

L066.190



PATENT SPECIFICATION

DRAWINGS ATTACHED

L066.190

Date of Application and filing Complete Specification: Sept. 7, 1965.

No. 38142/65.

Application made in United States of America (No. 396,124) on Sept. 14, 1964.

Complete Specification Published: April 19, 1967.

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Index at acceptance:—B2 L26H; B8 S(2B1, 10U)

Int. Cl.:—B 05 c // B 65 g

COMPLETE SPECIFICATION

Method and apparatus for applying a Particulate Material to a Body

We, RHEEM INTERNATIONAL INC., a corporation of the State of Delaware, United States of America, of 400 Park Avenue, New York, United States of America do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method and apparatus for applying a particulate material to a body for the purpose of forming a substantially uniform coating on the body. More particularly, this invention relates to a method and apparatus for applying a particulate material, such as a powdered resin or a metallic powder, so as to form a coating on the interior surface of a cylindrical body, such as the interior surface of a metal shipping container.

Metal shipping containers, such as black steel drums and pails, are used extensively for transporting and storing a wide variety of products, but their effective use can be greatly extended if the inside of such containers is coated with a material resistant to corrosive activities and reactions of products which cannot now be carried and stored in such drums because of such product activities and reactions. By way of example, presently it is not possible or practical to pack products with high acid activity qualities in black steel drums, and often excessively expensive drums, such as stainless steel drums, are used for such purpose. The application of the method and apparatus of the present invention to black steel drums will produce coated black steel drums at a cost far below the cost of stainless steel drums, and such coated drums will have corrosive-resistant characteristics commercially comparable, and often superior, to those of substantially more expensive drums, such as stainless steel drums.

Various corrosive resistant coatings have been applied to drums by many methods, such

as painting or dipping, in order to build up the corrosive-resistant capacities of drums and pails, but many limitations have been encountered. For instance, several of the coating materials are relatively expensive. But more important are the considerations that such coatings are often inefficient in that they leave voids created by air bubbles or give an incomplete coverage of the entire interior surfaces of the drums to which they are applied; the coatings formed thereby are excessively thin; they often become brittle and break away from the drum body; and it is generally impossible or impractical to build up sufficiently dense coatings by repeated applications of layers of coatings.

To overcome these coating deficiencies, more recently it has been found advantageous to apply particulate materials to the interior surfaces of heated drum bodies, and it has been found that such application, if carefully conducted, produces a firm bond between the coating material and the surface of the body of a drum, and that the coating renders the drum body corrosive-resistant. Various methods and apparatus have been devised for applying such particulate material coatings to drum bodies, but often they are elaborate and do not adapt themselves for ready installations as a part of a modern, high-speed drum production line.

It is, therefore, an object of this invention to provide a method and apparatus for applying a resinous or metallic powder to the interior surface of a cylindrical body, such as a drum body, to form a solid, complete, corrosive-resistant coating on said surface.

It is a further object of the invention to provide such a method and apparatus which render it commercially feasible to apply quickly, easily, and relatively inexpensively, a single, firm, solid and complete coating of corrosive-resistant material to the inside surface of a body, such as the body of a black steel ship-

ping container, which coating is free of voids.

It is still a further object of the invention to provide such a method and apparatus which will permit the application of the coating in a single coating operation.

It is another object of the invention to provide such a method and apparatus which are relatively simple and readily adaptable to take their places in a modern, high-speed steel container production line without causing undue production delays.

According to the present invention there is provided apparatus for applying a particulate material to the inner surface of an open-ended, heated cylindrical body so as to form a substantially uniform coating thereon, which apparatus comprises; an elongate bin containing a quantity of said particulate material; a vertically disposed, elongate trough disposed in the bin so as to be filled with a pre-determined amount of particulate material, the trough being slidably movable laterally from the bin; means for rotatably mounting an open-ended, heated cylindrical body adjacent the bin so as to receive the trough when the trough is moved laterally; and means mounted on the trough for discharging particulate material from the trough after it has been moved so that the particulate material will fall by gravity upon the inner surface of the heated body when rotated and coat said surface.

Further, according to the present invention there is provided a method of applying a particulate material to the inner surface of an open-ended, heated cylindrical body which comprises the steps of; heating the body; disposing a predetermined quantity of particulate material in an elongate trough; rotating the body; introducing the trough into the rotating body; and discharging the particulate material by gravity so as to deposit the particulate material substantially uniformly over the entire inner surface of the body.

One embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a side elevational view of the apparatus of the present invention showing a trough element retracted from the body to be coated;

Fig. 2 is an enlarged fragmentary view of a portion of the apparatus showing the trough element extended into the body to be coated;

Fig. 3 is a further enlarged cross-sectional view taken on line 3 — 3 of Fig. 2;

Fig. 4 is an isometric view of the trough element of the present invention;

Fig. 5 is an enlarged cross-sectional view taken on line 5 — 5 of Fig. 4; and

Fig. 6 is a reduced fragmentary view, partially broken away, and taken on line 6 — 6 of Fig. 5.

As shown in Fig. 1 of the drawings, a bench 10 has an elongate bin 12 mounted thereon

adjacent one end of the bench 10. Mounted on the bench 10 above the bin 12 is a hopper 14 disposed so as to receive and hold a quantity of particulate material such as powdered resin or metallic powder, and discharge said particulate material into the bin 12 by means of a discharge chute 16.

Longitudinally, slidably disposed in the bin 12 is an elongate trough 20, best illustrated in Fig. 4, hereinafter described in detail.

A reciprocating fluid cylinder 30 is mounted on the bench 10 laterally of the bin 12 and supported on one end of the bin 12, and a piston rod 32 is disposed in the cylinder 30 and protrudes from the cylinder 30 into the bin 12 in axial alignment with the trough 20, on which the free end of the piston rod 32 is mounted.

At the other end of the bin 12 there is an opening 34, shown in Fig. 3, the opening 34 being disposed so as to slidably receive the trough 20 so that, when fluid pressure is introduced into the cylinder 30 in one direction, the piston rod 32 moves the trough 20 laterally in the bin 12 through the opening 34 and further, moves the trough 20 externally of the bin 12; and when fluid pressure is introduced into the cylinder 30 in the opposite direction, the piston rod 32 will retract into the cylinder 30 so as to move the trough 20 in the opposite direction and restore it to its position within the bin 12. The vertically disposed top 36 of the opening 34 serves as a leveller which removes excess particulate material from the trough 20 as the trough 20 passes there-through, so that the quantity of particulate material in the trough 20, is pre-determined.

Figs. 1 and 2 illustrate an open-ended drum 40, the interior surface of which is to be coated. The drum 40 is supported on rollers 42 rotatably mounted on a stand 44. The stand 44 is positioned laterally of the bench 10, adjacent to the end of the bench 10 on which the bin 12 is mounted, and the position and height of the stand 44 and the rollers 42 mounted thereon is such that, when the trough 20 is extended, as hereinabove described, the trough 20 will be disposed within the drum 40 parallel to the longitudinal axis of the drum 40 and spaced apart from the interior surface of the drum 40.

The rollers 42 have vertically disposed disc plates 46 mounted on their outer ends, the purpose of the plates 46 being to retain the drum 40 on the rollers 42 during the coating operation, hereinafter described.

A second stand 50 is disposed laterally of the stand 44 and supports a bearing box 52 for a shaft 54 on which the rollers 42 are mounted, and the stand 50 also supports a vibrator, such as a magnetic vibrator 56, which is disposed so that it will slidably receive and act as a support for a spur 58 mounted on the free end of the trough 20 which the trough 20 is extended by the action of the piston rod

32, and will vibrate the trough 20 so as to aid in the discharge of particulate material in a substantially even curtain, as hereinafter described.

5 Mounted in suspended position over the drum 40 is a heater 60, such as an infra-red heater, having a reflector 64 directed toward the inside of the drum 40 so that during the coating operation the temperature of the body
10 of the drum 40, which is pre-heated before the coating operation is undertaken, will be kept within a satisfactory heat range.

During the coating operation the drum 40 is rotated as hereinafter explained, and rotation
15 of the drum is accomplished by rotation of the shaft 54 on which the rollers 42 are mounted. The shaft 54 may be rotated by any suitable means, such as the powered chain and sprocket drive 70 shown in Figs. 1 — 3 of the drawings.

The trough 20 is of triangular configuration and has side members 80 and 82 which converge downwardly toward each other from
25 glide members 83 and 84, respectively, said glide members 83 and 84 being slidably disposed in parallel tracks 85 and 86, respectively, longitudinally disposed in the bin 12 and aligned with the opening 34 in the bin 12 so
30 as to slidably support the trough 20. The bottom edges of the side members 80 and 82 are spaced apart from each other, the side member 80 being shorter than the side member 82, and the bottom edges are bevelled, so as to define a longitudinally disposed slotted opening 88
35 in the bottom of the trough 20, as best illustrated in Fig. 3 of the drawings.

As shown in Fig. 4 of the drawings, parallel transverse divider panels 90, spaced apart from each other, are mounted in the trough 20 so
40 as to aid in the even distribution of particulate material deposited in the trough 20, and the side members 80 and 82 may have grooves 92 formed on their interior surfaces and disposed so as to direct particulate material in the trough 20 toward the slotted opening 88.
45 Blocks 94 are disposed within the trough 20 at its ends.

Disposed externally on the side member 80 adjacent the slotted opening 88 is an elongate
50 gate 100 which serves to open and close the slotted opening 88. The gate 100 is slidably disposed in a slotted opening defined by the side member 80 and a step 102 in an elongate plate 104 mounted on the side member 80.

55 A hub 106 and hub bearings 108, best shown in Fig. 5, are disposed in each of the blocks 94 and the side member 80, the hubs 106 having outwardly directed flanges 110. Upwardly directed arcuate slotted openings
60 112 are formed in the plate 104 in alignment with the hubs 106, and pins 114 are mounted on the flanges 110 of the hubs 106 and extend through tight bores in the gate 100 into the arcuate openings 112 from which they protrude.
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Mounted on the gate 100 adjacent to but spaced apart from the inner end of the trough 20 and depending from the gate 100 is a
70 striker plate 120. The elongate plate 104 is cut away, as at 122, shown in Figs. 2 and 6, to accommodate the striker plate 120.

A bracket 124 is mounted on the bench 10 and disposed below the opening 34 in the bin 12, the bracket 124 having an upwardly extending arm 126 which is positioned so as to
75 intercept the striker plate 120 when the trough 20 is extended.

A tension spring 130 is mounted on the lower end of an end plate 132 on the protruding end of the trough 20 and on the forwardly
80 disposed pin 114.

In operation, the trough 20 is fully retracted into the bin 12 by the action of the assembly of the reciprocal cylinder 30 and piston rod
85 32, the gate 100 on the trough 20 being in its downward position to close the slotted opening 88 at the bottom of the trough 20, and the hopper 14 is charged with particulate material which flows through the discharge chute 16 into the bin 12 filling the trough 20.
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Meanwhile, the drum 40 is pre-heated in an oven (not shown). In pre-heating of the drum 40, it has been found advantageous to bring the drum to a metal temperature of approximately 450° Fahrenheit and to maintain
95 that temperature for approximately three minutes. Although the suggested temperature of the drum and the residence time in the drum may vary, according to the gauge of the steel in the drum body and other conditions, so that the temperature and residence time are given as illustrations, and are not intended as
100 limitations. The pre-heated drum 40 is then removed from the oven and placed on the rollers 42.

The cylinder 30 is then activated by fluid pressure, and the piston rod 32 extends so as to project the filled trough 20 from the bin 12 and into the drum 40 until the spur 58
105 is lodged in the vibrator 56. It will thus be seen that for the balance of the coating operation, the trough 20 will be disposed within the drum 40 parallel to the longitudinal axis of the drum 40, and in position to discharge the particulate material contained in the trough 20 by gravity, aided by the vibrator 56, in a curtain, as hereinafter described.
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As the trough 20 becomes positioned within the pre-heated drum 40, the rollers 42 are rotated so as to rotate the drum 40, and it has been found that if the drum 40 is a standard
115 fifty-five gallon drum and the particulate material is polyethylene resin, satisfactory coating results are obtained if the drum 40 is completely rotated ten times during the coating operation at a modest speed. Although the number of revolutions of the drum 40 may vary according to the particulate material used and other factors so that the number of revolutions specified are given by way of example,
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and are not intended to be limiting.

As the drum 40 revolves, the heater 60 is activated, and heat is directed into the drum 40 to assist in maintaining the body temperature of the drum 40 at a high level during the coating operation.

Just prior to the full extension of the trough 20 to the full seating of the spur 58 in the vibrator 56, the striker plate 120 on the gate 100 strikes the arm 126 of the bracket 124 and interrupts the free lateral movement of the gate 100 with the trough 20. As the trough 20 continues its lateral movement toward its final seated position, the pins 114 ride arcuately upwardly in the arcuate slots 112, and thus carry the gate 100 upwardly, against the biasing action of the spring 130, so as to open the slotted opening 88 in the trough 20.

The pre-determined amount of particulate material in the trough 20, as determined by the leveller 36, then drops by gravity, aided by the action of the vibrator 56, through the slotted opening 88 and falls in a curtain on the inner surface of the revolving, heated drum 40, so that there is a substantially even coverage of the particulate material over the entire inner surface of the drum 40. Thus, a substantially even coating, free of voids, is formed on the drum 40 by the fusion and adhesion of the particulate material.

When the coating operation is completed, the reciprocating cylinder 30 is activated to retract the trough 20 and restore it to its initial position within the bin 12, whereupon the trough 20 is again filled with particulate material for the start of the next coating operation.

As the retraction of the trough 20 gets under way, the striker plate 120 moves away from the arm 126 of the bracket 124, and the spring 130 is then free to act on the pin 114 on which it is mounted so as to move the pins 114 downwardly in the arcuate slots 112. The gate 100 is thus moved downwardly to close the slotted opening 88 as the trough 20 proceeds through the opening 34 in the bin 12, so that when the trough 20 is positioned within the bin 12, it is closed to retain another pre-determined load of particulate material deposited therein for the next coating operation.

After the trough 20 is retracted, the drum 40 is removed from the rollers 42, and another pre-heated drum 40 is placed on the rollers 42 for the next coating operation.

If desired, after removal from the rollers 42 at the completion of the coating operation, the drum 40 may be post-heated in an oven (not shown) at a suggested temperature of 390° Fahrenheit for a period of approximately fourteen minutes, although post-heating, and temperature and time of post-heating, are not to be considered to be limiting.

WHAT WE CLAIM IS:—

1. Apparatus for applying a particulate material to the inner surface of an open-ended, heated cylindrical body so as to form a sub-

stantially uniform coating thereon, which apparatus comprises: an elongate bin containing a quantity of said particulate material; a vertically disposed, elongate trough disposed in the bin so as to be filled with a pre-determined amount of particulate material, the trough being slidably movable laterally from the bin, means for rotatably mounting an open-ended, heated cylindrical body adjacent the bin so as to receive the trough when the trough is moved laterally, and means mounted on the trough for discharging particulate material from the trough after it has been moved so that the particulate material will fall by gravity upon the inner surface of the heated body when rotated and coat said surface.

2. Apparatus as defined in Claim 1, including: a hopper for receiving particulate material, the hopper being disposed above the bin; and a discharge chute mounted on the hopper and entering the bin so as to pass particulate material by gravity flow from the hopper to the bin.

3. Apparatus for applying a particulate material to the inner surface of an open-ended, heated cylindrical body so as to form a substantially uniform coating thereon, which apparatus comprises: a bench, an elongate bin mounted on the bench adjacent one end of the bench, said bin being disposed so as to receive and retain a quantity of the particulate material; an elongate trough vertically slidably disposed in the bin so as to be filled with particulate material in the bin; means mounted on the bench adjacent the bin and connected to the trough so as to move the trough laterally through an opening in the bin, means for removing excess particulate material from the trough as it is moved from the bin; a stand adjacent the bin; means for rotatably mounting an open ended, heated cylindrical body on the stand so as to receive the trough when the trough is moved; means for vibrating the trough after it has been moved; means mounted on the trough for discharging particulate material from the trough after it has been moved so that the particulate material will fall by gravity aided by vibration, upon the inner surface of the rotating heated body and coat said surface; means for closing said discharge means upon completion of a coating cycle; and reciprocating means for returning the trough to the bin upon completion of the coating cycle.

4. Apparatus as defined in Claim 3, including means mounted adjacent the stand for supplying heat to the cylindrical body during the coating cycle.

5. Apparatus as defined in Claim 3, wherein the discharge means on the trough comprises: an elongate, slotted opening on the bottom of the trough; an elongate gate slidably mounted on one side of the trough and normally disposed downwardly so as to close the slotted opening; a striker plate mounted on the gate;

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and are not intended to be limiting.

As the drum 40 revolves, the heater 60 is activated, and heat is directed into the drum 40 to assist in maintaining the body temperature of the drum 40 at a high level during the coating operation.

Just prior to the full extension of the trough 20 to the full seating of the spur 58 in the vibrator 56, the striker plate 120 on the gate 100 strikes the arm 126 of the bracket 124 and interrupts the free lateral movement of the gate 100 with the trough 20. As the trough 20 continues its lateral movement toward its final seated position, the pins 114 ride arcuately upwardly in the arcuate slots 112, and thus carry the gate 100 upwardly, against the biasing action of the spring 130, so as to open the slotted opening 88 in the trough 20.

The pre-determined amount of particulate material in the trough 20, as determined by the leveller 36, then drops by gravity, aided by the action of the vibrator 56, through the slotted opening 88 and falls in a curtain on the inner surface of the revolving, heated drum 40, so that there is a substantially even coverage of the particulate material over the entire inner surface of the drum 40. Thus, a substantially even coating, free of voids, is formed on the drum 40 by the fusion and adhesion of the particulate material.

When the coating operation is completed, the reciprocating cylinder 30 is activated to retract the trough 20 and restore it to its initial position within the bin 12, whereupon the trough 20 is again filled with particulate material for the start of the next coating operation.

As the retraction of the trough 20 gets under way, the striker plate 120 moves away from the arm 126 of the bracket 124, and the spring 130 is then free to act on the pin 114 on which it is mounted so as to move the pins 114 downwardly in the arcuate slots 112. The gate 100 is thus moved downwardly to close the slotted opening 88 as the trough 20 proceeds through the opening 34 in the bin 12, so that when the trough 20 is positioned within the bin 12, it is closed to retain another pre-determined load of particulate material deposited therein for the next coating operation.

After the trough 20 is retracted, the drum 40 is removed from the rollers 42, and another pre-heated drum 40 is placed on the rollers 42 for the next coating operation.

If desired, after removal from the rollers 42 at the completion of the coating operation, the drum 40 may be post-heated in an oven (not shown) at a suggested temperature of 390° Fahrenheit for a period of approximately fourteen minutes, although post-heating, and temperature and time of post-heating, are not to be considered to be limiting.

WHAT WE CLAIM IS:—

1. Apparatus for applying a particulate material to the inner surface of an open-ended, heated cylindrical body so as to form a sub-

stantially uniform coating thereon, which apparatus comprises: an elongate bin containing a quantity of said particulate material, a vertically disposed, elongate trough disposed in the bin so as to be filled with a pre-determined amount of particulate material, the trough being slidably movable laterally from the bin, means for rotatably mounting an open-ended, heated cylindrical body adjacent the bin so as to receive the trough when the trough is moved laterally, and means mounted on the trough for discharging particulate material from the trough after it has been moved so that the particulate material will fall by gravity upon the inner surface of the heated body when rotated and coat said surface.

2. Apparatus as defined in Claim 1, including: a hopper for receiving particulate material, the hopper being disposed above the bin; and a discharge chute mounted on the hopper and entering the bin so as to pass particulate material by gravity flow from the hopper to the bin.

3. Apparatus for applying a particulate material to the inner surface of an open-ended, heated cylindrical body so as to form a substantially uniform coating thereon, which apparatus comprises: a bench, an elongate bin mounted on the bench adjacent one end of the bench, said bin being disposed so as to receive and retain a quantity of the particulate material; an elongate trough vertically slidably disposed in the bin so as to be filled with particulate material in the bin; means mounted on the bench adjacent the bin and connected to the trough so as to move the trough laterally through an opening in the bin, means for removing excess particulate material from the trough as it is moved from the bin; a stand adjacent the bin; means for rotatably mounting an open ended, heated cylindrical body on the stand so as to receive the trough when the trough is moved; means for vibrating the trough after it has been moved; means mounted on the trough for discharging particulate material from the trough after it has been moved so that the particulate material will fall by gravity aided by vibration, upon the inner surface of the rotating heated body and coat said surface; means for closing said discharge means upon completion of a coating cycle; and reciprocating means for returning the trough to the bin upon completion of the coating cycle.

4. Apparatus as defined in Claim 3, including means mounted adjacent the stand for supplying heat to the cylindrical body during the coating cycle.

5. Apparatus as defined in Claim 3, wherein the discharge means on the trough comprises: an elongate, slotted opening on the bottom of the trough; an elongate gate slidably mounted on one side of the trough and normally disposed downwardly so as to close the slotted opening; a striker plate mounted on the gate;



- and stop means mounted on the bench, the stop means being engageable with the striker plate as the trough is extended to slide the gate upwardly on the side of the trough away from the slotted opening in the trough, so as to free the slotted opening for discharge of particulate material. 25
- 5 6. Apparatus as defined in Claim 5, including means mounted on the trough for returning the gate to closed position upon the retraction of the trough and removal of the striker plate from contact with the stop means. 30
- 10 7. The method of applying a particulate material to the inner surface of an open ended, heated cylindrical body which comprises the steps of: heating the body, disposing a pre-determined quantity of particulate material in an elongate trough; rotating the body; introducing the trough into the rotating body; and discharging the particulate material by gravity so as to deposit the particulate material substantially uniformly over the entire inner surface of the body. 35
- 15 8. The method of Claim 7, wherein the step of heating the drum is conducted at approximately 450° Fahrenheit for a period of approximately three minutes. 40
9. The method of Claim 7, wherein the step of rotating the body is conducted for approximately ten full revolutions of the body.
10. The method of Claim 7, including the steps of: removing the trough from the body, and post-heating the body. 35
11. The method of Claim 10, wherein the step of post-heating is conducted at approximately 390° Fahrenheit for a period of approximately fourteen minutes. 40

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press (Leamington) Ltd.—1967. Published by The Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.

15 NOV 1967

Submittal

I CERTIFY THIS, INCLUDING THE DRAWING FORMING PART HEREOF TO BE A TRUE COPY OF THE SPECIFICATION AS ACCEPTED.

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