Nov. 5, 1963 D. H. BROOKS 3,109,680

SPRAY COATING

Filed May 24, 1961 2 Sheets-Sheet 1

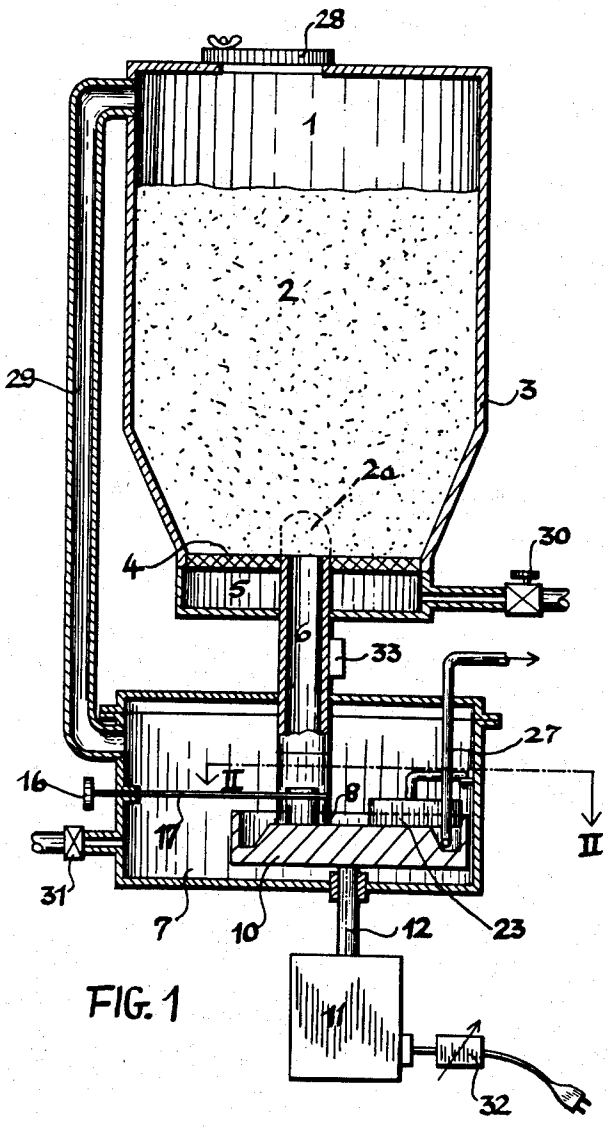


FIG. 1

Inventor
DONALD HERBERT BROOKS

By John G. Kovalick, Agent
Karl Kuhn
Jayne E. Bowman
Peter C. Rose
Attorneys

Nov. 5, 1963 D. H. BROOKS 3,109,680

SPRAY COATING

Filed May 24, 1961 2 Sheets-Sheet 2

FIG. 2

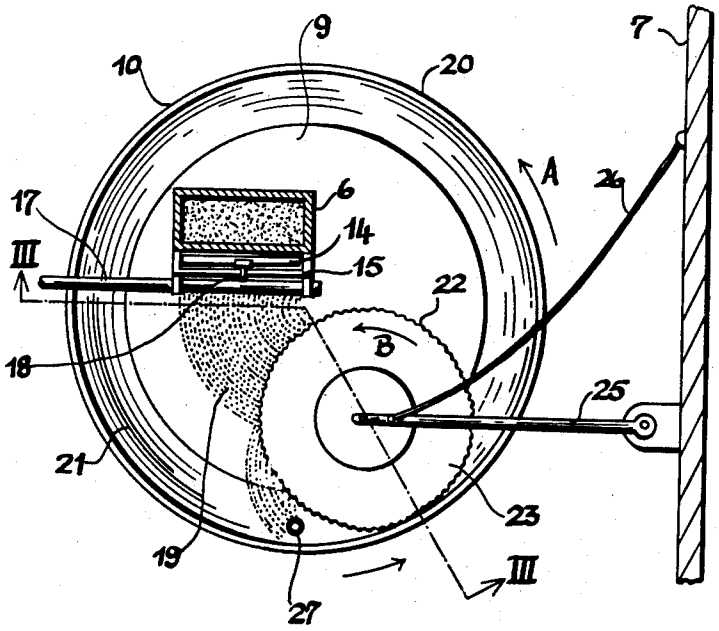
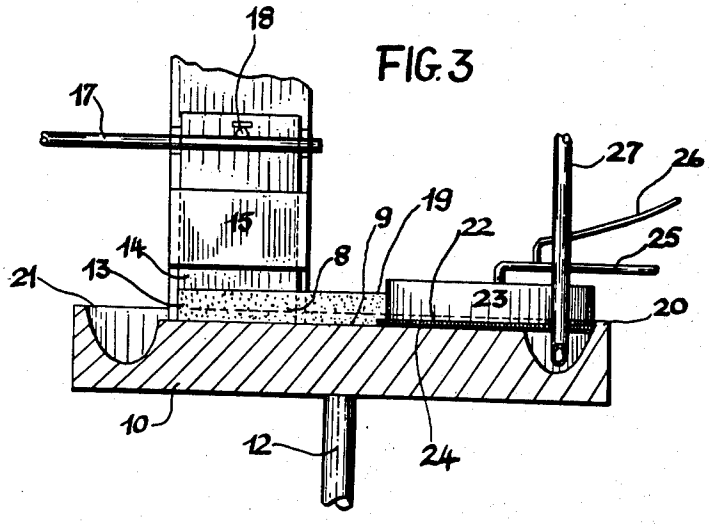


FIG. 3



Inventor
DONALD HERBERT BROOKS

By John B. Kondis, Agent
Karl Hubing
James C. Rose
Helen C. Rose
Attorneys

United States Patent Office 3,109,680 Patented Nov. 5, 1963

3,109,680

SPRAY COATING

Donald Herbert Brooks, Northdene, District Vanderbijl Park, Transvaal, Republic of South Africa, assignor to Indevco Ltd., Mauren, Liechtenstein, a corporation of Canada

Filed May 24, 1961, Ser. No. 112,287
1 Claim. (Cl. 302—11)

The present invention relates to spray coating with particulate coating materials, in particular coating powders. Such spray coating is generally carried out by spraying the at least initially particulate material onto the surface to be coated and causing the coating material to adhere to the said surface.

Various modifications are known. For example, the particles may be sprayed onto a surface previously rendered tacky. Alternatively the particles are of a thermoplastic material and caused to adhere to the surface to be coated by the application of heat. In the latter case the heat application may, all or in part, take place before, during or after the application of the powder to the surface. Spray coating with a thermoplastic particulate material may also be carried out according to the method known as flame spraying, in which latter procedure the particles are ejected from a nozzle onto the surface to be coated through a flame directed at the said surface. Normally, this procedure is carried out in such a manner that the particles are at least partly caused to melt as they pass through the flame, and the surface to be coated is simultaneously heated by the flame. Frequently the surface to be coated by a spray coating method is preheated prior to the actual powder application.

Spray coating as summarised above may be carried out with metal powders. In recent years, however, spray coating with thermoplastic resin powders has also assumed considerable commercial importance. For spray coating, in particular flame spray coating, to be successful it is essential to produce an absolutely even powder feed. An uneven powder feed will result in irregular, patchy coatings, and in the case of flame spray coating the effect is aggravated by the irregularity of the length and intensity of the flame resulting from an uneven powder feed. An irregular feed presents a particular problem with plastic powders, which tend to build up electrostatic charges and which in some cases quite generally have a tendency to form lumps. Complete or partial clogging of the spray coating apparatus may result. Many existing spray coating methods and devices suffer from the disadvantage that they do not produce an absolutely even flow. Examples are those methods in which a venturi jet or similar device is used to withdraw a cloud of powder from the bottom part of a powder storage vessel. (E.g. German Patent 1,005,413.) Other disadvantages of the last-mentioned method are the very limited practical range through which the powder feed rate can be varied, the low maximum powder feed rate, the invariably high dilution of the powder stream with propellant gas and the high consumption of propellant gas.

In our patent application No. 846,375, filed October 14, 1959, now abandoned, the above-mentioned difficulties and drawbacks have been overcome to a far-reaching extent by a method which comprises producing an aerated bed of particulate plastic coating material in an aerating vessel, the degree of aeration being below the limit at which a substantial part of the particulate material becomes entrained in the aerating medium, withdrawing at the desired rate a stream of aerated material from the aerating vessel by virtue of the pressure in the aerating vessel at the locality of withdrawal and feeding this stream to means serving for forwarding and discharging the particulate material onto the article to be coated.

It is an object of the invention to provide a new method and means allowing the production of a particularly even powder spray with a high degree of centainty.

It is a further object of the invention to provide a method and means allowing the accurate control within a wide range of the powder feed rate for spray coating purposes.

A spray coating method in accordance with the present invention comprises maintaining a continuous supply of a particulate coating material in a substantially free-flowing condition with a pressure head in a passage having a downwardly directed open end facing an upwardly directed conveying surface, maintaining said conveying surface in continuous, even, uni-directional movement relative to, past and underneath the said open end of the said passage while maintaining, for the duration of a particular constant feed rate, a constant gap between the said lower end of the said passage and the said conveying surface, said gap facing in the direction of movement of the conveying surface, thereby producing an even ribbon of particulate material being carried away by the surface, continuously causing the particulate material to be removed from the said conveying surface at the same rate as that at which it is moved along on the conveying surface at a locality remote from the said passage and continuously carrying away substantially all particulate material thus removed from the conveying surface through a conduit leading in the direction of a locality of spray production by creating a positive pressure differential across the last-mentioned conduit.

The pressure differential may be produced by applying suction to the far end of the last-mentioned conduit, or by maintaining an excess pressure at the locality at which the particulate material is picked up by the conduit. In either case conditions may be such that the particulate material is carried through the said conduit in a stream of propellant gas.

According to the preferred method the said continuous removal of the particulate material from the conveying surface is brought about by continuous and even mechanical wiping. The said conveying surface is preferably a substantially plane surface.

The powder feed rate may be controlled by adjusting the dimensions of the said gap between the said passage and the conveying surface. Alternatively the powder feed rate is controlled by adjusting the speed of movement of the conveying surface or by a combination of the last-mentioned two methods.

The method may be carried out with a powder of a type having substantially free flowing properties in its normally settled condition. However, the method is also suitable for being carried out with other particulate materials. To produce a free flowing condition irrespective of the type of material, the particulate material is preferably maintained in an aerated condition in the said passage.

Normally the particulate material is continuously supplied to the said passage from a space of larger cross-section, in which the particulate material is aerated by passing gas therethrough in an upwards direction, the intensity of aeration being below that at which substantial entrainment of the particulate material in the gas stream occurs. The exact degree of aeration is preferably adjusted to suit the particular coating material. For example, with some powders, in particular powders largely composed of jagged particles having a tendency to interlock and form lumps, a high degree of aeration, e.g. the condition known as a fluidised bed (in the sense of a dense phase bed bounded by an upper free surface and in which the particles are in turbulent movement) is preferably employed. Normally the degree of aeration

is allowed to diminish as the particulate material moves along the said passage towards the open end facing the conveying surface.

In the said passage it is preferred to maintain a static aerate state of aeration, the expression static aerate being defined as a state of aeration intermediate between that of a truly fluidised bed as defined above and the fully settled material. This condition is described in great detail in our patent application No. 846,376. A static aerate condition may also be maintained in the space from which the powder is supplied to the said passage, particularly if the powder particles are well rounded.

From the above and the following a person duly skilled in the art will be able to devise a variety of means for putting the process into effect. Preferably, however, the process is carried out with a specially designed spray coating apparatus in accordance with the invention, which comprises a supply vessel for particulate material, communicating at its lower end with a downwardly leading feed pipe, the lower end of which is close to and faces the upper surface of a conveyor and provided at its lower end with a recess providing an enlarged gap between the feed pipe and the conveyor substantially normal to the line of movement of a point of the conveyor passing immediately underneath the said gap and facing in the direction of movement, and a carrying away pipe so related to the conveyor as to continuously carry away particulate material as it is transported by the conveyor from the said gap towards the carrying away pipe as soon as a positive pressure difference is set up across the carrying away pipe.

Means for creating a pressure differential across the carrying away pipe may be provided as part of the apparatus proper, preferably in the form of means for setting up a super-atmospheric pressure inside the apparatus proper. Alternatively, suction may be applied to the far end of the said pipe, e.g. by means of a spray gun provided with a venturi jet, e.g. of a type known per se.

The preferred apparatus also comprises a mechanical wiper for continuously wiping the particulate material carried by the conveyor off the aforementioned upper surface of the conveyor into a depression from which the particulate material is to be picked up by the said carrying-away pipe. The wiper may be provided by the periphery of a rotating cylinder, said periphery being normal to and flush against the said conveyor surface and forming a moving barrier across the path of the particulate material carried by the conveyor, guiding the particulate material into the said depression.

Although a conveyor belt can be used for the said conveyor, it is preferred to employ a rotating disc facing the said pipe leading downwards from the storage vessel and rotating around an axis normally disposed to the said upper surface and lateral of the last-mentioned pipe.

The above-mentioned depression from which the particulate material is picked up by the carrying-away pipe, may take the form of a channel-formed recess in the conveyor parallel to the ribbon of particulate material produced on the conveyor during its passage under the feed pipe.

In the preferred apparatus, at least part of the bottom of the supply vessel takes the form of a gas-pervious bed support underneath which a gas box for aerating medium is provided. In this embodiment the top of the supply vessel may be closed substantially gas-tight, a presusre equalising pipe leading from the upper end of the supply vessel to a compartment enclosing the said conveyor and associated means, a valve being provided for bleeding off gas from the substantially closed system in order to regulate the pressure, and the said carrying away pipe passing through the wall of the said enclosure.

It is furthermore possible to provide a vibrator on the pipe leading from the lower end of the storage vessel to the conveyor.

The invention and the manner in which it may be put into practice will be further described by way of example with reference to the accompanying drawings, in which—

FIGURE 1 represents a vertical section through a spray-coating apparatus in accordance with the invention;

FIGURE 2 represents a horizontal section along line II—II in FIGURE 1, and

FIGURE 3 represents a vertical section in greater detail along line III—III in FIGURE 2.

Referring to the drawings, the preferred embodiment of a spray coating apparatus in accordance with the invention comprises a supply vessel **1** containing a particulate coating material, say up to the level **2**. The lower portion **3** of the supply vessel tapers towards a gas-pervious bed support **4** of a type suitable for aerating vessels. Underneath the bed support **4** a gas box **5** is provided having a gas inlet. A feed pipe **6** leads from the centre of bed support **4** down to the metering mechanism proper enclosed in a gas-tight casing **7**.

The pipe **6** has an open end **8** facing the upper surface **9** serving as the conveying surface, of a conveying disc **10**. The disc **10** is rotated in the direction indicated by an arrow A in FIG. 2 by an electric motor **11** with built-in reduction gear. The axis of rotation **12** of disc **10** is parallel to and by-passes the feed pipe **6**.

Facing in the direction of movement of disc **10** an enlarged gap **13** is provided between the lower end **8** of the pipe **6** and the said disc, the height of which gap may be adjusted by means of a gate **14** held in a gate holder **15**. A dial **16** connected to a shaft **17** and provided with a cam **18** serves to raise or lower the gate **14**. The level of the lower edge of the gate controls the height of the ribbon of powder **19** emerging from the gap **13**.

At the outer periphery of disc **10** a ridge **20** is provided which projects above the level of the conveying surface **9**. Just inside the ridge **20** the disc **10** is recessed to form a peripheral groove **21**. The ridge **20** is engaged by the milled edge **22** of the wiper **23**. This wiper takes the form of a cylindrical disc in sliding contact with the conveying surface **9**, a felt pad **24** being provided on the underside of the wiper. The wiper is rotatably mounted on an arm **25** spring-loaded by means of spring wire **26**.

A powder carrying-away pipe **27** passes through the casing **7** and its lower end projects into the groove **21** in close proximity to the wiper **23**. The powder carrying-away pipe **27** leads directly to a spray nozzle, which is not shown. The spray nozzle may form part of a spray gun, which latter may be adapted for flame spraying in a manner known per se. The spray gun may incorporate a venturi jet to produce a vacuum in pipe **27**. However, the preferred spray coating apparatus operates at super-atmospheric pressure which obviates the need for a venturi jet in the spray gun. In this preferred apparatus the top of the supply vessel **1** is closed with a gas-tight lid **28**. The upper part of the supply vessel **1** communicates with the gas tight casing **7** through a pressure equalising pipe **29**. The pressure may be regulated by means of the valve **30** which controls the compressed gas throughput through the aerating vessel and by means of bleed-off valve **31** through which the gas not needed for carrying powder through the carrying-off pipe **27** may escape. If desired or required this latter control may be incorporated in the spray gun or the like. A control device **32** for controlling the speed of the motor **11** and also for switching on and off the motor may also be provided and this device is preferably incorporated in the spray gun held by the operator, the speed of the motor being one of the factors on which the powder feed rate depends.

The apparatus is operated as follows:

The supply vessel **1** is filled with a suitable coating powder, e.g. a thermoplastic resin powder having a particle size between approximately 0.05 mm. and 0.2 mm.,

preferably between 0.06 and 0.1 mm., say largely of the order of 0.075 mm. (approx. 200 mesh A.S.T.M.).

Aerating gas under pressure, normally air (although an inert gas may also be used) is then admitted to the gas chamber **5** through valve **30** and inlet pipe The gas flow through the powder bed is regulated to achieve the required degree of aeration, a high degree of aeration being required for powders having poor flow properties. Under all circumstances the gas flow is adjusted in such a manner that the degree of aeration does not exceed that of a dense phase fluidised bed bounded by a definite upper free surface above which there is little or no powder entrained in the gas. Even if fully fluidised conditions prevail in the bulk of the powder bed, there will be a section, diagrammatically indicated by the dotted line **2***a* just above the feed pipe **6** in which section the degree of aeration is lower, the powder moving into this section collapsing to a certain extent to a denser state of aeration.

The moment the electric motor is set in motion, the rotation of the disc **10** will cause a ribbon of powder to be carried away from the gap **13** towards the wiper **23**. The rate at which the powder is forwarded depends on the setting of the gate **14** and the speed of rotation of the disc **10** as explained above. In a typical numerical example the disc **10** has a diameter of the order of 10 inches and rotates at a rate of approximately 8 revolutions per minute. The minimum opening of the gate for practical purposes is about 10 thousandths inch and an opening of 3/16 inch will rarely be exceeded, the horizontal width of the gap being normally of the order of 1¾ inches for an apparatus operating with a single normal spray gun. As the powder is carried away by the conveying surface **9**, more powder moves down through pipe **6** and with most powders the degree of aeration will gradually diminish as the powder moves downwards. Throughout most of pipe **6** the condition of the powder may be described as a static aerate as defined above, but towards the gap **13** the state of a settled powder may actually be approached.

The aerating gas passing through the powder in the supply vessel is subsequently fed through the pressure balancing pipe **29** into the gas-tight compartment **7** as a result of which a positive pressure differential is set up across the powder carrying-away pipe **27**. This pressure differential may be adjusted by means of valve **31**.

As the powder ribbon **19** reaches the wiper **23**, which rotates in the direction of arrow B the powder is swept into the channel **21**, from where it is picked up as a result of the said pressure differential by the powder carrying-away pipe **27**.

The above-described method and apparatus may also be applied to the continuous coating of strip material. For this purpose the strip material may be passed at a constant rate past stationary spray guns fed from one or more powder feed systems as described above. The powder feed rate can be adjusted so accurately and will remain so constant that the method and apparatus lend themselves very well to continuous mass production processes.

As an optional feature a vibrator **33** may be built onto the powder feed pipe **6**, however, most powders can easily be fed through the pipe in the manner described above without the need for such a vibrator.

In the case of pressurised beds the pressure may be varied from approximately 1 lb. per sq. inch to approximately 100 lbs. per sq. inch.

The above-mentioned process allows of the finest powders, which are the most desirable for spray coating, but also the most difficult to handle, being used without difficulty. Furthermore the polyvinyl-chlorides which were, owing to the ease with which they oxidised, extremely difficult to handle to date, may now be used without difficulty.

The apparatus described in the example was specially designed for fine work involving comparatively low but very accurate feed rates. Higher feed rates can obviously be attained by scaling up some of the dimensions.

I claim:

A spray coating apparatus which comprises a supply vessel for particulate material communicating at its lower end with a downwardly leading feed pipe the lower end of which is close to and faces the upper surface of a conveyor and which is provided at its lower end with a recess providing an enlarged gap between the feed pipe and the conveyor substantially normal to the line of movement of a point of the conveyor passing immediately underneath the said gap and facing in the direction of movement and a carrying away pipe so related to the conveyor as to continuously carry away particulate material as it is transported by the conveyor from the said gap towards the carrying away pipe as soon as a positive pressure difference is set up across the carrying away pipe, a mechanical wiper being provided for continuously wiping the particulate material carried by the conveyor of the aforesaid upper surface of the conveyor into a depression from which the particulate material is to be picked up by the said carrying away pipe, the said wiper being provided by the periphery of a rotating cylinder, said periphery being normal to and flush against the said conveyor surface and forming a moving barrier across the path of the particulate material carried by the conveyor, guiding the particulate material into the said depression.

References Cited in the file of this patent

UNITED STATES PATENTS

2,897,009	Gianniny	July 28, 1959
2,924,488	Lawyer	Feb. 9, 1960
3,001,829	De Saint-Martin	Sept. 26, 1961