Oct. 7, 1941. E. G. ROBINSON 2,258,125

MATERIAL HANDLING APPARATUS

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Fig. 1.

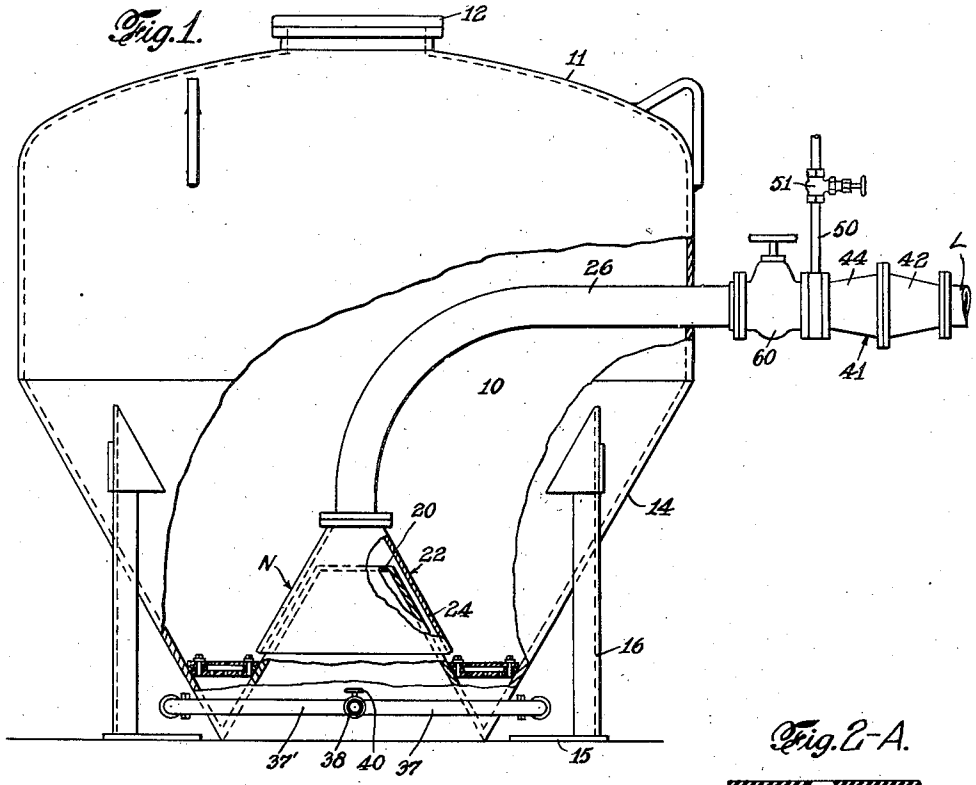

Fig. 2-A.

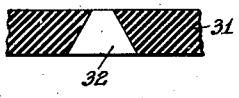

Fig. 2.

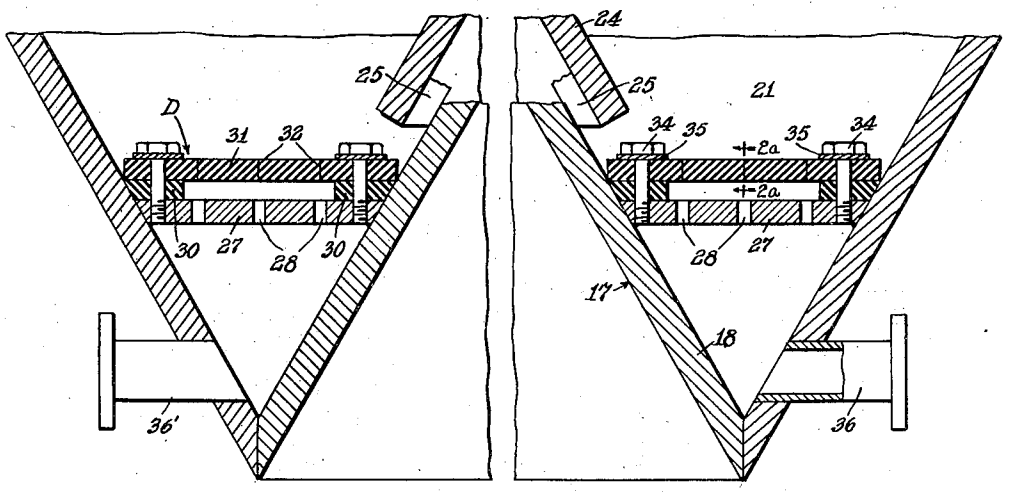

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Fig. 3.

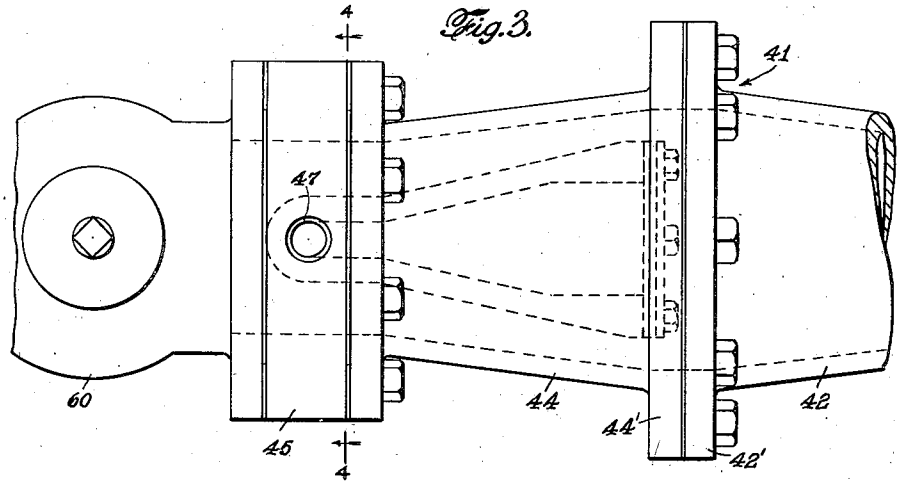


Fig. 4.

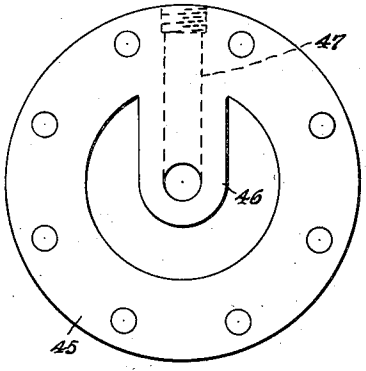


Fig. 5.

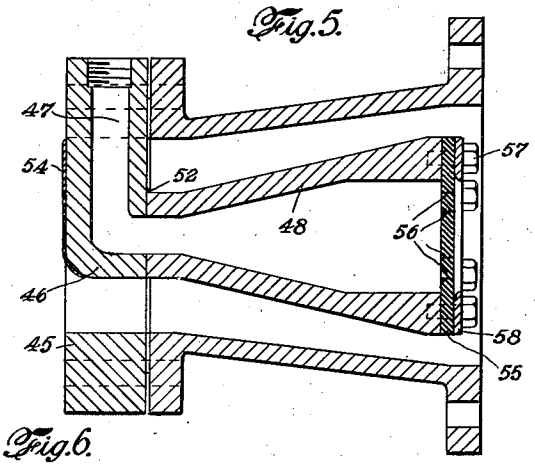


Fig. 6.

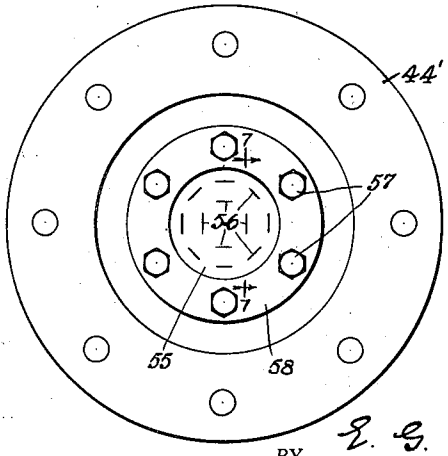
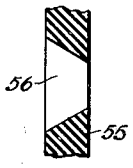


Fig. 7.



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UNITED STATES PATENT OFFICE

2,258,125

MATERIAL HANDLING APPARATUS

Evelyn G. Robinson, New York, N. Y.

Application March 21, 1940, Serial No. 325,132

3 Claims. (Cl. 302—53)

This invention relates to material-handling apparatus of the general type to which my patent application Serial No. 277,231, filed June 3, 1939, is directed, the present apparatus, like the apparatus disclosed in the application just mentioned, being adapted for use in the pneumatic handling of various materials of granular, flocculent, pulverulent or similar nature.

Although apparatus characterized according to the invention defined in the above application have proved highly successful in the pneumatic conveying of material, it has been found desirable to continue to supply the container with air under pressure until the material, pursuant to complete removal of such material from the container, is in its entirety dispelled from the discharge conduit line. The length of time required for complete evacuation of the discharge conduit line, pursuant to complete romoval of the material from the container, is dependent, at least in part, upon the length of that line. In instances where an extremely long discharge conduit line is employed, the time required to effect complete removal of the material therefrom, after the receptacle has been evacuated, may be of a duration comparable with the time required to recharge and evacuate the container. This means that where, for example, three minutes are required to charge the container with material, and like periods are required to evacuate the container and to effect complete removal of the material from the discharge conduit line, there is a time loss of three minutes encountered during each cycle of operation.

An important object of the present invention is to obviate time losses of the above character, thereby—in effect—speeding up the cycle of operation and thus increasing the efficiency of the apparatus.

To the above and other ends I contemplate improved injector means disposed in the discharge conduit line and constructed to so function as to effect complete removal of material from that line following each evacuation of the container, thus making it practicable to open the container and re-charge it without waiting for the discharge conduit line to relieve itself of its material content.

Other objects and advantages of the invention will become apparent from the following description when taken in connection with the accompanying drawings, in which—

Fig. 1 is a view partly in section and partly in elevation of an apparatus embodying the present invention;

Fig. 2 is an enlarged, fragmental, sectional view of the air-distributing unit of Fig. 1;

Fig. 2—A is an enlarged, fragmental, sectional view of the distributor element shown in Figs. 1 and 2, the section being taken on line 2*a*—2*a* of Fig. 2;

Fig. 3 is an enlarged plan view of the injector unit disposed in the discharge conduit line of Fig. 1;

Fig. 4 is a sectional view taken on line 4—4 of Fig. 3;

Fig. 5 is a central, longitudinal, sectional view of the nozzle assembly of the injector unit,

Fig. 6 is an end view showing the nozzle assembly as it appears from the right in Fig. 5, and

Fig. 7 is an enlarged, fragmental, sectional view of the distributor element shown in Figs. 5 and 6, the section being taken on line 7—7 of Fig. 6.

Although the present invention is adapted for use in connection with various forms of receptacles or containers, it is herein illustrated in association with a container 10 particularly designed for use in the handling of pulverulent materials, notably cement. The container is preferably cylindrical at its upper end and is there provided with a dome-like header 11 having a filling opening, not shown, with which is associated a closure 12 adapted to be clamped or otherwise held in sealed position so as to guard against the escape of air by way of the filling opening during the unloading operation. The lower portion of the container 10 is so shaped that its wall 14, which is inclined at an angle of 60° to the horizontal, presents an inverted frustum of a cone. The container 10 may be adequately supported on a suitable base which is fragmentally shown at 15 and from which extend upwardly a plurality of post-like frame members 16 suitably connected to the inclined wall 14 of the container.

To the lower end of the inclined wall 14 there is suitably connected a bottom-forming unit 17 which is so shaped that it presents a frustum of a cone, the side wall 18 of the bottom-forming unit being inclined at an angle of 60° to the horizontal and the upper end of that unit being closed by a disc-like header 20. Inasmuch as the inclined wall 14 of the container 10 and the inclined wall 18 of the bottom-forming unit 17 form, respectively, with the horizontal an angle of 60°, it follows that these walls are disposed at an angle of 60° to each other and form with each other at the lower end of the container an

annular V-shaped material-receiving channel 21 into which the material carried within the container 10 and to be pneumatically removed therefrom flows during the unloading operation.

Within the container 10 there is arranged a hood-like cowl 22 which substantially envelopes the bottom-forming unit 17. As to the cowl 22, it will be observed that its wall 24, which is inclined at an angle of 60° to the horizontal presents an inverted frustum of a cone, the wall 24 being disposed in a parallel relation to, and spaced from, the inclined wall 18 of the bottom-forming unit 17. The wall 24 of the cowl 22 is maintained in a definite spaced relation to the wall 18 of the bottom-forming unit 17 by a plurality of spacing lugs 25 interposed between the two walls and suitably secured thereto.

From the foregoing it will be understood that the cowl 22 and the bottom-forming unit 17 are so cooperatively related that they constitute a pick-up nozzle, indicated generally by the reference character N, such nozzle being characterized by the fact that the wall 24 of the cowl 22 forms with the wall 18 of the bottom-forming unit 17 an annular ejector passage which communicates at it slower end directly with the container 10. The upper end of the cowl 22 is suitably connected to and is adapted to communicate with a discharge conduit 26, leading from the container 10 by way of its side wall and constituting a portion of a discharge conduit line L which is of such length as is required to convey the material to a desired point of delivery.

Some materials, such as dry or powdered cement, have a tendency to pack into a highly compact mass when introduced into the container 10; and with this in mind, means are herein provided for loosening such material by aeration, so that the pick-up nozzle N may operate to efficiently effect removal of the material from the container. The aerating means herein illustrated is in the form of a fluid pressure distributor unit D which includes an annular metal ring 27, provided with a multiplicity of apertures 28, the ring being welded throughout its outer and inner margins to, and thus forming a gas-tight union with, the inclined wall 14 of the container 10 and the inclined wall 18 of the bottom-forming unit 17. Disposed upon each of the margins of the metal ring 27 is an elastic annular gasket 30, the gaskets being of a suitable material such as the product known commercially as "neoprene." The gaskets 30 are spaced from each other and carry thereon, in a normally spaced relation to the metal ring 27, an elastic annular or ring-like distributor element 31 constructed of "neoprene." The distributor element is provided with a multiplicity of slits 32, each of which tapers in length, as shown in Fig. 2—A, from a relatively small dimension at the upper face of the distributor element to a somewhat greater dimension at the lower face of that element. As to the slits 32, it may be well to mention that each of them is of a straight-line character and that they, generally speaking, extend lengthwise of the annular distributor element 31. That is to say, the slits 32 are disposed at right angles to such radii of the distributor element 31 as intercept them intermediate their ends. The gaskets 30 and the annular distributor element 31 are anchored in their respective positions by a plurality of bolts 34 which pass through a pair of compression rings 35 disposed on the distributor element 31 at its inner and outer margins. In order that air under pressure may be delivered to the lower portion of the V-shaped material-receiving channel 21, which in the present embodiment of the invention serves as an annular conduit peculiar to the distributor unit D, the container 10 is provided with a pair of pipe fittings 36 and 36' to which are connected branch pipes 37 and 37' of an air-pressure supply pipe 38 equipped with a valve 40 and adapted to be connected to an air compressor, not shown, or other source of air pressure supply.

Interposed in the discharge conduit line L and forming a part of such line is an injector unit 41, which includes a pair of pipe fittings such as standard reducers 42 and 44. These fittings when connected together at their larger ends through the medium of their flanges 42' and 44' constitute an injector housing which tapers toward its opposite ends, the outlet end of the housing being connected through the medium of its flange to the adjacent section of the discharge conduit line L and the inlet end of the housing being connected through the medium of its flange to a ring-like fitting 45. The fitting 45 is provided with an inwardly extending boss 46 which, together with the annular portion of the fitting, is so cored or drilled as to afford a radially extending air duct 47 which terminates in the vicinity of the center line of the fitting and there extends axially in a direction generally away from the container 10. Associated with the ring-like fitting 45 is a distributor nozzle 48, the inlet end of which registers with the air duct 47, into which compressed air may be delivered from a suitable source, not shown, by way of a supply pipe 50 connected to the ring-like fitting and communicating with the air duct thereof, the delivery of air to the distributor nozzle being under the control of a valve 51 disposed in the supply pipe 50. It may be well to mention that, for the sake of convenience, the ring-like fitting 45 and distributor nozzle 48 are separately formed and are then united by welding them together, as at 52. Although the distributor nozzle 48 is disposed in the general line of flow of material through the discharge conduit line L, such material passes substantially unobstructedly over the nozzle due to the ample clearance that is afforded around the same and due to the gradual slope of the outer wall surface of the nozzle. By so forming the nozzle 48 and its surrounding fitting 44 as to permit unobstructed flow of the material over such nozzle, excessive abrasive action by the material on these parts of the injector unit is obviated. In order to resist abrasive action by the moving material on the forward face of the boss 46, such face is curved to present a substantially semi-cylindrical surface and is provided with a coating 54 of abrasion-resisting material, such as "Stellite." In order that the compressed air entering the nozzle 48 may be delivered to and commingled with the material as it passes through the injector unit 41, such nozzle is provided at its outlet end with an elastic disc-like distributor element 55 which is constructed of "neoprene" and provided with a plurality of slits 56, each of which tapers in length from a relatively small dimension at the outer face of the distributor element to a somewhat greater dimension at the inner face of that element. It may be well to mention that each of these slits 56 is of a straight-line character and that they, generally speaking, are disposed in circular groups about the center of the distributor element 55, which

is secured at its peripheral margin to the nozzle 48 by a plurality of lag screws 57 which pass through a clamp ring 58, disposed in a face relation to and engaging the peripheral margin of the distributor element.

In order that communication between the discharge conduit 26 and the injector unit 41 may be severed under certain operating conditions, a cut-off valve 60 is provided. This valve is connected, through the medium of one of its flanges, to the forward or inlet end of the ring-like fitting 45 and is connected, through the medium of its other flange, to the discharge conduit 26 so that the valve, like the discharge conduit 26 and the injector unit 41, constitutes a portion of the discharge conduit line L by way of which material is conveyed from the container 10 to any remotely located point of discharge that may be desired.

The operation of the apparatus is as follows:

After conditioning the apparatus for use by introducing into the container 10 the material to be conveyed, the closure 12 is anchored in sealing position, whereupon compressed air is introduced into the container by way of the supply pipe 38 and its associated branch pipes 37 and 37' until a suitable operating pressure is built up within the apparatus. During such time as the compressed air is being introduced into the container 10, it passes into the distributor unit D from which it escapes by way of the multiplicity of slits 32. As the compressed air escapes from the distributor unit D it passes up through the material carried within the container 10 and in so doing the material, such as cement in dry or powdered form, is effectively loosened or aerated. After aerating the material, thus conditioning it for removal, and while continuing to introduce compressed air into the container 10, the valve 60 is opened with the result that the material is caused to enter the pick-up nozzle N under the influence of a flowing stream of air entering that nozzle from the container, the material being carried from the pick-up nozzle and out of the container through the discharge conduit line L to any remotely located point of discharge that may be desired. Due to the fact that the distributor unit D is provided with a multiplicity of slits 32 and is located slightly below, and in close proximity to, the inlet of the pick-up nozzle N, I am enabled to effect such aeration of the material in the immediate vicinity of the inlet of the pick-up nozzle that the material, even prior to the instant it enters the pick-up nozzle, is placed in a state of air suspension, thus promoting efficient and reliable functioning of the device as a material-handling apparatus. As the material is removed from the lower vicinity of the mass, downward movement of the remaining material under the action of gravity is insured due to the relatively steep inclination of the wall 14 of the container 10 and the wall 24 of the cowl 22, which walls serve to guide the material in its downward travel into the immediate vicinity of the inlet of the pick-up nozzle N, where it undergoes aeration preparatory to its being pneumatically delivered from the container by way of the discharge conduit 26. Inasmuch as the entire bulk of material moves into the relatively narrow V-shaped material-receiving channel 21 where it is subjected to aeration in the vicinity of the inlet of the pick-up nozzle N, it follows that complete removal of the material may be effected by the apparatus embodying the present invention.

Incident to the completion of the removal of the material from the container 10, the valve 51 is opened and the valve 60 is closed, whereupon the valve 40 is closed preparatory to re-charging the container 10 with material. During such time as the container 10 is being re-charged with material, movement of the column-like load of material, traveling in a state of air-suspension within the discharge conduit line L intermediate the outlet end thereof and the injector unit 41, is maintained under the action of the compressed air admitted to the discharge conduit line by way of the injector unit. It is to be observed in connection with the injector unit 41 that since this unit is brought into operation while the column-like load of material is moving under the influence of compressed air entering the discharge conduit line by way of the pick-up nozzle N the valve 60 may be closed, preparatory to conditioning the container 10 for re-charging, without impeding the movement of the column-like load through the discharge conduit line. The movement of the column-like load of material through the discharge conduit line L pursuant to closing the valve 60 may be regarded as a scavenging operation which is continued under the action of the injector unit 41 until such time as the discharge conduit line is completely evacuated of its material load.

By carrying out the scavenging operation in the manner above described, certain advantages are attained—among which may be mentioned the fact that the time required for effecting a complete cycle of operation is decreased inasmuch as the container 10 may be opened and re-charged without having to wait for the discharge conduit line to deliver its material content, which delivery is necessary in the interest of reliable operation, especially in cases where an extremely long discharge conduit line is employed, as will be readily understood when it is taken into account that were movement of the material in the discharge conduit line discontinued such material would precipitate out of its state of air suspension and collect in such quantities in the discharge conduit line, especially at the low or valley points therein, that it would so obstruct that line as to cause complete clogging of the same.

Although in the foregoing description of operation of the apparatus, the injector unit 41 is described as being utilized only after complete removal of the material from the container has been effected, it may be well to here point out that the injector unit may be employed during such time as the container is being evacuated, in which case the action of the air entering the discharge conduit 26 as a material-translating medium, is augmented by air which is delivered by way of the injector nozzle 48 to the flowing stream of material in the vicinity of the distributor element 55 where additional aeration of the material is effected under the action of the plurality of air streams issuing from the several slits 58 of that distributor element. In cases where it is found desirable to utilize the injector unit 41 at the same time the air content of the container 10 is being employed to evacuate that container, scavenging of the discharge conduit line L is effected by the injector unit in the manner already described by allowing the valve 51 to remain open a sufficient length of time, subsequent to the closing of the valve 60, to insure complete evacuation from the discharge conduit line.

Referring again to the slits 32 of the distributor element 31, it has been found that their side walls impinge against each other with ample intimacy to prevent even such material as dry or powdered cement from filtering into the slits either during such time as the container is being charged or during such time as the material is allowed to remain stored therein. The impingement of the side walls of the slits 32 against each other is accounted for by the fact that the slits normally tend to close themselves due to the inherent elasticity of the material from which the distributor element 31 is made and is further accounted for by the distortion to which the distributor element is subjected under the weight of material within the container 10. Undue distortion of the distributor element 31 under the weight of the material within the container is obviated, however, because of the presence of the metal ring 27, into engagement with which the distributor element throughout a portion of its lower surface is bulged when distorted to a substantial extent. Upon introducing air pressure into the distributor unit D, aeration of the material is initiated, whereupon the material is sufficiently aerated to immediately relieve the distributor element 31 of the weight of the material and thus permit the force of the compressed air against the distributor element to bulge that element upwardly. Such upward bulging or distortion of the distributor element 31 appears, in practice, to provide for a freer passage of air through the slits 32 than is possible during the initial stage of the aerating process, which stage is represented by that period of time required for such aeration to be effected as will permit the distributor element to be distorted from its downwardly bulged condition to its upwardly bulged condition. It is believed that the freer flow of air through the slits 32 incident to upward bulging of the distributor element 31 is due, at least in part, to the fact that the slits respectively taper in length, as shown in Fig. 2—A, from a relatively small dimension at the upper face of the distributor element to a somewhat greater dimension at the lower face of that element, it being noted in this connection that the longer slit length so compensates or offsets any restriction of the lower end of the slit that may be effected incident to upward bulging of the distributor element that the slit, after having been enlarged at its upper end incident to the upward bulging of the distributor element, represents, or is comparable with, an aperture having a uniform or substantially uniform cross-sectional dimension from its point of inlet to its point of outlet.

Although the slits 32 have been described with particularity concerning their closed condition when the distributor element 31 is bulged downwardly and their opened condition when that element is bulged upwardly, it is to be particularly noted that the walls of these slits engage each other with sufficient intimacy at all times, except when the aerating step is being carried out, to prevent even such materials as dry or powdered cement from filtering into the slits. This means, of course, that even though the quantity of material within the container may be insufficient in weight to cause downward deflection of the distributor element, filtering of such material into the slits is effectively obviated. Needless to say that during the carrying out of the aerating step, material is prevented from entering the slits 32 because of the existence there of the film-like streams of air passing through these slits.

Referring to the slits 56 of the distributor element 55, it may be well to point out that their walls, like the walls of the slits 32 with which the distributor element 31 is provided, engage each other with sufficient intimacy at all times—except when air is being introduced into the discharge conduit line L by way of the distributor nozzle 48—to prevent even such materials as dry or powdered cement from filtering into the slits. Needless to say that during such time as air is being introduced into the discharge conduit line L by way of the distributor nozzle 48, material is prevented from entering the slits 56 because of the existence then of the film-like streams of air passing through the slits. It is to be observed that during such time as air is being introduced into the discharge conduit line L by way of the distributor nozzle 48, the distributor element 55 is distorted or bulged outwardly so that its outer face presents a convex surface. Such bulging of the distributor element 55 affords a free flow of air through the slits 56; and it is believed that such free flow is due, at least in part, to the fact that the slits respectively taper in length, as shown in Fig. 5, from a relatively small dimension at the outer face of the distributor element to a somewhat greater dimension at the inner face of that element, it being noted in this connection that the longer slit length so compensates or offsets any restriction of the inner end of the slit that may be effected incident to outward bulging of the distributor element that the slit, after having been enlarged at its outer end incident to outward bulging of the distributor element, represents, or is comparable with, an aperture having a uniform or substantially uniform cross-sectional dimension from its point of inlet to its point of outlet. Although the distributor element 55 is not likely to be subjected to any influence which would effect inward bulging thereof, it goes without saying that should there be encountered any condition which would effect inward bulging of the distributor element, such bulging would cause the side walls of the slits 56 to more intimately engage each other (as described in connection with the slits 32 of the distributor element 31 incident to downward bulging thereof) and thus further insure against entrance of material into the slits.

It should be observed that should any material, such as powdered cement in the presence of moisture, assume the form of a hard or solidified mass overlying, and thus tending to obstruct, any one of the slits 32 of the distributor element 31 or any one of the slits 56 of the distributor element 55, such mass of obstructing material is readily disrupted, on the one hand, under the action of air pressure within the distributor unit N and, on the other hand, under the action of air pressure within the distributor nozzle 48, as will be readily understood when it is taken into account that these distributor elements, incident to the introduction of air into the distributor unit N and distributor nozzle 48, become sufficiently bulged upwardly and outwardly, respectively, to so dislodge the obstructing mass as to insure unimpeded delivery of air by way of the slits 32 and 56.

Although only one form of the invention is herein illustrated and described, it is to be understood that various changes may be resorted to without departing from the spirit of the invention or the scope of the following claims.

What is claimed is:

1. A material-handling apparatus comprising a container adapted for the reception of material to be removed therefrom, a discharge conduit line leading from said container, and an air-delivery unit by way of which compressed air is delivered to said container to facilitate removal of material therefrom, said air-delivery unit comprising a mass of distensible elastic material having slit-like openings therein by way of which compressed air is directed into said container from said air-delivery unit, said openings being normally closed to passage of material thereinto from said container and having at their respective discharge ends a slit-length substantially less than the slit-length at their respective inlet ends.

2. A material-handling apparatus comprising a container adapted for the reception of material to be removed therefrom, a discharge conduit line leading from said container and by way of which material upon removal from said container is delivered to a discharge point, and means for facilitating passage of material to said discharge point by way of said discharge conduit line and including an injector unit disposed in said discharge conduit line, said injector unit comprising a distributor nozzle into which compressed air is directed and past which material flows in surrounding relation thereto during its delivery from said container toward said discharge point, and a distributor element associated with said nozzle and comprising a mass of distensible elastic material having slit-like openings therein by way of which compressed air is directed into said discharge conduit line from said nozzle, said elastic material being distensible in the general direction of flow of material past said nozzle incident to delivery of compressed air to said nozzle and said openings being normally closed and having at their respective discharge ends a slit-length substantially less than the slit-length at their respective inlet ends and being distensible incident to delivery of compressed air to said nozzle so as to afford paths of communication between said nozzle and said discharge conduit line.

3. For use in a material-handling apparatus of the type including a container in association with a discharge conduit line by way of which material upon removal from the container is delivered to a discharge point, material-aerating means comprising a distributor element in the form of a mass of distensible elastic material having slit-like openings therein by way of which compressed air is delivered for aerating purposes, said openings being normally closed and having at their respective discharge ends a slit-length substantially less than the slit-length at their respective inlet ends and being distensible incident to the passage of compressed air therethrough.

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