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SPRAY NOZZLE

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9 Claims. (Cl. 299—28.6)

This invention relates to spray nozzles, more particularly of the type to spray a stream of metallic particles.

As conducive to an understanding of the invention, it is noted that where heat is applied to metal particles for only an extremely short period of time, unless such heat is extremely high, some of the particles may not be transformed to the highly plastic state required for adherence to the article on which they are sprayed.

Where the heat is applied only to the outer periphery of a stream of particles, those particles at the core of the stream will receive less heat than those at such outer periphery, with the result that some of the particles may not be transformed to the desired plastic state with the resultant poor adherence thereof to the article being sprayed.

Where a stream of particles is propelled through a heated nozzle and the heated particles adhere to the bore surface of the nozzle, the latter is likely to clog with resultant inoperativeness thereof.

Where the stream of heated particles is not guided as it emerges from the spray nozzle, it may spread out with the result that some of the particles will not strike the article being sprayed, with resultant low efficiency of the spraying operation. In addition, if the particles and the article being sprayed are at such a high temperature that the particles remain highly plastic for any considerable time after they strike such article, the particles are likely to flow off the latter with resultant poor coating thereof.

It is accordingly among the objects of the invention to provide a spray nozzle through which a stream of particles may be propelled and which provides for uniform heating at a relatively high temperature of all of the particles passing therethrough so that all of such particles will be transformed to a highly plastic state and will emerge from the outlet of the nozzle as a stream of such plastic particles thereby assuring uniform adherence to the object being sprayed, which nozzle is relatively light in weight, compact and sturdy and has but few parts, none of which are likely to become deranged and which is not likely to become clogged even with long, continuous use, and which directs the particles emerging from the nozzle to a localized area to provide for efficient application to the article being sprayed, with substantially no waste, and which provides a cooling action for the plastic particles as they emerge from the nozzle so that they will more readily adhere to the article being sprayed and will not flow off the latter.

According to the invention, a stream of particles is propelled through a tube which is heated to a sufficiently high temperature to transform the particles passing therethrough to a highly plastic state. Gas, under pressure, is forced through the tube in direction substantially at right angles to the path of movement of the stream of particles, thereby agitating such particles for uniform application of heat thereto and preventing ad-

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herence of such particles to the bore surface of the tube. The stream of plastic particles emerging from the outlet of the nozzle is restrained from spreading by means of an encompassing gas stream which also serves to cool the particles.

In the accompanying drawings in which are shown one or more of various possible embodiments of the several features of the invention,

Fig. 1 is a longitudinal sectional view of one embodiment of the nozzle,

Fig. 2 is a view similar to Fig. 1 of another embodiment thereof,

Fig. 3 is a front view of the nozzle tip taken along line 3—3 of Fig. 1, and

Fig. 4 is a front view of another embodiment of the nozzle tip.

Referring now to the drawings, the nozzle shown in Fig. 1 comprises a tip 10 substantially circular as shown and desirably having an axial bore 11 therethrough with an outlet 12. The nose end 13 of the tip is desirably in the shape of a truncated cone and a plurality of gas outlet bores 14 extending through said nose and converging at their outlet ends as at 15 adjacent the outlet 12 of bore 11 terminate at their inner ends 17 in an annular chamber 18 in said tip.

Associated with the tip 10 and longitudinally spaced therefrom is the main body or base 21 of the nozzle. The body 21 which is substantially cylindrical, desirably has an axial bore 22 therethrough longitudinally aligned with the bore 11 in tip 10.

Extending between the opposed faces 24 and 25 of the tip 10 and body 21 is a tubular casing 26 of any suitable rigid material and illustratively of metal. In order to support the casing 26, the ends 27 and 28 thereof respectively encompass an inwardly extending annular flange 29 on tip 10 and a reduced portion 30 on body portion 21 which defines a shoulder 31. In order to insulate the casing 26 from the tip 10 and body 21, an annular insulating washer 32 which may be, for example, of ceramic material, is interposed between the flange 28 and shoulder 31 and the adjacent end 27, 28 of casing 26.

Coaxial with casing 26 and encompassed thereby is a tube 33 of porous material preferably of a sintered metal which may be of nickel alloy such as is commercially known as "Inconel." The ends 34 of tube 33 desirably are positioned in the bores 11 and 22 respectively of tip 10 and body portion 22 at the opposed faces 24 and 25 thereof and abut against shoulders 36 formed in said bores.

Means are desirably provided to retain the tube 33 and the casing 26 in fixed position with respect to tip 10 and body 21. Although any suitable means may be provided for this purpose, in the illustrative embodiment herein shown, the tip 10 and the body portion 21 each has a plurality of lugs 41 and 42 respectively, preferably formed integral therewith and extending radially outward therefrom.

Pairs of lugs 41 and 42 on the tip 10 and body portion 21 are longitudinally aligned and a bolt 43 extends through bores 44 in said lugs so that when nuts 45 on said bolts are tightened the tip 10 and the body portion 21 will be drawn together securely to retain the casing 26 and tube 33 therebetween.

Desirably the bolts 43 are insulated from the tip 10 and body portion 21 by means of bushings 46 of insulating material such as ceramic which encompasses that portion of the bolt 43 extending through the bores 44.

With the construction above described, the metal tip 10 and the metal body 21 are electrically insulated from each other by the insulating washers 32 and bushings 46.

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Thus, when a heating transformer (not shown) is connected by leads 47 and 48 to lugs 41 and 42 on tip 10 and body portion 21 respectively, current will flow through tube 33 which offers a relatively low resistance to the flow of current therethrough, and the tube 33 will heat up to the desired temperature.

Means are provided to eject a powder, which may be a metal such as zinc, through tube 33, to be heated thereby to a highly plastic state almost reaching the molten condition for adherence to an object to be sprayed.

Although the powder may be injected into tube 33 in any suitable manner, in the embodiment herein shown, the axial bore 22 in body portion 21 desirably has a plug 51 affixed therein, said plug having a substantially conical nose 52 and desirably having an axial bore 53 therethrough of enlarged diameter as at 54 at its rear end.

Although the plug 51 may be affixed in bore 22 in any suitable manner, in the embodiment herein shown, the plug 51 is externally threaded so that it may be screwed into the correspondingly threaded bore, the latter desirably having a closure plug 55 screwed in the end 56 thereof.

Extending longitudinally through body portion 21 adjacent the surface 57 thereof is a bore 58, the inlet end 59 of which is connected by a fitting 61 to line 62 from a source of compressed gas (not shown).

In order to supply such compressed gas to bore 22, a transverse passageway 63 is provided between bores 58 and 22. The flow of gas through passageway 63 is desirably controlled by a valve 64 preferably of the needle type.

This valve desirably comprises a hollow screw 65 threaded into a transverse cavity 66 in body portion 21 and retaining a packing 67 against the floor of said cavity to provide a seal. A valve adjustment screw 69 threaded through screw 65 desirably has its inner end 71 conformed as a valve head which may be moved against a seating conformation 72 at the outer end of passageway 63 to seal the latter. Thus depending upon the spacing between screw end 71 and seat 72, the flow of gas into passageway 63 may be regulated.

The portion of bore 22 in body portion 21 adjacent the conical nose of plug 53 desirably tapers so that the bore 22 is of reduced diameter as at 74 adjacent the inlet end 75 of tube 33. Extending into bore 22 adjacent the conical end 52 of plug 53 is the outlet end 76 of a powder feed passageway 77 which may be connected to a source of powder (not shown) by means of a feed tube 78 connected by fitting 79 to the inlet of said passageway 77.

The outlet 81 of bore 58 is desirably connected to annular chamber 18 by means of a tube 82, preferably of heat resistant, non-conducting material such as rubber or asbestos. Tube 82 is connected at one end by a fitting 83 to outlet 81 and at its other end by fitting 84 to an inlet port 80 formed in a boss 85 formed integral with tip 10, said port 80 desirably being connected by passageway 86 to chamber 18. Thus when gas is forced into chamber 18, it will pass through passageway 87 into the substantially gas-tight chamber 88 formed between casing 26 and tube 33.

Suitable means are desirably provided to control the flow of gas through the wall of porous tube 33. Such means may comprise a needle valve 89 substantially identical to valve 64 and comprising a screw 91 of larger diameter than bore 58 and having a valve head 92 movable toward and away from a seat 93 formed in the wall of bore 58.

In the operation of the spray nozzle shown in Figs. 1 and 3, the line 78 is connected to a source of powder particles such as zinc. The line 62 is connected to a source of gas under pressure, such gas being air or neutral gas. The power to the heating transformer (not shown) is turned on so that current will pass through the tube 33 which will provide a low resistance path for the current

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and heat up to a temperature, illustratively in the order of 2,500° C.

The valve 64 is adjusted to provide a flow of gas from line 62, through bore 58, passageway 63 into bore 22 and thence through bore 53 of bushing 51. By reason of the relatively small diameter bore 53, the gas under pressure will be forced therethrough at a high velocity thereby creating a suction in the reduced portion 74 of bore 22 adjacent outlet 76.

Such suction will draw the powder particles through passageway 77 and such mixture of gas and powder, by reason of the high velocity of the gas discharged through the bore 53 of plug 51, will be propelled through the length of tube 33 and out of outlet 12 of tip 10. By reason of the length of the heated tube 33, sufficient time is provided for the application of heat to the particles to insure softening thereof to a highly plastic though not molten condition and the plastic particles will emerge from outlet 12 as a spray.

Uniform application of heat to all of the particles is ensured by the fact that as they pass through the tube 33 they will be violently agitated by the flow of gas through the porous tube 33 at substantially right angles to the path of movement of the particles therethrough. Thus the particles at the core of the stream passing through the tube and normally most remote from the heated wall thereof will be moved toward such wall for application of heat thereto. By reason of such gas flow through the wall of tube 33 the plastic particles will be prevented from adhering to the bore surface thereof which would cause clogging of the tube and inoperativeness of the nozzle. By adjusting the valve 64 control is afforded of the flow of gas under pressure through tube 82, passageway 86 into annular chamber 18 and thence through passageway 87 into the chamber 88 encompassing tube 33.

By reason of the converging passageways 14 connected to annular chamber 18, excessive spreading of the spray emerging from outlet 12 of tip 10 is prevented. Thus the gas under pressure in annular chamber 18 will emerge as high velocity jets from the outlets 15 of passageways 14 and strike the periphery of the stream of particles and gas emerging from outlet 12 thereby substantially preventing spreading of such stream. In addition, as the gas emerging from outlets 15 is relatively cool, as the heated particles strike the article being sprayed they will rapidly cool and congeal thereby preventing dripping of such plastic particles from the article and insuring adherence of such particles thereto.

The embodiment of the spray nozzle shown in Fig. 2 is identical in many respects to the nozzle shown in Figs. 1 and 3 and corresponding parts have the same reference numerals primed.

As shown in Fig. 2, an inductive coil 101 is positioned in casing 26' encompassing the metal tube 33' so that when a source of alternating current is applied to the terminals 102 and 103 of the coil, the induced currents will heat the tube 33' to the temperature required.

The nozzle shown in Fig. 2 also utilizes a powder feed 60 which differs from that of the nozzle shown in Fig. 1.

Thus, a mixture of powder particles and gas are injected into bore 22' from a suitable source (not shown) connected to the inlet 56' of bore 22'. The stream of powder and gas will pass through the heated tube 33' and be agitated by the gas flowing through the porous wall of the tube from chamber 18'.

As the operation of the nozzle shown in Fig. 2 is identical to that shown in Fig. 1 except for the modifications above pointed out, it will not be further described.

Although as shown in Fig. 3, the tip ends of the nozzles are illustratively circular and the outlets 15 are arranged in a circle about the outlet 12 of tip 10, it is of course to be understood that the nozzle could be of any desired shape such as a narrow slot 105 shown in Fig. 4 and

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the outlets 106 encompassing the outlet 105 could have a corresponding contour.

With the nozzles above described, uniform application of heat to all the particles passing therethrough is assured so that when such particles strike the article being sprayed they will be in the required state for adherence thereto. The guiding and cooling effect of the jets of gas encompassing the outlet of the nozzles prevents spreading of the stream and thereby eliminates waste and provides a cooling action which will substantially prevent dripping of the plastic particles from the sprayed object.

As many changes could be made in the above construction, and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A spray nozzle comprising a porous tube having an inlet and outlet, means to heat substantially the entire length of said tube, and means to force gas under pressure through the porous wall of said tube, whereby when particles are forced under pressure into the inlet of said tube, the gas forced through the wall of the tube will agitate such particles and will prevent the latter from adhering to the bore of such tube, such particles emerging from the outlet of the tube as a spray of highly plastic particles.

2. The combination set forth in claim 1 in which said porous tube is of metal whereby when a source of current is applied to the ends of the tube the latter will become heated.

3. A spray nozzle comprising a porous tube having an inlet and an outlet, a tip and a body portion at the outlet and inlet ends of said tube respectively, said tip and body portions having bores therethrough in communication with said outlet and inlet respectively, means to heat substantially the entire length of said tube, a gas chamber encompassing said tube between said tip and said body portion, a chamber in said tip adjacent the bore therethrough, a passageway from said tip chamber to said gas chamber, means to charge said tip chamber with gas under pressure for flow of such gas through said passageway into said gas chamber and through the porous wall of said tube whereby when particles are forced under pressure through the bore in said body portion into the inlet of said tube, the gas forced through the wall of said tube will agitate such particles and will prevent the latter from adhering to the bore of said tube, such particles emerging from the bore of said tip as a spray of highly plastic particles.

4. The combination set forth in claim 3 in which said tip has a plurality of gas passageways therein having their inlets in said tip chamber, the outlets of said passageways being arranged around the outlet of the tip bore and directed toward a common point whereby the gas in said tip chamber will emerge from said outlets and abut against the periphery of said stream to prevent spreading thereof.

5. A spray nozzle comprising a porous tube having an inlet and an outlet, a tip and a body portion at the outlet and inlet ends of said tube respectively, said tip

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and body portions having bores therethrough in communication with said outlet and inlet respectively, means to heat said tube, a gas chamber encompassing said tube between said tip and said body portion, a chamber in said tip adjacent the bore therethrough, a passageway from said tip chamber to said gas chamber, means to charge said tip chamber with gas under pressure for flow of such gas through said passageway into said gas chamber and through the porous wall of said tube, a feed passageway in said body portion having an outlet leading into the bore therein, means to force a stream of gas past the outlet of said feed passageway and into the tube to create a suction in the bore in said body portion adjacent said outlet, whereby when a source of particles are connected to said feed passageway they will be forced through said tube and will pass through the latter, the gas forced through the wall of the tube agitating such particles and preventing the latter from adhering to the bore of said tube, such particles emerging from the bore of said tip as a spray of highly plastic particles.

6. The combination set forth in claim 5 in which the means to create a suction in the bore of said body portion comprises a plug having a bore therethrough longitudinally aligned with said tube, the outlet of said plug being positioned adjacent the outlet of said feed passageway, and means to connect a source of gas under pressure to the inlet end of said plug bore.

7. The combination set forth in claim 5 in which said gas chamber comprises a cylindrical casing encompassing said tube and spaced therefrom, said casing being affixed at its ends to the opposed faces of said tip and said body portion.

8. The combination set forth in claim 5 in which said gas chamber comprises as a cylindrical casing encompassing said tube and spaced therefrom, said casing being affixed at its ends to the opposed faces of said tip and said body portion, said tip and said body portion being of metal, and insulating means are positioned between the ends of the casing and the adjacent tip and body portion.

9. The combination set forth in claim 5 in which said body portion has a bore therethrough having an outlet and an inlet for connection of a gas line thereinto, valve means controlling the flow of gas through said bore and a tube connecting the outlet of said bore to said tip chamber.

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