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(54) Method and system for application of aggregate coatings

(57) In a method of applying an aggregate coating to a substrate (34), aggregate particles (30) are released from a supply (26) which moves relative to the substrate. The particles free-fall towards the substrate, and are at least partially coated by liquid binder material (32) sprayed from a nozzle (54). The nozzle is also arranged to spray the portion of the substrate where the particles land. A further layer of binder can be sprayed onto the particles after they land, and a further layer of particles can be deposited on the first layer.

The invention also extends to a system for carrying out the method, comprising an apparatus having a hopper (26) with release means for holding and releasing the particles (30), spray means (54) for spraying the liquid binder material (32) onto the particles (30) and the substrate (34), and supply means for supplying the liquid binder material (32) to the spray means (54), and also comprising means for moving the apparatus relative to the substrate.

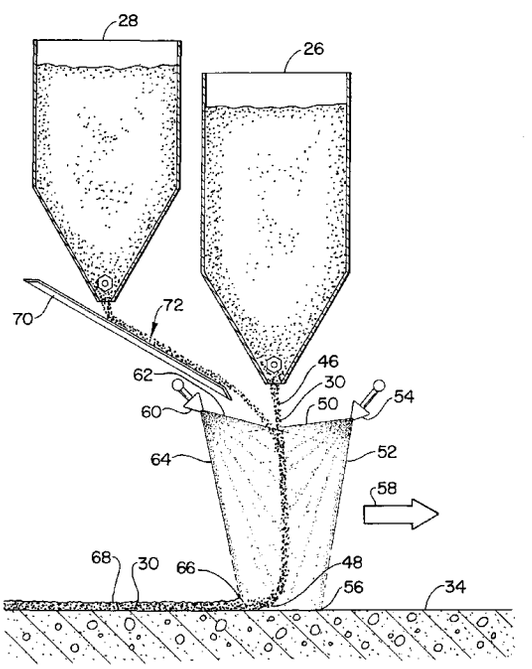

FIG. 3

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Description

The present invention relates to a method and system for coating a substrate, and specifically relates to a method and system for coating a substrate with an aggregate material.

Currently there are no commercially available spray applicators that can convergently spray thin abrasive anti-skid or decorative coatings on concrete and other surfaces. Coating a substrate such as concrete with abrasive anti-skid coatings or decorative coatings typically requires mixing a liquid binder material with an aggregate such as sand or ground quartz and then painting or spraying the mixture onto the concrete. If only a portion of the substrate requires coating, accuracy and control requirements typically dictate whether the mixture is applied by spraying or by painting with some sort of brush. Spray coating processes, however, are limited due to the low sprayability of the liquid binder materials which are typically highly viscous, the limit in attainable coating thickness, and the high amount of waste material generated.

Many liquid binder materials that are utilized in applying anti-skid coatings or decorative coatings (such as the reflective stripes used for lane markings on roadways) have viscosities at ambient temperature which preclude the use of conventional spray applicators. In order to reduce the viscosity to a level which can utilize conventional spray applicators, the liquid binder material is often mixed with a solvent. Unfortunately, such solvents are often environmentally hazardous, and therefore waste material from the spray coating process must be disposed of as hazardous waste.

The conventional spray coating processes comprise combining a liquid binder material (which may include a curing agent), solvents, and aggregate in a vat to form a mixture. This mixture is then pumped from the vat through conduits to a nozzle where it is atomized and sprayed onto the substrate. Once the mixture has been applied to the substrate, the solvent is removed therefrom by evaporation of volatile gas or by applying heat to the mixture to speed evaporation of the solvent.

Unfortunately, mixtures of aggregate and liquid binder material are very prone to clogging, in both the conduits and at the nozzle. Since the mixture must be pumped through the coating system, the liquid binder material can begin to set within the system. Furthermore, the abrasive effect of the aggregate on the pump, conduits, and nozzle substantially reduce the useful life of conventional spray system components, necessitating frequent repair or replacement of such components.

What is needed is a method and applicator to apply thin abrasive anti-skid or decorative coatings onto substrate such as concrete while avoiding the problems of the prior art.

It is therefore an object of the present invention to provide a method and system for application of aggregate coatings onto substrate such as concrete without subjecting spray nozzles to the abrasive effects of aggregate particles.

Another object of the present invention is to combine the aggregate particles with a liquid binder material external of the spray nozzles.

According to a first aspect of the present invention, there is provided a system for applying an aggregate coating to a substrate, said system including an apparatus comprising a first hopper for supplying aggregate particles, the hopper being arranged in spaced relation to and above the substrate, first release means for releasing the particles from said first hopper along a first predetermined path that intersects the substrate at a first location, spray means for spraying a liquid binder material along a plurality of paths, including a second predetermined path and a third predetermined path, wherein the second predetermined path intersects the first predetermined path above the substrate, and the third predetermined path intersects the substrate at a second location in spaced relation to the first location, and supply means for supplying the liquid binder material to the spray means; and means for moving the apparatus in a first direction relative to the substrate.

According to a second aspect of the present invention, there is provided a method for applying an aggregate coating to a substrate, said method comprising positioning a particle supply above a portion of said substrate, the supply containing a plurality of particles, releasing the particles from the aggregate supply at a predetermined rate, allowing said particles to free-fall towards said substrate, coating said particles with a liquid binder material as the particles free-fall towards the substrate, thereby producing coated particles, coating a portion of the substrate with the liquid binder material, thereby producing a coated portion, and impacting said coated particles onto the portion of substrate.

Preferred embodiments of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which:

FIG. 1 shows a first embodiment of the spray coating system of the present invention;

FIG. 2 shows an end view of the hoppers and primary bank of spray nozzles taken along line 2-2 of FIG. 1;

FIG. 3 is a cross-sectional schematic view of the hoppers, spray banks and predetermined paths of the first embodiment of the present invention; and

FIG. 4 is a cross-sectional schematic view of the hoppers, spray banks and predetermined paths of a second embodiment of the present invention.

The present invention, as exemplified in Figure 1, is directed toward improving spray coating processes for applying anti-skid or decorative coatings to substrates such as concrete by decreasing hazardous waste and system problems such as clogging and wear. The applicator 10 is preferably mounted on a vehicle 12,

such as a truck, to provide a means for moving the applicator in a first direction relative to the substrate. As used herein, the term "liquid binder material" means an adhesive material such as epoxy, polyurethane, or another polymer.

The applicator 10 has a supply means that includes at least one (and for binders which must be mixed with a curing agent, at least two) liquid binder storage containers 14,16, a motionless mixer/pump 18 that mixes both liquid binder material constituents (if a two part binder liquid binder is used), a first conduit 20 that extends from the containers 14,16, to the mixer/pump 18, and a second conduit 22 that extends from the mixer/pump 18 to one or more spray nozzles. In the preferred embodiment, the storage containers 14, 16 are heated and pressurized to reduce the viscosity of the liquid binder constituents without the use of solvents. The preferred embodiment further includes an air compressor 24 which may be integral with a generator, or may be driven by some other power source on the truck. The purpose of the air compressor is described in greater detail below.

As shown in Figure 2, in addition to the supply means, the applicator 10 includes at least one, and preferably two hoppers 26,28 for supplying aggregate particles 30 to the liquid binder material 32. Each hopper 26, 28 is located in spaced relation to, and above, the concrete travelling surface 34. Integral with each hopper 26, 28 is a release mechanism 36 for releasing the particles from the hopper 28 associated therewith. Preferably, the release mechanism 36 for each hopper 26,28 includes a slot 38 in the hopper 26,28 for releasing the particles from that hopper 26,28, and a motorized rotary agitator 40 located in the slot for controlling the rate at which the particles are released from that hopper 26,28 through the slot 38.

One or more spray nozzles 42 are located on the truck adjacent the release slots. The nozzles 42 are preferably fan spray nozzles of the type which produce a fan 44 of atomized liquid binder material 32 for broad coverage area. Although the pressure provided by the containers 14, 16 and the pump 18 is used to force the liquid binder material 32 to spray out of each nozzle 42, each nozzle is preferably air-assisted. As such, pressurized air from the air compressor 24 is introduced around each nozzle 42 and aimed in the same direction as the liquid binder material 32 exiting that nozzle 42. This additional air assists in carrying the atomized droplets along the desired paths. As shown in Figure 2, when a relatively long release slot 38 is used, several fan spray nozzles 42 may be manifolded to form a primary bank of nozzles which have spray fans 44 that overlap so as to insure complete coverage of the aggregate particles 30 released from the hoppers 26,28.

Referring now to Figure 3, aggregate particles 30 are released from the first hopper 26 along a first predetermined path 46 that intersects the concrete 34 at a first location 48. Each spray nozzle 42, because of its fan spray characteristics, sprays liquid binder material along a plurality of paths, and more specifically each nozzle in the primary bank 54 simultaneously sprays atomized liquid binder material along a second predetermined path 50 and a third predetermined path 52.

The second predetermined path 50 intersects the first predetermined path 46 above the concrete 34 , and therefore atomized droplets of liquid binder material sprayed along this path 50 substantially coat the aggregate particles as they free-fall from the first hopper 26. Atomized droplets of liquid binder material sprayed along the third predetermined path 52 intersect the concrete 34 at a second location 56 in spaced relation to the first location 48, which, due to the movement of the applicator 10 in the first direction 58 relative to the concrete 34, primes a selected portion of the concrete 34 with liquid binder material immediately prior to the substantially coated aggregate particles impacting thereon.

In the preferred embodiment of the present invention, a secondary bank 60 of spray nozzles is positioned adjacent to the first path 46 opposite the first bank 54. The nozzles of the secondary bank 60 are of the same type as the nozzles of the first bank 54, except that each spray nozzle in the secondary bank 60 simultaneously sprays atomized liquid binder material along a fourth predetermined path 62 and a fifth predetermined path 64. The fourth predetermined path 62 intersects the first predetermined path 46 above the concrete 34, and since the secondary bank of nozzles 60 opposes the primary bank, atomized droplets of liquid binder material sprayed from the second bank 60 along the fourth path 62 coats one side of each particle as it free-falls, thereby coating the portion of each particle which is shielded from the spray of the first bank by the particle itself.

The fifth predetermined path 64 intersects the substrate at a third location 66 in spaced relation to the first location 48, and the first location 48 is between the second 56 and third 66 locations. Atomized droplets of liquid binder material sprayed along the fifth predetermined path 64 intersect the concrete 34 at the third location 66, which, due to the movement of the applicator 10 in the first direction 58 relative to the concrete 34, lays down a top-coat 68 of liquid binder material over the aggregate particles 30 on the selected portion of the concrete 34.

The first embodiment of the applicator 10 of the present invention includes a second hopper 28 and a deflector plate 70 for deflecting particles released from the second hopper 70 into the first predetermined path 46 is located immediately below the first 26 and second 28 hoppers. If an aggregate coating is desired which includes a mixture of very fine particles of one type of material and coarser particles of another type of material, storing the fine and coarse particles in the same hopper would likely result in the fine particles settling to the bottom thereof. Accordingly, the concentration of fine particles in the aggregate released from the hopper would initially be relatively high, and decrease as the hopper was emptied during the coating process.

This problem is avoided by storing the two aggregate particle types in separate hoppers, 26,28 and using the deflector plate 70 to direct the particles released from the second hopper 28 into the path 46 of the particles released from the first hopper 26. By controlling the rate at which the particles are released from each hopper 26, 28, the desired concentration of fine particles can be maintained throughout the coating process until one of the hoppers becomes empty. Additional hoppers and release mechanisms may be added as needed to accommodate mixing of aggregate coatings having three or more different materials of varied particle size.

Even if aggregate particles of only one material, such as sand, are used in the coating, it may be desirable to use two hoppers 26, 28 to obtain a more consistent rate of delivery of the sand. For example, if the agitators tend to release the particles in pulses or "waves", the agitators can be mechanically or electrically controlled to insure that when the waves of particles released from the second hopper 28 intersect the first predetermined path 46, the waves of particles released from the second hopper 28 are out of phase with the waves of particles released from the first hopper 26.

A second embodiment of the applicator 10 of the present invention is shown in Figure 4. The second embodiment is the same as the first embodiment, except that the second embodiment does not include a deflector plate 70, and the second bank 60 of nozzles in the second embodiment does not oppose the first bank 54 of nozzles. Absent the deflector plate 70, aggregate particles are released from the second hopper and free-fall along a sixth predetermined path 72 that terminates at a fourth location 74.

Each spray nozzle in the secondary bank 60 of the second embodiment simultaneously sprays atomized liquid binder material along a fourth predetermined path 76 and a fifth predetermined path 78, as in the first embodiment. However, in the second embodiment, the fourth predetermined path 76 intersects the sixth predetermined path 72 above the concrete 34, and therefore atomized droplets of liquid binder material sprayed along this path 76 substantially coat the aggregate particles as they free-fall from the release mechanism of the second hopper 28. Atomized droplets of liquid binder material sprayed along the fifth predetermined path 78 intersect the concrete 34 at a fifth location 80 in spaced relation to the fourth location 74 and between the first 48 and fourth 74 locations.

Due to the movement of the applicator 10 in the first direction 58 relative to the concrete 34, liquid binder material sprayed along the fifth predetermined path 78 primes the aggregate particles from the first hopper 26, which have already been coated onto the selected portion of the concrete 34, with liquid binder material, immediately prior to subsequent coating of the selected portion with aggregate particles released from the second hopper 28. Since the second bank 60 of nozzles in the second embodiment is not positioned so as to produce a top-coat on the aggregate particles released from the second hopper 28, the second embodiment leaves an aggregate top surface 82 which is partially uncoated. This partially uncoated top surface 82 is used to provide a higher coefficient of friction for anti-skid coatings, or a higher reflectivity for decorative coatings.

The applicator of the present invention separately feeds the mixed liquid binder material and granular aggregate fillers (sand, filler etc.) into a convergent area and subsequently dynamically combines them external to the spray nozzles in a cross convergence. As those skilled in the art will readily appreciate, slot sizes and agitation can be varied for different materials or different selected areas of concrete. Although the invention has been shown and described as being useful for coating concrete, it is to be understood that the present invention is suitable for use on any similar substrate such as asphalt, brick, etc. The present invention represents an improvement over prior art spray coating techniques since it improves sprayability, reduces excess material, and improves flowability by reducing the viscosity of the liquid binder material without the production of hazardous waste, minimizes clogging and eliminates the wear that a nozzle typically experiences as a result of spraying an abrasive material such as aggregate therethrough.

Although this invention has been shown and described with respect to detailed embodiments thereof, it would be understood by those skilled in the art that various changes in form and detail thereof may be made without departing from the scope of the claimed invention.

Claims

1. A method for applying an aggregate coating to a substrate (34), said method comprising:

positioning a particle supply (26) above a portion of said substrate (34), said supply containing a plurality of particles (30) ;
moving said particle supply (26) relative to said substrate (34) ;
releasing said particles (30) from said particle supply (26) at a predetermined rate;
allowing said particles (30) to free-fall towards said substrate (34) ;
coating said particles (30) with a liquid binder material (32) as said particles (30) free-fall towards said substrate (34), thereby producing coated particles;
coating a portion of said substrate (34) with said liquid binder material (32), thereby producing a coated portion; and,
impacting said coated particles onto said coated portion of said substrate (34).

2. The method of claim 1 wherein the step of impacting said coated particles onto said coated portion of said substrate (34) is followed by the step of spraying a top coat of liquid binder material (32) onto the coated particles impacted onto said coated portion of said substrate (34) .

3. The method of claim 2 wherein the step of positioning a particle supply above a portion of said substrate includes

positioning a first particle supply (26) above a portion of said substrate (34), said supply containing a plurality of first particles; and,
positioning a second particle supply (28) above a portion of said substrate (34), said supply containing a plurality of second particles.

4. The method of claim 3 wherein the step of releasing said particles from said aggregate supply at a predetermined rate includes releasing said first particles from said first particle supply (26) at a first predetermined rate and releasing said second particles from said second particle supply (28) at a second predetermined rate.

5. The method of claim 4 wherein the step of releasing said first particles from said first particle supply (26) at a first predetermined rate and releasing said second particles from said second particle supply (28) at a second predetermined rate is followed by the step of mixing said first particles with said second particles external of said particle supplies (26,28)

6. The method of claim 4 wherein the step of impacting said coated particles onto said coated portion includes impacting said first particles onto said coated portion of said substrate (34).

7. The method of claim 6 wherein the step of spraying a top coat of liquid binder material (32) onto the coated particles impacted onto said coated portion is followed by the step of impacting said second particles onto said coated portion of said substrate (34).

8. A system for applying an aggregate coating to a substrate (34), said system comprising:

an apparatus (10) comprising
a first hopper (26) for supplying aggregate particles (30), said hopper being arranged in spaced relation to and above said substrate (34),
first release means (36) for releasing the particles (34) from said first hopper (26) along a first predetermined path (46) that intersects the substrate (34) at a first location (48),
spray means (54) for spraying a liquid binder material (32) along a plurality of paths, including a second predetermined path (50) and a third predetermined path (52), wherein the second predetermined path (50) intersects the first predetermined path (46) above the substrate (34), and the third predetermined path (50) intersects the substrate (34) at a second location (56) in spaced relation to the first location (48), and
supply means for supplying the liquid binder material to the spray means (54) ; and
means (12) for moving the apparatus in a first direction relative to the substrate (34).

9. The system of claim 8 wherein the supply means comprise at least one liquid binder storage container (14,16), a pump (18), a first conduit (20) that extends from the container (14,16) to the pump (18), and a second conduit (22) that extends from the pump (18) to the spray means (54) .

10. The system of claim 8 or claim 9, wherein the first release means (36) comprise a first slot (38) in the first hopper (26) for releasing the particles (30) from the first hopper (26), and a first agitator (40) for controlling the rate at which the particles (30) are released from the first hopper (26) through the first slot (38).

11. The system of any of claims 8 to 10, wherein the spray means (54) comprise at least one primary fan spray nozzle (44) which simultaneously sprays atomized liquid binder material (32) along the second and third predetermined paths (50,52) .

12. The system of any of claims 8 to 10, wherein the plurality of paths further include a fourth predetermined path (62) and a fifth predetermined path (64), wherein the fourth predetermined path (62) intersects the first predetermined path (46) above the substrate (34), and the fifth predetermined path (64) intersects the substrate (34) at a third location (66) in spaced relation to the first location (48), and the first location (48) is between the second and third locations (56,66).

13. The system of claim 12 wherein the spray means comprise at least one primary fan spray nozzle which simultaneously sprays atomized liquid binder material (32) along the second and third predetermined paths (50, 52), and at least one secondary nozzle which simultaneously sprays atomized liquid binder material (32) along the fourth and fifth predetermined paths (62, 64).

14. The system of any of claims 8 to 13, wherein the apparatus further comprises a second hopper (26)

for supplying aggregate particles, said second hopper (28) being arranged in spaced relation to and above said substrate (34), and second means for releasing the particles from said second hopper along a sixth predetermined path (72) that intersects the first predetermined path (46) above the substrate (34).

15. The system of claim 14 wherein the second release means comprise a second slot in the second hopper (28) for releasing the particles from the second hopper (28), a second agitator for controlling the rate at which the particles are released from the second hopper (28) through the second slot, and a deflector plate (70) for deflecting particles released from the second hopper (28) into the first predetermined path (46).

16. The system of any of claims 8 to 11, wherein the apparatus further comprises a second hopper (28) for supplying aggregate particles, said second hopper (28) being arranged in spaced relation to and above said substrate (34), and second means for releasing the particles from said second hopper (28) along a sixth predetermined path (72) that intersects the substrate (34) at a fourth location (74).

17. The system of claim 16 wherein the second release means comprise a second slot in the second hopper (28) for releasing the particles from the second hopper (28), and a second agitator for controlling the rate at which the particles are released from the second hopper (28) through the second slot.

18. The system of claim 17 wherein the plurality of paths further include a fourth predetermined path (76) and a fifth predetermined path (78), wherein the fourth predetermined path (76) intersects the sixth predetermined path (72) above the substrate (34), and the fifth predetermined path (78) intersects the substrate (34) at a fifth location (80) in spaced relation to the first location (48), and the fifth location (80) is between the first location (48) and the fourth location (74).

19. The system of claim 18 wherein the spray means comprise at least one primary fan spray nozzle which simultaneously sprays atomized liquid binder material (32) along the second and third predetermined paths (50,52), and at least one secondary nozzle which simultaneously sprays atomized liquid binder material (32) along the fourth and fifth predetermined paths (76, 78).

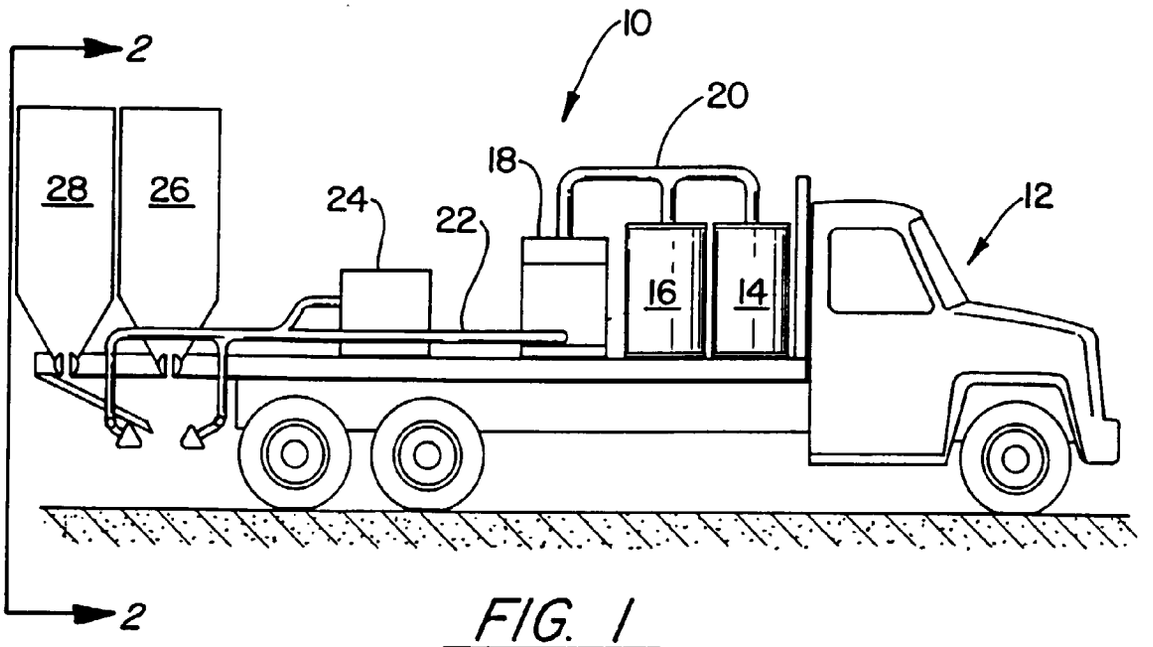

FIG. 1

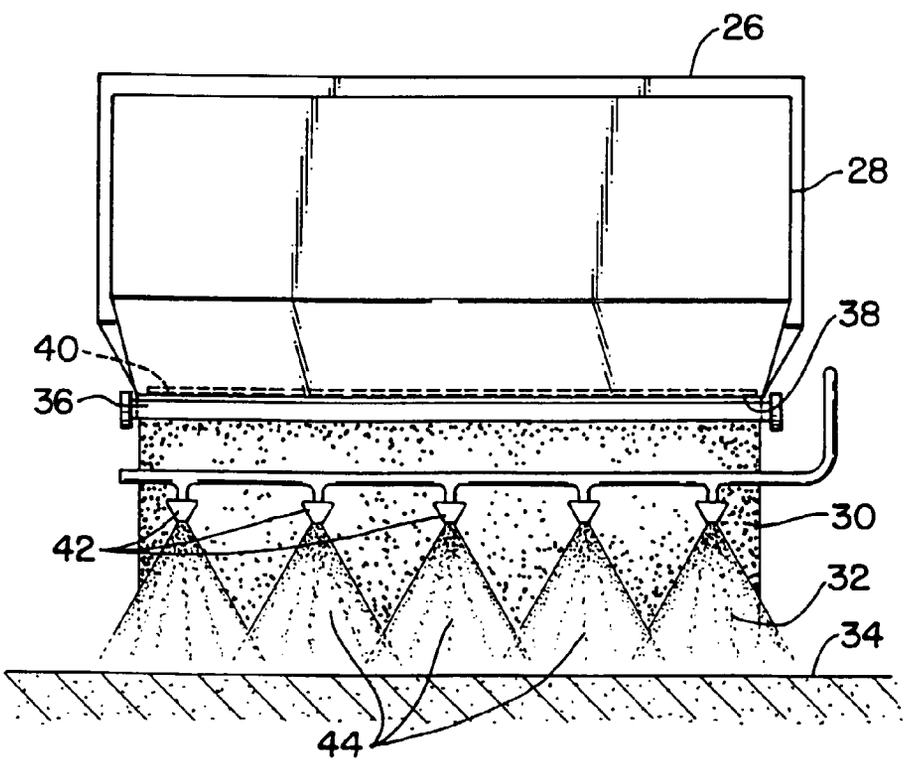

FIG. 2

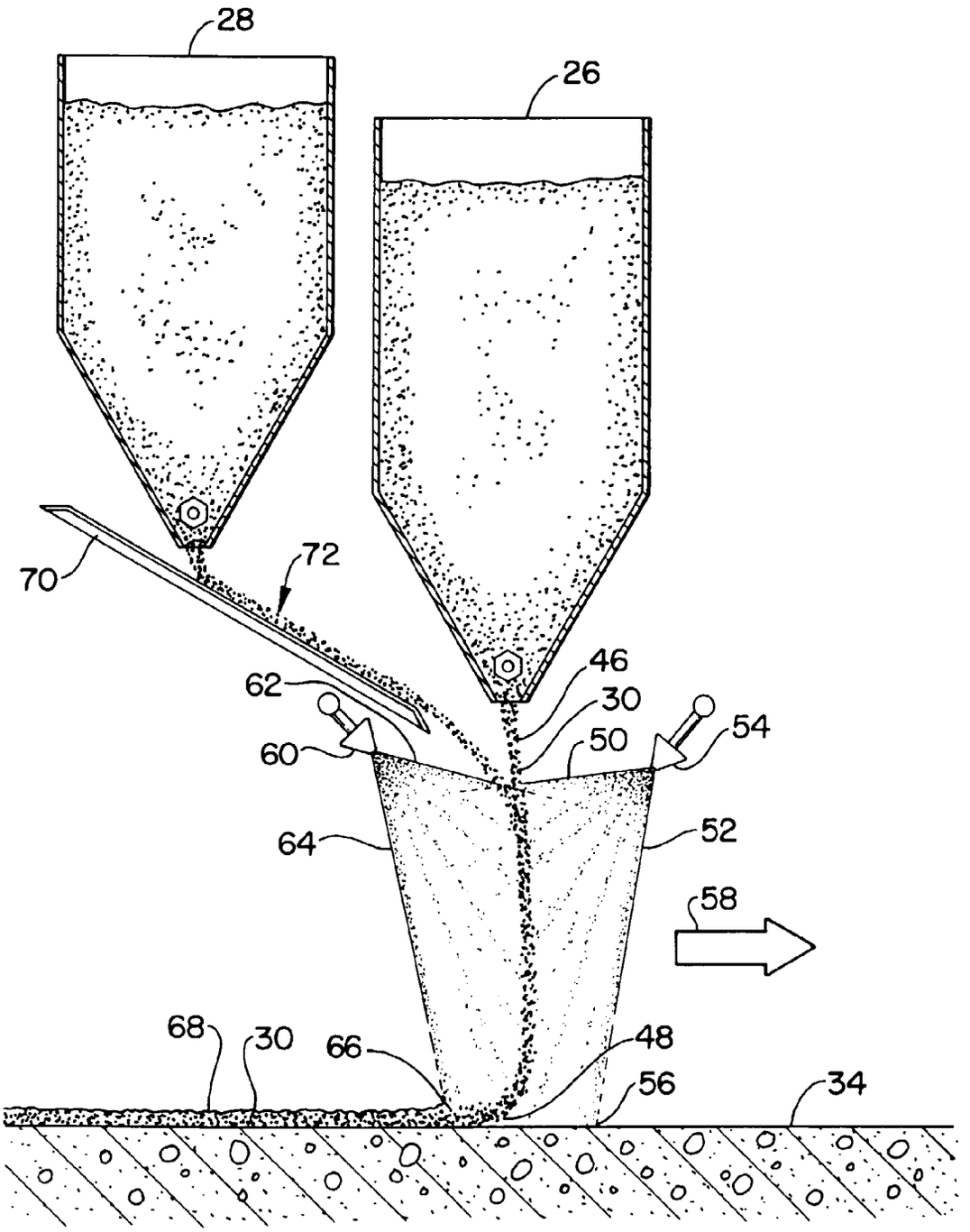

FIG. 3

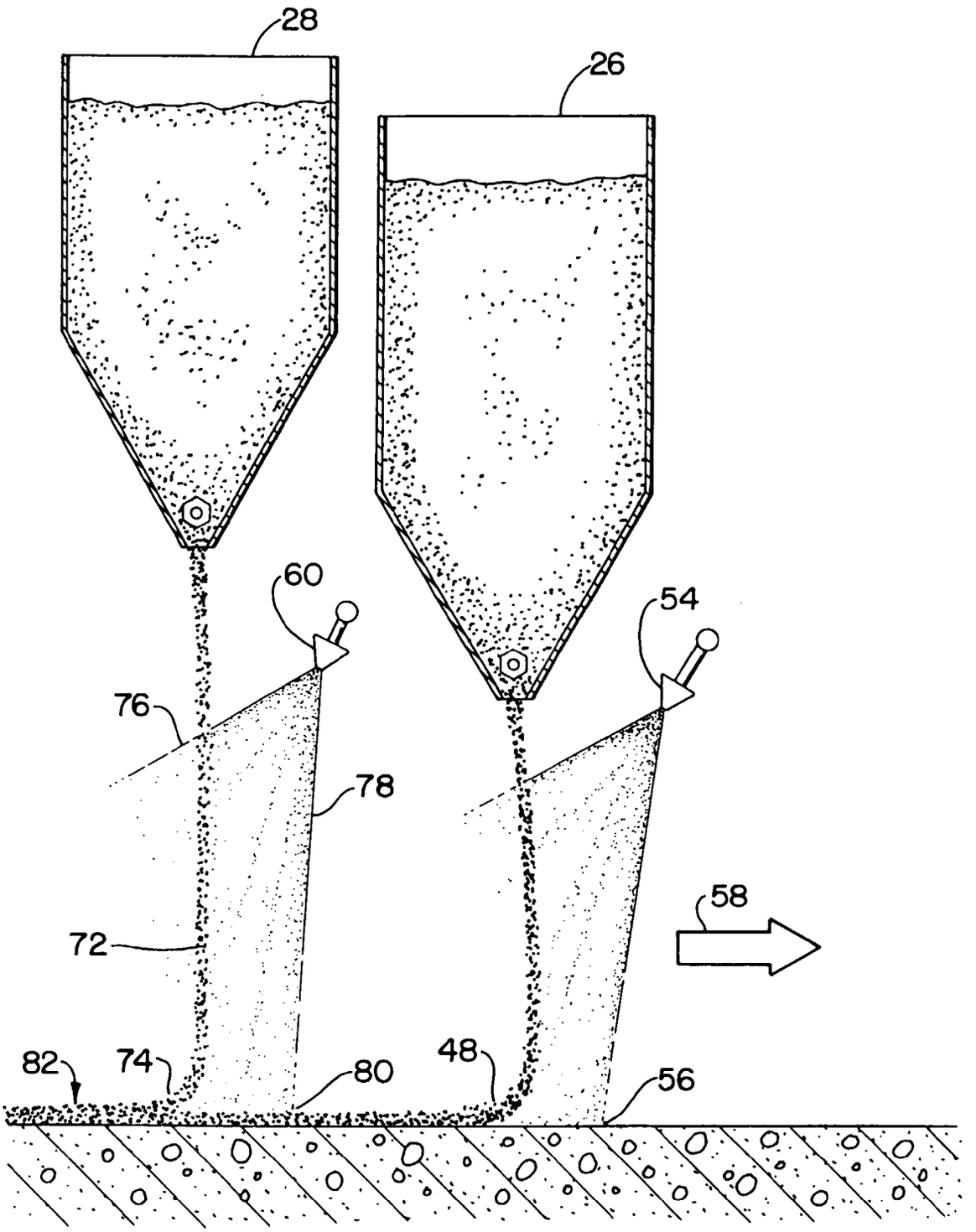

FIG. 4