

July 13, 1971

C. A. FROM, JR., ET AL

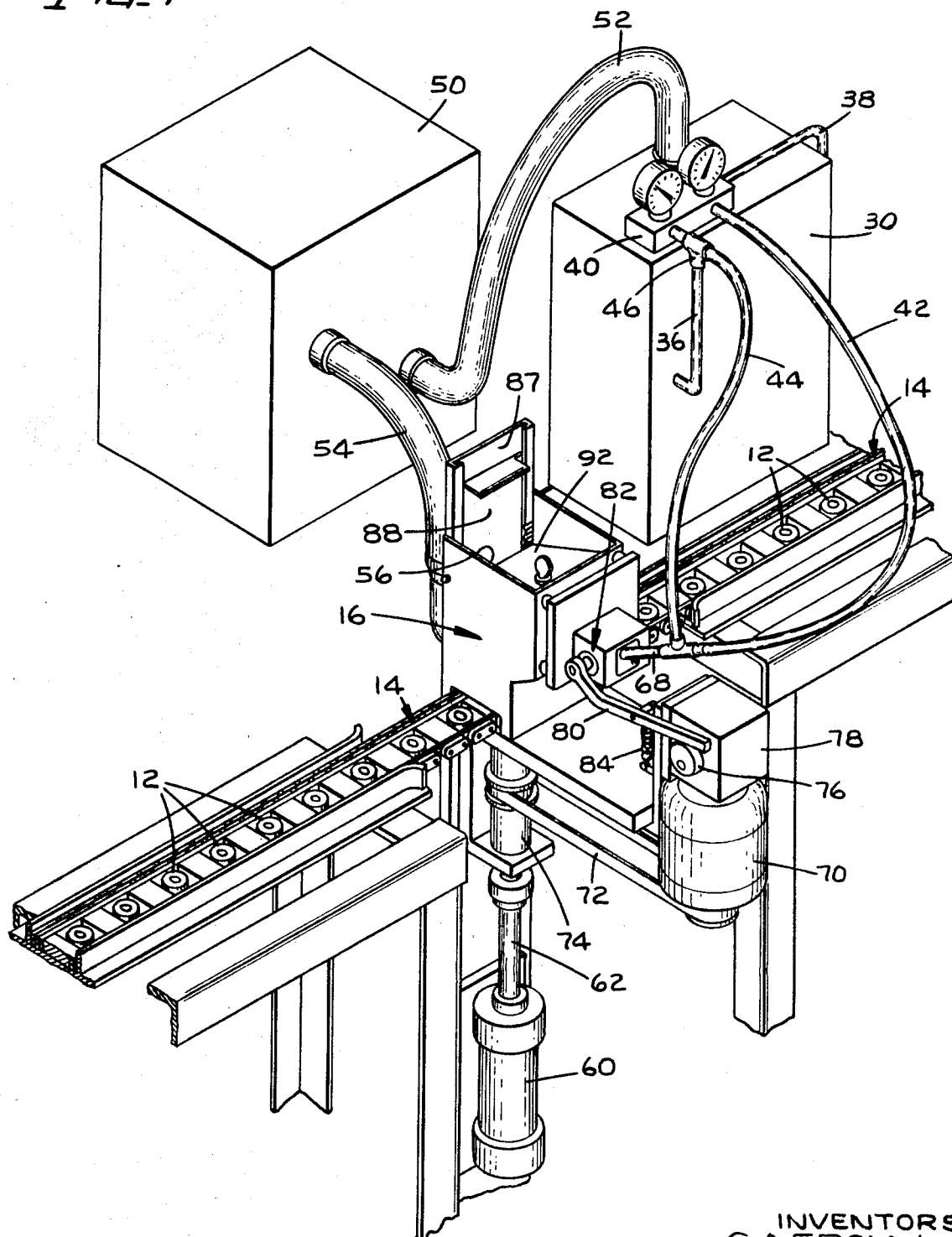
3,592,676

METHOD AND APPARATUS FOR COATING TOROIDAL-SHAPED ARTICLES

Filed Jan. 7, 1969

2 Sheets-Sheet 1

FIG. 1



INVENTORS
C.A.FROM, JR.
C.GRENKO
R.A.PECENY
BY *a. c. Schwab, Jr.*
ATTORNEY

July 13, 1971

C. A. FROM, JR., ET AL

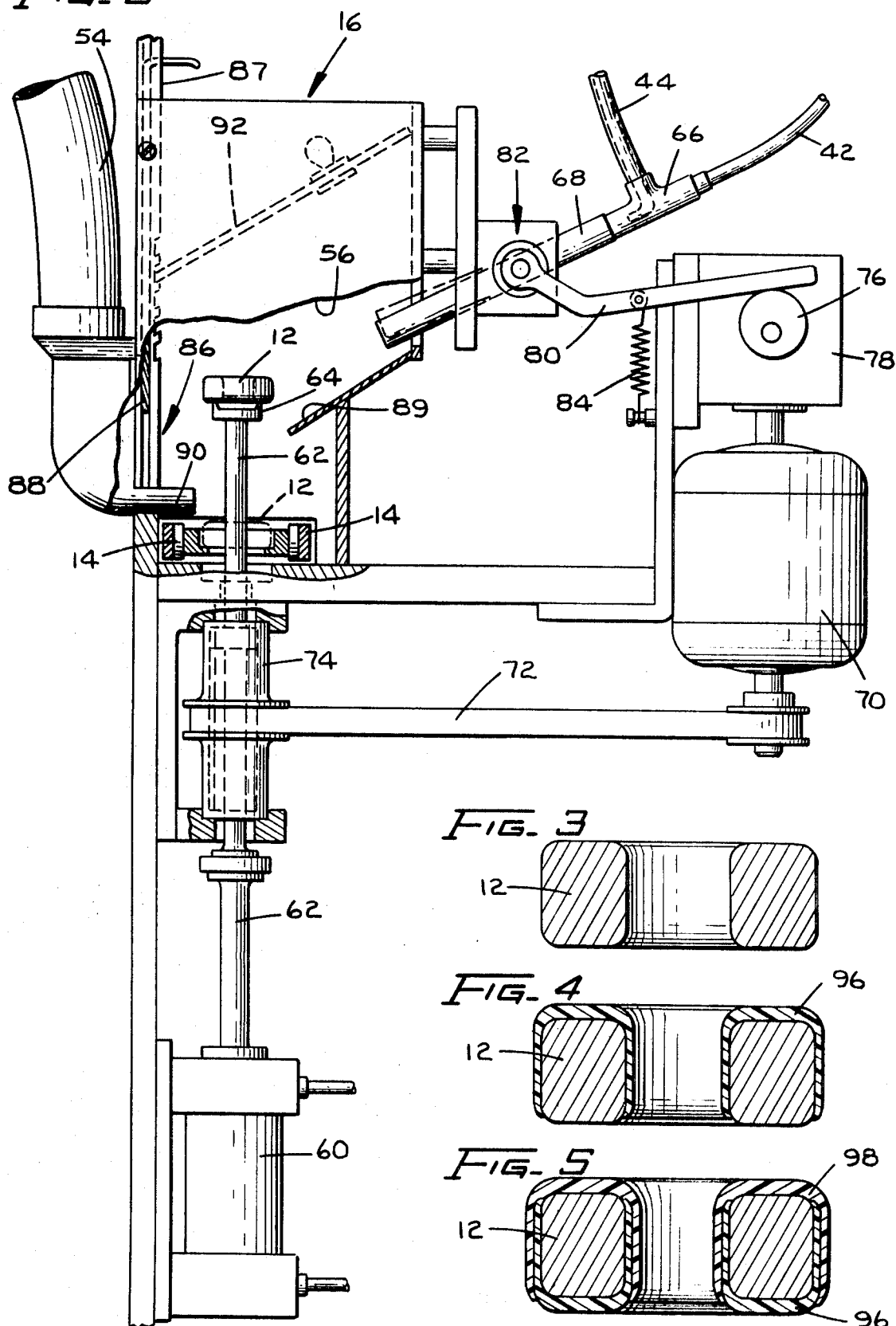
3,592,676

METHOD AND APPARATUS FOR COATING TOROIDAL-SHAPED ARTICLES

Filed Jan. 7, 1969

2 Sheets-Sheet 2

FIG. 2



1

3,592,676

**METHOD AND APPARATUS FOR COATING
TOROIDAL-SHAPED ARTICLES**

Charles A. From, Jr., Elmhurst, Charles Grenko, Berwyn,
and Robert A. Peceny, Westmont, Ill., assignors to
Western Electric Company, Incorporated, New York,
N.Y.

Filed Jan. 7, 1969, Ser. No. 789,544

Int. Cl. B44d 1/094

U.S. Cl. 117-18

7 Claims

ABSTRACT OF THE DISCLOSURE

As a heated cylindrically-shaped article is rotated continuously about its cylindrical axis, a gaseous suspension of solid particulate material is sprayed at first surface portions and circular intermediate surface portions of the article in an oscillatory path lying generally in a plane containing the axis of rotation of the article, so as to deposit a uniform coating on the first surface portions on the order of double the thickness of the coating being deposited on the intermediate surface portions. The article then is inverted and the spraying step is repeated on second surface portions of the article and the intermediate surface portions. A material scavenging system is provided downstream of the article to help preclude non-uniform deposition of the material on the article.

BACKGROUND OF THE INVENTION**(1) Field of the invention**

This invention relates to article coating and more particularly to coating an article with particulate, fusible material.

(2) Description of the prior art

Toroidal cores of high permeability metal are usually coated with an insulating material prior to being wound with wire. This coating material can be paint, a thermoplastic, or even a thermosetting plastic. Serious difficulties are encountered in obtaining a uniform coating thickness without also coating the jigs and fixtures that hold the cores.

Therefore, it is an object of the present invention to coat an article or workpiece inexpensively and efficiently.

It is another object of the present invention to coat an article with a coating that is uniform in thickness over the article.

It is a further object of the present invention to coat a toroidal core with a uniform thickness of epoxy resin.

It is still another object of the present invention to provide a method and apparatus for coating an article with a particulate material.

SUMMARY OF THE INVENTION

According to the present invention, as a cylindrically-shaped article, is rotated continuously about its cylindrical axis, a gaseous suspension of solid particulate material is sprayed at first surface portions and circular intermediate surface portions of the article in a direction defined generally by a plane containing the axis of rotation of the article, so as to deposit a uniform coating on the first surface portions of a substantially greater thickness than the coating being deposited on the intermediate surface portions. The spraying step is then repeated on second surface portions of the article and the intermediate surface portions. During each spraying operation a vacuum is created on the side of the article opposite from a source from which the material is sprayed, so as to scavenge the material that does not adhere to the article without substantially changing the direction of flow of the material.

2

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more readily understood upon consideration of the following detailed description when considered in conjunction with the accompanying drawings in which like reference numbers designate the same or similar parts throughout the several views, in which:

FIG. 1 is an isometric, overall view of an apparatus for coating toroidal cores;

FIG. 2 is a partially, cross-section fragmentary, elevational view of the coating apparatus of FIG. 1; and

FIGS. 3, 4, and 5 are cross-sectional views of a toroidal core progressing from the uncoated condition to the coated condition.

DETAILED DESCRIPTION

Referring now to the drawings and more particularly to FIG. 1, toroidal cores 12 are carried through the coating apparatus on a conveyor chain 14. Prior to reaching the coating apparatus in FIG. 1, these cores 12 are heated to a predetermined temperature in a preheating oven (not shown). Each core 12 is individually coated with a plastic material (epoxy resin) in a coating station 16 and then progresses from right to left to another oven, if necessary (not shown), which fixes or cures the coating material. After the coating has been cured, the cores 12 are turned upside-down and coated again to get a uniform thickness of plastic on all surfaces of the cores, with preheating and curing ovens used if necessary.

The cores 12 are preferably coated with prepared powdered epoxy resin compound, including a separate hardener which together support a chemical reaction to cure the resin. This reaction is greatly accelerated at elevated temperatures.

Such resins and hardeners have long been available in a form that is solid at room temperature and which is ground to a fine powder that can then be mixed mechanically without any chemical reaction taking place. However, when the mixed resin and hardener are heated above their melting temperature, they will mix in the liquid state, chemically react, and cure to a solid plastic body which when hardened around the toroidal core, forms a stiff, chemically-inert, insulating coating in a manner well-known to those skilled in the art.

While still in the cool, powdered or particulate form, these powders can be placed in a container 30. When air is blown or drawn through the powder in an upward direction, the powder is induced to rise in a cloud with the rising stream of air, thereby forming a well-known cloud or "fluidized bed" of powder particles. Any object that is at a temperature which is higher than the fusion temperature or melting point of the powder, if suspend in this fluidized bed, will melt any powders that come in contact with it. These powders will thus mix, fuse, and cure onto the hot, suspend object.

In the present apparatus, the well-known fluidized bed principle is used to generate an air suspension of the powdered epoxy compound inside of the container 30. A siphon tube 36 extends out the side of the container 30 at a level approximately in the middle of the cloud of air-entrained powder particles. Higher velocity air supplied through a supply tube 38 passes through a pair of pressure regulators 40. These regulators supply air at a predetermined pressure—and thus a predetermined velocity—through an air tube 42 and a mixture tube 44. The siphon tube 36 joins the mixture tube 44 at a venturi 46 which serves as a pump to draw air with its entrained powder through the siphon tube 36 and to mix this powder with the air from the regulator 40, thereby diluting the concentration of powder from that which exists in the fluidized bed within the container 30.

An exhausting and recovery system (not shown) creates a vacuum within a recovery chamber 50 which is connected by two vacuum tubes 52 and 54 to the container 30 and the coating station 16, respectively. Any powder that escapes from the fluidized bed within the container 30 is carried through the vacuum tube 52 to the recovery chamber 50, where the velocity of air is drastically reduced to permit the powder to precipitate to the bottom of the recovery chamber. Any powder that is not fused onto a heated core 12 is drawn from the coating chamber 16 through the vacuum tube 54 and is similarly precipitated within the recovery chamber 50. This prevents the escape of excess powder to the atmosphere.

Referring now to FIG. 2, the coating station 16 is shown slightly enlarged and with a side plate 56 partially cut away in order to illustrate better its operation. After a core 12 is advanced on the conveyor chain 14 into the center of the coating station, to the position shown in the dotted lines, the conveyor chain 14 stops and an air cylinder 60 is energized to move a shaft 62 upward. A pointed turntable 64 at the upper end of the shaft 62 engages the bottom of the heated core 12 and raises it up, away from the conveyor chain 14.

The mixture tube 44 and the air tube 42 join at a second venturi 66 which further dilutes the mixture of air and powder and delivers this dilute mixture to one end of a nozzle 68. The other end of the nozzle 68 directs the air and powder mixture at the raised core 12. Any particles of resin and hardener powder that strike the heated core 12 fuse and partially cure.

A low speed motor 70 drives a spline 74 through a belt 72. The spline 74 is in engagement with a spline section of the shaft 62, thereby rotating the shaft 62 and the core 12 about a vertical axis in order to coat the core all around its periphery, as illustrated in FIG. 4. The motor 70 also drives a cam 76 through a gear box 78. The cam 76 engages and oscillates a lever 80 that is firmly attached to the nozzle 68 at a pivot 82 and oscillates the nozzle 68 through an excursion indicated by the dotted lines in FIG. 2. A spring 84 pulls the lever 80 against the cam 76 and keeps the cam and lever in engagement. The oscillation of the nozzle 68 continuously varies the direction of flow of the air and powder mixture in a plane that is substantially parallel with the axis of rotation of the core 12.

To prevent excess powder from touching the bottom of the core 12, the conveyor chain 14, and the pointed turntable 64 (part of which is hot because of contact with the core 12) a scavenging port 86 is located in a rear wall 87 of the coating station 16 approximately on the opposite side of the core 12 from the nozzle 68. The purpose of the exit port 86, which is adjustable in size by a movable plate 88 slidable on the wall 87, is to permit excess powder particles to exit from the coating station 16 without substantially changing their direction of motion. The vacuum pipe 54 connects to the scavenging port 86 and draws the air and excessive powder from the scavenging port to the recovery chamber 50 to prevent eddies of air and entrained powder from occurring and coming into contact with the bottom of the core 12. Also, a shelf 89 is provided below the nozzle 68 to discourage powder and air from flowing down onto the conveyor chain 14. In addition, a scoop 90 is provided at the bottom of the scavenging port to prevent powder from touching the conveyor chain 14, which may still be hot as a result of passing through the preheating oven.

A cover 92 (shown in dotted lines in FIG. 2) is provided to cover the top of the coating station 16 to exclude stray air drafts from the inside of the coating station. The cover 92 is adjustable to control the thickness of the coating applied to the core 12 by varying the flow of the air within the coating station 16 and is easily removable for servicing. A sufficient vacuum and air flow is maintained through the vacuum pipe 54 to keep the interior of the coating station at a slight negative pressure to prevent the escape of a significant amount of powder.

After the core 12 has been coated with a satisfactory amount of insulating material, the air cylinder 60 is operated to lower the shaft 62 and with it the pointed turntable 64 and the core 12 until the core rests in the position shown in dotted lines in FIG. 2, in the center of the conveyor chain 14. The flow of air and powder may be intermittent or continuous during the lowering of the core and the movement of the conveyor chain 14, but the unused powder is drawn off through the scavenging port 86.

After coating, the core 12 is carried on the conveyor chain 14 to a post-heating oven (not shown), if necessary, where the epoxy coating is fully cured. After curing, the core 12 is turned upside-down (through an angle of substantially 180° about an axis substantially perpendicular to the axis of rotation of the core) and carried to a preheating oven (not shown), if the previous curing did not pre-heat, and then to a second coating station identical with that shown in FIGS. 1 and 2, and the core is coated on the other side. If necessary, the core 12 may then pass through a post-heating oven (not shown) to cure the coating.

The full coating of the core 12 is shown more distinctly in FIGS. 3, 4 and 5. In FIG. 3, the uncoated core 12 is shown in cross section. After passing through the first coating station, a cross section of the core 12 resembles the illustration shown in FIG. 4 in which a coating 96 is shown on the flat, top, end portion and on the curved sides of the core 12 but not on its flat, bottom, end portion.

The thickness of the coatings 96 and 98 have been exaggerated in FIGS. 4 and 5 to show more clearly that the coating is thicker at the flat, top, end portion of the core 12 than on the curved sides. This occurs because the stream of air-entrained particles issuing from the nozzle 68 is directed only to that portion of the curved side of the core 12 which at any given instance is facing the nozzle 68. However, the stream of air-entrained particles always strikes the flat, top, end portion of the core 12. The relative thickness of the coating 96 deposited on the top and sides of the core 12 is influenced by the average angle of the nozzle 68 with respect to the axis of the core 12 (the vertical axis in FIG. 2) during the coating operation. If the stream of air-entrained particles is directed at the core 12 at a higher angle, the coating applied to the top of the core will be thicker in relation to the thickness of coating on the sides of the core than would be the case if the stream of air-entrained particles were directed at the core from a lower or more nearly horizontal position.

In the case of the core 12 shown in FIGS. 3, 4 and 5 the average angle at which the nozzle 68 is directed to the core 12 in the coating position of FIG. 2 provides a coating 96 (FIG. 4) on the core 12 which is approximately twice as thick at the top of the core than at the sides. Therefore, when the core 12 is turned over or upside down as shown in FIG. 5 and when a second coating 98 is applied to the core, it can be seen that the core has a uniform thickness of coating on all sides because it receives only one coating on each flat, end portion but receives two coatings (each one-half as thick) on its curved sides.

What is claimed is:

1. A method of providing a uniform coating on first and second spaced surface portions of a cylindrically-shaped heated article and a uniform coating on circular surface portions of the article which are intermediate the first and second spaced surface portions of the article, which comprises:

- forming a suspension of solid, particulate material in a gas;
- supporting the heated article for rotation about its cylindrical axis without engaging the first spaced surface portions and the intermediate surface portions;
- rotating the article continuously about its cylindrical axis;
- spraying the suspension of solid, particulate material at the first spaced surface portions and the intermediate surface portions of the rotating article in a direction

5

defined generally by a plane containing the axis of rotation of the article, so as to deposit a uniform coating on the first spaced surface portions of a substantially greater thickness than the coating being deposited on the intermediate surface portions;

supporting the partially coated article for rotation about its cylindrical axis without engaging the second spaced surface portions and the intermediate surface portions;

rotating the partially coated article continuously about its cylindrical axis;

spraying the suspension of solid, particulate material at the second spaced surface portions and the partially coated intermediate surface portions of the rotating article in a direction defined generally by a plane containing the axis of rotation of the article, so as to deposit a uniform coating on the second spaced surface portions of a substantially greater thickness than the coating then being deposited on the intermediate surface portions; and

creating a vacuum on the side of the article opposite from a source from which the material is sprayed in each spraying operation, so as to scavenge the material that does not adhere to the article without substantially changing the direction of flow of the material.

2. A method as recited in claim 1, in which: the coating deposited on the spaced surface portions in each spraying operation is the order of double the thickness of the coating deposited on the intermediate surface portions.

3. A method as recited in claim 1, in which: the direction of spraying in each spraying operation is continuously varied in a path lying generally in the plane containing the axis of rotation of the article.

4. A method as recited in claim 1, in which: the article is inverted between the two spraying operations.

5. Apparatus for coating a cylindrically-shaped article having first and second spaced surface portions and circular surface portions intermediate the first and second spaced surface portions, which comprises:

a coating chamber;
a rotatable member for supporting an article in said coating chamber with either the first or the second spaced surface portions of the article, and the intermediate surface portions of the article, exposed for coating;

means for rotating said rotatable member and the article supported thereby about the cylindrical axis of the article;

means for forming a suspension of solid, particulate material in a gas;

6

a nozzle located adjacent one side of said coating chamber for spraying the suspension of solid, particulate material at the exposed surface portions of the article, said nozzle being disposed in a plane containing the axis of rotation of said rotatable member and the rotating article and being disposed at an angle to the axis of rotation of said rotatable member and the rotating article so as to deposit a uniform coating on the exposed spaced surface portions of a substantially greater thickness than the coating which said nozzle deposits on the intermediate surface portions; and

vacuum scavenging means adjacent the opposite side of said coating chamber from said nozzle, for drawing excess particulate material away from the article being coated without substantially changing the direction of movement of the material between said nozzle and said scavenging means.

6. Apparatus as recited in claim 5, in which: said nozzle is disposed so as to deposit a coating on the spaced surface portions which is of a thickness on the order of double the thickness of the coating which said nozzle deposits on the intermediate surface portions.

7. Apparatus as recited in claim 5, which further comprises:
means for continuously oscillating said nozzle in a path lying generally in the plane containing the axis of rotation of said rotatable member and the rotating article.

References Cited

UNITED STATES PATENTS

1,876,251	9/1932	Lehman	118—309
2,169,078	8/1939	Waite	117—31
2,231,324	2/1941	Crompton	117—17
2,573,835	11/1951	Dyar	118—308
2,642,033	6/1953	Miller	117—F.B.
2,723,206	11/1955	Falk	117—104
2,745,375	5/1956	Frederick	118—309
2,976,838	3/1961	Rychlewski et al.	118—321
3,111,430	11/1963	Graf	118—324
3,291,630	12/1966	Deyle et al.	118—312
3,311,085	3/1967	Smith	118—312

FOREIGN PATENTS

942,413	11/1963	Great Britain	117—33
---------	---------	---------------	--------

WILLIAM D. MARTIN, Primary Examiner

R. M. SPEER, Assistant Examiner

U.S. Cl. X.R.

117—19, 20, 21, 105.4; 118—308, 309, 312, 321