Jan. 30, 1968 E. A. BARBER 3,366,277

PNEUMATIC HANDLING SYSTEM FOR PARTICULATE MATERIAL

Filed June 17, 1966 3 Sheets-Sheet 1

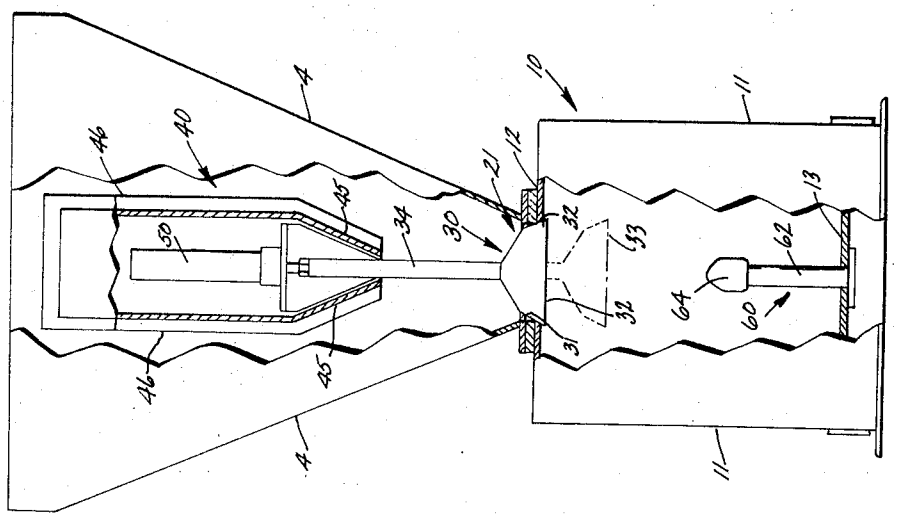


FIG. 2.

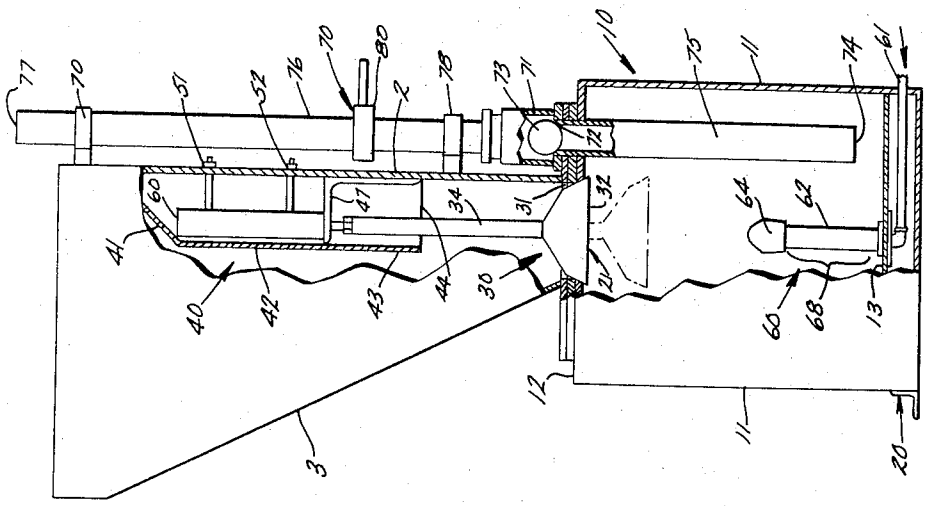


FIG. 1.

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PNEUMATIC HANDLING SYSTEM FOR PARTICULATE MATERIAL

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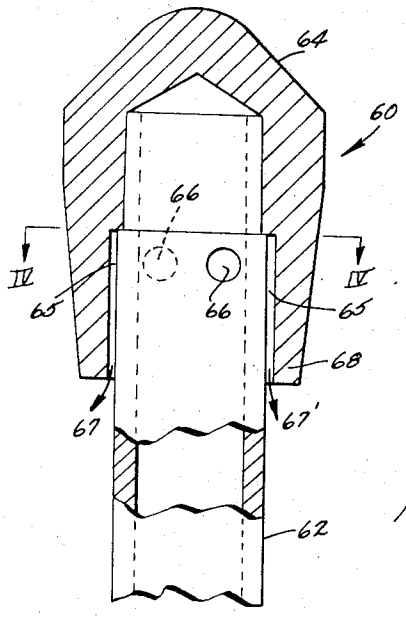


FIG. 3.

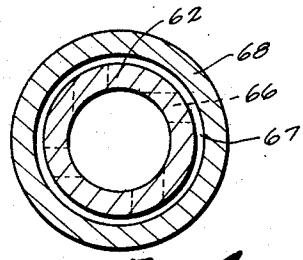


FIG. 4.

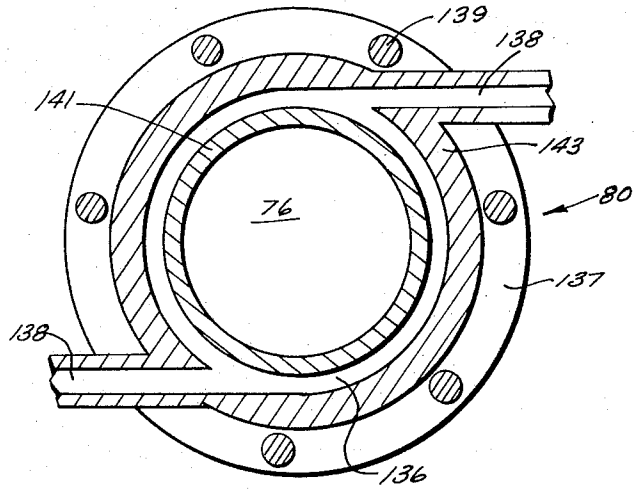


FIG. 6.

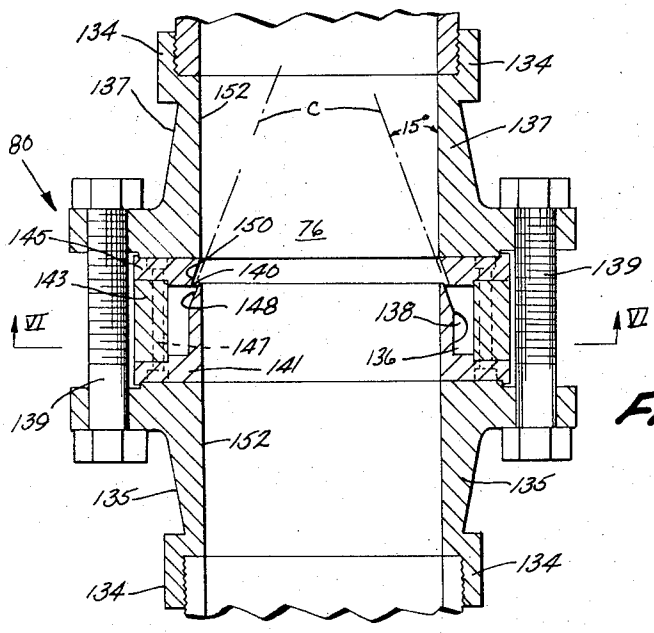


FIG. 5

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PNEUMATIC HANDLING SYSTEM FOR PARTICULATE MATERIAL

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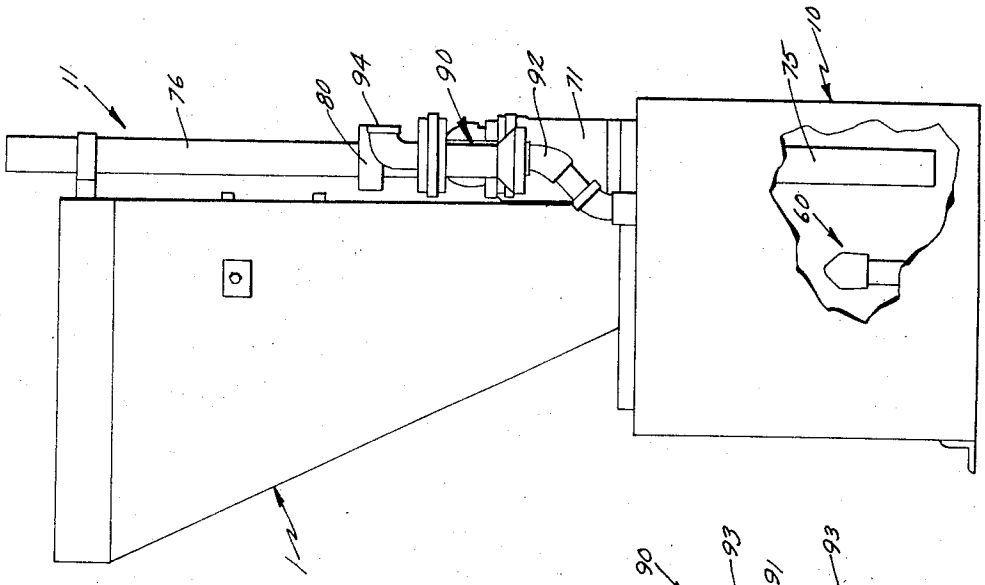


FIG. 7.

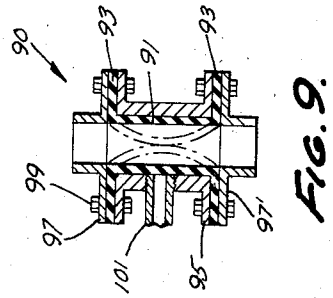


FIG. 9.

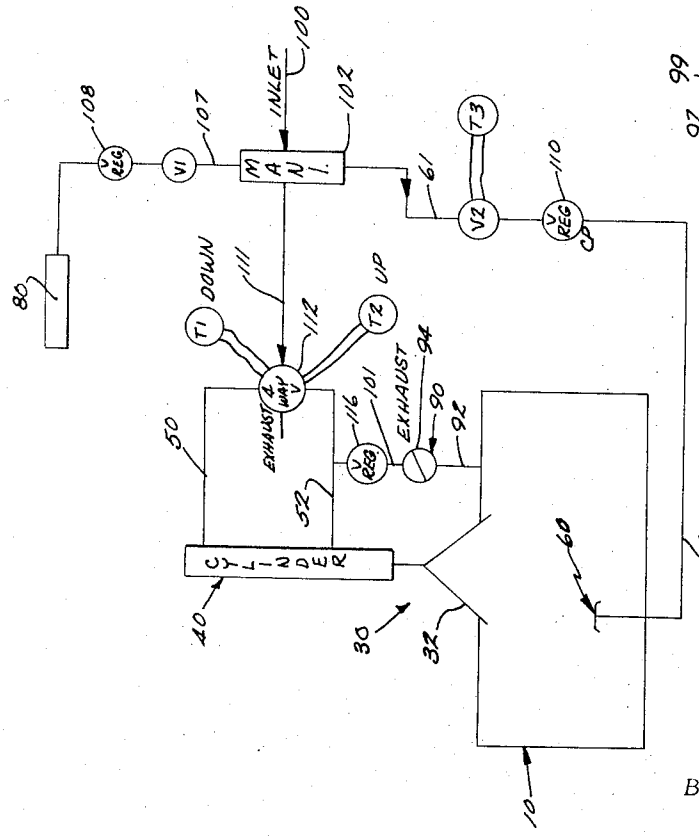


FIG. 8.

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3,366,277

PNEUMATIC HANDLING SYSTEM FOR PARTICULATE MATERIAL

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Continuation-in-part of application Ser. No. 477,677, Aug. 6, 1965. This application June 17, 1966, Ser. No. 558,455

10 Claims. (Cl. 222—70)

ABSTRACT OF THE DISCLOSURE

Granular material fluidizing and transporting apparatus employing in combination with a hopper, a fluidizing chamber, and material inlet valve means, a special arrangement of a specifically located and configurated fluidizing nozzle apparatus in combination with the inlet valve and with a specifically located and operated material discharge, all controlled to effect instantaneous, swirling fluidizing and discharge, preferably in combination with a special venting system.

This is a continuation-in-part application of copending patent application entitled Pneumatic Sand Transporter, Ser. No. 477,677 and filed Aug. 6, 1965.

This invention relates to apparatus for pneumatically transporting granular or powdered material from one location to another, and more particularly relates to apparatus for pneumatically fluidizing and conveying materials such as foundry sand, bentonite, iron oxide, fire clay, sea coal, paint pigment, and most other flour-like or particulate and granular materials.

Since this apparatus was developed initially for handling foundry sand, it will largely be explained in relation thereto for convenience. However, the apparatus can be used for other materials like those noted. It is particularly useful, however, for sand since it contrasts sharply with all other prior attempts to convey sand in an upward direction out of a chamber.

Since forging and casting plants utilize great quantities of sand which must be conveyed to many working stations, it is desirable that this sand be transported from a receiving station to the working locations throughout the foundry without utilizing valuable floor space such as working aisles. Further, the sand should be conveyed rapidly and dependably to economically meet the demand of all work stations, yet without causing substantial air contamination with dust or the like.

Pneumatic sand conveying systems have been developed and used heretofore, using a fluidizing action on the sand in order to obtain proper sand density in the flowing stream. However, most prior apparatuses have dropped the sand out of the bottom of a vessel with downwardly convergent sides. One prior device which does not drop it out the bottom in such that it requires a physical sand thruster plunging upwardly into the sand from the bottom to try to suspend it. The inventor herein has devised a particular type of apparatus and system that enables granular materials such as sand or the like to actually be dependably discharged upwardly out of a chamber without the need for an outlet from the bottom of the chamber and without the necessity of a physical sand thruster with all of its problems and complications. The invention is keyed around the discovery that fluidizing can be achieved very effectively with the use of a special type of fluidizing chamber and apparatus arrangement. This effective fluidizing action enables direct entrainment of the sand into the transporting gas without an initial mechanical, mass displacement of the sand with physical means

such as a sand thrusting diaphragm or the like. This greatly simplifies the equipment, reducing both initial and maintenance costs and increasing service life, thereby enabling such pneumatic sand conveying equipment to be economically and practically available to relatively small and medium size foundry operations. It further increases the output of the conveying apparatus many times over that of known apparatus of generally the same size. In fact, the novel equipment has received tremendously enthusiastic reception by handlers of granular material particularly small and medium size foundry men. The equipment has been ordered in great numbers by such foundries since it enables them to modernize their operations and economically compete more effectively. The novel equipment enables automatic operation and control of a good share of the foundry operations, even though the operations are relatively small. Further the minor expense required for replacement parts is tremendously small in comparison with other equipment.

Close observation of many of the units built according to the teachings of the parent application have shown that additional features are desirable to eliminate certain potential problems of the equipment. More specifically, firstly, it has been determined that sometimes certain materials such as sand do not drop from the hopper to the fluidizer chamber of the novel apparatus, but rather tend to bridge across the inlet to the chamber, so as to prevent sand from being conveyed from the fluidizer. Secondly, it has been noted that use of the equipment to convey sand containing resin powder (e.g. for shell molding or the like), or to convey flour type materials, sometimes results in undesirable dust in the air near the hopper and fluidizer. Upon careful analysis of the equipment during experimentation and operation, the inventor discovered that both the bridging and the dust blow problems were caused by certain residual pressure differential conditions and/or certain displacement air flow conditions.

It is one object of this invention to provide a granular fluidizing and conveying apparatus having relatively few moving parts, compactness, relatively low cost and maintenance requirements, and which is largely advantageous to small and medium size foundries to enable the operations thereof to be automated.

It is another object of this invention to provide a granular fluidizing apparatus capable of conveying materials such as sand out the top of a chamber but which does not require or employ displacement of the sand mass by any means other than the transporting air. It does not require a physical plunger or diaphragm or the like to cause complications. Yet the fluidizer is so effective that, immediately upon actuation of the pneumatic fluidizer, the sand or other material is ready to be conveyed as a fluid.

It is another object of this invention to provide a novel fluidizing nozzle capable of effectively fluidizing granular material such as sand to a completely flowable state even though the latter lies on a flat surface and within an enclosed fluidizing chamber.

Another object of this invention is to provide a granular fluidizing and conveying apparatus having a unique relationship between the fluidizing chamber structure, a special fluidizing nozzle, and an upwardly oriented outlet conduit for the fluidized material having its lower open end protruding into the chamber.

Another object of this invention is to provide a novel sand fluidizing and conveying apparatus having means to prevent bridging of sand dropping into the fluidizing chamber of the apparatus.

Another object of this invention is to provide a novel sand fluidizing and conveying apparatus having means to prevent dust blowing into the surrounding vicinity.

Another object of this invention is to provide a unique sand fluidizing and conveying apparatus having special pressure control means on the fluidizing chamber and capable of being programmed into automatic timed operation.

These and other objects of this invention will become apparent by study of the following specification in conjunction with the figures in which:

FIG. 1 is an elevational side view of the apparatus of this invention, with certain portions cut away;

FIG. 2 is an elevational front view of the apparatus in partial cross-section;

FIG. 3 is a fragmentary, enlarged, partially cross-sectioned elevation view of the fluidizing nozzle assembly;

FIG. 4 is a sectional view taken on plane IV—IV of FIG. 3;

FIG. 5 is a vertical sectional view of the venturi unit on the outflow conduit;

FIG. 6 is a sectional view taken on plane VI—VI of FIG. 5;

FIG. 7 is a side elevational view of the complete apparatus;

FIG. 8 is a schematic view of the control and operating circuit; and

FIG. 9 is a vertical sectional view of the vent valve assembly.

Referring now to the drawings, the assembly **11** includes the hopper **1**, fluidizer chamber **10**, inlet control valve assembly **30**, fluidizing nozzle assembly **60**, fluidized material outlet assembly **70**, and vent valve assembly **90**.

The hopper receives and temporarily stores granular material to be discharged to the fluidizer. This hopper is composed of a vertical back wall **2**, a downwardly inwardly slanted front wall **3**, and downwardly inwardly convergently slanted side walls **4**.

Positioned below the hopper is fluidizing chamber **10** preferably formed with a vertical cylindrical peripheral wall **11**, a top cover plate **12**, and a rigid bottom plate **13**. The entire assembly rests on support **20** which may be integral with the side wall.

The convergent bottom of hopper **1** is positioned above and communicates with the top of the fluidizing chamber through a passage throat **21**. The plunger valve assembly **30** is provided at throat **21** between the hopper and the top of the fluidizing chamber. A downwardly flaring valve seat **31** surrounds the throat. The plunger valve is shown in closed position in solid lines and open position in phantom lines. The valve head **32** is suspended on vertical shaft **34** attached to the extending piston rod of vertical control cylinder **50**.

The closure valve head **32** of the plunger valve assembly is generally dome-shaped, having downwardly divergent walls. It may have a double taper as shown in FIGS. 1 and 2 or a conical shape as shown in FIG. 8. The walls of throat **31** are also downwardly divergent to cooperate with the sides of the closure head when the latter is pulled up into the closed position. This arrangement facilitates the operation of the valve by causing the sand to flow off the sides of the head as the valve closes. It has another functional purpose as will be seen more fully hereinafter.

A plunger valve cylinder housing indicated generally at **40** is provided within hopper **1**. This housing is composed of wall members **41–46** to protect the valve operating mechanism from the abrasive effects of the granular material. Contained within the hopper is an L-shaped bracket **47** to support cylinder **50**. L-shaped bracket **47** has apertures (not shown) which shaft **34** passes and by means of which actuating cylinder **50** is rigidly positioned. The actuating cylinder **50** may be any type of prime mover capable of exerting an up and down thrust, preferably, a two-way air cylinder operated directly from air lines **51** and **52**.

The fluidizing nozzle assembly **60** includes a special

vertical standpipe **62** and a cooperative hood **64**. The cylindrical standpipe projects up from the chamber bottom at the center of the chamber. The standpipe positions the hood up within the fluidizing chamber, substantially spaced above bottom panel **13**, and centered under valve **30**. The standpipe is supplied with compressed air by an inlet pipe **61** communicating with the bottom of the hollow standpipe and extending through support **20**.

The details of the fluidizing nozzle assembly are best explained by reference to FIGS. 3 and 4. Adjacent the upper extremity of standpipe **62**, within the confines of hood **64** is located a plurality of generally radial apertures **66** which are spaced around the standpipe at intervals, and project tangentially from the pipe interior to exterior to cause a helical flow pattern in a manner to be described. It has been found, for example, that a standpipe having an outside diameter of 1.125 inches and four equally spaced quarter inch apertures will give satisfactory results. The fluidizing nozzle hood **64** is rigidly affixed to the upper extremity of standpipe **62**, and has a depending annular skirt **68** extending down around the upper end of the standpipe, beyond the orifices, slightly spaced from the standpipe and orifices to form an annular downwardly oriented air channel **65** around and below that portion of standpipe **62** containing apertures **66**. An annular air channel with a radial width of 0.040 inches has been found satisfactory on the standpipe mentioned above. The portion **68** of standpipe **62** preferably is tapered slightly downwardly divergently along its length, the wider end abutting the floor of the fluidizing chamber. The above described nozzle assembly emits an annular air stream in the downward direction indicated generally by arrows **67**. The annular stream is necessary for effective fluidizing. The helical air flow of the annular stream creates a swirling action in the chamber to fluidize the entire charge of material therein out to the chamber cylindrical wall, an asssits the migration of the material to the bottom inlet **74** of the outflow conduit. The annular air stream flares radially inwardly and outwardly as it emerges from annular channel **65**, to sweep around the base of the standpipe and to sweep outwardly to be effective at the annular corner junction of the generally horizontal bottom **13** and wall **11**. This is very important in this construction for effective fluidizing and material flow. It has been found that the lower outlet of channel **65** may be inclined radially outwardly at a small acute angle to the vertical but the angle should be small, if used, since the material should not enter apertures **66** when the fluidizer is shut off, since the flared air flow pattern should sweep around the base of the standpipe, and since the optimum helical pattern is then obtained.

The fluidized sand outlet assembly, indicated generally by reference numeral **70**, includes a downwardly open inlet **74** in lower conduit **75** projecting into fluidizing chamber, a check valve chamber **71**, valve seat **72**, a pressure responsive ball check valve **73**, and an upper conduit **76** extending up above the fluidizing chamber to communicate at **77** to other conduit means (not shown) to transport the entrained sand to the points of demand. The lower conduit **75** extends sufficiently into fluidizing chamber **10** so that port **74** is located well below the bottom of flange **68** of air nozzle **64**. Port **74** should be sufficiently close to bottom **13** to obtain optimum negative pressure at this point, such negative pressure being caused in the conduit by venturi unit **80**. Maximum negative pressure at this point **74** occurs when the spacing of it from bottom **13** is such that the planar area of port **74** equals the cylindrical area of the space between end **74** and bottom **13**. However, it has been found that if the port **74** is this close to bottom **13**, the material flow path tends to be restricted slightly. Therefore, it has been determined that if the cylindrical flow area noted is made to equal about 1.25 that of the planar area of port **74**, an optimum compromise is reached at which material output flow is maximized.

Enclosed within enlarged diameter valve chamber 71 is a ball check valve 73. The ball valve sits against lower seat 72 when not elevated by the fluidized sand. When ball 73 is elevated it is prevented from sealing by abutting a cross stop pin extending across valve chamber 71. Attached to the upper portion of the valve chamber is upper conduit 76. It may be stabilized by being secured to the hopper by suitable fastening brackets 78.

On conduit section 76 is a venturi unit 80 that cooperates with the system as a booster conveyor and as a primary conveyor. That is when the fluidizer is operating, the unit 80 creates a negative pressure at 74 to pull the fluidized material from the fluidizing chamber and pushes it up the conduit; and when the fluidizer is shut off, and check valve 73 closes, unit 80 acts as a prime conveyor of the fluidized material in conduit 76 and the conduits (not shown) downstream thereof. This is explained in more detail hereinafter. The combination of all of these elements achieves dependable, rapid material flow even though the fluidizing chamber is at a relatively low positive pressure and the material is moving in it at a relatively low velocity.

The details of construction of the Venturi unit 80 are shown most clearly in FIGS. 5 and 6. The unit is inserted and fastened to conduit 76 by appropriate connectors 134. The unit includes a pair of end pieces 135 and 137 held together by bolts 139. These end pieces clamp between them a manifold assembly composed of three rings 141, 143 and 145, secured together by bolts 147 and defining an annular manifold chamber 136. Compressed air is tangentially introduced into manifold chamber 136 by tangential air intakes 138. The walls 148 and 150 of rings 141 and 145 define between them a frustoconical nozzle 140 which opens into conduit 76. It will be noted from FIG. 5 that the jet 80 is so-constructed that there is no discontinuity in conduit 50 throughout the jet, except for the actual discharge opening of nozzle 140 itself. This construction significantly reduces the turbulence at jet 80 and aids in the rapid creation of a smooth air cushion downstream, i.e. up conduit 76 from unit 80. Air is discharged in a spiraling laminar pattern from annular nozzle 140 and expands in the conveying pipe into a divergent pattern. The rapid forward motion and quantity of air discharged from nozzle 140 creates a vacuum or negative pressure upstream of unit 80 which is transferred down to inlet 74 to draw the fluidized material up through the lower conduit section and pushes the material up through the upper conduit section. In order to compensate for the convergence of the air stream at the exit from nozzle 140, the surface of the imaginary cone C' defined by nozzle 140 is disposed at a 15° angle to conduit wall 152. The rapid spinning motion of the air stream as it travels through the conduit quickly causes the convergence forces to be overcome by the centrifugal forces action on the air molecules, so that the air stream quickly settles into a cylindrical air cushion spiraling along forwardly on the walls of the conduit. The air is introduced into manifold 136 by intakes 138 in a manner to cause counter-clockwise spinning of the air emerging from nozzle 140. This is the natural spin direction in the Northern Hemisphere. If this spin direction is not observed, a reversal of the spin direction occurs in the conduit at some distance downstream from unit 80 to possibly cause clogging, and to cause lowering of the efficiency of the unit. For the same reasons, the air outflow from nozzle assembly 60 is caused to move in a counter-clockwise direction, (looking down at the nozzle).

Another feature of the apparatus which enables rapid refilling of the fluidizing chamber on a cycled basis, and which prevents the dust blow problem which was encountered with earlier units, is the controlled venting valve means 90. This venting valve means 90 is communicant with fluidizing chamber 10 through conduit 92 and is communicant to the atmosphere through conduit 94. Valve means 90 is preferably of the type shown in FIG. 9, in order to enable it to be sealed off even though dust particles may be retained in the air stream moving through it. It preferably comprises a resilient cylindrical bladder 91 having a pair of radially extending peripheral end flanges 93. The housing of the assembly includes an annular rigid metal ring 95 having a central cylindrical section, and a pair of radially extending peripheral end flanges to fit within the annular outer peripheral channel between flanges 93 of the bladder, and to encompass the cylindrical bladder section 91. This annular member is secured to a pair of end coupling members 97 and 97' by suitable bolts 99. Coupling 97 connects to conduit 94, and coupling 97' connects to conduit 92. A control air pressure line 101 extends through annular member 94 to be communicant with the outside of bladder 91 so that, when air pressure is applied through this conduit, the bladder is deformed inwardly as shown by the phantom lines in FIG. 9 to seal off the conduit.

The control system for the apparatus is illustrated in FIG. 8. This control system is largely pneumatic, with certain of the valves being controlled by timers. More specifically, the pressurized inlet conduit 100 communicates with a manifold 102 which supplies pressurized air to three main branch assemblies. Conduit 107 communicates through a normally open solenoid valve V1, through a pressure regulator 108 to Venturi unit 80. Conduit 61 communicates through a solenoid valve V2, controlled by timer T3, through a pressure regulator 110 to fluidizer nozzle assembly 60. Conduit 111 communicates through a four-way solenoid valve 112 controlled by timer T1 and T2 for the down and up strokes of cylinder 40. The four-way solenoid valve communicates with inflow line 111, its exhaust line, and with the upper and lower ends of cylinder 40 through conduits 51 and 52. A bleed-off line 101 is taken from conduit 52 to the lower end of the cylinder, through pressure regulator 16, through vent valve assembly 90, which controls the venting action from fluidizing chamber 10.

When the apparatus is at rest, cylinder 40 is in its lowered position so that valve head 32 is in its lowered open condition as shown in phantom lines in FIG. 1. Sand or other granular material in the hopper is therefore free to flow by gravity down into the fluidizing chamber. Normally, it fills the entire chamber except for a peripheral area around the upper outer portion, and except for a void spot which forms directly below the lower flat underside surface of valve head 32.

When the apparatus is actuated, valve V1 is normally constantly open so that Venturi unit 80 is always energized. Also, upon activation of the assembly, valve V2 is opened so that pressurized air can flow through conduit 61 to fluidizer 60. Simultaneously, air pressure is allowed to pass through solenoid valve 112 through the conduit to the lower end of cylinder 40 to raise the cylinder rod and close valve head 32. It will be realized that since the sand or other material has been allowed to flow freely into the fluidizing chamber over the surface of valve head 32, a substantial amount of sand still rests on the upper surface of valve head 32. It also will be realized that sand normally acts as a solid material so that the valve head woud not be able to close, except that the fluidizer is so instantaneously effective that it forms a fluidized system of the entire charge in the fluidizing chamber, even the sand on top of valve head 32, so that the valve head can actually be rammed up closed into a sealed condition practically instantaneously upon starting or activation of the system. When the valve head 32 is rammed upwardly into a closed position, the fluidized sand previously resting upon its upper surface flows down around the valve and into the cavity beneath the lower surface of the valve. Simultaneously, with activation of the fluidizer and the cylinder, the bleed-off line 101 allows a controlled amount of air pressure, controlled by regulator 116, to close vent valve 90 by applying a peripheral pressure around bladder

91. After the sand becomes fluidized, it is swirled in the fluidizing chamber at a low velocity and under a slight positive pressure from the fluidizer nozzle. The negative pressure created at inlet 74 of the outlet system causes the sand nearest this port to be entrained first and sucked up through the conduit, opening the ball check valve 73, and flowing up past Venturi unit 80 which is constantly operating. This Venturi unit pushes the entrained material up through conduit 76 to the communicating conduits (not shown). The fluidizer assembly 60 is operated for a period of time determined by the setting of timer T3. This is initially regulated so as to accommodate the size of chamber 10 and the type of material. At the end of the timed fluidizing period, the chamber is scoured and practically clear of the granular material. It will be realized that, as the sand is removed from the fluidizing chamber, the level falls to a point near the bottom of apron 68 of the nozzle head, to expose the nozzle head. The downward conical blast of air erodes the sand away and scours the walls, drawing the material away from the base of the standpipe and also helically swirling it out of the peripheral corner juncture between the bottom 13 and walls 11. Timer T3 times out approximately 3 to 5 seconds prior to timing out of timer T1, so that the fluidizer is shut off a few seconds prior to opening of inlet valve head 32. During this 3 to 5 second interval, since the positive pressure is no longer applied through the fluidizer, and since Venturi unit 80 operates continuously, this Venturi unit applies a continuous negative pressure into opening 74, to decrease the positive pressure in the fluidizing chamber down to atmospheric or slightly above. Thus, when timer T1 times out and causes solenoid valve 112 to shift to open conduit 51 for lowering cylinder 40 and opening the receiving throat into chamber 10, no back pressure will blow the sand back up through the hopper into the atmosphere. Further, if a very slight residual positive pressure does remain in fluidizing chamber 10, the slight positive pressure is vented through resilient valve means 90 which is allowed to open simultaneously with opening of valve head 32. Thus, the granular material can drop freely down into the chamber without initially blowing back. Moreover, since vent valve 90 remains open while valve head 32 is open, the air contained in chamber 10 is displaced by the dropping sand, and passes out through valve 90 without blowing back up through the hopper as was previously experienced. It has been found that the filling time can thus be accomplished in a matter of a few seconds rather than requiring a much longer time as was previously necessary. After a few seconds, timer T2 times out to energize the four-way valve 112 to open it, allowing pressurized air to flow through line 52 to raise cylinder 40 and close valve head 42 for the next fluidizing action. The cycling control of timers T2 and T3 are subsequently controlled each time by being energized when timer T1 times out.

It will be realized that even when valve head 32 is opening, to drop another charge of granular material into the fluidizing chamber, the previous charge of material is simultaneously being conveyed through the conduits to the points of demand in the foundry or other facility because the Venturi unit 80 is still operating to push the sand upwardly through the conduit 76 and its communicate conduits not shown. This pressure caused in the conduit, downstream of the ball check valve causes the ball check to seal even more assuredly on its seat after the fluidizer is shut off. The unit 80 thus acts as a more or less secondary conveyor when the fluidizer is operating and the ball check is open, and acts as a primary conveyor when the fluidizer is shut off and the ball check closes.

In operation, the system has been found to work extremely effectively, rapidly, dependably, and to have a tremendous output in relation to its size. Because of the novel venting system used in combination with the apparatus, the sand does not tend to bridge over the inlet throat to the fluidizing chamber. Therefore each opening of valve head 32 assures a proper charge of material being dropped into the fluidizing chamber.

It is conceivable that certain minor structural features of this apparatus might be modified without departing from the concept. It is also conceivable that certain additional advantages or features may be apparent to those in the art upon studying the foregoing specification and specific preferred form shown. Hence, it is intended that the invention is to be limited only by the scope of the appended claims and the reasonably equivalent structures to those defined therein.

I claim:

1. Apparatus for fluidizing and transporting granular material, comprising: a hopper; a fluidizing chamber positioned below said hopper; a throat between said hopper and said fluidizing chamber for allowing granular material to flow from said hopper into said fluidizing chamber; valve means for sealing off said throat at predetermined intervals; a hollow member extending upwardly into said fluidizing chamber, generally centrally thereof, and having nozzle means on the upper end thereof, within said fluidizing chamber, with said nozzle means being positioned substantially from both the top and bottom of said fluidizing chamber tangential apertures at the upper inner end of said hollow member and hood means at said upper end with a depending flange surrounding that portion of said hollow member which contains said apertures to form, in conjunction with said hollow member, an annular, downwardly opening nozzle outlet, said tangential apertures and annular outlet cooperating to cause fluidizing of the material in a swirling flow in said chamber, and directing an annular stream of air in a substantially downward direction to fluidize said granular material; compressed air supply means to said hollow member; and discharge outlet means radially offset from said hollow member for conveying said fluidized granular material from said fluidizing chamber, having port means for receiving the pneumatically fluidized material substantially below the point of air discharge from said nozzle means.

2. The apparatus in claim 1 wherein said nozzle means is generally centrally located in said chamber, and is capable of creating a positive pressure in said chamber; said outlet means comprises generally upright conduit means spaced radially from said nozzle means with said port spaced below said nozzle means; and pneumatic conveying means on said outlet means arranged to create a negative pressure at said port to be cooperative with said nozzle means to cause optimum material flow.

3. The apparatus in claim 1 wherein said control means includes multiple way valve means alternately communicating said pneumatic supply connection means to opposite ends of said cylinder through first and second conduit means to shift said throat valve means open and shut; and wherein bleed-off conduit means extends from said conduit means to said venting valve means, to control the actuation thereof.

4. The apparatus in claim 1 wherein said nozzle means is centrally located in said chamber, and is capable of creating a positive pressure in said chamber; said outlet means comprises generally upright conduit means with said port spaced below said nozzle means; and pneumatic conveying means on said outlet means arranged to create a negative pressure at said port to be cooperative with said nozzle means to cause optimum material flow.

5. The combination as set forth in claim 4 wherein said valve means comprises: a power unit capable of providing vertical motion; a shaft having one end thereof attached to said power unit; a generally dome-shaped valve member having downwardly divergent walls attached to the other end of said shaft, and a valve seat for receiving said member, said valve member being shiftable between an open lowered position spaced below said valve seat in said fluidizing chamber, and a closed upper position against said valve seat.

6. The combination as set forth in claim 5 in which said nozzle means is positioned directly below said valve means, said dome shaped valve member causing material flowing into said fluidizing chamber to be deflected from falling directly on said nozzle means.

7. The apparatus in claim 3 wherein said chamber has a bottom surface, and said port is spaced from said surface such that the imaginary peripheral area created by extending an imaginary surface from the periphery of said port to said bottom surface is about equal to or slightly greater than the cross sectional area of said port.

8. The apparatus of claim 1 including, power operable venting valve means communicable with said chamber means and with ambient air outside said chamber and shiftable between open and closed positions; power operating means operably connected with said transfer control valve means; and power control means operably associated with said power operating means and said power operable venting valve means adapted to vent said fluidizing chamber with opening of said transfer control valve means.

9. The apparatus in claim 8 wherein said power operating means for said transfer control valving means is pneumatically operated through conduit means, and said venting valve means is pneumatically operated by a bleed-off connection from said conduit means.

10. Apparatus for fluidizing and transporting granular material, comprising: a hopper; a fluidizing chamber positioned below said hopper; a throat between said hopper and said fluidizing chamber for allowing granular material to flow from said hopper into said fluidizing chamber; valve means for sealing off said throat at predetermined intervals; annular nozzle means within said fluidizing chamber, said nozzle means being positioned substantially from both the top and bottom of said fluidizing chamber and directing an annular stream of air in a substantially downward direction to fluidize said granular material; outlet means for conducting said fluidized granular material from said fluidizing chamber, said outlet means having a port for receiving the air entrained material, said port being substantially below the point of air discharge from said nozzle means; pneumatically operable venting valve means communicable with said fluidizing chamber and ambient air outside said chamber; a pneumatic power cylinder operably connected to said throat valve means to open and close it; pneumatic supply connection means

to said nozzle means, to said cylinder, and to said venting valve means and control means operably associated with said pneumatic supply connection means to cause said venting valve means to open with actuation of said cylinder to open said throat valve means; said control means including multiple-way valve means alternately communicating said pneumatic supply connection means to opposite ends of said cylinder through first and second conduit means to shift said throat valve means open and shut; including bleed-off conduit means extending from said conduit means to said venting valve means, to control the actuation thereof; said pneumatic power cylinder extending up into said hopper; a hollow member extending upwardly into said fluidizing chamber, generally centrally thereof, and having said nozzle means at the upper end thereof, tangential apertures at the upper end of said hollow member, and hood means at said upper end with a depending flange surrounding that portion of said hollow member which contains said apertures to form, in conjunction with said hollow member, an annular, downwardly opening nozzle outlet, said tangential apertures and annular outlet cooperating to cause fluidizing of the material in a swirling flow in said chamber; pneumatic conveying means on said outlet means arranged to create a negative pressure at said port to be cooperative with said nozzle means to cause optimum material flow; and said control means including timer means to actuate said power cylinder, said multiple-way valve means, and said fluidizing nozzle means in controlled relationship.

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