including outer layers of one composite material and a central layer or layers of other composite materials. The outer layer can be composed to have one set of physical characteristics, such as resistance to oxidation and ultraviolet light, high gloss and color retention, hardness and other characteristics associated with exterior surfaces. The central layer or layers can be composed to have an entirely different set of physical characteristics, such as low density, low thermal conductivity, rigidity, low thermal expansion, and good adhesion with the outer layers. With this method and apparatus, a rigid structure can be economically and quickly made having specific physical properties not otherwise available.

It is also feasible to use this method and apparatus to provide coatings upon a myriad of surfaces such as wood, paperboard, plasterboard, polyester-based materials, cement-based or cement-impregnated paper materials and masonry exterior surfaces, including but not limited to brick, cement and stone. This method and apparatus can reduce the cost of the coating, reduce the weight of the coating, provide a surface with a coating having a variable surface contour and various colors, and provide an adherent coating with which mechanical fasteners may be easily used.

Plural component liquid materials which may be sprayed concurrently with granular and fibrous materials include polyester resins, epoxy resins, urethane resins, silicone rubber and the like. Generally, the plural component liquid material is converted, at ambient atmospheric temperature, from a liquid to a solid by the addition of an appropriate curing agent, which includes catalyst materials. Polyester resins may be cured by the addition of an organic peroxide catalyst and a naphthenate or aniline promoter. Epoxies may be cured by the addition of a suitable amine or anhydride curing agent. Urethanes may be obtained by the addition of a suitable isocyanate ester to a polyol resin.

Silicone rubber may be obtained by the addition of a suitable tin soap to a silicone elastomer.

The addition of the curing agent to the other plural component liquid material is usually made just prior to use to thereby initiate curing of the plural component material. Generally, the curing cycle of the plural component material is of short duration. For example, upon the addition of both a catalyst and a promoter, polyester resin may solidify in a matter of 45 minutes or less.

The plural component material can be mixed with granular materials such as perlite, clay, sand, talc, mica, aluminum hydrate, calcium carbonate, calcium silicate, glass beads, plastic spheres, fire retardants and the like, and with reinforcing fiber glass or other fibrous materials. Such particulate and fibrous fillers may provide any one or more of the following properties: reinforcement of the resin rigidity, reduced shrinkage, economy in the use of resin, low density and special properties such as fire retardancy.

With the method and apparatus of this invention, higher concentrations, as well as different combinations, of such materials can be obtained in such structures than with other methods and apparatus. The difficulty of wetting a high concentration of fillers in attempting to pre-mix it with the resin, as well as the difficulty in pumping and atomizing the viscous mixture, has limited concentration of filler material to typically about 17% by volume. This invention permits significantly higher mixed concentrations because of the increased wetting of particulate and fibrous materials that is achieved by this new method and apparatus.

Among older methods U.S. Pat. No. 3,399,834 shows an apparatus for and a method of depositing commingled sprays of promoted polyester and catalyst wherein a spray of the catalyst is mixed with sprays of promoted polyester externally of the spray apparatus using a plurality of converging sprays. Prior to deposition upon a surface to be coated, the mixed spray has chopped lengths of glass fibers mixed therewith. The chopped lengths of glass fibers are used to enhance the physical properties of the polyester resin. In addition, U.S. Pat. No. 3,676,197 shows an apparatus for and a method of mixing granular material entrained in a fluid medium with sprays of a plural component material and a curing agent and depositing the resultant mixture upon a surface of an article.

The method and apparatus of this invention is capable of forming multiple-component composite structures that were not possible with prior existing methods and apparatus. The present invention provides an apparatus for and a method of wetting and substantially uniformly mixing granular and fiber material in large concentrations with a plural component material exteriorly of a spray apparatus and prior to engagement of such materials with and deposition on a mold surface.

In the drawing:

FIG. **1** is a perspective view of one embodiment of the present invention;

FIG. **2** is a diagrammatic view showing spray patterns of the embodiment of FIG. **1**;

FIG. **2***a* illustrates the spray pattern at a point prior to intersection of the separate sprays;

FIG. **2***b* illustrates the spray pattern approximate the point of convergence;

FIG. **2***c* illustrates the spray pattern at a point downstream from the point of convergence; and

FIG. 3 is a partial cross-sectional view of the embodiment of FIG. 1 through the particulate passageways in its housing.

Referring now to FIG. 1 of the drawing, a spray apparatus of the present invention is indicated by the reference numeral **10**. The spray apparatus **10** includes housing or support means **11**, outboard plural component spray means **12** and **13** and centrally located curing agent spray means **14** positioned between the outboard spray means **12** and **13**. The housing **11** serves as the main support member for the outboard spray means **12** and **13** and for the curing agent spray means **14**. The curing agent spray means **14** may provide a spray of organic peroxide catalyst where the outboard spray means **12** and **13** may be spraying a promoted polyester resin or a spray of suitable amine or anhydride where the outboard spray means are spraying an epoxy resin. Urethanes may be obtained by the addition of a suitable isocyanate ester to a polyester resin. Silicone rubber may be obtained by the addition of a suitable tin soap to a silicone elastomer.

Each of the outboard spray means **12** and **13** are suitably connected through plural component material manifold **15** and conduit **16** to a source (not shown) of a plural component material. The plural component material may be supplied under pressures of about 300 to 3000 p.s.i. to the outboard spray means **12** and **13** by an air-operated hydraulic pump (not shown). Using the apparatus **10** shown in FIG. **1**, the plural component material is atomized by interaction with the surrounding air upon emerging from the orifices of the outboard spray means **12** and **13**. The plural component material, of course, may be atomized by any other suitable means such as by compressed air. The outboard spray means **12** and **13** are illustrated as including nozzles which hydraulically atomize the plural component material, and the curing agent spray means **14** is illustrated as being a compressed air spray means. The outboard spray means **12** and **13** are angled or inclined toward each other as shown in FIG. **2** in such a manner that the spray patterns **19** and **20** provided by each of the outboard spray means converge and intersect at a locus spaced about 5 inches from the front of the spray apparatus **10**.

The centrally located curing agent spray means **14** is flanked by and on substantially the same horizontal plane with the outboard spray means **12** and **13**. The curing agent spray means **14** is connected to a source (not shown) of curing agent through curing agent manifold **17** and conduit **18**. The curing agent spray means **14** is positioned to provide a spray **21** of curing agent that intersects the converging sprays of the outboard means at the locus of their intersection. The vertical width of the spray pattern of the curing agent as it intersects the sprays of the outboard spray means **12** and **13** is preferably substantially the same as the vertical width of the sprays of the plural component material to assure substantially uniform mixing of the curing agent with the plural component material.

In order to provide a spray of substantially uniformly mixed plural component material and curing agent, the curing agent spray means **14** is desirably centrally located between the outboard spray means **12** and **13**. The outboard spray means **12** and **13**, when dispensing a polyester resin, dispense up to about **99** weight percent of the total weight of the fluid component of the spray issuing from apparatus **10**. The outboard spray means **12** and **13** dispense approximately **50** weight percent of the total weight of the fluid component when dispensing a urethane. The remainder of the liquid component of the spray issuing from the spray means **10** is dispensed by the curing agent spray means **14**. The relative ratios of other resins and curing agents, of course, may vary, depending upon the plural component material used. Locations of the curing agent spray means **14** at a position other than centrally between the outboard spray means **12** and **13** may not yield as thorough a mixing of the curing agent with the other plural component and may result in an undesirable deflection in the resulting spray.

Spaced from but positioned closely adjacent each of the outboard spray means are granular material emitting means **22** and **23**. The granular emitting means may include spray-forming nozzles pivotally mounted upon housing **11** to direct the granular material emitted toward the sprays from the outboard spray means **12** and **13** as desired.

The granular material may be any suitable material which, by using a suitable fluidized bed and immersed venturi pump, may be entrained in a flowing stream of compressed air, or may be conveyed using any other suitable granular material conveying means. Such granular material may include perlite, clay, sand, talc, mica, aluminum hydrate, calcium carbonate, calcium silicate, glass beads, plastic spheres, fire retardants and the like.

A suitable source of granular material is shown in FIG. **1**. The source includes an open container **24** with a porous plate **25** adjacent its bottom to form an air chamber **26** at its bottom. The granular material is supported by the porous plate **25**, which is made from a material like sintered polyethylene. Compressed air from an air source is supplied through hose **27** to an immersed venturi pump **28** and through a sealed tube **29** to the air chamber **26**. The slow and uniform flow of air through porous plate **25** fluidizes the granular material in the container **24**, and the flow of compressed air through the venturi pump **28** draws the fluidized granular material into an opening (not shown) in the venturi pump, entrains it in the moving air stream and delivers it through hose **30** to a smooth passageway or passageways in housing **11** (shown more particularly in FIG. **3**) that direct the air-entrained granular material to granular spray-forming nozzles **22** and **23** that are mounted on and carried by housing **11**.

FIG. **3** shows in greater detail the portion of apparatus **10** that is associated with the emission of granular filler materials. The passageways **11***a* (only one of which is shown in FIG. **3**) in housing **11** through which granular and particulate material are directed are straight throughout the housing. The granular spray-forming nozzles **22** and **23** are mounted at the forward end of passageways **11***a*. The hose **30** conveying the granular material from the fluidized bed is inserted into and held within the passageways **11a** by a hose retainer **30***a*. Hose **30** extends thus from the source of powder **24** up to the granular nozzle means **22** and **23** and provides an uninterrupted and smooth-walled passageway for the air-entrained granular material to provide an even delivery of granular particles to the spray-forming means.

The granular nozzles may be designed to form the air-entrained granular material into any pattern desired for association with the liquid plural component material sprays from nozzles **12**, **13** and **14**. The outputs of the granular nozzles **22** and **23** are located closely adjacent to the outboard spray means **12** and **13**. The cre-

ation of spray by these liquid spray means forms an area of low pressure closely adjacent the means **12** and **13**. Locating the granular-emitting nozzles closely adjacent this area of low pressure, as for example, within an inch or so, results in entrapment of the granular material in the liquid spray with the assistance of the air flow adjacent the front of the apparatus **10**. The nozzles **22** and **23** shown in FIG. **1** and FIG. **2**, for example, include orifices that are generally elliptical with a major diameter of about 0.5 inches and a minor diameter of about 0.25 inches. The nozzles include inner surfaces adjacent to orifices that are curved to direct the air-entrained granular material into the area adjacent the means forming the liquid sprays.

The granular material from nozzles **22** and **23** should intersect the sprays of the plural component material so that the granular material is adequately wetted by and substantially uniformly mixed with the plural component material prior to deposition upon surface **31**. Locating the granular-emitting means **22** and **23** about one inch above the orifices of the outboard spray means **12** and **13** and curing agent spray means **14** so the granular material is brought into the spray of plural component material within several inches of the front of the spray apparatus **10** appears to result in good wetting and substantially uniform mixing of the granular material with the sprays of the liquid plural component material.

A cutter means **32** is used to spray and deposit cut fibers with the plural component material and granular material. The cutter means **32** cuts fibers into various lengths by changing the spacing between blades in a cutting wheel within the cutter. Such a cutter means **32**, described in U.S. Pat. No. 3,399,834, preferably includes a housing **33**, an adjustable attaching means **34**, and a directional opening **35**.

In this type of cutter means, the attaching means **34** provides for movable mounting of the housing **33** upon the housing **11**, preferably above the granular emitting means and so that the opening **35** through which the cut roving is ejected may be angularly varied with respect to the sprays issuing from spray means **12, 13, 14, 22** and **23**. This provides for directing the cut roving in the spray streams so that the roving will be "prewet" and will not ride on top of or fall through the spray stream.

Cutter means **32** is positioned to receive roving strand **36** and to cut the continuous strands into short filaments, which are then ejected through opening **35** into the spray streams of spray means **12, 13, 14, 22** and **23**, as shown in FIG. **2**. Fiber material most frequently used is a roving of glass fibers. The cut lengths of fiber glass can be used to provide reinforcement throughout the body of the composite material.

Operation of the apparatus can be effected by actuation of trigger means **38** carried by housing **11**. Actuation of trigger means **38** can provide in the proper sequence, operation of valve means controlling the flow of liquid to spray means **12, 13** and **14**, the flow of atomizing air to spray means **14**, and the flow of compressed air to air motor **37**. The flow of compressed air to the apparatus **10** through hose **39** can be detected by an air flow switch (not shown) whose output can be used to effect a flow of air to the granular material source through hose **27** and delivery of granular material to apparatus **10** through hose **30**.

Release of the trigger **38** will substantially simultaneously terminate the flow of plural component material from spray means **12** and **13**, the flow of curing agent and atomizing air from spray means **14** of apparatus **10** and the flow of granular material and fibers from granular emitting means **22** and **23** and cutter means **32**.

As shown in FIG. **2***a*, the converging spray streams **19** and **20** issuing from outboard spray means **12** and **13** may have a substantially oval or elliptical-shaped transverse cross section. The liquid sprays are formed below the means to emit granular material and films and form a base for such materials. As shown in FIG. **2b**, emission of the particulate material closely adjacent the sites of formation of the liquid sprays results in the granular material being quickly urged into the liquid sprays. The intersection of the converging liquid and granular sprays issuing from the outboard liquid and granular spray means and the fibers from cutter means **32**, as shown in FIG. **2***c*, causes a resultant mixed homogeneous spray with the granular and fiber material substantially uniformly wetted by the liquid and distributed in the spray.

As illustrated in FIG. **2***a*, the array of liquid and solid sprays form a pyramid-like arrangement before intersecting. The outboard liquid sprays **19** and **20** carry almost all the liquid material sprayed and form a spray pattern base with the curing agent spray **21**. They capture the granular materials emitted from nozzles **22** and **23** and the fibers ejected from orifice **35** and intersecting, uniformly mix and wet the granular materials and fibers. Where cut fibers are used, they form a significant percentage of the weight of the composite spray material, typically **25** to **35** percent in glass-reinforced polyester structures; however, lower percentages may be used, if desirable.

Where two different granular materials are used, such as glass beads and aluminum hydrate, the apparatus **10** can be arranged to intermingle the two particulate materials prior to, or at about the locus of intersection with the liquid sprays.

The apparatus of this invention thus forms a superior means to mix a plurality of materials. The liquid components are atomized by the use of a high hydraulic pressure of from 300 to 3000 p.s.i. and with specially shaped nozzles, for example, adapted to form the liquid into a thin, expanding fan-shaped form. The liquid is ejected at a very high velocity from the nozzles and atomized by interaction with the atmosphere. An area of low pressure is created adjacent the nozzles by operation of the nozzles in forming the spray. Particulate, or granular, material to be mixed with the liquid component is uniformly delivered to and released closely adjacent the liquid nozzles in the low pressure area where it is captured by the air flow at the front of the apparatus. With two liquid nozzles in use, two particulate components may be used, one located closely adjacent each liquid nozzle so that each particulate material is captured by a spray of liquid material. By directing the two liquid nozzles so that they intersect, the liquid and granular sprays are uniformly mixed and the particulate material is wetted. Plural component material may be formed with an unusually high percentage of particulate material using this method and apparatus. In addition, fibers can be added to this material by cutting and ejecting the fibers into the air flow forwardly of the apparatus. Where a catalyzed resin liquid material is used, curing agent is desirably introducted into the spray from between the two liquid nozzles.

Suitable additives may be introduced into the plural component material for color, ultraviolet absorption, flameproofing and the like. Pigments may be used to achieve the desired color of the plural component material. Antimony oxide, aluminum trihydrate, chlorinated waxes and the like may be used to assist in flameproofing the plural component material.

The volume of granular material to plural component material may vary considerably. Using perlite, the volume of perlite may be about 30 to 65 percent by volume of perlite with the remaining percentage of polyester resin. Using glass beads, the percentage of total volume that may be glass beads is most generally 20 to 40 percent; however, smaller percentages may be used, if desirable.

The thickness of a coating of plural component material and granular material using this method and apparatus may be as desired. The lower limit on thickness of the coating is about **15** to **20** mils with the upper limit only limited by the economics of the situation. Generally, for coatings having good weathering characteristics and strength, the thickness of a coating including a binder of polyester and perlite granular material should approach about 0.125 to about 0.25 of an inch or more.

Cut fiber glass provides reinforcement and may be used in percentages of 10 to 30 percent, to be determined by the difficulty of roll-out. Thick coatings of material, including cut fiber glass and particulate, must be "rolled out"; that is, the deposited coating must be worked with a roller to eliminate air trapped in the interstices of the fibers. Where these composite coatings are too thick, it is not possible to roll out such entrapped air. The coating is instead pushed about by the roller and entrapped air is not removed. Thus such mixed coatings on the order of one inch thick are not practical with cut glass fibers.

The spray apparatus **10** may be hand held or carried by any suitable boom (not shown) and movable base (not shown) to facilitate the movement of the spray apparatus.

The following examples are intended to illustrate the formation of multiple component composite structures using the apparatus and method of this invention.

EXAMPLE I

A laminated multicomponent structure can be manufactured using the method and apparatus of this invention by the following procedures. A mold surface is spaced about 18–36 inches in front of the spray apparatus **10.** Polyester resin is supplied to the outboard spray means at a pressure of about 2000 p.s.i. at a rate of about 1900 cubic centimeters per minute through the airless spray nozzles forming the polyester resin into an elongated, fanshaped spray pattern having an acute angle of 25°. The sprays from the outboard spray means converge about 5 inches in front of the spray apparatus. Undiluted methyl ethyl ketone peroxide catalyst is atomized from the central nozzle at a rate of about 30 cubic centimeters per minute, using atomizing air pressure of 20 p.s.i. from a compressed air spray nozzle of more or less standard configuration, such as the Spraying Systems' No. E18B. A spray of catalyst intersects the outboard spray means about 5 inches in front of the spray apparatus at the locus of their intersection. Aluminum trihydrate, the granular material, is supplied to the granular emitting nozzles associated with the outboard spray means at a rate of about 2050 grams per minute. The granular emitting spray means are located closely adjacent the sites of atomization of the polyester resin to direct the aluminum trihydrate into the liquid spray. The aluminum trihydrate is manufactured by Aluminum Company of America and sold under the trade name "ALCOA C31". Chopped fiber glass is directed into the spray of liquid and granular material at a rate of about 1.5 pounds per minute. The cut fibers have an average length of about one inch. This composite laminate is deposited on the mold surface to a thickness of about 0.1 of an inch. Entrapped air is rolled out of this coating. This layer is allowed to cure at room temperature of 70° Fahrenheit for one hour.

A central core is then deposited upon the resulting laminate structure. As before, the apparatus is spaced 18–36 inches away from the laminate. Polyester resin is supplied to the outboard spray means under a pressure of 2000 p.s.i at the pump at a rate of about 1900 cubic centimeters per minute. The outboard spray means are nozzles which form the polyester resin material into aan elongated spray pattern having an acute angle of about 25°. As before, the outboard sprays converge about 5 inches in front of the spray apparatus. Undiluted methyl ethyl ketone peroxide catalyst is delivered to a compressed air atomizing nozzle at a rate of about 40 cubic centimeters per minute and atomized by compressed air supplied to the atomizing nozzle at 20 p.s.i. A spray of peroxide catalyst intersects the resin sprays about 5 inches in front of the spray apparatus. From the central core, the aluminum trihydrate is supplied to only one of the granular emitting means at a rate of about 400 grams per minute. The other spray emitting means is connected with the source of Minnesota Mining and Manufacturing Company glass beads. These glass beads have an average diameter of about 3 mils. The Minnesota Mining and Manufacturing Company glass beads are supplied to the other granular emitting means at a rate of about 800 grams per minute. The two granular emitting means are located closely adjacent the resin atomizers and direct the glass bubbles and aluminum trihydrate into the liquid sprays in front of the apparatus. The commingled, catalyzed polyester resin, the glass beads and aluminum trihydrate are carried and deposited on the first layer to a thickness of about 0.1 of an inch. The central core is then allowed to cure at ambient temperature of 70° Fahrenheit for about 60 minutes.

After the central core has had an opportunity to cure, a top layer like the bottom layer is added to the central core. The apparatus and method of operation are exactly like those used in making the first layer and the materials in this top layer are deposited to a thickness of 0.1 of an inch and rolled out as before. The top layer is then allowed to cure for about 60 minutes at 70° Fahrenheit.

The resulting three-layered laminate is a rigid, composite structure of 0.3 of an inch thick, having glass reinforced outer layers and a low density central layer to increase its rigidity. Because of the use of the aluminum trihydrate and the glass beads, approximately 25 percent less resin is used to form this structure than would otherwise have been required with a resulting saving in weight and cost.

EXAMPLE II

A composite structure is manufactured using the apparatus and method of this invention with the benefits of a substantial saving in resin and weight and with little, if any loss of rigidity and strength. The surface of

a mold is spaced about 18 to 36 inches in front of the spray apparatus **10**. Polyester resin is supplied to the outboard spray means under a pressure of 2000 p.s.i. at the pump at the rate of about 1900 cubic centimeters per minute through airless nozzles forming the polyester resin into an elongated fan-like spray pattern having an acute angle of about 25°. Undiluted methyl ethyl ketone peroxide is supplied to the atomizing nozzle at a rate of 40 cubic centimeters per minute and atomized by compressed air supplied to the Spraying System No. E18B atomizing nozzle at 20 p.s.i. The liquid sprays of resin and catalyst intersect about 5 inches forwardly of the apparatus. Particulate aluminum trihydrate, sold by Aluminum Company of America under the trade name "ALCOA C31", is supplied to the two granular emitting means at a combined rate of 2000 grams per minute. The granular emitting means are arranged to direct the aluminum trihydrate into the liquid sprays forwardly of the site of formation of the liquid sprays. Fiber glass roving is cut and expelled into the liquid and granular sprays at a rate of 400 grams per minute. Standard fiber glass gun roving is cut into fibers having an average length of about ¾ of an inch. The composite material is sprayed onto the mold form to a thickness of about 0.1 of an inch and is allowed to cure at toom temperature of 70° Fahrenheit. The resulting composite material structure was a rigid, translucent, glassreinforced polyester sheet having low density and good strength. "Suzorite", a particulate mica sold under this name by Marietta Resources International Ltd., can be substituted for the aluminum trihydrate.

EXAMPLE III

A composite material structure was prepared that is suitable for the hull of a boat. Pure pigmented catalyst polyester resin is sprayed onto a polished mold surface to a thickness of about 0.005 inches. The pigmented polyester resin is a high quality type of the type normally used as gel coat in the manufacture of polyester resin particles and in spraying, the apparatus is operated in a manner known to those skilled in the art. Then glass beads are added to the gel coat and another 0.010 inches of coating is applied. The gel coat resin is allowed to cure for 60 minutes at 70° Fahrenheit. When the gel coat has cured, the procedure as set forth in Example I above was repeated, but with glass bubbles substituted for ALCOA C31 in the central core. The resulting composite material structure was ideally suited for the hull of a boat.

The method and apparatus of this invention can thus be used to manufacture many different composite material structures. Such a device is particularly applicable in the manufacture of boats, bathroom fixtures, counter tops, and many other such items.

We claim:

1. A spray gun for forming multiple-component composite structures comprising a housing forming a handle and carrying a trigger, a pair of spray-forming means carried at the forward portion of the housing at spaced-apart locations, each of said spray-forming means being adapted for connection with a source of plural component material, an atomizing nozzle carried by the housing at a location centrally located between the pair of spray-forming means and adapted for connection with a source of curing agent, a pair of granular emitting means carried by the forward portion of the housing, each of said granular emitting means being located closely adjacent one of said pair of spray-forming means, a pair of passageways formed by the housing and connected at the rear with the source of granular material, cutter means for cutting fibrous materials adjustably carried by the housing having an orifice for the ejection of cut fibers located above the granular emitting means and centrally located therebetween, a valve means within the housing operated by the trigger simultaneously causing the operation of the spray-forming means, the curing agent atomizing nozzle, and the cutter means.

2. The apparatus of claim **1** wherein each of the granular emitting means is located about 1 inch above its associated spray-forming means for resinous material.

3. The apparatus of claim **1** wherein the orifice for ejection of cut fibers is located about 3 inches above the pair of spray-forming means for resinous material and centrally located therebetween.

4. Apparatus for forming multiple-component composite structures comprising

first means to form a liquid resin and curing agent into a catalyzed resin spray pattern base;

second means to emit granular material from closely adjacent and above said first means and into the catalyzed resin spray pattern base;

third means to project cut fibers from above said first and second means into the catalyzed resin spray pattern base and

control means to operate said first, second and third means.

5. Apparatus for forming multiple-component composite structures comprising

a housing forming a handle and carrying a trigger;

a plurality of spray-forming means carried at the forward portion of the housing at spaced-apart locations, said plurality of spray-forming means being connected with separate sources of resin material and curing agent;

granular emitting means carried by the forward portion of the housing;

a fluidized bed source of granular material;

a hose connected with said fluidized bed source, carried by said housing and terminating adjacent to said granular emitting means;

means to entrain granular material in a flow of gas in said hose to deliver the granular material to said granular emitting means;

cutter means for cutting fibrous materials carried by the housing above the granular emitting means; and

means to cause the operation of the plurality of spray-forming means, the source of granular material and the cutter means.

6. Apparatus for forming multiple-component composite structures comprising

a plurality of spray-forming means carried by a housing at spaced-apart locations, each of said plurality of spray-forming means being connected with a source of plural component material including separate sources of resin and curing agent and at least one of the plurality of spray-forming means emitting resin at high velocity under the action of high hydraulic pressure;

a granular emitting means carried by the housing and being located closely adjacent said one of the plurality of spray-forming means;

a means to entrain granular material in a flow of gas and deliver it to the granular emitting means, in-

cluding smooth, uninterrupted walls from the source of granular material to said granular emitting means;

a cutter to form fibrous material into fibers of predetermined length; and

means carried by the housing to operate simultaneously, said plurality of spray-forming means, the curing agent and said cutter.

* * * * *