# United States Patent [19]

**Ortlip et al.**

[11] **3,738,464**

[45] **June 12, 1973**


[54] **DROP BOOT TO PREVENT WIND LOSS OF FINELY DIVIDED FLUENT MATERIALS**


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[52] **U.S. Cl.** ..... **193/25,** 141/284, 141/392

[51] **Int. Cl.** ..... **B65g 65/28**

[58] **Field of Search** ..... 222/64, 74, 527, 222/53, 56, 523; 141/258, 193, 263, 198, 284, 93; 193/25, 30; 198/36; 214/10



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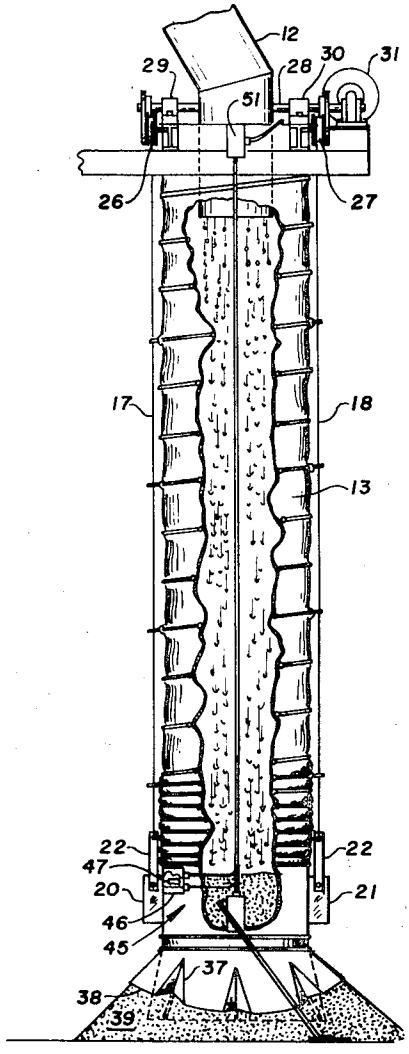
[57] **ABSTRACT**

An apparatus for controlling the delivery of particulate solids onto a surface exposed to atmosphere for avoiding wind loss, and including a closed elongated flexible conduit means having a discharge opening at the bottom thereof, and means for controlling the lateral and elevational disposition of the discharge opening. A downwardly flared flexible boot is secured to the base of the conduit and is arranged to enclose the material being delivered onto the exposed surface in an enclosed column of material, with the perimeter of the boot and the accumulated solid column forming a seal between the atmosphere and the interior of the flexible conduit. The column of material which is accumulated within the boot is arranged to rise to a level determined by a sensing detector, and will normally remain at a level below a certain predetermined upper limit. Means are provided for intermittently elevating the conduit and the flared boot in a series of short upwardly directed strokes, with the elevating events continuing until the column drops below its upper limit, these upper and lower level limits normally being generally equal to the vertical distance defined by the difference in the extreme flare angle and relaxed flare angle of the boot so as to continuously maintain the atmospheric seal.


**7 Claims, 7 Drawing Figures**



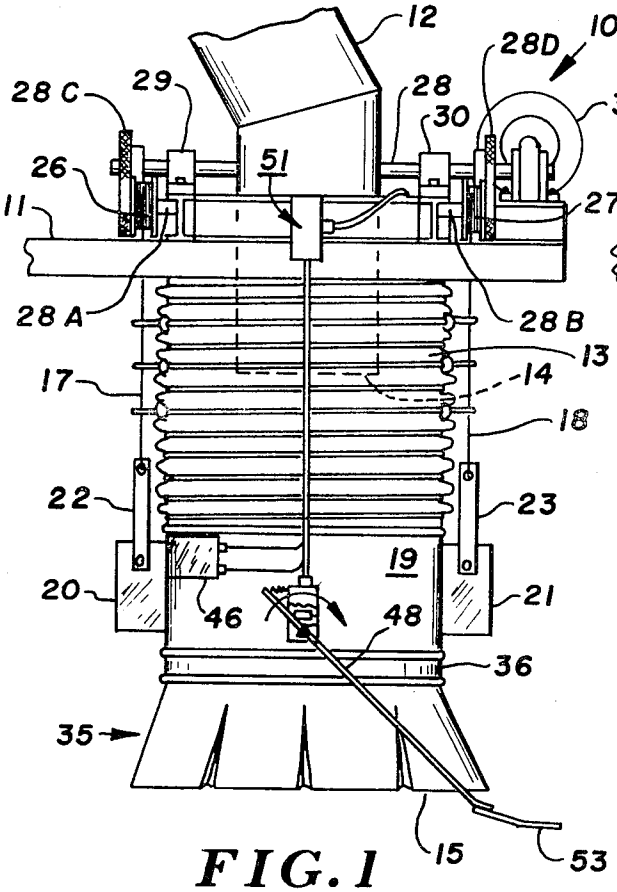



FIG. 1

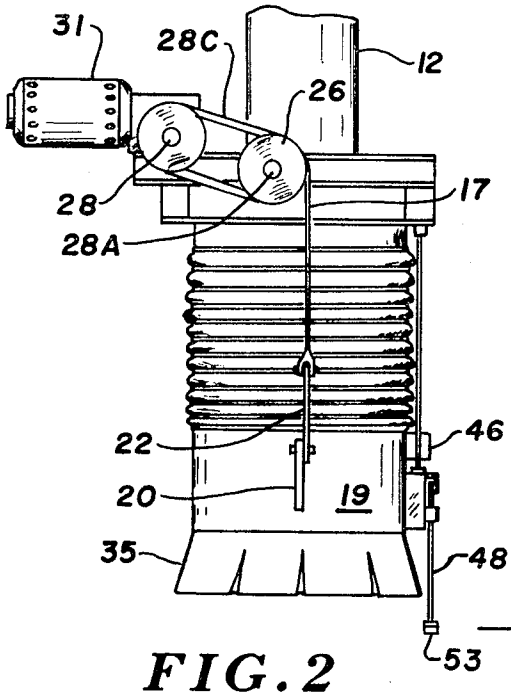



FIG. 2

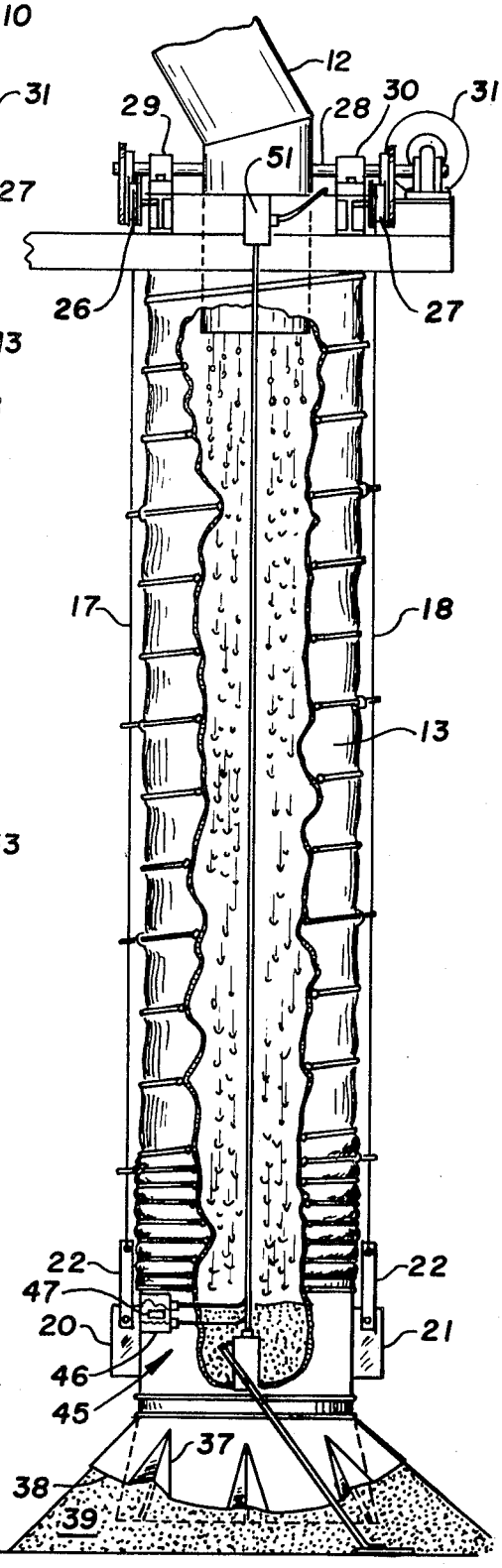



FIG. 3

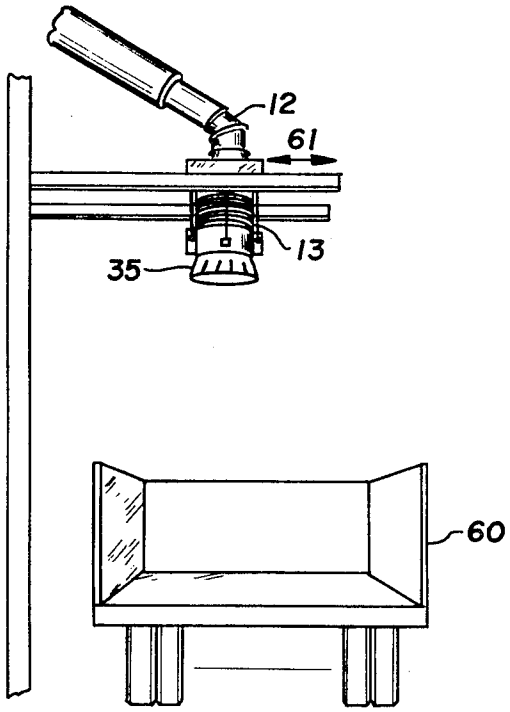



FIG. 4

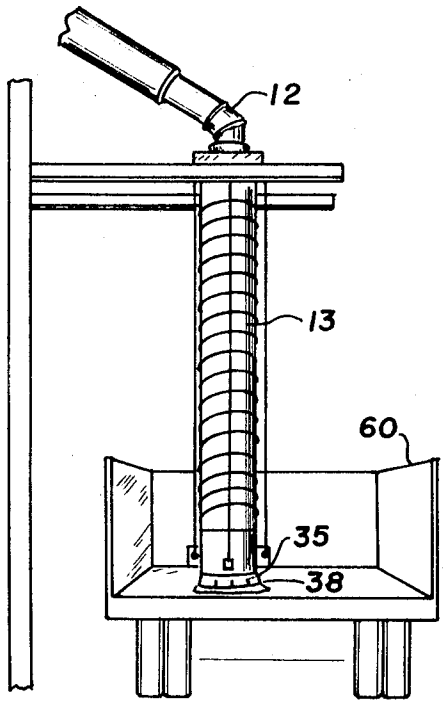



FIG. 5

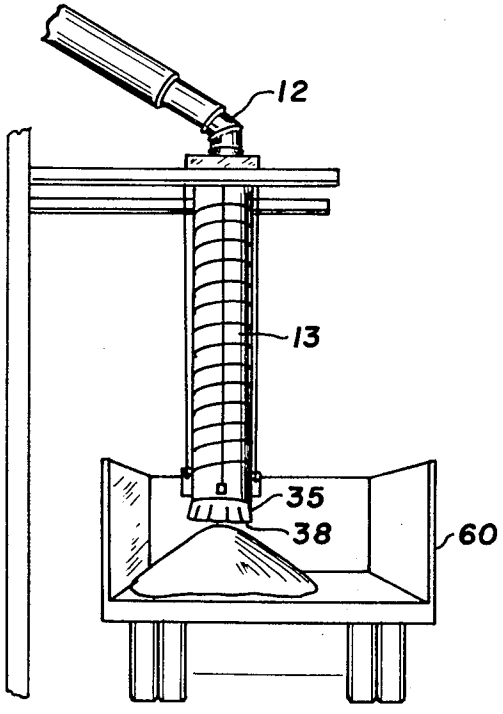



FIG. 6

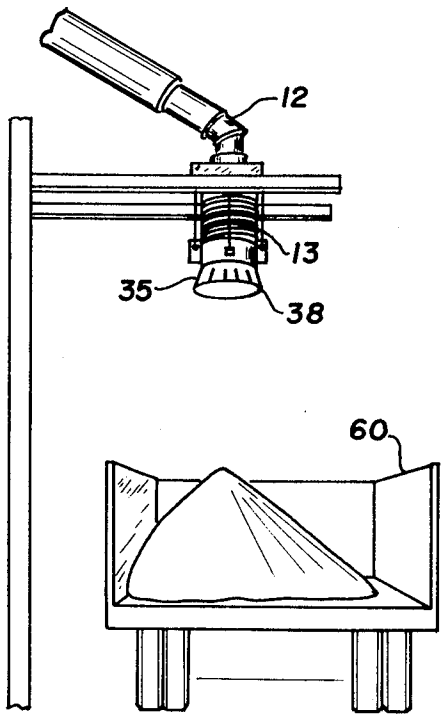



FIG. 7

# DROP BOOT TO PREVENT WIND LOSS OF FINELY DIVIDED FLUENT MATERIALS

## BACKGROUND OF THE INVENTION

The present invention relates generally to an improved flexible conduit means for continuously delivering particulate solid material onto a surface exposed to atmosphere, wherein the interior of the flexible conduit is maintained in sealed relationship relative to the atmosphere so as to avoid wind loss of the discharged product. More specifically, the present invention relates to an apparatus for controllably delivering particulate solid material onto a surface exposed to atmosphere through a flexible conduit means, wherein the conduit is provided with a means to permit a column of material to be retained therewithin for discharge from the base of the column, and with a downwardly flared flexible boot being provided to maintain a constant seal between the discharged material and the column of material remaining within the flexible conduit. The apparatus of the present invention finds particular utility in controlling or eliminating the pollution of the atmosphere by the discharge of particulate solid material thereinto, whenever these particulate solids are transferred onto a surface which is exposed to the atmosphere.

In the past, various techniques have been employed for controlling the delivery of particulate solid material onto surfaces exposed to atmosphere, with these means generally utilizing a flexible conduit which has a discharge opening arranged to be controllably maintained at an elevation raised from contact with the delivered material. As such, various fines present in the particulate material may find their way into the surrounding atmosphere due to wind loss or the like. As such, the surrounding environment may become loaded or polluted with these particulate solids because of wind pickup made possible by the uncontrolled discharge of the materials. In addition, various other techniques have been employed wherein the discharge of particulate solids onto a surface exposed to the atmosphere has been protected from the environment or the atmosphere only intermittently, with the seal which forms between the discharge opening and the accumulated material being intermittently broken so as to permit free flow of material onto the accumulated pile or stack.

In addition to problems with atmospheric pollution, the wind loss of certain particulate solid material can be costly, particularly in the event of handling of commodities of significant value. For example, fertilizer is frequently sold in bulk quantities, with the fertilizer comprising particulate or pulverulent solids. Substantial wind loss of this material, in addition to being undesirable from the standpoint of the environment, may also be undesirable from the standpoint of economy.

## SUMMARY OF THE INVENTION

In accordance with the present invention, an improved means is provided for controlling the delivery of particulate solid material onto a surface exposed to atmosphere which includes an elongated flexible conduit having a discharge opening at the bottom thereof, with a downwardly flared flexible boot means being secured to the base of the conduit and actually defining the discharge opening. The flared boot means is sufficiently flexible so as to have a relaxed flared angle and an extreme flared angle. The relaxed angle is assumed just prior to the point at which the boot means is essentially out-of-contact with the accumulation of delivered material, and the extreme angle is assumed when the interior of the flexible conduit is containing or confining a full charge or column of material therewithin. The lip portion of the boot along with a portion of the discharged material forms a seal between the atmosphere and the interior of the flexible conduit, with this seal being maintained continuously during discharge. Means are provided for controllably and intermittently raising the conduit with a series of short intermittent strokes, and accordingly the discharge opening, with the amplitude of each controlled elevating stroke or event being generally less than the vertical distance defined by the difference in the extreme flared angle and the relaxed flared angle of the boot, so as to substantially continuously maintain the interior of the conduit in sealed relationship to the surrounding atmosphere. Generally strokes of from one-fourth to one-half inch are useful.



Therefore, it is a primary object of the present invention to provide an improved means for controllably delivering particulate solid material onto a surface exposed to atmosphere utilizing a closed elongated flexible conduit means having a discharge opening arranged to maintain a continuous seal between the interior of the conduit and the atmosphere.

It is yet a further object of the present invention to provide an improved means for controllably delivering particulate solid material onto a surface exposed to atmosphere which includes a closed elongated flexible conduit means having a downwardly flared flexible boot means at the base thereof, with the boot means being arranged to form a substantially constant seal between the interior of the conduit and the atmosphere, and with lifting means being provided for intermittently controllably elevating the flexible conduit and the flared boot distances sufficient to maintain a continuous seal between the interior of the conduit and the surrounding atmosphere.

It is yet a further object of the present invention to provide an improved means for controllably delivering particulate solid material onto a surface exposed to atmosphere which includes a closed elongated flexible conduit means having product level sensing means operatively coupled to the flexible conduit, with the sensing means being immediately arranged to sense the column height or level of particulate material within the conduit and relative to the discharge opening for the purpose of maintaining a constant seal between the interior of the flexible conduit and the surrounding atmosphere.

Other and further objects of the present invention will become apparent to those skilled in the art upon a study of the following specification, appended claims, and accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of the product delivery apparatus of the present invention, and illustrating a portion of the means for receiving product into the device, along with a portion of the supporting framing, with the conduit means being shown in extreme elevated disposition;

FIG. 2 is a view similar to FIG. 1, and taken at right angles to the view of FIG. 1 and illustrating the arrange-

ment of the lifting cables employed on the apparatus;

FIG. 3 is a view taken in the plane of FIG. 1 and being partially broken away and illustrating the disposition of the apparatus in a more fully distended disposition, and further illustrating an accumulation of delivered particulate material at the base thereof;

FIG. 4 is a perspective view of the apparatus of the present invention and showing the structure in extreme elevated disposition so as to permit the movement of a truck to be loaded thereunder; and

FIGS. 5, 6 and 7 are views similar to FIG. 4 and illustrating the disposition of the apparatus upon various phases of the loading operation.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

In accordance with the preferred embodiment of the present invention, and with particular attention being directed to FIGS. 1, 2 and 3 of the drawings, it will be observed that the particulate solid delivery system generally designated 10 includes a support beam or frame member 11 which is disposed adjacent a delivery spout 12. Frame 11 is preferably in the form of a pair of parallelly disposed rails or the like having means for controllably laterally moving the delivery system 10.

The structure further includes an elongated flexible conduit means 13 which is arranged in communication with the discharge opening 14 of delivery spout 12, thereby being arranged to receive a charge of material adjacent the top thereof as shown in FIG. 3. Guides in the form of radially disposed eyes or the like may be arranged at intervals along the extent of conduit 13, with these eyes serving to guide or control the alignment of conduit 13 in a vertical manner. The structure utilized for conduit 13 includes a combination flexible sleeve and wound metal helix disposed thereabout. These flexible conduit assemblies are commercially available. A discharge opening 15 is arranged at the base or bottom of the conduit, with the details of this opening being described more fully hereinafter. Means are also provided for controlling the elevational disposition of the discharge opening 15, these means being in the form of a pair of suspension cables 17 and 18, which are secured at the base to a load ring 19 having a pair of attaching ears or lugs 20 and 21 extending radially therefrom. A coupling in the form of an attaching bracket or the like is utilized to attach the cables 17 and 18 to the ring 19, such as the brackets 22 and 23. A pair of pulleys 26 and 27 are arranged at the upper end of the structure adjacent frame 11, with these pulleys each being driven from a common shaft 28, the pulleys being fast on stub shafts 28A and 28B which are in turn driven from shaft 28 by belts 28C and 28D. Shaft 28 is journaled for rotation in the structure by means of bearings or bushings shown at 29 and 30, with a motor means being shown at 31 for providing controlled rotational motion to shaft 28 and ultimately to pulleys 26 and 27 through shafts 28A and 28B. Motor 31 is a conventional gear head motor and, as can be appreciated, is arranged to move shaft 28 at a low rotational velocity.

As is apparent, control means are provided for programming the motion of motor 31 and accordingly shafts 28, 28A and 28B, and these controls will be described more fully hereinafter. Briefly, however, the controls are arranged to function from a signal received from a sensing foot adjacent the discharge opening, and from a level control switch which senses the immediate level achieved by the column of accumulated delivered material retained in the conduit 13 and held adjacent to the discharge opening.

Turning now to the details of the discharge opening, it will be seen that a downwardly flared flexible boot means 35 is secured to the base of conduit 13 by means of a coupling ring 36 which is, in turn, secured to load ring 19. Boot means 35 is provided with a plurality of generally triangular segments, such as the triangular segment 37 shown in FIG. 3, with these segments being utilized to provide a controllable and adjustable flare in the base of the boot means 35. Boot 35 is preferably fabricated from rubber or other resilient material, and when free from contact with delivered product or free from internal forces, assumes a relaxed flare such as is shown in phantom in FIG. 3. This relaxed flare is the normal disposition for flexible boot means 35 and is achieved upon occasion during the filling and loading operation. An extreme flare angle is also reached on occasion during the filling and loading operation, the extreme flare angle being achieved as a result of internal forces being exerted on the boot means from an accumulation of particulate solid material on the interior of the flexible conduit means. Thus, as the material is being continuously discharged from delivery spout 12, it will pass downwardly through conduit 13, and strike or otherwise make contact with the surface of the column of previously discharged material. While remaining at rest, the material will settle and form its natural or normal solid column, with the boot 35 expanding when the column of material forms a cone and reaches a magnitude sufficient to apply a force against the interior surface of boot 35.

It will be appreciated that the difference between the relaxed flare angle and the extreme flare angle of boot means 35 will be reflected in a vertical distance or vertical height of the column of material maintained in the conduit 13. This vertical distance is significant in the operation of the device, particularly from the standpoint of maintaining a continuous seal between the delivered particulate material and the atmospheric environment.

Boot means 35 is preferably fabricated from either synthetic or natural rubber material, such as, for example, silicone rubber or the like. The resilient characteristics of the material are significant from the standpoint of arrangement of flared angles, and maintaining seals, however the flexibility is perhaps a more significant parameter. Flexibility of the material will provide a more effective seal between the lip 38 and the accumulated material, such as is shown at 39. In the normal flow of particulate solids, the seal will be maintained intact between the accumulated material 39 and the lip 38 of boot means 35.

Product level sensing means are operatively coupled to the flexible conduit, with the sensing means being shown generally at 45. These sensing means 45 include a switch housing 46 containing or housing limit switch 47, which is in the form of a diaphragm type bin level switch. Such switches are commercially available. Switch 47 is arranged to be operatively associated with a motor control 51, motor control 51 being arranged to intermittently actuate motor 31 in a manner made manifest hereinafter.

Sensing foot 53 is coupled to the free end of arm 48, and is arranged to make contact with the delivery sur-

face. This sensing foot is disposed immediately adjacent the discharge opening, and is accordingly arranged to sense contact with the delivery surface. Thus, sensing foot **53** provides the operator with a remote indication of contact between the boot **35** and the delivery surface, and when such contact is reached, the operator will cease further dropping of conduit **13** and its lower boot **38.**

As has been indicated hereinabove, the discharge or delivery spout **12** is arranged to continuously deliver material into the delivery apparatus of the present invention. The discharge opening of the conduit **13** is arranged to remain at dwell during the continuous discharge of material from spout **12,** with the dwell periods being interrupted by intermittent elevation of the discharge opening. Therefore, as the loading operation commences, the discharge opening is placed at a vertical elevation substantially adjacent the delivery surface, with foot **53** having sensed contact with this surface. As the filling continues and progresses, the particulate material will flow outwardly from the confines of boot **35,** and will form a column as it accumulates within conduit **13,** until contact is made with bin level switch **46,** with level sensing switch **46** being arranged in constant contact with the upper surface of the column of discharged particulate material. As the discharge continues, the flare angle of boot means **35** will increase, thereby maintaining a constant seal between the discharged material and the interior of flexible conduit **13.** When the column reaches its predetermined height within conduit **13,** the contacts in switch **46** will change from a normally open position to a closed or "elevate" condition, and motor control **51** will function to actuate motor **31** for a predetermined interval. This interval is preferably time-programmed, to elevate in strokes or pulses of one-fourth to one-half inch magnitude and the re-establishing of a normal condition in switch **46.** At this point, motor control **51** responds to interrupt flow of power to motor **31,** and thereby re-establishes the normal dwell position of the delivery conduit. Motor control apparatus such as shown in combination with this apparatus are commercially available in the form of conventional limit controls. Since delivery of material from chute or spout **12** is continuous, a substantial number of strokes or pulses may be necessary each time the bin level switch indicates a full column present, and this continuation of pulses will proceed until a significantly lower level of fill is maintained within conduit **13.**

As an alternate to the stroking elevation of conduit **13,** means may be provided for initiating an elevate cycle when a certain degree of fill has been achieved within conduit **13,** with the elevational motion continuing until a certain lower limit or column height is sensed. In such an instance, the controllable elevation of conduit **13** continues as a function of immediate level control.

As a further alternate, a timed cycle may be employed wherein upon sensing a condition indicating an upper level has been achieved, an elevate cycle may be initiated which will continue for a predetermined period of time. Thus, a time delay network may be utilized in combination with the control means so as to control the extent of elevation of conduit **13** in response to the nature of the condition being sensed.

Attention is now directed to FIGS. **4–7** of the drawings for a description of the operational sequence of the apparatus of the present invention. In FIG. **4,** the flexible conduit **13** is at an extreme elevated position, thus permitting truck **60,** which is to be loaded, to be moved thereunder. The lateral disposition of the apparatus **10** is controlled so as to provide delivery at a desired point on the bed of the box of truck **60.** This motion is indicated by the double-headed arrow **61** in FIG. **4.** Spout **12** has telescoping segments to accommodate lateral motion. Upon reaching the desirable lateral position, flexible conduit **13** is lowered until contact is achieved between the base of boot **35** and the surface of the bed of the box of truck **60.** As is apparent, it is this bed surface which is exposed to atmosphere. Upon achieving the desired lateral and elevational disposition in conduit **13,** the flow of material is commenced by the operator and continued for the duration of the loading operation. The initially delivered product is shown in FIG. **5,** as it emerges from the flexible boot means **35,** with the seal being maintained between lip **38** of boot **35** all during the filling operation. The loading continues with intermittent elevation of the flexible conduit means until an intermediate disposition is reached, such as is illustrated in FIG. **6.** Upon achieving a completion of the loading, such as is illustrated in FIG. **7,** flexible conduit **13** is raised to its fully elevated disposition and the truck **60** may be removed. In this connection, it will be appreciated that a continuous seal is maintained by boot **35** between the interior of conduit means **13** and the atmosphere.

By way of example, a periodic intermittent elevating event which has been found satisfactory for most particulate solid material is approximately one-fourth to one-half inch, with this degree of intermittent motion being adequate to continuously maintain the seal, while preventing a capture or loading of the solids about boot **35** so as to render excessive resistance to periodic elevation of the delivery means. A column of between about 24 inches and 30 inches has been found to be preferred within conduit **13** for continuous operation of the system, however for certain low density materials, a column height of more than 30 inches may be utilized.

We claim:

**1.** Means for controlling the delivery of particulate material onto a surface exposed to atmosphere and including:

a. a closed elongated flexible conduit means having means for receiving a charge of particulate material at the top and having a discharge opening at the bottom thereof and means for controlling the lateral and elevational disposition of said discharge opening;

b. a downwardly flared flexible boot means secured to the base of said flexible conduit and defining said discharge opening, said flexible boot means having a normal relaxed flare angle and an extreme flare angle achieved in response to a radially outwardly directed force against the wall of said boot means;

c. product level sensing means operatively coupled to said flexible conduit and having sensor means disposed within said flexible conduit and at an elevation from said discharge opening and arranged to sense the level of particulate material within said conduit relative to said discharge opening;

d. condition responsive means responsive to the level sensed by the sensor means of said product level

sensing means and arranged to activate said elevational control means to raise said flexible conduit a predetermined distance through a series of elevational strokes in response to said sensor detecting a predetermined level of discharged particulate material retained within said conduit; and

e. said predetermined distance being generally no greater than the vertical distance defined by the difference between said extreme flare angle and said relaxed flare angle of said boot means so as to maintain a generally controllably closed discharge opening between the interior of said flexible conduit means and atmosphere.

**2.** The apparatus as defined in claim **1** being particularly characterized in that said elevational control means is arranged to periodically raise said flexible conduit between intermittent periods of dwell.

**3.** The apparatus as defined in claim **1** being particularly characterized in that said elevational control means is an electric motor.

**4.** The apparatus as defined in claim **1** being particularly characterized in that said flexible conduit means includes a load ring adjacent the base thereof, and wherein generally vertically disposed cables extend between said elevational control means and said load ring.

**5.** The apparatus as defined in claim **1** being particularly characterized in that said flexible boot means are resiliently biased from said extreme flare angle to said normal relaxed flare angle.

**6.** The method of delivering particulate solid material onto an atmospherically exposed surface which includes:

a. continuously passing said particulate material through a flexible conduit having a discharge opening with a downwardly flared flexible boot means disposed at the base thereof, with said downwardly flared flexible boot means having a normal relaxed flare angle and an extreme flare angle assumed in response to radially outwardly directed forces;

b. intermittently elevating said discharge opening in response to accumulation of particulate material within said flexible conduit;

c. detecting the condition of accumulation of particulate material within said flexible conduit which corresponds generally to the attainment of said extreme flare angle in said boot means; and

d. thereupon periodically elevating said discharge opening by an incremental amount corresponding generally to a vertical distance no greater than the vertical distance defined by the difference between said extreme flare angle and said normal relaxed flare angle of said boot means.

**7.** The method as defined in claim **6** being particularly characterized in that said discharge opening is elevated for substantially equal amounts during each incremental elevating event.

* * * * *