March 1, 1960 E. J. GOUGH 2,927,044

METHOD AND APPARATUS FOR SPRAY COATING THE INTERIOR OF HOLLOW ARTICLES

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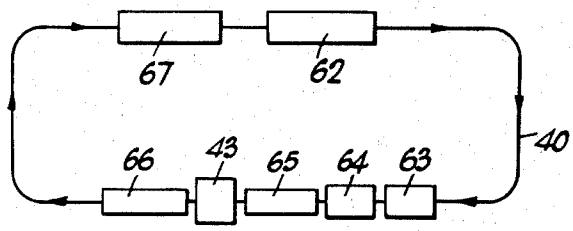


Fig. 9.

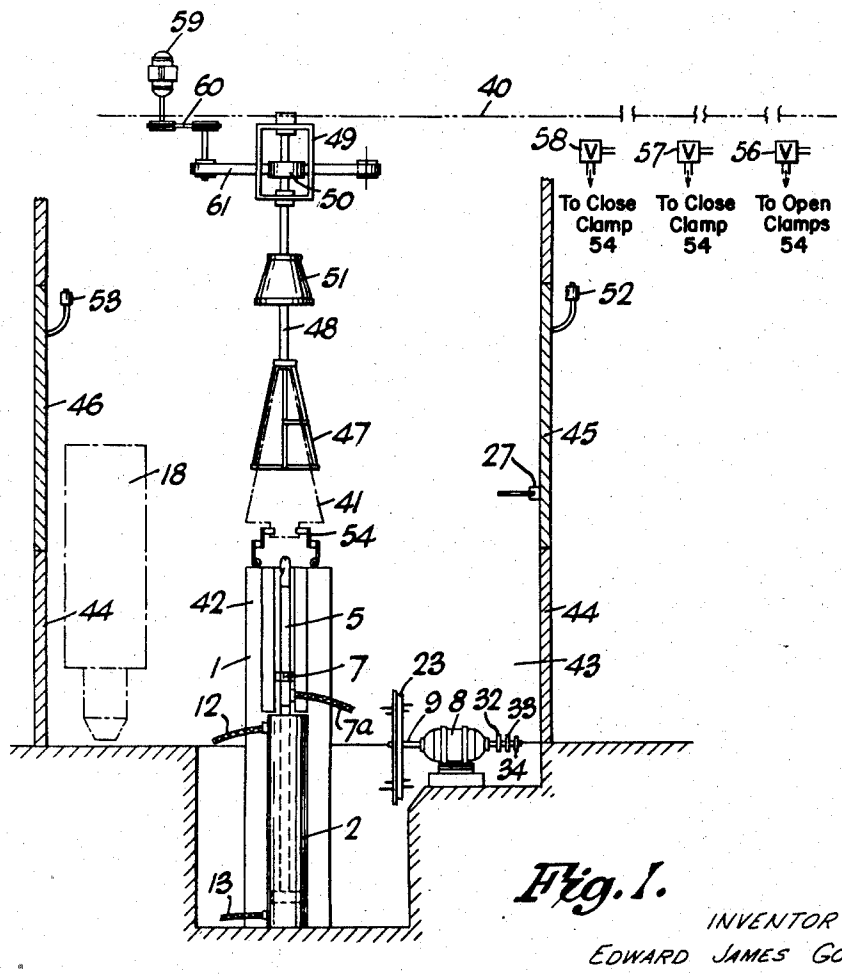


Fig. 1.

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METHOD AND APPARATUS FOR SPRAY COATING THE INTERIOR OF HOLLOW ARTICLES

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Fig. 3.

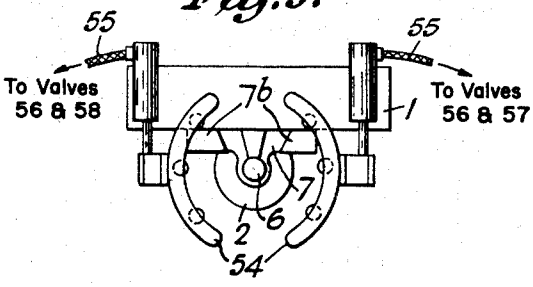
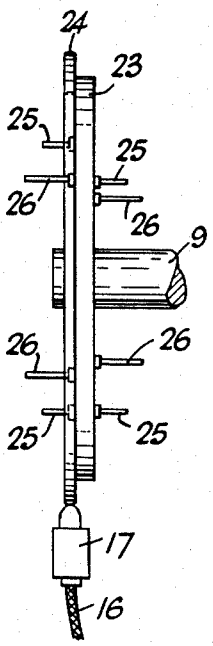


Fig. 4.



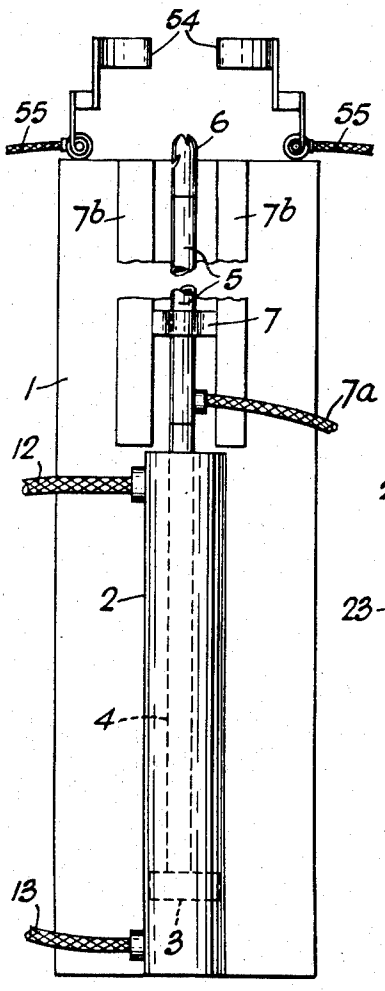


Fig. 2.

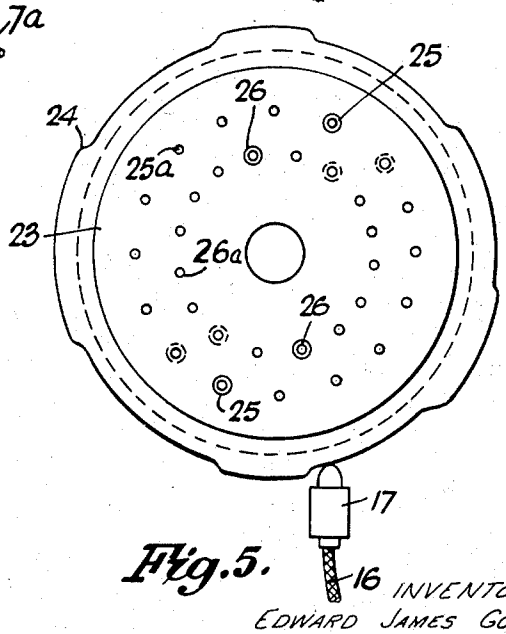


Fig. 5.

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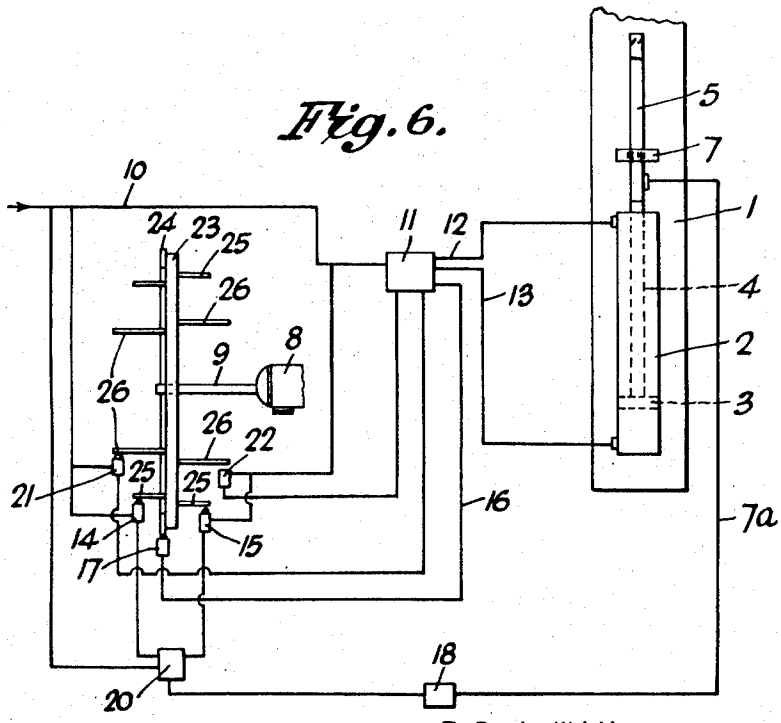
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Fig. 6.



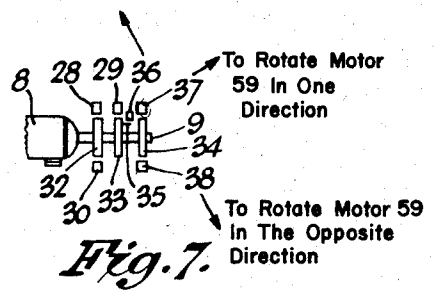


Fig. 7.

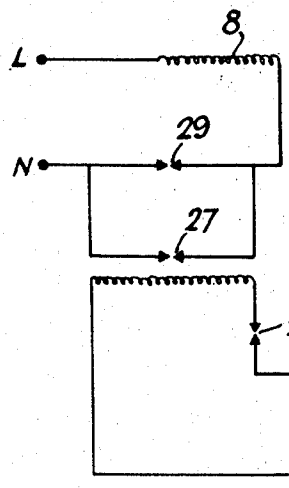


Fig. 8.

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METHOD AND APPARATUS FOR SPRAY COATING THE INTERIOR OF HOLLOW ARTICLES

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Application March 5, 1957, Serial No. 651,124

Claims priority, application Great Britain March 5, 1956

6 Claims. (Cl. 117—96)

The invention relates to spraying apparatus, and more particularly to apparatus for spraying the interior of hollow vessels, casings or the like with a plastic substance, such as polyethylene, in powder or in liquid form.

The invention has among its objects to provide an apparatus which deposits an even coating or lining of material on the interior of a vessel or casing, even when the vessel has an irregular cross-section, for example, a vessel of conical or tapered form such as a tapered fire extinguisher casing.

According to the invention, apparatus for spraying the interior of a vessel, casing or the like comprises a spray nozzle mounted for vertical reciprocation, inside the vessel to be sprayed, means for rotating the vessel alternately in opposite directions, and means for controlling the speed of reciprocation of the nozzle in accordance with the varying cross-section of the vessel being sprayed.

According to the invention furthermore, the means for controlling the rate of reciprocation of the nozzle may comprise a Tufnol disc or the equivalent mounted on the shaft of an electric motor, on which disc is provided a cam plate which cooperates with the exhaust valve of a double-acting pneumatic cylinder, in which moves a piston the piston rod of which carries the nozzle, to vary the rate of escape of air from the cylinder in the upward or downward movement of the piston rod.

According to the invention furthermore, the Tufnol disc or the equivalent may be provided with laterally extending pins which, through switches or the like, operate valves to cause the piston rod, together with the spray nozzle, to move up or down and to operate, through switches or the like, valves to control the flow of the plastic substance or synthetic resin, preferably in the form of powder, under pressure from the nozzle.

According to the invention moreover, the shaft of the electric driving motor may be provided with a series of disc cams which serve to actuate electric switches to control the step by step movements of a conveyor from which the vessels are suspended, to measure out the amount of plastic substance or synthetic resin required for each operation, and to control the direction of rotation of the vessel being sprayed.

The invention further comprises the features of method and construction hereinafter described.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:

Figure 1 is a general arrangement showing an apparatus according to the invention;

Figure 2 is a front elevation of the spraying apparatus;

Figure 3 is a plan view corresponding to Figure 2;

Figure 4 is a side elevation of the disc 23;

Figure 5 is a front elevation of the disc 23;

Figure 6 is a diagram of the compressed air circuit;

Figure 7 is a side elevation showing the disposition of of the micro switches;

Figure 8 is a diagram of the electrical circuit; and

Figure 9 is a schematic layout of a suggested continuous system in which the spraying apparatus is incorporated.

The invention is described with reference to the application of a coating of polyethylene in the inner surface of fire extinguisher casings.

The casings or containers to be sprayed are suspended from a conveyor 40, which is operated through Geneva mechanism to move the containers 41 at predetermined time intervals to a spraying position above the spraying apparatus 42 mounted in a spraying enclosure 43.

The spraying enclosure 43 consists of an outer wall 44, provided with swing doors 45 and 46 through which the containers 41 pass into and out of the spraying enclosure 43.

The containers 41 are suspended from the conveyor 40 by means of supporting frame 47 which is mounted on one end of a rod 48. The rod 48 is rotatably mounted in a frame member 49 which is secured to the conveyor 40. A roller 50 is mounted on the rod 48 within the frame 49 for a purpose hereinafter described. Furthermore a bell-shaped member 51 is provided on the rod 48 and is adapted to engage rollers 52 and 53 provided on the swing doors 45 and 46 to open said doors to allow passage of the containers into and out of the spraying enclosure 43.

The spraying apparatus comprises a vertical support 1 at the lower end of which is mounted a cylinder 2 provided with a piston 3 and an upwardly extending rod 4. A spray pipe 5 of brass is secured to the outer end of the piston rod, the wall of the end of the pipe 5 remote from the piston rod 4 being provided with a downwardly extending slit or slits formed in a nozzle 6 through which the polyethylene is sprayed in powder form both upwardly and/or laterally and downwardly and laterally. The slits formed in the nozzle 6 are so provided that whilst the major portion of the powder is sprayed laterally, a sufficient quantity of the powder is ejected upwardly and/or downwardly to ensure that the uppermost and lowermost parts of the casing are coated with the powder when the nozzle is reciprocated. The spray pipe 5 is guided for vertical reciprocating movement on the support 1 by means of a member 7 secured on the spray pipe 5, the member 7 engaging and running between two guide members 7*b* provided on the support 1. A flexible pipe 7*a* connects the nozzle 6 to a reservoir 18 containing the powder or the like to be sprayed.

At the upper end of the support 1 a pair of clamps or steadies 54 are provided to surround the lower end of the container 41 and to hold it steady in the spraying position. The clamps 54 are operated by compressed air through air lines 55 and are adapted to open simultaneously to receive a container to be sprayed and then to close in succession by means of pilot valves 56, 57, 58 provided on the conveyor 40, which valves are actuated by the movement of the containers along the conveyor.

Mounted on the conveyor 40 at a position above the spraying apparatus is an electric motor 59 having a reversible starter which is operable by switches as hereinafter described, to rotate the container 41, during spraying, first in one direction and then in the other direction. The motor 59 is adapted through a chain and sprocket connection 60 to drive a belt 61 which engages and rotates the roller 50.

Mounted at a convenient position at or near the spraying apparatus is an electric motor 8, the drive shaft 9 of which projects from each end of the motor. One end

of the shaft 9 supports the air control gearing (Figure 6) and the other end the electric switch control gearing (Figure 7).

As illustrated in Figure 6, compressed air passes through a line 10 to a reversing valve 11 and then through one of the two-way lines 12 and 13, respectively, to the top or bottom of the cylinder 2. The reversing valve 11 is operated by pilot valves 21 and 22 to cause the piston 4 to move up and down respectively.

The exhaust air from the cylinder 2, which passes through lines 12 or 13, depending on the direction of movement of the piston 4 flows through a common exhaust line 16 to a spring-loaded exhaust valve 17.

The reservoir 18 for the powder to be sprayed is mounted at a position near the spraying apparatus, the reservoir 18 being in communication with the nozzle 5 through the flexible pipe 7*a*. The air which serves to spray the powder through the spray nozzle 6 is controlled by a reversing valve 20 which is actuated by two pilot valves 14 and 15 which operate to turn on and off respectively the supply of powder.

The means for operating the exhaust valve 17 and the pilot valves 14, 15 and 21, 22 comprises a circular metal disc 23 which is mounted on the shaft 9 of the motor 8. A cam plate 24 is mounted on the outer edge of the disc 23 to bear on the exhaust valve 17, the cam plate 24 being so shaped as to vary the rate of escape of exhaust air and thus to control the speed of movement of the piston 4. Thus, as a conical container is being sprayed the spray nozzle will be required to move more quickly at the top of the container, where it is of lesser diameter, than at the bottom of the container where the diameter is larger in order to ensure that an even coating is applied.

Mounted to project laterally on each side of the disc 23 are two pairs of adjustable pins 25 and 26. The pins 26 on one side of the disc 23 serve to contact the pilot valve 21 to cause the piston 4 to move upwardly, and on the other side to contact the pilot valve 22 to cause the piston 4 to move downwardly. The pins 25 on the one side of the disc 23 serve to contact the pilot valve 14 to provide the supply of powder to the nozzle 6 and on the other side to contact the pilot valve 15 to cut-off the supply of powder from the nozzle 6.

Thus it will be understood that in one spraying operatoin, that is to say in one complete cycle of the disc 23, the pilot valves 14, 15 and 21, 22 will each be operated twice, so that two coatings of powder will be applied to the walls of each container one with the container rotating in one direction and one with the container rotating in the opposite direction.

The pins 25 and 26 are adjustable by providing the disc 23 with a series of holes 25*a* and 26*a* into which the pins 25 and 26 are placed and secured. The holes 25*a* and 26*a* are so provided as to permit adjustment of the distance between the pins or to enable additional pins to be added in such manner as to vary the distance between the pins and thus to vary the interval of time between operations.

As illustrated in Figures 7 and 8, the electrical circuit comprises an electric relay switch 27, a micro-switch 28, the motor 8, a micro-switch 29 and an interlock switch 30 in series with the main conveyor motor 31.

Three cams 32, 33 and 34 are mounted on the other end of the shaft 9 of the motor 8, remote from the disc 23. The cam 32 operates the switches 28 and 30, and cam 33 operates the switch 29. The cam 33 is provided with a projecting pin 35 which operates a micro-switch 36 which serves to actuate a mechanism in the powder container or reservoir 18 to weigh off the required amount of powder for the next spraying operation.

The cam 34 operates two further micro-switches 37 and 38 which are connected to the motor 59 and serve to control the direction of rotation of the container 47.

At the beginning of a cycle of operation, the gear motor 8 is inoperative and the switch 30 is maintained closed by the cam 32 to permit operation of the conveyor motor 31 to move the conveyor. The pilot valve 56 on the conveyor 40 operates to open the clamping members 54, which steady a container 41 in the spraying position to permit the next container to be sprayed to move into the spraying position. As the container is moved into the spraying position two further pilot valves 57 and 58 are operated to close the clamping members 54. Simultaneously, the movement of the container 41 into the spraying position engages and closes the relay switch 27, which is mounted adjacent to the door 45 of the spraying enclosure 43, to start the gear motor 8. The relay switch 27 also closes a circuit (not shown) to start the motor 59 which rotates the container 41 in the spraying position. The direction of rotation of the container 41 in the spraying position is controlled by the switch 37 which is in contact with the cam 34, the switch 37 ensuring that the motor rotates in a direction effective to rotate the container in a clockwise direction. On rotation of the shaft 9, the cam 32 opens the switch 30 immediately so as to open the circuit of the conveyor motor 31 to stop the conveyor at the same time the cam 33 closes the switch 29 which the cam 33 has held open when the motor 8 was stationary.

Simultaneously with the closing of the relay switch 27, the disc 23 is rotated by the shaft 9 and the pilot valve 21 operated by one pin 26 on one side of the disc 23 to move the piston 4 upwardly. When the nozzle 6 reaches the top of the container the pin 26 on the other side of the disc 23 actuates the pilot valve 22 to move the piston 4 downwardly and at the same time one pin 25 on one side of the disc 23 contacts the pilot valve 14 to supply powder to the nozzle 6. When the piston 4 reaches its lowermost position the pin 25 on the other side of the disc 23 contacts the valve 15 to discontinue the supply of powder to the nozzle 6. The cycle of operation is then repeated by the second pin of each pair. Furthermore at the end of the first cycle of operations, the cam 34 opens the switch 37 and closes the switch 38, closure of the switch 38 being effective to cause the motor 59 which rotates the container 41 to turn in the opposite direction so that the container now rotates in an anti-clockwise direction.

After the cam 32 has rotated through approximately 90°, it contacts the switch 28, which is normally closed to hold the relay switch 27 closed, and opens the switch 28 for a short period, thus causing the relay switch 27 to open. The circuit of the motor 8 is then completed through the switch 29 only.

Just before the piston 4 reaches its lowermost position for the second time, the pin 35 on the cam 33 contacts the switch 36 which operates a mechanism mounted in the reservoir 18 for weighing off the amount of powder for the next operation.

Immediately afterwards, the cam 33 actuates the switch 29 to open the circuit of the motor 8, thus stopping the motor 8 and simultaneously the cam 32 contacts the switch 30 to close the circuit to the conveyor motor 31 to move the conveyor to bring the next container into the spraying position.

The switch 29 also serves to open the circuit to the motor 59 which rotates the container 41 thus stopping this motor.

The powder is sprayed through the nozzle 6 during the downward stroke of the piston 3, the cam 24 on the disc 23 being so provided that air from the cylinder 2 is released through the exhaust valve 17 at such a rate that the downward rate of travel of the nozzle 6 is such that a substantially uniform coating of powder is applied to the inner surface of the container.

It will be understood that the construction of the nozzle 6, the cam 23 and the supporting frame 47 may be varied to adapt the apparatus for use with containers of any shape.

A preheating oven may be provided to ensure that the containers are in a heated condition at the spraying position, together with a fusing-out oven into which the containers pass from the spraying position. Means may also be provided to ensure that the surface of the container is in a suitable condition to receive the coating; such means may comprise a wheelabrator, a shot blast plant and a vacuum dust extractor.

A suitable layout for incorporating the spraying apparatus in a continuous system is illustrated in Figure 9 which shows a loading bay **62**, a shot blast plant **63**, a vacuum dust extractor plant **64**, a pre-heating oven **65**, the spraying enclosure **43**, a fusing oven **66** and an unloading bay **67**.

I claim:

1. A method of spraying the interior surface of a hollow article including the steps of rotating said article in a first circumferential direction at a uniform speed; directing a spray of coating material against the interior surface of said article and progressively moving the spray axially with respect to said article to thereby coat successive portions of the interior surface thereof, the rate of movement of the spray being proportional to the transverse dimensions of the successive portions of the interior surfaces thereof so that the interior surface of said article receives a coating throughout its length; thereupon rotating said article in the opposite circumferential direction and repeating the steps of directing the spray and moving the spray axially with respect to the article to thereby provide a second coating of the interior surface of said article, the spray in said last-mentioned steps being directed against the interior surface of said article such that the second coating, due to the opposite circumferential rotation of said article, coats any portions of said interior surface not coated in the first-mentioned spraying step whereby any seams, burrs or the like on said interior surface are completely coated.

2. An apparatus for spraying the interior surfaces of hollow vessels with a plastic substance, comprising: support means for supporting a vessel; a reversible motor connected to said support means for selectively rotating said vessel in opposite circumferential directions; a spray nozzle receivable within said vessel and means for reciprocating said nozzle axially within said vessel; control means connected to said reciprocating means for regulating the rate of reciprocation of said nozzle so that said nozzle moves at a rate proportional to the transverse dimensions of the portion of the vessel being sprayed thereby; and further control means for actuating said motor to cause rotation of said vessel in a first circumferential direction during one cycle of reciprocation of said nozzle and then rotating said vessel in the opposite circumferential direction during the second consecutive cycle of reciprocation of said nozzle.

3. An apparatus for spraying the interior surface of hollow vessels with a plastic substance, comprising: support means for supporting a vessel; a reversible motor connected to said support means for selectively rotating said vessel in opposite circumferential directions; a spray nozzle receivable within said vessel, a cylinder and a piston slidable with said cylinder, said nozzle being connected to said piston whereby fluid pressure within said cylinder causes movement of said nozzle with said vessel; a source of fluid pressure; a first reversing valve connected to said source and to the respective ends of said cylinder whereby fluid pressure may be alternately applied to one end or the other end of said cylinder; a normally closed exhaust valve, said reversing valve also including means connecting said exhaust valve to the end of said cylinder which is not pressurized; a source of the plastic substance; conduit means connecting said last-named source to said spray nozzle; a second reversing valve in said conduit means; a rotatable disc having a pair of sets of pins thereon; means actuated by one set of pins for actuating said first reversing valve to thereby connect one end or the other end of said cylinder to said source of fluid pressure; means actuated by the other set of pins for actuating said second reversing valve to thereby connect or disconnect said source of plastic substance with said nozzle; a cam on said disc and actuating means on said exhaust valve operable by said cam to open or close said exhaust valve and thereby control the rate of movement of said piston; and means for energizing said motor to rotate said vessel in a first circumferential direction during one cycle of reciprocation of said nozzle and then rotating said vessel in the opposite circumferential direction during the second consecutive cycle of reciprocation of said nozzle.

4. An apparatus for spraying the interior surfaces of hollow vessels with a plastic substance, said vessels being carried by a conveyor, comprising: means for supporting a vessel in a vertical position with the opening therein extending downwardly; clamp means engageable with a vessel for releasably positioning same at a spraying station; a reversible motor connected to said support means when at said spraying station for selectively rotating said vessel in opposite circumferential directions; a vertically extending cylinder position below said clamp means at said spraying station; a piston vertically movable with said cylinder and a spray nozzle on the upper end of said piston, said nozzle being receivable within a vessel at said spraying station; a source of fluid pressure and first valve means for selectively connecting said source to either end of said cylinder whereby fluid pressure may be selectively applied to one end or the other end of said cylinder; a normally closed exhaust valve and means connecting same to the end of said cylinder which is not connected to said pressure source; a source of plastic substance and means including second valve means connecting said last-named source to said spray nozzle; control means for controlling the operation of said first and second valve means to reciprocate said piston within said cylinder and to supply plastic substance to said spray nozzle at timed intervals, and further control means for controlling the time and amount of opening of said exhaust valve to thereby control the rate of reciprocation of said piston; and means for energizing said motor to rotate said vessel in one circumferential direction and then reversing the direction of rotation of said vessel in timed relation to the movement of said piston.

5. An apparatus for spraying the interior surfaces of hollow vessels with a plastic substance, comprising: support means for supporting a vessel; drive means connected to said support means for selectively and alternately rotating said vessel in opposite circumferential directions; a spray nozzle receivable within said vessel and means for reciprocating said nozzle axially within said vessel; control means connected to said reciprocating means for regulating the rate of reciprocation of said nozzle so that said nozzle moves at a rate proportional to the transverse dimensions of the portion of the vessel being sprayed thereby; and further control means for actuating said drive means to cause rotation of said vessel in a first circumferential direction during one cycle of reciprocation of said nozzle and then rotating said vessel on the opposite circumferential direction during the second consecutive cycle of reciprocation of said nozzle.

6. An apparatus for spraying the interior surfaces of hollow vessels with a plastic substance, comprising: a spray nozzle receivable within the vessel for spraying the plastic substance onto the interior surface thereof and means supporting said nozzle and the vessel for relative axial movement and relative rotation with respect to each other; means for reciprocating said nozzle with respect to the vessel; control means connected to said reciprocating means for regulating the rate of relative reciprocation of said nozzle so that said nozzle moves at a rate proportional to the transverse dimensions of the portion of the vessel being sprayed thereby; drive means for selectively and alternately relatively rotating said ves-

sel and said nozzle in opposite circumferential directions; and further control means for actuating said drive means to cause relative rotation of said vessel and said nozzle in a first circumferential direction during one cycle of relative reciprocation of said nozzle and said vessel and then relatively rotating said vessel and said nozzle in the opposite circumferential direction during the second consecutive cycle of relative rotation of said nozzle and said vessel.

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