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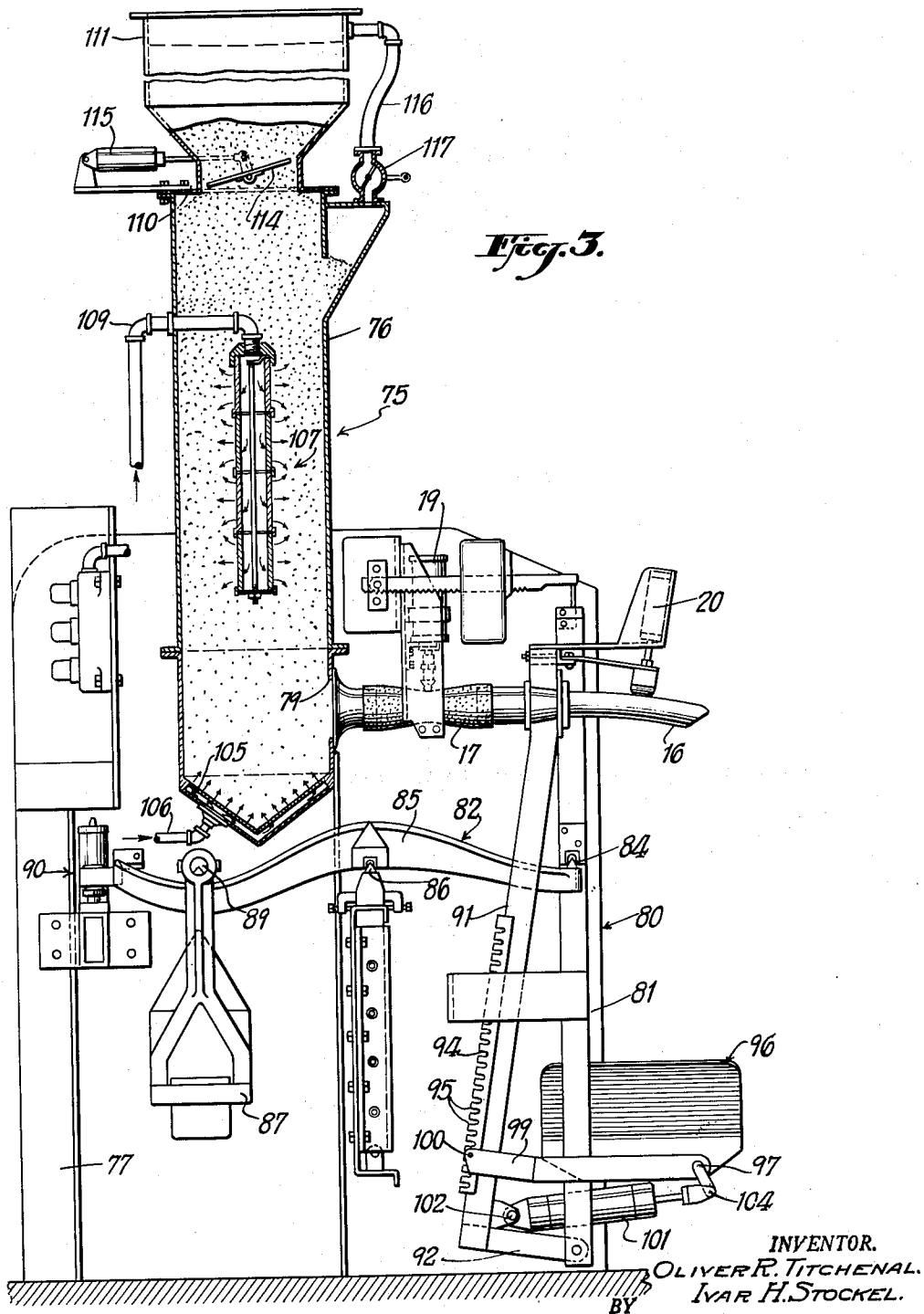
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APPARATUS FOR PACKAGING DRY DIVIDED SOLID MATERIALS

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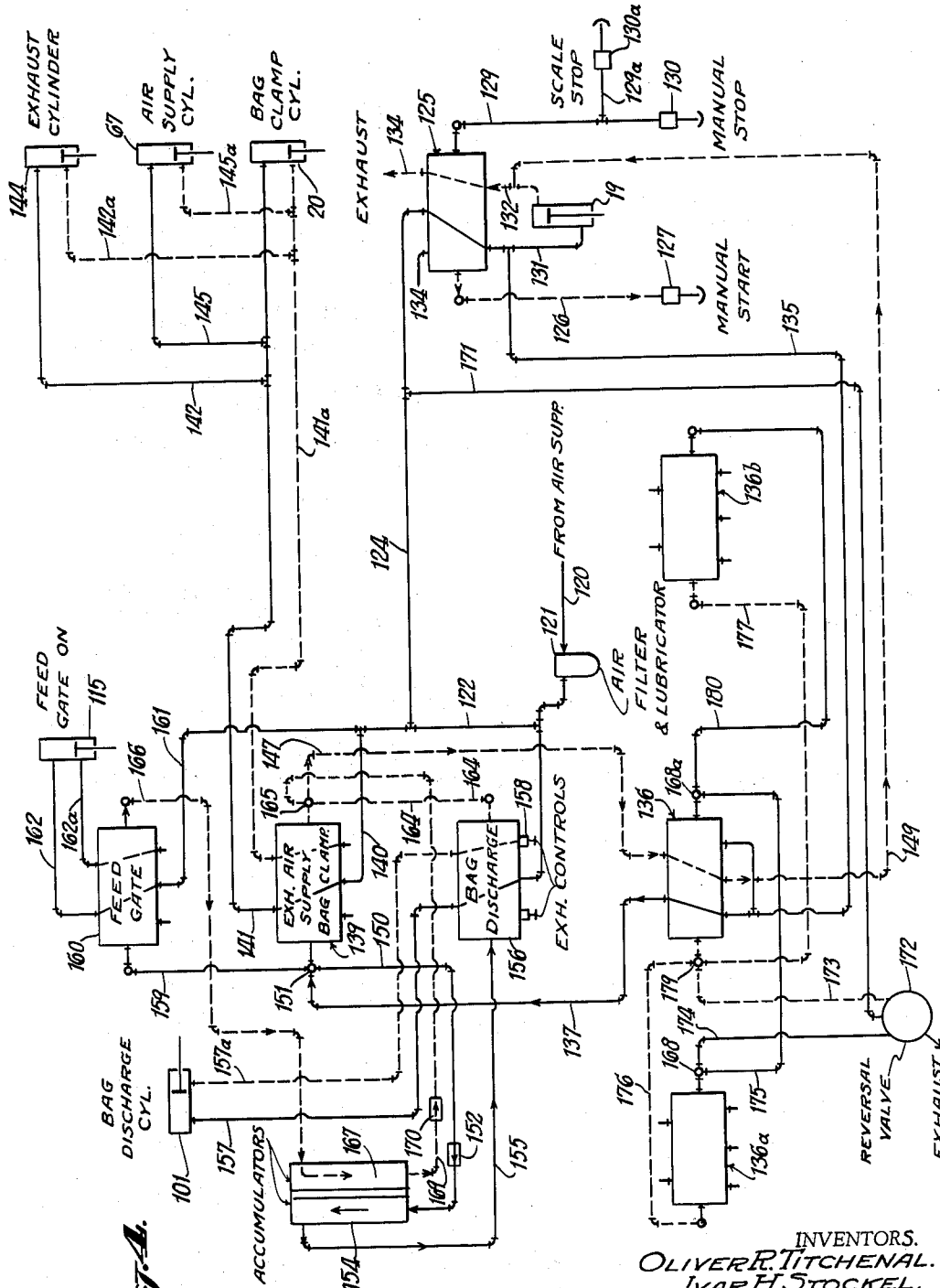


Fig. 4.

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Fig. 5.

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APPARATUS FOR PACKAGING DRY DIVIDED SOLID MATERIALS

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This invention relates to the packaging of dry divided solid material, and, more particularly, to a method and apparatus for fluidizing such material and delivering it into packaging containers, such as paper bags, for example, while in a fluidized state.

Constructions of the class described are well known to the art and much effort has been expended in the development of various operating methods and apparatus. One familiar construction that has been utilized heretofore includes a vertical bin open at the top and having a discharge spout at its lower end. Air is introduced under controlled pressure into the lower end of the bin through an inclined air pervious pad to fluidize the material in the bin and carry it out through the spout. While this type of apparatus has achieved a certain degree of commercial success, it, along with other known apparatus of the class described, has proven to be far from satisfactory in a number of respects. For example, it has been found that while known apparatus may perform reasonably well for one or a relatively small group of dry divided solid materials, no known packer is satisfactory for all such materials or even for more than a few types of material. Accordingly, to package several different materials, a number of different, costly machines were necessary.

Additionally, bearing in mind that it is the general object of all packing equipment of the class described to obtain good weight results, as dust-free operation as possible, and good filling speed, all with as little air as possible, it has been found that in known fluidizing packers, it is often necessary to sacrifice one or more of these objectives in order to obtain desired results with the others, so that none of the known commercial fluidizing packers is entirely satisfactory.

It is thought that the failure of the art to produce a suitable packer is due to the fact that many of the presently held theories concerning the performance of dry divided solid material when fluidized in air for discharge from packaging machinery, are not entirely correct.

Accordingly, in an effort to develop a method and apparatus of the class described that would not only operate in a satisfactory manner for one or a relatively small group of materials under various conditions, but would also prove satisfactory for all dry divided solid materials under a variety of conditions, an extensive program of research and development was undertaken in which the conduct of air and materials under fluidization was studied. As a result of this undertaking, an improved and expanded theory concerning the nature and conduct of fluidized solids as related to packaging was developed and, in order to facilitate a better understanding of the present invention, will be set forth briefly and in part here.

Consider a particle mass uniformly packed and lying at rest in a bin of uniform cross-section and open at its top through which it may be fed material to be packed. Each particle is supported against gravity by its neighboring particles creating a total weight per unit of area, or "head of material" in the bin. If air is caused to flow upward through the voids between the particles from a uniform supply of air entering through the bottom of the bin, the air flow will drag upward upon the particles and thus help to support them. The greater the air flow, the greater the support. There is a volumetric air flow rate (c.f.m.) for which the upward acting drag support on

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each particle just balances its downwardly acting weight. This is called the point of incipient fluidization, or the critical volumetric air flow rate. The pressure drop through the material for this critical volumetric air flow rate may be termed the critical pressure drop. For volumetric air flow rates less than this critical value, support of the particles is shared by drag and contacting neighboring particles; for volumetric air flow rates greater than the critical value, the drag support overbalances gravity and the particles momentarily move upwardly. As a result of this upward movement, the particle mass occupies a larger volume in the bin, and the void space between particles is increased; therefore, the air velocity need not increase. The column expands until the increased volumetric air flow rate above such critical rate causes no increase in velocity immediately surrounding and supporting a particle. Additionally, the pressure drop through the head of material remains very nearly constant above the critical volumetric air flow rate.

In fluidizing a material, with a volumetric air flow rate equal to or greater than critical air flow rate, an air pressure is obtained in the material at the bottom of the column which is equal to the "head of material," that is, the weight of the material in the column per unit of column cross-sectional area. What is important here is that this "head of material" is not developed by the particles of material resting upon other particles, but rather that an "apparent head" of material is developed in the manner described wherein the material throughout the column is fluid-like in behavior, that is, easily deformed and ready to pass through a filling spout into a bag, for example.

From the foregoing, it will be seen that the air pressure required at the bottom of a column of material to fluidize that column is the fluidized density of the material times the height of the column. It is somewhat more complicated to determine the critical volumetric air flow rate for a given material since this depends not only upon the material density but also upon particle size distribution and shape distribution. Since, for direct determination, a tedious microscopic examination is necessary, a simple experiment is recommended. Air flow rate is increased in an open bin until there is insignificant or no further increase in pressure in the bin, indicating that the critical volumetric air flow rate has been reached.

If now we open a discharge spout adjacent the bottom of the bin, we find that the apparent head of material in the column due to the pressure of particle supporting air will cause material and air to flow out of the bin through the spout. The material flows downwardly in the bin and thus reduces the upward air velocity below that at which it moved upwardly when the spout was closed. In fact, if material down flow velocity is large enough, the air may stand still or even flow downwardly. Therefore, it follows that maintenance of fluidization of down-flowing material may require less air flow through the pad at the bottom of the bin than does fluidization of a stationary column, and quite often no air flow is required through the pad.

The foregoing discussion has assumed an ideal material. In practice, it is often found that initial voids vary from one region to another in the bin, and air does not flow uniformly through the material. Or, the material may be partially bound, plugged or bridged so that as the critical point is reached, some of the material expands, but bound portions of the material are partially supported by wall friction. The expanded material, being lighter, causes a smaller pressure drop to exist across itself than that which would occur with ideal material. Unfortunately, this smaller pressure drop further starves the bound region so that additional increases in total flow only further expand the lighter expanded material, and further starve the bound material. Thus, the condition is self-

aggravating. In time, agitation may wear the bound material away, but considerable time may be required for this; or, on the other hand, the extent to which the majority of air flow may localize varies from the mild extent already described, to an extreme in which a nearly material-free channel develops which may occupy less than 1% of the bin cross-section but carry over 90% of the air. Discharge under these conditions could be practically free of material or, in the event of a plugged tube, no discharge might occur for a period of time.

Furthermore, when dealing with an actual material, it has been found that even if a rather ideal state of fluidization is achieved, the particles, in their slightly agitated state, may happen to group more closely than average at a particular region of the bin, and may momentarily bind. This very local condition can, depending purely upon chance, aggravate itself until considerable material has become involved so that the previously described large scale redistribution of air flow results. Conversely, the material particles at a location in the bin may, in their agitated state, so move quite by chance as to create a local diluted region through which the air flow short circuits, thereby starving adjoining regions. Once again, a condition is created which can aggravate itself. The latter two situations clearly assist one another, so that it is unimportant which one occurs first.

Another condition that may exist in practice comes about when the volume of air flow is much greater than the critical value. Here, the column "boils," that is, much of the air passes up through the material as relatively large air bubbles. Because this bubbling action causes considerable agitation, and because there is a large surplus of air flow, the other aforementioned behaviors are much less likely to occur. The state of the material everywhere, except for the small amount of dust in the bubbles, is one of fluidity.

Each of the conditions mentioned, except the last, may occur at any time and reduce the performance of the packer. These conditions reduce the pressure above the pad, and therefore, reduce the effective head, the purpose of which is to provide a pressurized air-material mixture at the bottom of the column. Due to these conditions, the material feeding through the filling spout may be partially bound or overly dilute. If partially bound, the filling rate may be reduced; if overly dilute, excessive air and wild material enter the package, providing the basic factor in a dirty operation.

To insure total fluidization, it is tempting to employ the last condition, namely, bubbling or boiling due to greatly increased air flow. But this condition readily leads to excessive dilution and a dirty operation, longer filling times, high bag pressures, and a generally unstable cycle.

What is desired then, is the elimination of the first-named conditions without resorting to the last-named condition, such solution being applicable to all materials of the class described under a wide range of desired conditions.

In essence then, the present invention resides in the provision of a method and apparatus that fulfills the aforementioned need; there being provided such method and apparatus which is relatively simple, and yet, is successful in eliminating the foregoing difficulties and disadvantages.

As a most important feature of the present invention, there is introduced into the column of material a secondary supply of air. This secondary supply is located above the primary pad at the bottom of the bin. As a result of this secondary air supply, excessive air flow rate can be obtained through the material in the column above the primary pad, while only critical flow rate or less than critical flow rate need be introduced through the primary pad. Excessive air above the region of the primary pad insures a fluidized state, while the critical air through the material in the bottom of the bin provides relatively com-

pack, but fluid material in the region just before it flows through the discharge or package filling spout. In accordance with this feature of the invention, the secondary air supply will be so positioned that the material does not have time to destabilize on its way to the spout, and also that the material density can increase to the desired high value before it enters the spout.

The utilization of this secondary air supply quite naturally introduced the desirability of going to higher pressures to (1) decrease bag filling time through small filling spouts, and (2) eliminate the possibility of a condition wherein the pressure at the bottom of the bin approaches that of the bag, that is, the creation of a back pressure which would materially reduce or stop flow into the bag. But to increase the pressure with an atmospheric packer, that is, one that is open at the top, would mean increasing the height of the bin substantially where it is desired to package a dry divided solid material, this being due to the weight per unit of volume of the material—most such material weighing between thirty-five and sixty-five pounds per cubic foot. On the other hand, if it became necessary to reduce the height of the bin, the obtainable pressure drop through the bin would be proportionally reduced for the same air flow rate. Therefore, to utilize the higher pressures, the height of the bins must be materially increased. This, of course, is not desirable since higher bins are more costly and require a greater number of secondary air supply means. Furthermore, since these atmospheric bins are loaded at the top, higher bins necessitate lifting of the material charge to a higher level and this often involves more costly equipment. There is, therefore, a need for a low head closed bin packer capable of utilizing during bag filling low to relatively high pressure ranges (2–15 p.s.i.g., for example).

Accordingly, another important feature of the present invention resides in the utilization of a bin that is of considerably lower height than known atmospheric or open type packers but that is capable of utilizing such relatively high pressure range. Packers having bins of the low head enclosed type are subdivided into the batch in-feed type and the continuous in-feed type. The latter bin may be fed continuously through known types of continuous feeding devices, such as auger or star valve types of feeding apparatus, and, while such a packer of fluidized dry divided solid materials has proven satisfactory, nevertheless, it does present the problem of leakage of pressurizing fluid through the feeding valves. While this problem can be minimized by the introduction of sufficient secondary air to replace that which is lost in packaging as well as through the feed mechanism, the leakage becomes more of a problem as the valve wears and as higher pressures are used.

Therefore, another feature of the present invention resides in the application of secondary air to the closed bin low head batch type packers that may be opened to atmosphere between each bag filling cycle in order to take in a new charge of material, but which are closed to atmosphere during the actual filling of the bag. This type of packer packages batches of material between charges, and since continuous feeding is not required, a good, tight seal of the material charging valve may be effected between charges.

In packers of the closed bin batch type, the secondary air not only provides the energy level required to discharge fluidized material through a bag filling spout, but also replaces the air that moves out of the bin during packaging, and thus all or almost all of the air fed into the bin during bag filling in this type of packer is such secondary air. Accordingly, merely enough air flow for material fluidizing or less (even zero flow) is fed during bag filling into the bin via said primary air source at the bottom region of the bin, and above it is fed such secondary air which thus accomplishes the aforementioned pressure charge in the bin during bag filling (2–15 p.s.i.g., for example). It should be noted that the time lost during

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recharging of the bin is negligible since the packer is shut down while bags are changed, in any event. While this type of packer requires a slightly larger head than that of the continuous feed type, generally it is only necessary for the bin to have a capacity of 1 to 1½ bags of any given material.

The expression "energy level" as used herein refers in the atmospheric or open bin type of packer to the pressure of the air or gas surrounding a particle of material in the region inside the bin near the outlet to the filling spout. Such air or gas pressure is symbolic of a function of said energy level of the divided solid material and air or gas mixture. There is in the atmospheric type of packer, as its name suggests, substantially atmospheric pressure at the top region of the bin. But near the bottom of the bin there is substantially higher air pressure surrounding the particles, attributable to the air fed through said pervious pad or air filter. Hence in the atmospheric type of bin there is a pressure differential between the pressure of the air surrounding a particle near the bin outlet to the spout and the pressure of the air surrounding a particle near the top or in the top region of the bin. However, in the closed pressurized or low head type of bin, when such bin is closed, the pressures of the air near the outlet and also in the top region thereof are substantially the same, and hence there is no pressure gradient between these two locations.

Another aspect of the invention contemplates the utilization in bins of the enclosed type of vent valve. It is often desirable to vent the bins just before the spout is closed to minimize dusting (blowback) problems. In the low head, continuous feed type packer, venting naturally takes place through the feeding mechanism, but a vent valve is desirable nevertheless to assure adequate venting. In the batch type packer, such a valve may also be used to evacuate the package through the bin just before the spout is shut, so as to minimize dusting (blowback) problems, or such a valve may be used to vent the bin before opening it to its feeding apparatus so as to prevent an explosion into the feeder. Such a vent valve may also be used to lower the head towards the end of each filling cycle to obtain dribble feed into the package, thereby giving fine weight control. Another function for this vent valve is to enable bin pressure to be raised to a relatively high value before opening the discharge or filling spout and then quickly dropping the pressure to operating pressure simultaneously with opening of the spout to obtain an explosion effect in the bin, thus obtaining excellent fluidity.

Where such a vent valve is employed, means may be provided whereby venting takes place to the supply bin so that any material vented through the valve is not lost, but is ultimately fed back to the bin.

A further feature of this invention resides in the utilization of this vent valve as a cut-off device. When packaging certain materials, it has been found that by quickly venting the bin, the flow of material from the bin into a bag can be stopped or cut off substantially simultaneously with actuating of the vent valve. In such cases it is unnecessary to provide a filling spout cut-off mechanism or the attendant cut-off mechanism control equipment. Of course, the filling spout cut-off mechanism may be retained for use during clean-out of the bin, in which case it can be manually operable.

Another feature of the present invention resides in the concept of so controlling the movement of the bag seat as to enable the same to be utilized to assure full opening of the bag. In this connection, it should be noted that one of the problems of the industry is that of incomplete opening of the bags because of the stiffness of the paper, stiff bottoms on pasted bags, and sometimes because the bottoms are pasted closed. Then, as the bag is being filled, the material being packed piles up in the bag above the portion of the inner walls that are pasted together until a sufficient weight of material is so accumulated to break the bond. At this point, the accumulated material

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drops to the bottom of the bag and its impact tilts the scale beam to indicate a full bag when, in fact, the bag is only partially filled. Since the position of the scale beam is frequently used to control the operation of the packer, the bag will be improperly discharged as full. The present invention contemplates means for assuring full opening of the bag.

Still a further feature of the present invention resides in the bin design wherein the primary air pad may be disposed lower than the filling spout. The lower region of the bin may be conical, for example, with the primary pad adjacent the conical surface and the filling spout above such surface. This provides better distention of air in the lower region of the bin and facilitates the provision of a clean-out opening at the bottom or apex of the conical lower bin region. The bin may be readily cleaned out and its contents conveyed to the supply bin or other desirable location by closing the spout and vent, pressurizing the bin, and opening the clean-out opening.

There has thus been outlined rather broadly the most important features of the present invention in order that a detailed description thereof that follows may be better understood and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereafter and which will form the subject of claims appended hereto. Those skilled in the art will appreciate that the conception on which the present disclosure is based may readily be utilized as the basis for designing the other structures for carrying out the several purposes of this invention. It is important, therefore, that the claims be regarded as including such equivalent constructions as do not depart from the concept and scope of this invention.

A specific embodiment of the invention has been chosen for purposes of illustration and description and is shown in the accompanying drawings, forming a part of the specification, wherein:

FIG. 1 is an elevational view, partially broken away, to reveal the interior of the bin of an atmospheric type packer in accordance with the present invention and illustrating the filling spout inserted through the valve of a bag;

FIG. 2 is an elevational view showing a low head type packer with continuous feed means;

FIG. 3 is an elevational view of a batch type packer in accordance with the invention and showing an overall arrangement of the packer and the bag weighing means as it might be used in relation to any of the various types of packers;

FIG. 4 is a schematic view of a pneumatic control circuit for the packer shown in FIG. 3 and illustrating the condition of the circuit when a cycle of operation is initiated; and

FIG. 5 is a schematic view of the circuit shown in FIG. 4 but showing the condition of the circuit when a stop signal has been initiated.

Referring now to the drawings in detail, there is shown in FIG. 1 a packer 10 of the atmospheric type, that is, one that is open to atmosphere at its top, comprising a bin 11 having an outlet opening 12 adjacent its bottom. The bottom of the bin may be conical in shape and may have a conduit 14 connected to its apex. A valve 15 is provided in this conduit for a purpose to be later described.

The outlet opening 12 is connected to a filling spout 16 by a flexible sleeve or pinch tube 17 which may be squeezed shut to stop the flow of material through the spout by a cut-off device 19 of known construction.

A pneumatically operable bag clamp assembly 20 of a known type is mounted above the spout to engage a bag 21 in the region of its valve and clamp the same against the spout.

It will be understood that in the various embodiments of the invention illustrated, any suitable bag clamping and

spout flow control device may be utilized, as such devices per se constitute no part of the present invention.

As has been mentioned, the bottom of the bin 11 may be of conical shape. A primary air pad 22, which may be similarly shaped, is spaced slightly from the conical bottom of the bin, thus forming a subchamber 24 therebetween and the pad 22 is preferably formed of any suitable air porous material. Fluidizing air under pressure is admitted to the subchamber 24 through a pipe 25.

Near the top of the bin, a secondary air pipe 26 enters the bin and connects with a secondary air pad 27 which, as shown, may be in the form of a cylinder having its longitudinal axis coincident with the axis of the bin. This secondary air pad is essentially an air porous muffler and, as shown, may be made in sections 29 that interfit, as by screw threads, so that any desired number of sections may be used. The primary and secondary air control means will be described in connection with the embodiments of the invention to be discussed hereinafter. It is necessary at this point to understand that the air flow rates through both the primary and secondary pads can be maintained at levels suitable for the particular materials being packaged, whereby the primary pad 22 can supply the critical flow to establish incipient fluidization at the bottom of the bin, thus providing relatively compact, flowable material in the region of the bin adjacent the filling spout, while the secondary air pad 27 can supply excessive air flow, that is, flow in excess of critical to insure a fluidized state, thus preventing the binding, plugging, bridging or channeling of the material above the secondary pad without resorting to "boiling" in which the material entering the filling spout will be overly dilute. It will also be understood that the secondary air pad will be located low enough so that the material does not have time to de-stabilize on its way to the filling tube, but high enough so that the material density can increase to the desired high value before it enters the filling spout.

Referring now to FIG. 2, there is shown a low head packer 40 comprising a bin 41 that is substantially smaller in its vertical dimension, than is the bin 11 of the packer 10.

In this embodiment of the invention, the bin is shown with an inclined bottom 42, by way of example, and spaced therefrom is a primary air pad 44 providing a subchamber 45 therebetween that is fed air through a pipe 43. The bin also has an outlet opening 46 which may be connected to a spout 16 through a sleeve 17 in the same fashion as is the outlet opening 12 of the bin 11 already referred to. In this connection it will be seen that a suitable cut-off device 19 is used to control flow through the outlet opening and a bag clamp 20 is also used, as described, to clamp the bag in fill position.

This packer is provided with a top plate 45 that closes the bin to atmosphere. The plate 45, however, has a feed opening 46a connected to an infeed conduit 47 leading from a hopper 49. This conduit 47 is provided with any suitable feed valve 50, such as the star valve shown, for effecting the continuous feed into the bin 41 of material to be packaged.

The secondary air pad is here shown as a horizontally disposed muffler 51 to which is connected a secondary air pipe 52.

The flow rates in the primary and secondary air pads for each type of packer may, for example, be controlled by feeding the air supply through two variable orifices for each pad. Thus, as shown in FIG. 2, each of the air supply lines 43 and 52 is forked to form lines 43a, 43b and 52a, 52b, respectively. Each line 43a and 43b is supplied through a double orifice assembly 54 having chambers 55 and 56, each of which has a variable orifice 57, 59, respectively, in a portion therein. The variable orifices are set manually by control knobs 57a and 59a. A main air supply line 60 delivers air through branch lines 60a and 60b to the chambers 55 and 56, a valve 61 being

provided to control the flow through one branch or the other.

The branches 52a, 52b of secondary air supply line 52 are each connected to a chamber of a double orifice assembly 62 that is similar to double orifice assembly 54, a valve 64 controlling the flow of air from supply line 60 to one chamber or the other.

Valves 61 and 64 are preferably controlled through links 61a and 64a linked to a rod 65 that is connected to a piston 66 reciprocable in an air cylinder 67, though other means may be used.

A complete description of the operation of the various embodiments of the invention will be presented later, but for the present it should be understood that the cylinder 67 will be connected in the pneumatic control system so that the valves 61 and 64 will operate at desired points in the filling cycle to control the flow of air through the air pads. In each case, the setting of the orifices will depend upon the material being packed and, as an example of the relationship of primary and secondary air flow control in a given cycle, the cylinder 67 may be connected in the pneumatic circuit to operate with the filling tube cut-off mechanism to reduce the air to both primary and secondary pads as the machine is filling or the cut-off is open; or, it may be desired to increase flow through the secondary pad while decreasing flow through the primary pad as flow through the filling tube is cut off; thus maintaining a pressure level during down time and eliminating the need to build up a head after the filling spout is opened. In any event, it will be seen that the flow rates through the pads may be readily varied at desired points in the filling cycle by diverting the air through one chamber or another of the orifice assemblies 54 and 62 by means of the valves 61 and 64, respectively. Also, for some materials, it may be desired to shut off one of the air pads at say the filling tube cut-off point in the cycle. When packing such material, one of the orifices in the supply line to that pad is closed, and at filling tube cut-off the appropriate valve directs air to the chamber in the orifice assembly containing that closed orifice, thus cutting off the air flow to the pad. It will be appreciated by those persons skilled in the art, that such an air supply control system provides universal control and enables the packers of the present invention to be utilized for an extremely wide range of materials not heretofore able to be packed in a satisfactory manner by a single packer.

As has already been mentioned, the invention contemplates the utilization of a vent valve in bins of the enclosed type.

Accordingly, as shown in FIG. 2, a pipe 69 containing such a valve 70 extends from the top plate 45 of the bin 41 to a suitable level in the hopper 49. The valve 70 is normally in the closed position, but may be opened, for example, just before the spout is shut to drop the pressure in the bin to effect dribble feeding at the spout. While in continuous feed packers some venting naturally takes place through the feed mechanism, it is desirable to provide a vent valve to assure proper venting. It will be noted that any material that passes out of the bin through the vent valve is fed back to the hopper 49 so that the use of such a valve involves no waste.

Turning now to FIG. 3, there is shown a batch type packer 75, that is, a packer that is opened to atmosphere between each bag filling cycle in order to take in a new charge of material. The bin, of course, is closed to atmosphere during the actual filling operation.

The packer 75 includes a bin 76 mounted on a suitable frame 77 and formed with an outlet opening 79 adjacent its bottom. The outlet opening 79 leads through a flexible sleeve 17 to a filling spout 16 as in the embodiments of the invention already discussed. A filling spout cut-off device 19 is provided for shutting off the flow of material through the filling spout as each bag is filled. A bag clamp device 20 is also provided to clamp the bag to the spout during filling.

As is well known in the art, the filling spout 16 and bag clamp 20 may be mounted on a frame 80 that includes a pair of downwardly extending legs 81 (only one of which is shown). The legs 81 are supported from a scale beam 82 by knife edge fulcrums as at 84. The beam 82 has rearwardly extending members 85 (only one being shown) that are in turn supported by knife edge fulcrums as at 86 mounted on the frame 77. The rear portion of the beam supports a weight basket 87 through knife edge fulcrums as at 89. An adjustable beam stop 90 is mounted on the frame 77 to limit the beam movement.

The frame 80 also includes an inclined member 91 connected to the legs 81 at its lower end by a link 92. A plate 94 secured to the member 91 has a series of spaced recesses 95 therein. A bag seat 96 is pivotally mounted as at 97 on seat support link 99 that extends rearwardly thereof and has a cross-pin 100 that may rest in the recesses 95. By this means, the seat may be adjusted to support bags of different size in proper filling relation to the fill spout.

A pneumatic ram 101 is pivoted as at 102 to the member 91 and has its piston rod pivoted to a crank arm 104 that is fixed to the bag seat pivot 97 whereby the ram may be actuated to pivot the seat 96 about the axis of pivot 97 for a purpose to be described hereinafter.

The bin 76 has been shown with a conical bottom which may have a cleanout pipe 14 and valve 15 (not shown in FIG. 3) connected thereto at its apex, as in FIG. 1. A primary air pad 105 is spaced from the bottom of the bin and primary air is fed by pipe 106 into the spaces therebetween to pass through the pad and into the bin. A secondary air pad 107 similar to that of FIG. 1 is shown within the bin and connected to an air supply pipe 109.

It will be seen that the upper end of the bin 76 is closed by a plate 110 having a central opening by which a hopper 111 communicates with the bin through a valved section 112. The valve member or gate 114 for this section is controlled by a pneumatic ram 115.

As in the low head packer of FIG. 2, the bin 76 has a vent line 116 extending between the top thereof and hopper 111, and a normally closed vent valve 117 is interposed in this line 116.

Referring now to FIG. 4, there is shown schematically a pneumatic circuit for control of the various operating elements of the packer of FIG. 3, and illustrating the condition of the circuit at the start of a filling operation, the solid lines representing pressurized lines and the broken lines representing exhausting lines. Any suitable source of compressed air supplies such air to the line 120 which conducts the air through a filter and lubricator 121 to a manifold line 122 which in turn is connected to a line 24 that leads to an air valve 125 of the sliding spool type. One end of the valve chamber communicates through line 126 with a manual start button 127, while the other end communicates through lines 129 and 129a with a manual stop button 130 and a scale stop button 130a, respectively. Depression of the manual start button 127 exhausts one side of the chamber of valve 125 allowing the spool to shift to the left to direct air through line 131 to cylinder 19 to open the fill spout, the cylinder exhausting through line 132, the valve 125 and exhaust 134.

The valve 125 supplies pilot air through a tap line 135 for the operation of other valves in the system. Thus, the line 135 supplies air to the valve 136 which, in one position, established by pressure led to the right side of its chamber through the lines 124, and 171, the reversal valve 172 and lines 174 and 175, completes communication between the line 135 through line 137 with the chamber of a valve 139 so as to move the spool therein to the right, as viewed. This valve 139 therefore establishes communication between manifold line 122, line 140, and lines 141 and 142 to actuate a cylinder 144 to close the vent valve 117 (FIG. 3); also from line 141 to line 145 to actuate the cylinder 67 (FIG. 2) to set the valves 54 and 62 to supply air as desired to the primary and secondary pads; also to

the bag clamp cylinder 20 moving it into clamping position. It will be seen that the lefthand side of the chamber of the valve 136 exhausts through the line 173 and reversal valve 172.

The opposite sides of each of these cylinders 144, 67 and 20 are simultaneously opened to atmosphere through lines 142a, 145a and 141a, respectively, through the opposite side of valve 139. Meanwhile, the chamber of valve 139 exhausts through line 147, valve 136, lines 149, 132, valve 125 and exhaust 134.

Simultaneously, air under pressure flows from line 137 into line 150 at the cross-connector 151, thence through flow control 152 in the restricted direction, accumulator 154, providing a predetermined delay in the air signal, and line 155, to one side of the chamber of bag discharge control valve 156 shifting the spool therein to allow air to flow from the supply line 120 through line 157 to bag discharge cylinder 101 (FIG. 3).

At the same time, air flows from the cross-connector 151 through line 159 to the chamber of the feed gate control valve 160, shifting the spool therein to allow air under pressure to flow from manifold line 122, lines 161 and 162 to the feed gate control cylinder 115 (FIG. 3) to close the feed gate 113, the cylinder 115 exhausting through line 162a and valve 160.

It will be seen that as bag discharge control valve 156 communicates the start signal to the bag discharge cylinder, the chamber of that valve 156 exhausts through line 164, cross-connector 165, line 147, valve 136, lines 149 and 132, valve 125 and exhaust 134, while the cylinder 101 exhausts through line 157a, valve 156 and needle valve control 158 that allows fine control of the bag discharge cylinder speed. Also, as the spool in the feed gate control valve 160 shifts to the right, as viewed, the chamber exhausts through line 166, accumulator 167, line 169, flow control 170 in the non-restricted direction, cross-connector 165, line 147, valve 136, lines 149 and 132, valve 125 and exhaust 134.

If it is desired to operate a bank of several packers, the pressure line 174 leading out of the reversal valve 172, may be tapped by a cross-connector 168 to feed pressurized air to the right side of the chamber of a valve 136a similar to valve 136. A similar cross-connector 168a enables air to be brought from cross-connector 168 through line 175 to line 180 to valve 136b, these valves exhausting through lines 176 and 177, respectively, cross-connector 179, line 173 and reversal valve 172, and serving to control circuits similar to that just described, in the same manner as does the control valve 136.

To summarize the operation of the control circuit, upon the initiation of a start signal, the filling tube cut-off device 19 moves to the open position allowing communication between the bin and the bag; the bag clamp cylinder 20 is moved to clamp the bag on the spout; the air supply is delivered to the pads 105 and 107 at predetermined flow rates, as described in connection with FIG. 2 for a filling condition; the vent valve 117 is closed; the feed gate 114 is closed; and then, after a delay of say two seconds, for example, determined by the accumulator 154 and the flow control 152, the bag seat 96 is retracted to the position shown in FIG. 3.

The purpose for delaying retraction of the bag seat relates to the matter of assuring full opening of each bag. The bag, when mounted on the fill spout, is not fully extended before the seat is retracted. As filling starts, a small amount of material enters the bag and, if the bag is not fully open (exemplary reasons for this having been stated), this material accumulates above the bag bottom. After a slight delay, and before an amount of material so accumulates sufficient to tilt the scale beam to cut-off position, the bag seat is quickly retracted, snapping the bag to its fully extended length and enabling the accumulated material to drop towards the bottom of the bag, thus breaking any bond of paste in its path. As mentioned, this amount of material will not be sufficient to tilt the scale beam to cut-off position.

Referring now to FIG. 5, there is shown schematically the same pneumatic control circuit illustrated in FIG. 4, but showing the condition of the circuit elements when a stop signal is initiated. In this view, as in FIG. 4, the solid lines represent the pressurized side of the circuit and the broken lines represent the exhaust side.

The stop signal may be initiated manually by depressing the stop button 130 or automatically when the scale makes its weight by actuation of the button 130a by the scale beam. Upon actuation of either of these buttons, the spool of valve 125 moves to the right, as viewed, directing air under pressure from line 124, through the valve and the line 132 to one side of cut-off cylinder 19 to actuate the same to cut off the flow of material through the spout by closing the pinch tube 17 (FIG. 3). The other side of cylinder 19 exhausts through line 131 the valve 125 and exhaust 134.

At the same time, air under pressure moves through the line 149, the valve 136, line 147 and cross-connector 165 to the righthand side of the chamber of valve 139, as viewed, shifting the spool to the left, thus exhausting one side each of the cylinders 144, 67 and 20 through the lines 142, 145 and 141, respectively, the valve 139 and the exhaust 138, thereby opening the exhaust valve 117 (FIG. 3), shifting the cylinder 67 to regulate the air supply to the air pads as desired during down time, as explained with reference to FIG. 2, and opening the bag clamp.

Pressurized air, upon reaching the cross-connector 165 flows through lines 164 to the right side of valve 156 to shift its spool to the left, as viewed, whereby air from supply line 120 flows through the valve to line 157a and one side of the bag discharge cylinder 101 thus tilting the seat 96 (FIG. 3) to discharge the bag from the fill spout, the opposite side of this cylinder 101 exhausting through line 157, valve 155 and adjustable exhaust 158 which is set to slow the action of the cylinder 101.

Air also flows from the cross-connection 165 through line 169, flow control 170 in the restricted direction, accumulator 167 providing a predetermined delay in the air signal, line 166 to the right side of the chamber of feed gate valve 160 thus shifting its spool to the left, as viewed, and enabling air under pressure in the manifold 122 to move through line 161, valve 160, and line 162a to the feed gate cylinder 115 shifting the feed gate 114 (FIG. 3) to the open position to allow a new charge of material to move from the hopper 111 to the bin 76, the opposite side of this cylinder 115 exhausting through the line 162 and the valve 160. As the spools in the valves 139, 156 and 160 shift to the left the chambers exhaust through lines 137a, 155 and 159, respectively, to the cross-connector 151 and thence through line 137, the valve 136, lines 135 and 131, valve 125 and exhaust 134.

If a bank of packers are being used, the reversal valve 172 may be conveniently actuated to shift the positions of the spools in valves 136a and 136b by directing pressurized air through the line 173 to the cross-connector 179 and thence through lines 176 and 177 to the respective chambers, the opposite sides of the chambers exhausting through lines 174 and 180 respectively, along with the exhaust of valve 136 through the line 175 and the reversal valve.

To summarize the operation of the control circuit upon the initiation of a stop signal, the bag clamp moves to release position, the filling tube cut-off device is moved to the closed position stopping movement of material into a bag; the air supply is delivered to the pads 105 and 107 at predetermined flow rates as described in connection with FIG. 2 for a down condition; the vent valve 117 is opened; the feed gate is opened, and the bag seat is tilted in a clockwise direction, as viewed in FIG. 3, but slowly because of the controlled exhaust through exhaust 158 on valve 155, to discharge the full bag.

It is important to note that the circuit illustrated is exemplary only. Actually, any cylinder can be con-

trolled in its speed of operation by delaying its exhaust as, for example, by the adjustable exhaust valves 158. Also, the signal to any valve can be delayed by use of a flow control and accumulator in the particular line, as in the line 150, for example. Such variations are not shown herein, because those persons skilled in the art, upon familiarizing themselves with the illustrative circuits shown would be readily able to adapt the same to provide the desired variations.

It is, therefore, within the concept of the present invention to delay the operation of the bag discharge cylinder 101 after the initiation of a stop signal so as to permit natural venting of the air in the bag through the bag itself, thereby to minimize the blowing of dust out through the bag valve when it and the filling spout are separated. This could readily be accomplished by inserting a flow control and accumulator in the bag discharge valve signal circuit on the stop side, for example.

It is also within the present concept to delay the operation of the cut-off cylinder 19 in the stop side of the cycle until after the opening of the vent valve 117. This would enable the bag to vent back through the bin, thus giving a quick, clean operation. In fact, with some materials, the cut-off can be eliminated altogether, the material flow stopping immediately upon venting the bin pressure through the valve 117.

Similarly, if desired, the opening of the cut-off could be delayed in order to pre-pressure the bin before starting to fill.

Another important part of the present contribution resides in the utilization of the vent valve to allow some venting of the bin to lower the pressure therein as the filling portion of the cycle approaches its end. Thus, the speed of flow of material will be reduced to provide a dribble feed into the bag, giving fine weight control. The vent valve may also be used to raise the pressure in the bin to a relatively high value just before starting to fill, and then quickly dropping the pressure by opening the vent valve simultaneously with the fill spout to obtain an effect similar to an explosion in the bin, thereby creating a condition of excellent fluidity in the material. The vent valve would, of course, be immediately closed again as packing begins.

It has been found that the present invention enables certain powdery compressible materials to be pre-compressed and actually extruded through the filling spout into the bag. Where it is desired to accomplish such packing the primary air may be shut off completely by closing both of the variable orifices in the primary air supply line and raising the pressure of the secondary air to start the material flowing. In this connection, it is important to note that with some materials it has been found advantageous to utilize the control circuit so as to shut off the primary air during filling and to turn it on during the down time while a new bag is being applied. In this way, the down time is utilized to fluidize the material, so that when the spout is opened, the secondary air can effect flow of the material through the spout without the addition of air in the region of the spout, thus maintaining the material in the spout at a relatively high density. This technique may be used with materials which retain for a period of time a sufficient degree of fluidity after the primary air is shut off.

The circuit illustrated in FIGS. 4 and 5 may readily be adapted to the atmospheric packer of FIG. 1 simply by eliminating those elements that are not needed such as the feed gate 114 and the vent valve 117, and the controls necessary for their operation.

If a bank of packers are being used, the present invention contributes a method whereby they may be cleaned out most economically. The bags are filled normally until the several bins have each less than a full bag of material remaining in them. Then, instead of cleaning each bin separately, thus wasting all of the material involved, the filling spouts are closed, and the mate-

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rial is fluidized and moved into one of the bins, valved interconnections being provided for the purpose. This one bin is then used to fill more bags and, when less than a full bag of material remains therein, a bottom outlet, such as 14 in FIG. 1 is opened, the fill spout is closed, and the bin is pressurized, thus discharging the remaining material.

It is to be understood that the term "dry divided solid materials" as used herein, is not to be interpreted as excluding materials that have a moisture content, the criterion being the ability of the material to be fluidized with a gas. In fact, such products as doughnut flour, the moisture content of which may run as high as 20%, and mixed molasses feeds, for example, come within the scope of the term.

From the foregoing description, it will be seen that the present invention contributes a method and apparatus for packaging dry divided solid material quickly, efficiently, with a minimum of air at the filling spout so that the material enters the bag in a dense state, with a minimum of dusting and with uniform bag weights; but most important, the present concept enables the accomplishment of such packaging for an extremely wide range of materials. For example, the batch packer of FIG. 3 has been used in tests to successfully package materials ranging from 6 pounds per cubic foot up to approximately 80 pounds per cubic foot, and with particle sizes ranging from 400 mesh and finer up to $\frac{1}{4}$ inch pellets. Most bags can be packed with a free top as low as 1 to 1½ inches.

While the invention has been described in detail with respect to a preferred embodiment, it will be understood by those skilled in the art that various modifications may be made without departing from the spirit and scope of the invention and it is intended to cover all such changes and modifications in the appended claims.

We claim:

1. A packaging apparatus comprising in combination, a bin for containing material to be packaged and being provided with material discharge means, weighing means including a seat movably mounted thereon for supporting a bag in material receiving position relatively to said discharge means, means operative when said weighing means records a predetermined bag weight to close said discharge means, and control means operative to position said seat in a first position to support the bag to receive material from said discharge means and then to shift said seat to a second position to support said bag to receive additional material from said discharge means, said shifting movement assuring full opening of said bag, said material entering said bag while in said first position being of insufficient weight to cause said weighing means to record said predetermined bag weight upon said shifting of said seat from said first to said second position.

2. A packaging apparatus comprising in combination, a bin for containing material to be packaged and being provided with discharge means, weighing means including a seat movably mounted thereon for supporting a bag in material receiving position relatively to said discharge means, means operative when said weighing means records a predetermined bag weight to close said discharge means, and control means operative to position said seat in a first position to support said bag in partially extended position to receive a limited quantity of material from said discharge means into the upper region thereof and then after a predetermined delay to shift said seat to a second position to support said bag in fully extended position thus allowing said material in the upper region thereof to drop to the bottom of the bag to snap the inner bag surfaces away from one another to assure unobstructed filling of the bag during the remainder of the fill period.

3. Apparatus for filling powdered or granular material into containers, comprising: a stationarily mounted closed bin having an upper charging inlet for charging

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said material therethrough and closure means therefor, and said bin having a lower dispensing outlet for discharging said material, means for introducing air under pressure into said bin for pressurizing the same and discharging said material through said outlet, and normally closed venting means, releasable for venting said bin to atmosphere thereby to terminate said discharge.

4. Apparatus for dispensing fluidizable, comminuted material, comprising: a substantially gas-tight bin having an upper charging inlet and a lower dispensing outlet, said inlet having means for charging said material therethrough and for thereafter gas-sealing said inlet, said outlet having normally closed valve means, releasable for dispensing said material therethrough, and said bin mounting adjacent said outlet a first valve controlled, air injection and dispersing means for fluidizing said material, and mounting thereabove a second valve controlled, air injection means for applying supplemental air pressure within said bin, said valves being adjustable for regulating the air flow through each, and means for opening the valves of said first and second air injection means in timed relation to release and closure of said outlet valve means.

5. Apparatus for dispensing fluidizable, comminuted material, comprising: a substantially gas-tight bin having an upper charging inlet and a lower dispensing outlet, said inlet having means for charging said material therethrough in substantially gas-sealed relation to the outer atmosphere, said outlet being normally closed by a substantially gas-tight valve means, releasable for dispensing said material, and said bin mounting adjacent said outlet, a first valve controlled, air injection and dispersing means for fluidizing said material, and mounting thereabove a second valve controlled air injection means for applying supplemental gas pressure within said bin, said valves being adjustable for regulating the gas flow through each, and means for opening and closing the valves of said first and second air injection means in timed relation to release and closure of said outlet valve means.

6. Apparatus for dispensing fluidizable, comminuted material, comprising: a bin having an upper section for receiving and a lower section for dispensing the same, valve feeding means interconnecting said sections arranged to seal said lower section against atmospheric pressure at least during periods said material is being dispensed, a dispensing outlet at the base of said lower section closed by valve means releasable to dispense said material, said lower section mounting adjacent said outlet, a first valve controlled air injection and dispersing means for fluidizing said material, and mounting thereabove, a second valve controlled air injection means for controlling the gas pressure within said bin, valve controlled venting means interconnecting said bin sections, and means for opening and closing the valves of said first and second air injection means and the valve of said venting means in preselected timed sequence to release and closure of said outlet valve means.

7. A machine for filling powdered or granular material into containers comprising: a stationarily mounted fluidizing chamber provided with an atmospheric exhaust vent opening, means for supplying fluidizing gas to said chamber, a discharge spout connected to said chamber, valve means for controlling the flow through said spout, means for applying fluid pressure to said chamber, and manually actuated, pneumatic control means for simultaneously admitting said fluid pressure to said chamber, closing said vent and opening said valve.

8. A machine for filling powdered or granular material into containers comprising: a stationarily mounted fluidizing chamber provided with an atmospheric exhaust vent opening, means for supplying fluidizing gas to said chamber, a discharge spout connected to said chamber, valve means for controlling the flow through said spout, means for supplying fluid pressure to said chamber, manu-

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ally actuated, pneumatic control means for simultaneously admitting said fluid pressure to said chamber, closing said vent and opening said valve, and additional means including a control actuated manually and a control actuated automatically by a preselected container weight of said material for subsequently opening said vent, closing said valve and cutting off said fluid pressure.

9. A machine for filling powdered or granular material into containers comprising: means defining a fluidizing chamber provided with an atmospheric exhaust vent opening, means stationarily mounting said chamber, means for supplying fluidizing gas to the base of said chamber, a discharge spout connected to the base of said chamber, means for clamping said container to said spout, valve means for controlling the flow through said spout, means for injecting fluid under pressure into an upper portion of said chamber, manually actuated, pneumatic control means for simultaneously admitting said fluid under pressure to said chamber, closing said vent, opening said valve and actuating said clamping means.

10. A machine for filling powdered or granular material into containers comprising: means defining a first fluidizing chamber, means stationarily mounting said chamber, means for supplying fluidizing gas to said chamber, a first conduit connected to said chamber for venting the same to atmosphere, a first valve for controlling the flow through said first conduit, a material discharge spout connected to said first fluidizing chamber, a second valve for closing said discharge spout, means defining a second chamber, a second conduit connecting said second chamber with the upper end of said first chamber, third valve means for controlling flow through said second conduit, manually actuated, pneumatic control means for opening said second valve and simultaneously closing said first and third valve means and additional means comprising controls actuated manually and by a preselected container weight of said material for subsequently closing said second valve and simultaneously opening said first and third valves.

11. A machine for filling powdered or granular material into containers comprising: means defining a first fluidizing chamber, means stationarily mounting said chamber, means for supplying fluidizing gas to said chamber, means for supplying fluid pressure to said chamber, a first valve means for controlling the admission of said fluid pressure to said chamber, a first conduit connected to said chamber for venting the same to atmosphere, a second valve means for controlling flow through said first conduit, a material discharge spout connected to said chamber, a third valve means for controlling the flow through said spout, means defining a second chamber, a second conduit connecting said second chamber with the upper end of said first fluidizing chamber, a fourth valve means for controlling flow through

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said second conduit, manually actuated, pneumatic control means for opening said first and third valve means while simultaneously closing said second and fourth valve means, and additional means including controls actuated manually and by a preselected container weight of said material for subsequently closing said first and third valve means while simultaneously opening said second and fourth valve means.

12. A machine for filling powdered or granular material into containers comprising: means defining a first fluidizing chamber, means stationarily mounting said chamber, means for supplying fluidizing gas to the base of said chamber including a plenum faced by an air permeable pad therein, means for supplying gas pressure to said chamber and for dispersing said gas therein, a first valve means for controlling the admission of said gas pressure, a first conduit connected to the top wall of said chamber for venting the same to atmosphere, a second valve means for controlling flow through said first conduit, a material discharge spout connected to said chamber adjacent said plenum, a third valve means for controlling the flow through said spout, said spout having means for clamping said container thereto, means defining a second chamber, a second conduit connecting said second chamber with the upper end of said first chamber, a fourth valve means for controlling flow through said second conduit, manually actuated, pneumatic control means for opening said first and third valve means and actuating said clamping means while simultaneously closing said second and fourth valve means, and additional means including controls actuated manually and by a preselected container weight of said material for subsequently closing said first and third valve means and releasing said clamping means while simultaneously opening said second and fourth valve means.

References Cited by the Examiner

UNITED STATES PATENTS

40	1,437,916	12/1922	Shelor	141—45
	1,971,852	8/1934	Goebels	222—195 X
	2,032,367	3/1936	Kennedy et al.	302—53
	2,500,768	3/1950	Peterson	141—83
	2,766,912	10/1956	Calamai	222—195
45	2,905,362	9/1959	Aust	222—195 X
	3,073,401	1/1963	Zenke	177—63

FOREIGN PATENTS

50	462,361	1/1950	Canada.
	808,124	1/1937	France.

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