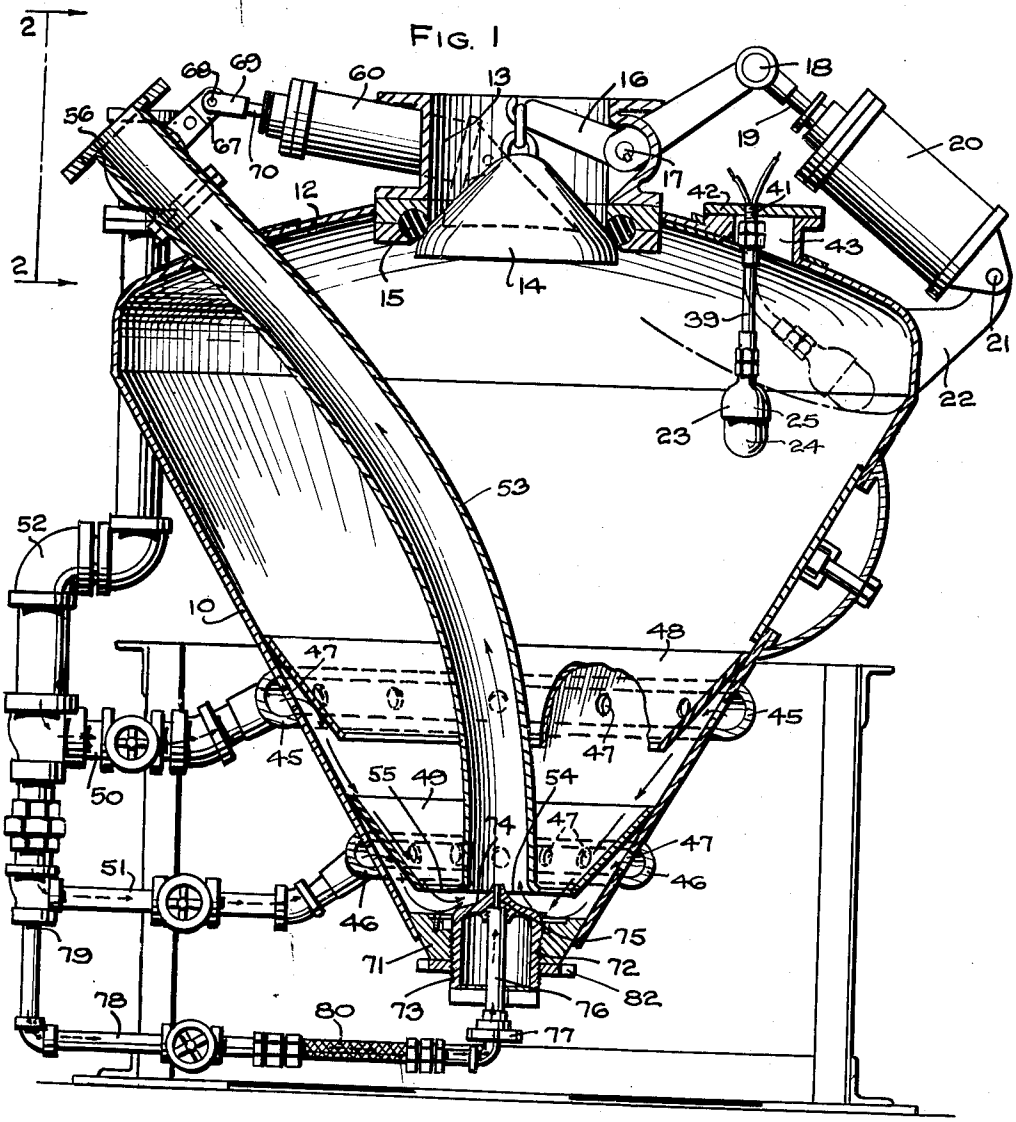
Aug. 10, 1954 J. H. HAMPTON ET AL 2,686,083

MATERIAL HANDLING APPARATUS

Filed March 10, 1950

3 Sheets-Sheet 1

FIG. 1



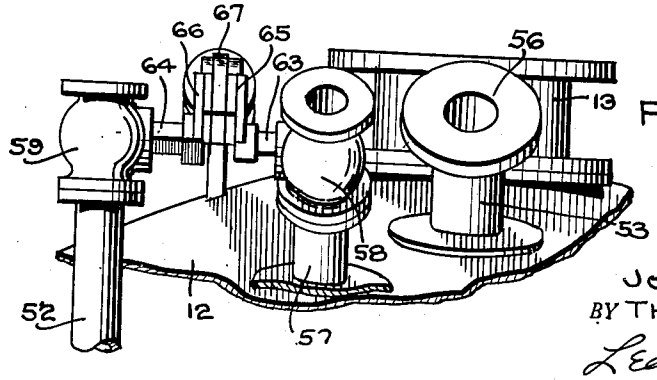


FIG. 2

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MATERIAL HANDLING APPARATUS

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FIG. 3

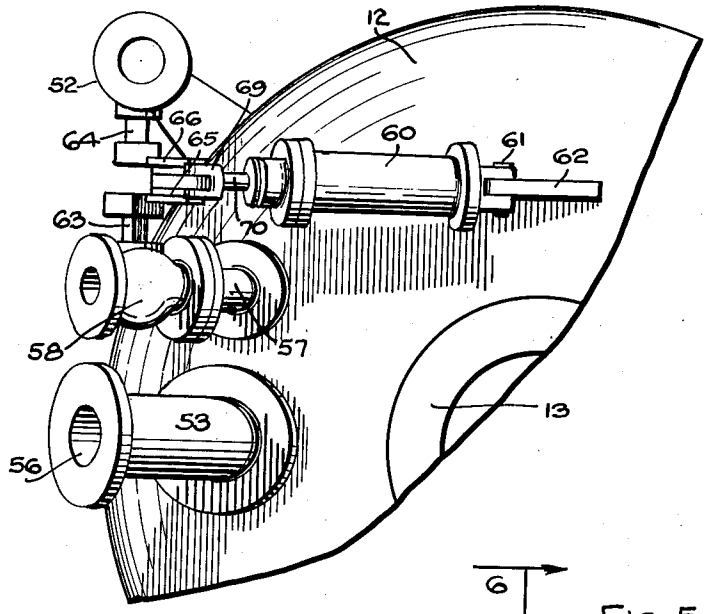


FIG. 4

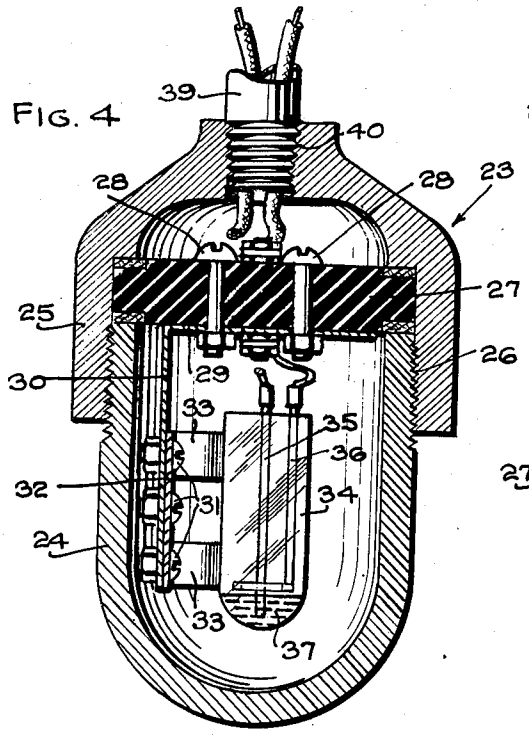
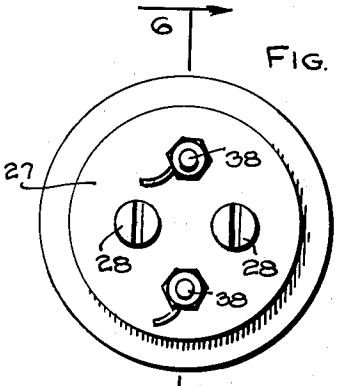


FIG. 5



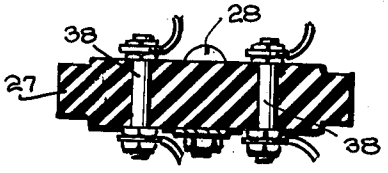


FIG. 6

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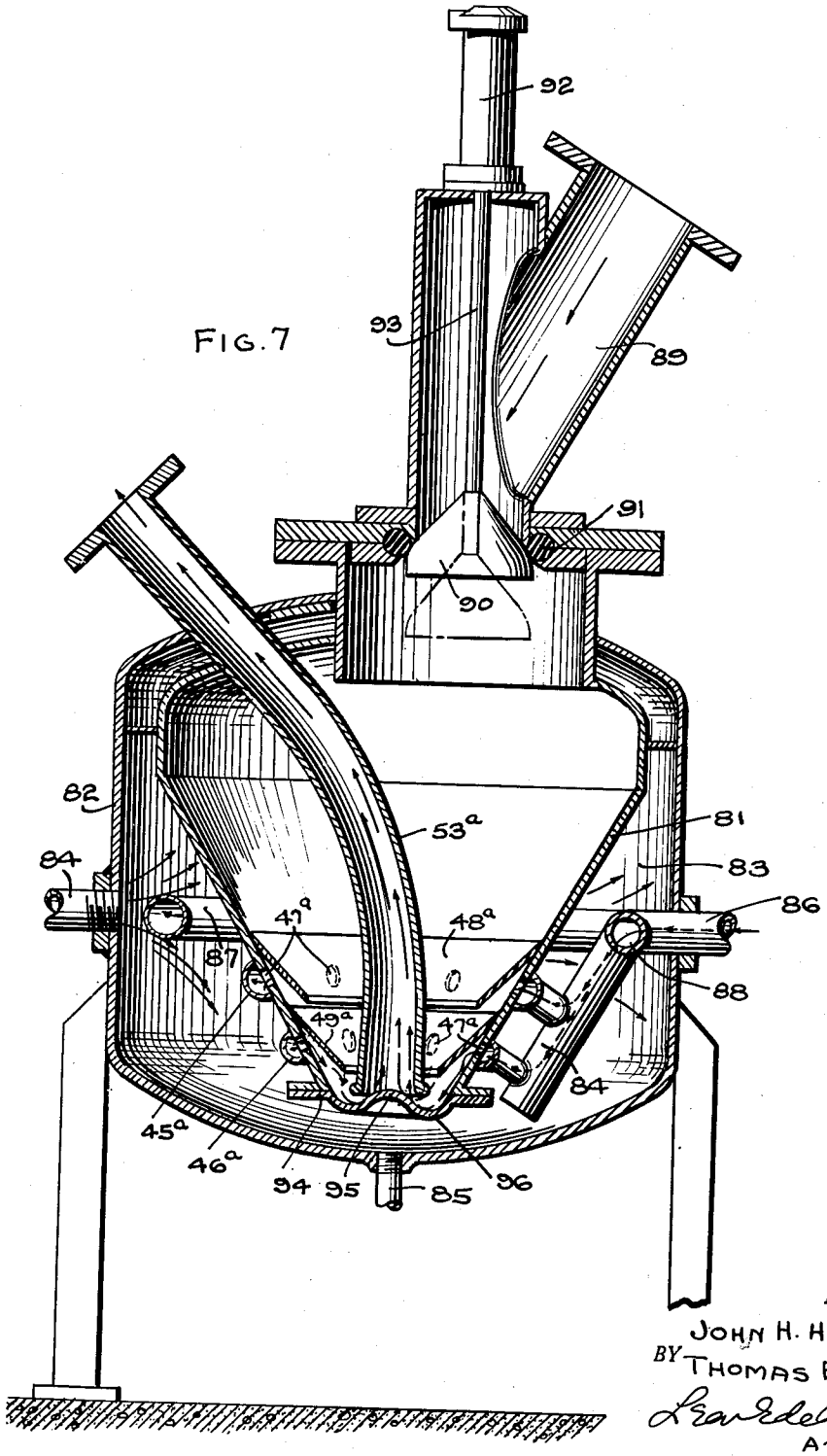
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FIG. 7



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UNITED STATES PATENT OFFICE

2,686,083

MATERIAL HANDLING APPARATUS

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Application March 10, 1950, Serial No. 148,952

6 Claims. (Cl. 302—53)

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This invention relates generally to material-handling apparatus and more particularly to apparatus designed for the pneumatic handling and conveying of bulk material which is powdered, ground or otherwise reduced to finely comminuted state.

Among the principal objects of the present invention is to provide an improved apparatus which includes a main container for receiving successive batches of the comminuted material and from which each batch of the material is discharged by compressed air for pneumatic conveyance thereof through a conduit system to a remote point of use of the material, the container being provided with means which are operative to (1) insure reception in the container of only a predetermined quantity of the material to be handled; (2) insure automatic sealing of the container when the material therein reaches a predetermined level, such sealing being effected preliminarily to introduction of compressed air in the container for expulsion of the comminuted material; and (3) insure venting of the container to atmosphere following discharge of the material therefrom and during the operation of filling the container with a succeeding batch of material.

In addition to the foregoing, it is among the objects of the present invention to provide a pneumatic conveyor apparatus for comminuted materials having multiple-ported manifold means for introducing air under pressure at points spaced substantially uniformly about the material-receiving container, thereby insuring uniform distribution and application of the material-expelling compressed air to the mass of materials in the container, the apparatus including, in addition to said manifold, baffle means which serve to prevent clogging of the air delivery ports of the manifold.

A further and important object of the invention is to provide an apparatus of the character aforesaid having means for loosening, by aeration, the material within the container so as to prevent any tendency for the material to become solidly packed within the container, particularly in the material pick-up region immediately surrounding the inlet to the discharge conduit of the container, said means being operative to effect uniform aeration of the material throughout said material pick-up region.

Still another object of the present invention is to provide in an apparatus of the character aforesaid a material-receiving container having auxiliary means for injection of a high-velocity

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jet of compressed air into the inlet end of the container discharge conduit in such manner as to induce a suction action upon the material in the immedate zone of entry of material into said conduit, said suction action supplementing the positive pressure of the compressed air within the sealed container to insure complete expulsion of the material from the container.

A still further object of the present invention is to provide in an apparatus of the character aforesaid means, essentially in the form of a steam jacket for the material-receiving container, for drying the material within the container and so conditioning it for most efficient discharge from the container and conveyance to its point of use.

Other objects and advantages of the invention will appear more fully hereinafter, it being understood that the present invention consists substantially in the combination, construction, location and relative arrangement of parts, all as described in detail in the following specification, as shown in the accompanying drawings and as finally pointed out in the appended claims.

In the accompanying drawings, which are illustrative of certain preferred embodiments of the present invention,

Figure 1 is a vertical sectional view of one preferred form of apparatus constructed in accordance with and embodying the principles of the present invention;

Figure 2 is a partial side elevational view of the top portion of said apparatus as viewed from the line 2—2 of Figure 1;

Figure 3 is a top plan view of the portion of the apparatus shown in Figure 2;

Figure 4 is a vertical sectional view of a preferred construction of a level indicator and control device which is operative to effect closure of the container when the same is charged with material to a predetermined level;

Figure 5 is a top plan view of the terminal plate of said level indicator;

Figure 6 is a sectional view of the terminal plate as taken along the line 6—6 of Figure 4; and

Figure 7 is a vertical sectional view of a modified form of the apparatus of the present invention.

Referring now to the drawings and particularly to Figure 1 thereof, it will be observed that the apparatus of the present invention includes a container 10 adapted to receive successive charges of the comminuted material to be handled. The container 10 is preferably of the

form shown, its main body portion being of inverted frusto-conical shape the upper end of which is closed by a centrally apertured dome-like top 12, the central aperture of the top being fitted with an annular sleeve or collar 13 to provide an opening through which the container may be filled to a predetermined level. Operatively associated with the filling opening fitting 13 is a closure member 14 of generally conical shape, this closure member, when it its raised position as shown in Figure 1, being adapted to seat against an annular rubber gasket 15 suitably fitted in the bottom end of the fitting 13. Preferably, the closure member 14 is suspended, as at 15, from the inner end of a bell-crank lever assembly 16 having a supporting shaft 17 suitably journalled in a side wall portion of the fitting 13. The outer extremity of the lever assembly 16 is connected, as at 18, to the piston rod 19 of a compressed air cylinder 20, which latter is in turn pivotally mounted, as at 21, upon a bracket 22 suitably secured to the upper end of the container 10.

The general arrangement of the closure 14 and its associated compressed air cylinder 20 is such as to provide for automatic fluid pressure actuation of the closure member 14 by means of an electrically operated control unit 23 suitably suspended from the top wall 12 of the container for disposition within the interior thereof.

As most clearly appears in Figures 1 and 4 to 6, this control unit 23 essentially consists of a hollow bulb-like casing formed of a pair of separable, generally cylindrical members 24 and 25 which are screw-threaded together, as at 26, to clamp therebetween a circular terminal block 27 suitably formed of insulating material. Secured to the bottom surface of this terminal block 27, as by means of a pair of bolts 28—28, is a right angular bracket member 29 having a vertically depending arm 30. Mounted upon this depending arm 30 by means of bolts 31 is a clip member 32 having vertically spaced pairs of spring-clip-fingers 33. Supported by these spring-clip-fingers 33 is a mercury type contact unit consisting of a glass tube 34 in which is sealed a pair of electrical conductor rods 35—36, the lower ends of which are adapted to be bridged by a pool of mercury 37 when the tube 34 is inclined with respect to the vertical. This mercury type contact tube is well known in the art, one form thereof being manufactured and sold under the name "Mercoid" by The Mercoid Corporation, of Chicago, Illinois. It will be understood, accordingly, that the mercury contact tube 34, apart from its associated elements as described, forms no part of the present invention.

The conductor rods 35—36, which are normally electrically disconnected when the tube 34 is vertically disposed, are respectively connected to a pair of terminal bolts 38—38 carried by the plate 27 in insulating relation with respect to the bracket supporting bolts 28—28. The terminal bolts 38—38 are in turn respectively connected to a pair of conductor wires which extend upwardly from the external casing of the control unit 23 through a flexible conduit 39 threadedly secured at its lower end, as at 40, to the unit 23 and at its upper end, as at 41 (see Figure 1), to a supporting plate 42 suitably secured to the top wall 12 of the container in covering relation to an opening 43 in said top wall for projection of the control unit therethrough. The conductor wires 38—38 leading from the control unit may be conventionally connected with any suitable

type of audible or visual indicator (not shown) adapted to be energized when the control unit is deflected, as shown in dotted lines in Figure 1, to effect electrical bridging of the mercury tube conductor rods 35—36. Preferably, however, the conductor wires 38—38 are connected in circuit with a relay (not shown) for controlling the operation of the fluid pressure cylinder 20, this arrangement being such that automatically as the mercury tube 34 is tilted out of its normal vertical position, the fluid pressure cylinder 20 is actuated to raise the closure 14 against its seat 15 and so seal off the interior of the container 10.

It will be apparent that tilting of the control unit 23 into position to effect closing of the electrical circuit for control of the fluid pressure cylinder 20 or for actuation of an audible or visual signal will occur automatically as the level of the material introduced into the container 10 reaches a predetermined height, such level being indicated for illustrative purposes by the dotted line in Figure 1. Inasmuch as it is necessary to securely maintain the closure 14 in its closed position, as shown in Figure 1, until all of the material in the container 10 has been completely expelled therefrom, any suitable provision may be made for holding closed the relay circuit which controls actuation of the fluid pressure cylinder 20 upon return of the control unit 23 into its normal full line position shown in Figure 1, as when the material in the container 10 drops below the normal position of said control unit. Since the electrical circuit, which includes the control unit 23 and the cylinder actuating relay or relays, forms no part of the present invention, it is not thought necessary to describe the same herein, it being merely pointed out in this connection that the circuit arrangement would be such as to automatically seat the closure member 14 in its closed position when the container 10 is charged with a predetermined quantity of the material to be handled and to automatically open the closure member 14 when the container is completely emptied of material and is freed of any superatmospheric air pressure. It will be understood, of course, that where the control unit 23 is employed merely as a make-and-break switch for electrical control of an audible or visual signal to indicate when the material introduced into the container 10 reaches a predetermined level, the fluid-pressure cylinder 20 may be manually controlled for fluid-pressure closing and opening of the member 14, or, if so desired, the closure member 14 may be designed for manual opening and closing thereof as required.

In one preferred construction of the apparatus, as shown in Figure 1, the conical body portion of the container 10 is internally fitted with a vertically spaced pair of compressed air supply manifolds 45 and 46. Each of these manifolds is in the form of an annular channel, preferably of semicylindrical cross-section which is secured to and extends circumferentially about the external wall of the container. Formed in a portion of the container wall, which is embraced by each of the manifolds 45 and 46, is a row of circumferentially spaced openings 47, which openings serve as ports for introduction of compressed air from each of the manifolds into the interior of the container 10.

Secured to the inner wall surface of the container 10 are a pair of vertically spaced annular baffles 48 and 49, each of inverted frusto-conical shape. As clearly appears in Figure 1, the baffles

48 and 49 are respectively secured in position to overlie the circumferentially spaced air delivery ports of the manifolds 45 and 46, the baffles being each relatively so inclined inwardly of the ported wall portions of the container 10 as to permit free and unobstructed passage of the compressed air into the container 10 at the same time that they shield the air delivery ports from becoming clogged by the material with which the container is charged.

The manifolds 45 and 46 are respectively connected by way of suitably valved laterally extending pipe lines 50 and 51 to a main compressed air supply line 52, which latter is preferably disposed to one side of the container 10 and rises vertically to a point above the top of the container where it may be connected to a conduit (not shown) leading to a supply of compressed air, ordinarily of a pressure in the neighborhood of 100 pounds per square inch.

Projecting through the top wall 12 of the container 10 into the interior of the container is a material discharge conduit 53, the lower end of which is open, as at 54, and centered within the container 10 at a point spaced just above the closed bottom thereof. Preferably, the open bottom end of the conduit 53 is disposed in substantially coplanar relation with respect to the bottom edge of the lowermost baffle 49, thereby providing an annular space 55 between the concentric bottom edges of the baffle 49 and the conduit 53 for free flow of the material into the bottom end of the conduit for subsequent discharge of the material from the container 10 by way of the conduit 53. It will be understood, of course, that the outer end 56 of the material discharge conduit 53 may be suitably connected to a conveyor pipe (not shown) for conveyance of the material to any desired point remote from the container 10.

As most clearly appears in Figures 2 and 3, the top wall 12 of the container 10 is fitted with a suitably valved air vent 57, its valve body being indicated as at 58. The compressed air supply line 52 is correspondingly fitted with a valve, the external body of which is indicated as at 59. The valves 58 and 59 are preferably interconnected for conjoint fluid pressure operation by means of an air cylinder 60 having one end thereof pivotally secured, as at 61 (see Figure 3), to a suitable bracket or support 62 suitably fixed to the top wall 12 of the container. The operating shaft 63 of the air vent valve 58 and the operating shaft 64 of the air pressure supply valve 59 are respectively fitted with actuating arms 65 and 66, the free ends of which latter are secured together to form a yoke having an extension 67 which is pivotally connected, as at 68, to a clevis 69 secured to the end of the piston rod 70 of the air cylinder 60. The valves 58 and 59 are relatively so set that upon either one of said valves being opened the other is closed. Thus, when the air cylinder 60 is operated to open the valve 59 for introduction of compressed air into the interior of the container 10, the air vent valve 58 will be automatically closed. Conversely, when the valve 59 is closed following expulsion of all of the material from the container 10, the air vent valve 58 is automatically opened to vent the interior of the container 10 to atmosphere, whereupon the container may be filled with another batch of the material to be handled.

In the form of construction of the apparatus shown in Figure 1, the lower end of the container 10 is fitted with a centrally apertured member 71

which is tapped, as at 72, to threadedly receive an axially adjustable compressed air supply nozzle unit 73. This nozzle unit 73 includes an externally threaded body member, the closed inner end wall of which is curved, as shown, to provide an axially curved surface 74 for streamlined flow of the material into the intake end of the material discharge conduit 53. The axially pointed inner end wall of the nozzle unit 73 is axially bored, as at 75, to form an air discharge orifice of restricted diameter, this orifice being in communication with an air inlet tube 76 centrally fitted in the unit 73. The outer end of the air inlet tube 76 is connected by means of a swivel joint 77 to a valve air supply pipe 78 which is tapped into the air supply line 52, as at 79. In order to permit axial adjustment of the nozzle unit so as to vary, as desired, the spacing between the end of the nozzle unit 73 and the proximate end of the discharge conduit 53, the air supply line 78 leading to the nozzle unit 73 may include a flexible hose section 80.

It will be understood, of course, that the function of the auxiliary air nozzle 73 is to inject into the lower end of the material discharge conduit 53 a high velocity jet of compressed air which not only serves to prevent clogging of the inlet end of the conduit 53 by the material being handled, but also induces a suction action in the immediate region of the inlet end of the conduit 53 which aids continuous flow of the material from the container into and through the conduit 53. The nozzle unit 73 may be secured in its axially adjusted position by a locking nut 82 threaded upon the nozzle body 72 for clamping engagement against the nozzle supporting member 71.

In operation of the apparatus shown in Figure 1, a batch of the material to be handled is gravity fed, from railroad cars, trucks or storage bins, into the container 10 by way of the opened conical closure member 14. During the operation of charging the container, its vent 57 is open to permit free flow to atmosphere of the air displaced in the container by the material, while at the same time the valve 59 controlling the supply of compressed air to the container is closed. When this material reaches a predetermined level in the container as indicated by the level indicator and control unit 23, this member 14 is closed, either manually or automatically under control of the unit 23, following which the air vent valve 58 is also closed to seal the container simultaneously as the compressed air supply valve 59 is opened, preferably by the air cylinder 60 as hereinbefore described.

The compressed air may be introduced into the container through either one or both of the manifolds 45 and 46, and, if necessary, compressed air may also simultaneously be introduced into the container by way of the auxiliary nozzle unit 73. The continual supply of compressed air into the container aerates the material therein and forces it to enter the conduit 53 at its inlet end 54 for transfer of the material to a receiving bin (not shown) located at the far end of the conveying line which is an extension of the conduit 53. It will be observed that the compressed air primarily enters the container 10 by way of the multiple-ported manifolds 45 and 46 and that the several ports 47 of these manifolds are protected by the conical baffles 48 and 49 against clogging by the material in the container. By virtue of the circumferential spacing of these air inlet ports 47, the material is uni-

formly aerated, particularly in the lower region of the container, thereby preventing such packing of the material as might interfere with its free flow into and through the conduit 53.

By suitably adjusting the auxiliary nozzle unit 73 axially with respect to the material intake end of the conduit 53, the size of the feed gap may be varied for entry of the material into the discharge conduit 53. Different materials may require larger or smaller feed gaps for best discharge thereof from the container for a given pressure of air supplied thereto, and the axially adjustable nozzle provides a convenient means for obtaining such variable feed gap.

It will be understood, of course, that the air pressure is maintained in the container 12 until all of the material therein has been discharged therefrom by way of the conduit 53, whereupon the air supply valve 59 is closed simultaneously as the air vent valve 58 is opened. The container is then under atmospheric pressure only and may be charged with a further supply of material by way of the opened conical closure member 14 to repeat the cycle of operation as just described.

It is sometimes the case that the material to be handled is in moist condition and in order to best convey such material it may be desirable to heat and dry the material within the conveyor tank preliminary to its introduction into the conveyor conduit. Figure 7 illustrates a modified construction of the apparatus of the present invention wherein the container 81 for initial reception of the material to be handled is enclosed within a jacket 82 to provide a chamber 83 into which steam may be introduced for heating the container 81 and the material contained therein.

The steam is introduced into the steam jacket by way of a steam pipe 84, the bottom of the jacket being provided with an outlet 85 for discharge of the steam condensate. The material-receiving container 81 is generally of the shape and construction previously described in that it is provided with compressed air delivery manifolds 45a and 46a which closely embrace and extend circumferentially about vertically spaced annular rows of inlet ports 47a formed in the wall of the container, these ports being protected against clogging by the material in the container by the internal conically-shaped baffles 48a and 49a.

The compressed air for expelling the material from the container 81 by way of the material-discharge conduit 53a is commonly supplied to the manifolds 45a and 46a by a pipe section 84 which constitutes the terminal extension of the compressed air supply line 86. Preferably, this supply line, upon entering the steam jacket 82, extends circumferentially thereabout in the form of a coil 87 having its end connected to the pipe section 84, as at 88, so that the compressed air circulating through said coil may be heated by the steam prior to its introduction into the container. If desired, the coil section 87 of the air supply line may be finned to provide for increased heat transfer, it being understood, of course, that the heated compressed air assists in quick drying of the material contained within the container 81.

As in the previously described form of the apparatus of the present invention, the top of the container 81 is suitably provided with a material charging inlet 89 leading to a filling opening which is adapted to be sealed by a cone valve 90 designed to seat against a rubber seal 91. The cone valve 90 may be arranged for fluid-pressure actuation thereof, as by an air cylinder 92 having its piston rod 93 connected to the cone valve as shown.

In the steam-heated form of the apparatus shown in Figure 7, the bottom of the container 81 is preferably enclosed by a plate member 94 which is dished, as shown, to provide a raised central portion 95 of convex shape circumferentially bounded by a contiguous annular portion 96 of concave form, the surfaces of these portions merging smoothly to provide an annular reentrant surface for flow of the material around the circumferential edge of and into the inlet end of the material-discharge conduit 53a. If desired, the bottom closure plate member 94 may be employed in the form of apparatus shown in Figure 1 in lieu of the axially adjustable auxiliary nozzle unit 73. Also, if desired, the container 81 of the apparatus shown in Figure 7 may be provided with a level indicator and control unit similar to the unit 23 described in connection with the apparatus of Figure 1.

It will be observed that in both forms of the apparatus as shown, the compressed air is directed by the baffle plates, particularly the lowermost one, directly into the region immediately surrounding the feed gap communicating with the inlet end of the material-discharging conduit. The compressed air so directed into the interior of the container acts as a scavenging medium to prevent such packing or lodgment of the material in the bottom of the container as would interfere with its free expulsion from the container by way of the discharge conduit, the scavenging operation being rendered especially effective by the reentrant flow surface provided for the material at the feed gap, such as the annular concave surface surrounding the auxiliary air jet orifice 75 in the apparatus of Figure 1 and the corresponding surface surrounding the central raised portion 95 of the bottom plate 94 employed in the apparatus of Figure 6.

It will be understood that the present invention is susceptible of various other changes and modifications which may be made from time to time without departing from the general principles or real spirit of the invention, and it is accordingly intended to define the same broadly as well as specifically as indicated in the appended claims.

What is claimed as new and useful is:

1. In an apparatus for the pneumatic handling and conveying of finely comminuted material, a main container for the material of generally inverted conical shape having a closed bottom end and a material inlet opening in the top thereof, means for sealing said inlet opening, a material-discharge conduit extending from a point within said container adjacent its bottom end to and through the top wall of the container, a compressed-air supply manifold of annular form snugly embracing the external wall of the container, said manifold being commonly in communication with a plurality of circumferentially spaced air inlet openings formed in the wall of the container, and an annular baffle member of inverted conical shape disposed internally of the container with its upper circumferential edge contiguous with the wall of the container along a circumferential line spaced above said air inlet openings, the annular wall of said baffle member being downwardly and inwardly inclined relatively to the wall surface of said container so

that the internal surface of said baffle member serves to deflect the material away from said air inlet openings to prevent clogging of the latter while the external wall surface of said baffle member serves as a deflector to direct the compressed air introduced into the tank by way of said air inlet openings downwardly into the bottom region of the container immediately surrounding the lower end of said material-discharge conduit.

2. In an apparatus of the character defined in claim 1 wherein said material-discharge conduit is disposed with its lower end substantially in the horizontal plane of and concentric with the lowermost edge of said baffle member whereby to provide an annular material feed gap between the concentric bottom edges of said baffle member and said conduit.

3. In an apparatus of the character defined in claim 1 wherein is included a second compressed air manifold in vertically spaced relation to said first-mentioned manifold, said second manifold being also arranged to supply compressed air into the container by way of a plurality of circumferentially spaced air inlet ports formed in the wall of the container, and wherein a second baffle member is operatively disposed internally of the container in vertically spaced relation to the first-mentioned baffle member to prevent clogging of the air inlet openings of the second-mentioned manifold and to direct the air delivered therethrough downwardly into the bottom of the container.

4. In an apparatus for the pneumatic handling and conveying of finely comminuted materials, a main container having a material-receiving body portion of generally inverted conical shape, said container being enclosed at its top and bottom ends and being provided with a material inlet opening in its top, means for sealing said inlet opening, a material-discharge conduit extending into said container for pneumatic conveyance of the material from the container, a plurality of circumferentially spaced air inlet ports formed in the wall of the container, baffle means disposed internally of the conveyor in overlying relation to said inlet ports to protect the latter against clogging by the material in the container, and a compressed-air supply manifold of channel-shaped cross-section snugly embracing the external wall of the container with its opposite side walls embracing therebetween the air inlet ports aforesaid, said baffle means being in the form of an annular member of inverted frusto-conical shape, the annular wall of which is inwardly inclined with respect to the container wall so that the external surface of the annular baffle member serves as a deflector to direct the compressed air issuing from said air inlet ports downwardly into the bottom region of the container.

5. In an apparatus as defined in claim 4 wherein the closure for the bottom end of the container is of such diametric cross-section as to provide an annular flow surface coaxial with and vertically spaced from the material intake opening at the lower end of said discharge conduit, said flow surface being of concave form in transverse cross-section and so disposed relatively to the lower end of said discharge conduit as to direct the material around the edge of the material intake opening and thence upwardly into the conduit for discharge of the material therefrom, said flow surface being self-cleaning by the passage of material thereover under the pressure of the compressed air in the container.

6. In an apparatus as defined in claim 4 wherein the closure for the bottom end of the container is of such diametric cross-section as to provide an annular flow surface coaxial with and vertically spaced from the material intake opening at the lower end of said discharge conduit, said flow surface being of concave form in transverse cross-section and so disposed relatively to the lower end of said discharge conduit as to direct the material around the edge of the material intake opening and thence upwardly into the conduit for discharge of the material therefrom, said flow surface being self-cleaning by the passage of material thereover under the pressure of the compressed air in the container, and said closure being axially adjustable relatively to the conduit intake opening to vary the size of the feed gap formed between said annular flow surface and the proximate lower end of the conduit.

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