ABSTRACT

Apparatus is disclosed for communicating a plurality of fluidized sources with a spray apparatus. A plurality of sources are communicated to individual ones of a plurality of ports extending through a stationary plate member. A rotary and longitudinally displaceable plate member is arranged in alignment with the stationary plate member and is provided with a single orifice which communicates with the spray apparatus. The rotary plate is further provided with means forming a sealing member which are arranged to cooperate with gasket means provided for each of the source orifices on the stationary plate member so as to sealingly close the nonselected orifices and to provide for contamination free communication between the selected source orifice and the single orifice on the rotary plate member.

5 Claims, 5 Drawing Figures
SPRAYABLE MATERIAL CHANGER APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of spray apparatus in general and more particularly to that portion of the above-noted field which is concerned with the spraying of materials such as for coatings. The present invention is more particularly directed to that portion of the above-noted field wherein a plurality of materials must be intermittently sprayed in a random sequence fashion and wherein it is highly desirable to avoid any cross contamination of the material. More particularly, the present invention is directed to apparatus for use in association with an electrostatic powder spray apparatus for providing that powder spray apparatus with communication to a plurality of dry powder sources in a manner which will allow rapid change of powder communication from a first selected powder to a second selected powder and which will avoid any cross contamination of the powder being sprayed with residue from a previous spray operation.

2. Description of the Prior Art

In the spraying of dry powder materials such as film forming coatings on, for example, automotive body panels, it is frequently necessary to have a single spray station spray a different powder coating on each of a succession of body panels. A single spray station may have one or more spray apparatus, typically referred to as spray guns, arranged to spray the material in unison. In order to maintain the speed of the spray assembly operation at a smooth and economically rapid level, it is necessary that the spray apparatus be capable of changing from one sprayable material to another sprayable material in approximately the same amount of time as that required for the successive body panel to come into the range of the spray apparatus. It is therefore a general objective of the present invention to provide a means for changing the material being supplied to a spray station in the time period required for successive parts to enter the spray station.

One way in which this objective may be obtained is to provide each spray material with separate spray apparatus and to automatically change between successive spray apparatus for each successive body panel. However, this is an expensive and awkward solution to the problem in view of the fact that powder coating materials are normally sprayed with an electrostatic charge to facilitate uniform deposition of the uniform coating and the provision of a plurality of spray apparatus would necessitate the provision of a plurality of electrostatic charging devices. Such a solution would also be cumbersome in the sheer bulk of equipment required to be maintained at any one spray station. Furthermore, a safety hazard would be introduced by the additional machinery required to switch between successive spray apparatus and by the necessity of maintaining a large number of electrostatically charged pieces of spray apparatus. It is therefore an object of the present invention to provide a changer for spray apparatus which may intercommunicate a single spray apparatus with a plurality of sprayable material sources.

One mechanism which has been successfully used in the past to achieve the aforementioned objective has been to provide a plurality of powder manifolds each having a spray channel and a powder channel. The manifolds are interconnected to align the spray channel so as to provide a common passage through the manifold. Each powder channel intersects the spray or common passage and communicate with a single material source. Such an apparatus is thereafter controlled by sequential valving situated in the powder channel upstream from the junction of that channel with the spray passage. This valving may open individual powder channels and will concomitantly close all other powder channels to prevent any cross contamination. However, such valving apparatus, situated as it must be within the powder channels slightly upstream from the junction of the respective powder channel with the spray channel, provides a small pocket area where residue spray material may accumulate. While it is normally the custom to provide for a flushing operation of the spray channel and of the spray apparatus between successive applications of material by the spray apparatus, the pockets of accumulated spray material are difficult to thoroughly flush and frequently result in contamination of the material being sprayed by a residue of material from a previous spray operation. It is therefore a further and specific object of the present invention to provide a material changer apparatus for use in conjunction with a spray apparatus which may intercommunicate the spray apparatus with a plurality of sprayable material sources and which will prevent any cross contamination of the sprayable material. More specifically, it is an object of the present invention to provide such apparatus which will avoid the formation of accumulation regions downstream from the control valving to thereby avoid the formation of residue of sprayable material.

Still another attempt to solve the above noted problem has been to provide the spray apparatus with a plurality of material supply conduits. The supply conduits are arranged to have each of their exhaust ports aimed or focused to deliver streams of material to be sprayed to the center of a vortex nozzle. This single material may be supplied from a selected supply conduit and may be sprayed by the apparatus. The spray nozzle may be subsequently communicated to a different supply. This arrangement is size limited in that only a small number of conduits may be arranged to be focussed toward the center of the vortex and is further complicated by the fact that the vortex aiming is critical. It is therefore a further and specific object of the present invention to provide material changer apparatus for a spray apparatus which may communicate that spray apparatus with a large plurality of sprayable material sources or reservoirs. It is a still further and particular object of the present invention to provide such an apparatus in which placement of the means for communicating the changer apparatus with the material reservoirs may be noncritical in use. It is a still further object of the present invention to provide such apparatus which may automatically change the communication of the spray apparatus from a first selected material reservoir to a second selected material reservoir while providing an intermediate flushing action. More particularly still, it is an object of the present invention to provide a changer apparatus which may intercommunicate a plurality of fluidized dry powder sources with an electrostatic spray apparatus which is inexpensive and reliable and which avoids cross contamination of sprayed powders. Other and further objects of the present invention will be apparent from the description which follows and the claims which are appended.
SUMMARY OF THE PRESENT INVENTION

The present invention provides a valving mechanism comprised of a pair of relatively movable plate members. One plate member is arranged to be stationary and the other plate member is arranged for rotary and translatory movement. The stationary plate member is provided with a plurality of passages extending therethrough, one of which may be communicated to a source of flushing fluid and the remainder of which may be communicated to a plurality of reservoirs of sprayable material. The movable plate member is provided with a single passage means which may be arranged to communicate with the spray apparatus on the one side and, through suitable translatory and rotary movement of the plate, with selected ones of the stationary plate passages. Each of the stationary plate member passages may be provided with means defining a gasket seat or ridge surrounding the orifice thereof while the rotary plate member may be provided with means defining a sealing structure to cooperate with the gasket seat or ridge provided on the stationary plate member to provide for sealing of each of the stationary plate member passages when the plate members are closely proximate to each other.

In order to achieve the desired translatory movement of the movable plate member, a double acting piston and cylinder means is provided for interconnecting the stationary and movable plate members which may be rendered operative to translate the movable plate member toward and away from the stationary plate member. In order to accomplish the desired rotational movement of the movable plate member, a stepping motor means may be provided to rotate the movable plate member clockwise and counterclockwise about an axis so as to align the movable plate member passage means with selected ones of the stationary plate member passage means.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 illustrates a side sectional view of the changer apparatus according to the present invention.

FIG. 2 illustrates an end view of the apparatus of FIG. 1.

FIG. 3 illustrates in a schematic diagram form the present invention as applied to an electrostatic powder coating spray operation.

FIG. 4 illustrates a block diagram for one form of a control system for controlling the material changer apparatus according to the present invention and useful in a system according to FIG. 3.

FIG. 5 illustrates an alternate embodiment of the valve sealing for the changer according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, FIG. 1 illustrates the material changer apparatus 10 according to the present invention. For purposes of illustration, the present invention will be described hereinbelow with reference to the application of various color fluidized powder film forming materials by electrostatic spray deposition methods to automotive vehicle body panels. It will be appreciated that the present invention is applicable to spray apparatus other electrostatic spray apparatus and with sprayable materials other than dry powder film-forming coating material.

Powder changer apparatus 10 is comprised of a stationary plate member 12 and a movable plate member 14 which is supported for rotation about axis 16. Plate member 12 has a powder supply side 18 and a sealing surface side 20. Plate member 12 is provided with a plurality of passages 22 which extend therethrough from the powder supply side 18 to the sealing surface side 20. Each of the passages 22 may be communicated, for example, by means of hoses 24 with a source of fluidized powder and by means of hose 26 with a source of a flushing agent as will be described hereinafter.

Stationary plate member 12 is connected to the movable plate member 14 by cylinder means 28 which is illustrated as being attached to the powder supply side 18 of the stationary member 12. Cylinder means 28 includes a double acting piston member 30 situated within the cylinder cavity 32. Piston 30 is arranged for reciprocating movement within cylinder means 28 and is provided with stub shaft member 34 which extends through the stationary member 12 and is fixedly attached to movable plate member 14. It will be appreciated that stub shaft member 34 should be provided with some form of pressure retaining sealing between it and stationary plate member 12. Piston member 30 is arranged to be actuated in the first direction by fluid pressure provided to cylinder cavity 32 through fluid conduit 36 and is arranged to be actuated in a second direction by fluid pressure provided to cylinder cavity 32 through fluid conduit 38. Piston 30 is further provided with a pair of seal members 40 which operate to seal each end of the piston 30. As illustrated, seal members 40 may be, for example, flexible O-rings or such other seal means as are convenient.

The application of fluid pressure through fluid conduit 36 and fluid passage 42 to face 46 of piston 30 is operative to displace piston 30 rightward relative to FIG. 1, and through its connection to the movable plate member 14 by stub shaft 34, to cause movable plate member 14 to translate rightwards. The application of fluid pressure through fluid conduit 38 and fluid passage 44 to the right hand face 48 of piston 30, relative to FIG. 1, will be operative to cause piston 30 to translate leftward relative to the figure. Due to the interconnection of piston 30, stub shaft 34 and movable plate member 14, leftward movement of piston 30 will cause the movable plate member 14 to also translate leftward.

Each of the material supply hoses 24 and the flushing material supply hose 26 is arranged to extend through stationary plate member 12 from the supply side 18 to the sealing surface side 20. The hoses 24, 26 are terminated in an extending flange portion 50 which generally surrounds the passages 22 of the stationary plate member 12. Each flange portion 50 is provided with a gasket seat or ridge 52 which may be, for example, a ridge portion formed as a part of the flange portion 50. Ridge 52 may also be a separately embedded member or annulus of suitable material such as metal.

Movable plate member 14 is provided with means defining a single fluid passage 54 which communicates on the one side with spray apparatus supply hose 56 and is arranged to communicate on the other side with a similarly provided passage 58 which extends through cooperating seal element 60. In a preferred embodiment, cooperating seal element 60 is an annular band of natural rubber material which extends around the periphery of the inner side of movable plate member 14. Cooper-
ating seal element 60 is provided with a single passage 58 and is therefore operative, when movable plate member 14 is in the extreme leftward position relative to FIG. 1, to cooperate with the gasket seats or ridges 52, and the flange portions 50, of each of the hoses 24, 26 to seal the hoses from the environment. In the case of the selected, here illustrated as hose 26, which is in fluid communication with spray apparatus supply hose 56, the sealing action of cooperating seal element 60 and gasket seat or ridge 52 will be to provide for fluid tight communication from the selected one hose 24 and the spray apparatus supply hose 56.

A second stub shaft 62 is attached to piston 30 so as to extend away from face 46 of piston 30. This stub shaft 62 extends through cylinder 28 and may be connected, for example, by a sliding spline connection, to a stepping motor 64. When energized, stepping motor 64 may be arranged to rotate stub shaft 62, piston 30, stub shaft 34, and movable plate member 14. Thus, when fluid pressure is applied to the face 46 of piston 30 and piston 30 has been displaced rightward so as to displace movable plate member 14 rightward with respect to stationary plate member 12, energization of stepping motor 64 will be operative to rotatably displace movable plate member 14 with respect to stationary plate member 12. By arranging the spacing of the steps of the step motor 64 in any of the well known ways, the single passage means 54 of the movable plate member 14 may be aligned with selected ones of the passages 22 so as to permit, upon leftward displacement of the piston 30, direct communication between the spray apparatus supply hose 56 and the selected one of the material supply hoses 24, 26.

With reference now to FIGS. 1 and 2 it can be seen that passage means 54 of the movable plate member 14 and the passages 22 of the stationary plate member 12 are arranged to be equidistantly spaced from the axis 16. Furthermore, passages 22 may be arranged to be equidistantly spaced from the peripheral of stationary plate member 12. As illustrated in FIG. 2, there are six passages 22 arranged about the stationary plate member 12. It will be appreciated that the number of passages 22 is dependent only on the size of the passages 22 and the size of stationary plate member 12. It can also be seen that the stationary and movable plate members 12, 14 preferably are of circular configuration. It will be appreciated that, while reference is made herein to the passages 22 as being individual passages and passage 54 has been referred to as a single passage, passage 54 could be a plurality of passages in any desired configuration, each of which could be communicative to one of a plurality of spray apparatus supply hoses. The passages 22 of stationary member 12 could be similarly arranged and configured and could communicate with a plurality of hoses 24, 26 each of which would then communicate with a reservoir of sprayable material. The advantage of this arrangement would be to permit the supply of a single sprayable material to a plurality of spray nozzles as may be used for example to apply coatings to a large surface area when a single spray apparatus would not have sufficient delivery capability.

Referring now to FIG. 3, the changer apparatus 10 according to the present invention is illustrated as applied to a powder paint spray apparatus operation 66 utilizing an electrostatically charged powder spray apparatus 66. Powder spray apparatus 66 is electrostatically charged from electrostatic charging means 68 through conductors 70. Electrostatic charging apparatus 68 is illustrated as being energized from a conventional AC electrical source through electric line cord 72. Electrostatic powder spray apparatus 66 is operative to provide a spray of electrostatically charged powder coating material to the surface of a member to be coated, shown as 74. As is well known, the powder paint material will be uniformly distributed and will adhere to member 74 through the action of the electrostatic charge. In the spray coating of automobile bodies, for example, as discussed hereinabove it is frequently necessary that successive spray applications of material to successive body panels be of differing colors. In order to facilitate a rapid and contamination-free change of the powder being provided to the powder spray apparatus, the changer of the present invention is arranged to communicate with a plurality of reservoirs of fluidized powder coating material through a plurality of connecting hoses 24. For example, FIG. 3 illustrates a pair of connecting hoses 24 being communicated to reservoirs 76, 78 each of which contains a fluidized bed of powder material of differing colors and a venturi-type powder pump 80, 82. A pneumatic fluid line 90 extends from the control system 84 to each of the powder pumps 80, 82 for providing an energizing fluid flow for the selected material. In addition, hose 26 may be communicated to a source of flushing agent. One convenient flushing agent is shop air which may be used to purge the hoses and passages downstream from the changer apparatus between successive applications of powder coating material.

In operation, the present invention functions as follows. A flushing agent such as shop air is communicated through hose 26 and through the appropriate passages of the changer apparatus 10 to the powder apparatus supply hose 56 and the spray apparatus 66. After a sufficient period of time has elapsed to assure that all residue powders have been exhausted from the spray apparatus supply passage 56 and from the spray apparatus 66, the control system 84 will command the application of fluid pressure, which may also be shop air, to fluid conduit 36 and the face 46 of piston 30 to cause movable plate member 14 to translate rightward, relative to FIGS. 1 and 3, away from the stationary plate member 12. Proximity sensor switch 86 will respond to plate 14 reaching the extreme rightward position so that stepping motor 64 may be actuated to rotatably displace movable plate member 14. Step motor 64 may be arranged to rotate clockwise and/or counterclockwise at a predetermined angular distance to align passage 54 with a selected one of the passages 22 so that upon application of fluid pressure to passage 38 and face 48 of piston 30 and leftward displacement of rotatable plate member 14, the spray apparatus supply hose 56 will be placed in fluid communication with the selected one of the powder hoses 24 and its associated material reservoir so that the application of the appropriate powder coating material to the next successive body panel 74 may be achieved. Upon leftward displacement of movable plate member 14, proximity sensor switch 86 will inform the control system 84 that leftward displacement has been achieved and the material reservoir powder pump for the selected material may be energized. Due to the dual sealing action of the inter-plate sealing means 50, 60 powder supplied from the one selected powder reservoir 76 and 78 which communicates directly with the spray apparatus supply hose 56 will be prevented from entering and accumulating in the pas-
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sages 22 which communicate with the nonselected reservoirs. After the passage of an amount of time selected to correspond with the rate of travel of the body panel 74 on the conveyor apparatus past the nozzle 88 of spray apparatus 66, the control system 84 will depressurize the powder pump in the reservoir of the selected material and the movable plate member 14 will be automatically indexed to place the spray apparatus supply hose 56 in communication with the flushing agent supply hose 26 so that residue powders may be exhausted from supply hose 56 and from the spray apparatus 66. In the preferred embodiment, the flushing agent may be pressurized shop air but alternatively, the spray apparatus 66 and supply hose 56 may be flushed by a vacuum operation in which the powders which act as residue within the spray apparatus and the spray apparatus supply hose may be collected and returned to the respective fluid supply reservoirs 76, 78.

Referring now to FIG. 4, a representative control system 84 for controlling the sequence of operation of the changer apparatus 10 according to the present invention is illustrated. In the illustrated control system, the principal element of the control is the memory and electrical sequence signaler 90 which may be, for example, an Edon Memo-Chain control mechanism having memory capability. This central processing unit 90 receives material selection indications from the powder selector 92 and applies suitable control signals to the pneumatic control means 94. Unit 90 also applies suitable electrical signals to indexer 64 to accomplish clockwise or counterclockwise stepping motion when switching from one of the selected passages 22 of stationary plate member 12, to the flushing position, and to a second selected passage 22 of the stationary plate member 12. Pneumatic control means 94 receives pneumatic fluid, which may also be shop air, under pressure from pneumatic source 96. Pneumatic control means 94 may be comprised, for example, of suitable electromechanical valve means for controlling the application of pneumatic pressure to a selected pumping means 80, 82, for example and to control actuation of the cylinder means 28. Material to be sprayed would therefore be pumped by pump means 80, 82 through the associated material supply hose 24 to changer 10. This material would be delivered to spray apparatus supply hose 56 to be sprayed from nozzle 88. The lateral position of movable plate member 14 relative to stationary plate member may be communicated from switch member 86 to central processing unit 90 by conductor means 98.

Referring now to FIG. 5, a fragmentary view of a portion of the stationary and rotary plate members 12, 14 according to the present invention and showing an alternate valving and sealing mechanism is illustrated. According to the structure of FIG. 5, each of the passages 22 of the stationary plate member 12 is provided with a replaceable check valve means 100 and a separate sealing means 102. In the illustrated embodiment, the check valve means is comprised of a ball member 104 which is seated to a seat 106 by resilient means 108. Valve seat 106 is provided in combined valve seat and seal member 110 which may be formed of a resilient material. Movable plate member 14 is similarly provided with a complementary seal forming member 112 which is arranged to coact with the member 110 to provide a fluid tight seal between the passage 122 of stationary member 12 and the passage means 54 of the rotary member 14.

While my invention has been described with reference to a particular utilization and specific exemplary structure has been described, the practitioner will recognize that certain modifications may readily be made. For example, the changer apparatus may be used with material supplies which are not fluidized and need not be limited to use with powders. The translatory and indexing structure may be constructed to provide a nonrotary piston member sealingly coupled to a shaft through shaft with the shaft being slidingly splined to either the movable plate or the indexer, or the shaft may be fixedly attached to both with the indexer being slidingly and nonrotarily coupled to the stationary plate member.

I claim:

1. Apparatus for communicating a powder spray gun with a plurality of fluidized powder sources while
avoiding cross contamination of powders comprising in combination:

a stationary plate member having a powder side and a sealing side, a plurality of powder passages and at least one flushing passage, said passages extending through said plate from the powder side to the sealing side;
hose means coupled to said powder passages on the powder side of said plate for fluid-tight communication of said powder passages with the plurality of powder sources;

further hose means coupled to said at least one flushing passage on the powder side of said plate;

means coupled to said further hose means for flowing a flushing medium therethrough;

plate valve means supported in closely spaced relation to said stationary plate member and having a flow passage means extending through said plate valve means and aligned for fluid communication with said powder passage and said at least one flushing passage;

hose means coupled to said flow passage means for communicating said flow passage means with the spray gun;

means connected to said valve plate means for varying the spatial relation between said valve plate means and said stationary plate member;

indexing means operative to align said flow passage with a selected one of said powder and flushing passages;

seal means interposed between said stationary plate member and said valve plate means for seals said communication between said flow passage and said selected one of said powder and flushing passages;

said plate valve means comprising a plate member mounted for rotation about an axis, said rotation axis being arranged to extend through the stationary plate member, and said spatial relation varying means comprise cylinder means interconnecting said stationary plate member and said plate valve means actuable to increase the spatial relation to a first predetermined amount and to decrease the spatial relation to a second predetermined amount;

and

said indexing means comprising step motor means operative when the spatial relation between the stationary plate member and the valve plate means is at the first predetermined amount to rotate said valve plate means about said axis until said flow passages is aligned with the selected one of the powder and flushing passages and to actuate said piston means to establish a spatial relation of the second predetermined amount.

2. The apparatus of claim 1 including control means to automatically and sequentially operate the piston means and the indexing means to communicate different selected ones of the powder passages with the flow passage and to communicate the flow passage with the flushing passage between successive different powder passage communications.

3. Apparatus for communicating a powder spray gun with a plurality of fluidized powder courses while avoiding cross contamination of powders comprising in combination:

a stationary plate member having a powder side and a sealing side, a plurality of powder passages and at least one flushing passage, said passages extending through said plate from the powder side to the sealing side;
hose means coupled to said powder passages on the powder side of said plate for fluid-tight communication of said powder passages with the plurality of powder sources;

further hose means coupled to said at least one flushing passage on the powder side of said plate;

means coupled to said further hose means for flowing a flushing medium therethrough;

plate valve means supported in closely spaced relation to said stationary plate member and having a flow passage means extending through said plate valve means and aligned for fluid communication with said powder passages and said at least one flushing passage;
hose means coupled to said flow passage means for communicating said flow passage means with the spray gun;

means connected to said valve plate means for varying the spatial relation between said valve plate means and said stationary plate member;

indexing means operative to align said flow passage with a selected one of said powder and flushing passages;

seal means interposed between said stationary plate member and said valve plate means for seals said communication between said flow passage and said selected one of said powder and flushing passages;

seal means interposed between said stationary plate member and said valve plate means operative to seal closed the nonselected ones of the powder and flushing passages;

said seal means comprising

a. a plurality of first seal element means situated on said stationary plate member in proximity to the sealing side thereof and arranged to be in surrounding relation to the sealing side orifice of each of the powder and flushing passages and

b. means defining second seal element means positioned on said plate valve member in juxtaposed relation to the plurality of first seal element means, the second seal element means including a passage means aligned with the flow passage means of the plate valve means to provide unrestricted material flow through from a selected one of the powder and flushing passages to said flow passage means.

4. The apparatus of claim 3 including further a plurality of check valve means situated in the powder passages and having orifices extending from the seal side of the stationary plate member toward the valve plate means, and valve operating means extending from the flow passage, operative to engage and open the check valve means situated in the selected one of the powder and flushing passages.

5. The apparatus of claim 4 wherein each of said check valve means comprise a check valve member means resiliently biasing said seal valve member toward a valve seat and said valve operating means comprise a projecting finger element situated in the flow passage means of said plate valve means.