Aug. 30, 1966 I. H. STOCKEL ET AL 3,269,428

METHOD FOR PACKAGING DRY DIVIDED SOLID MATERIALS

Filed Oct. 10, 1961 5 Sheets-Sheet 1

Fig. 2.

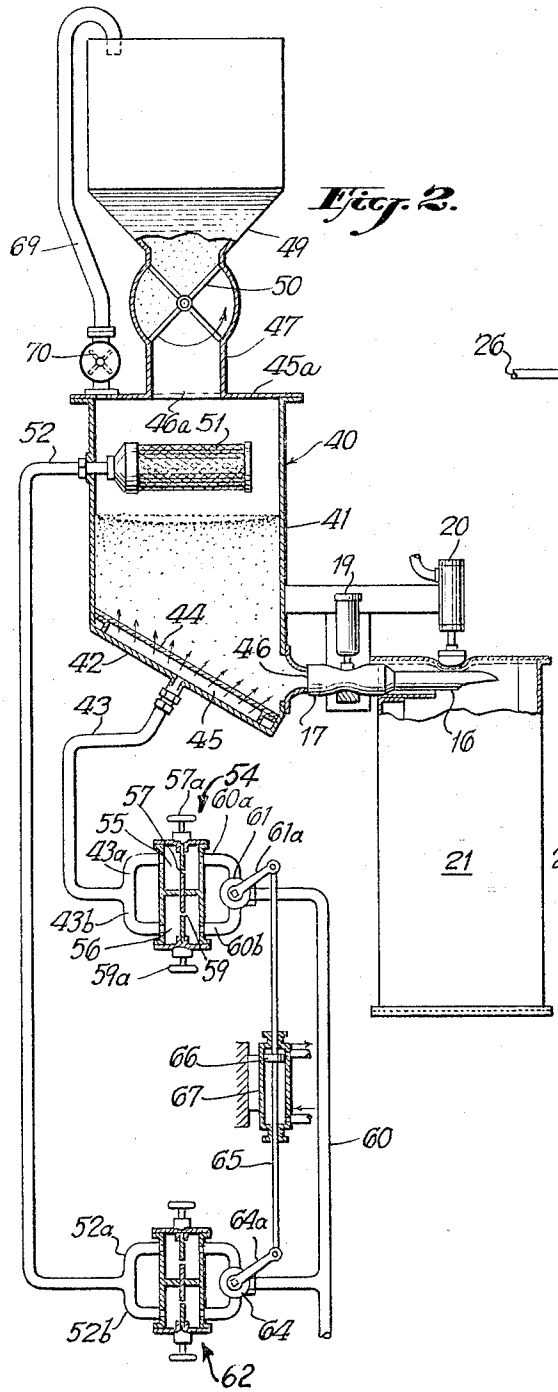
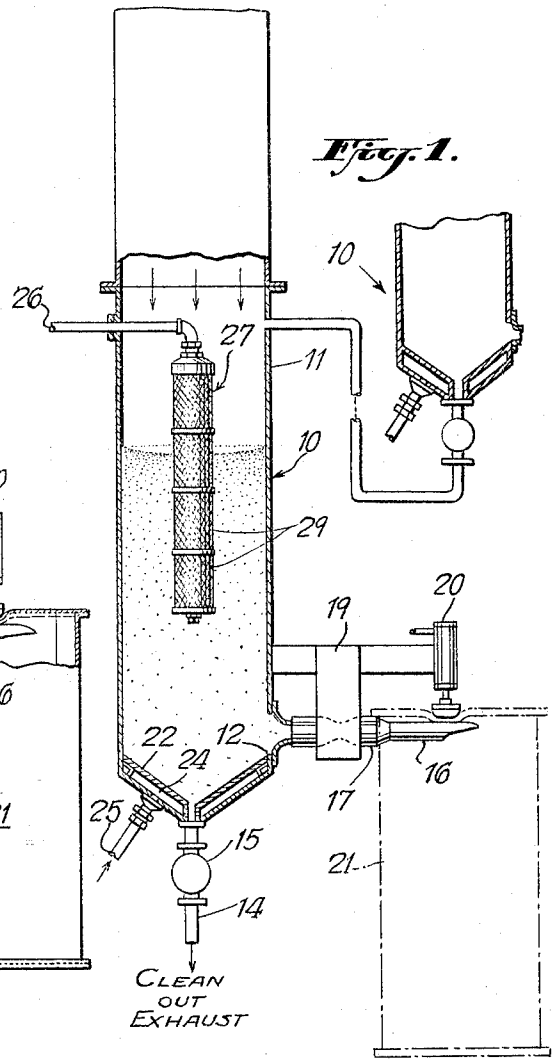


Fig. 1.



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Filed Oct. 10, 1961 5 Sheets-Sheet 2

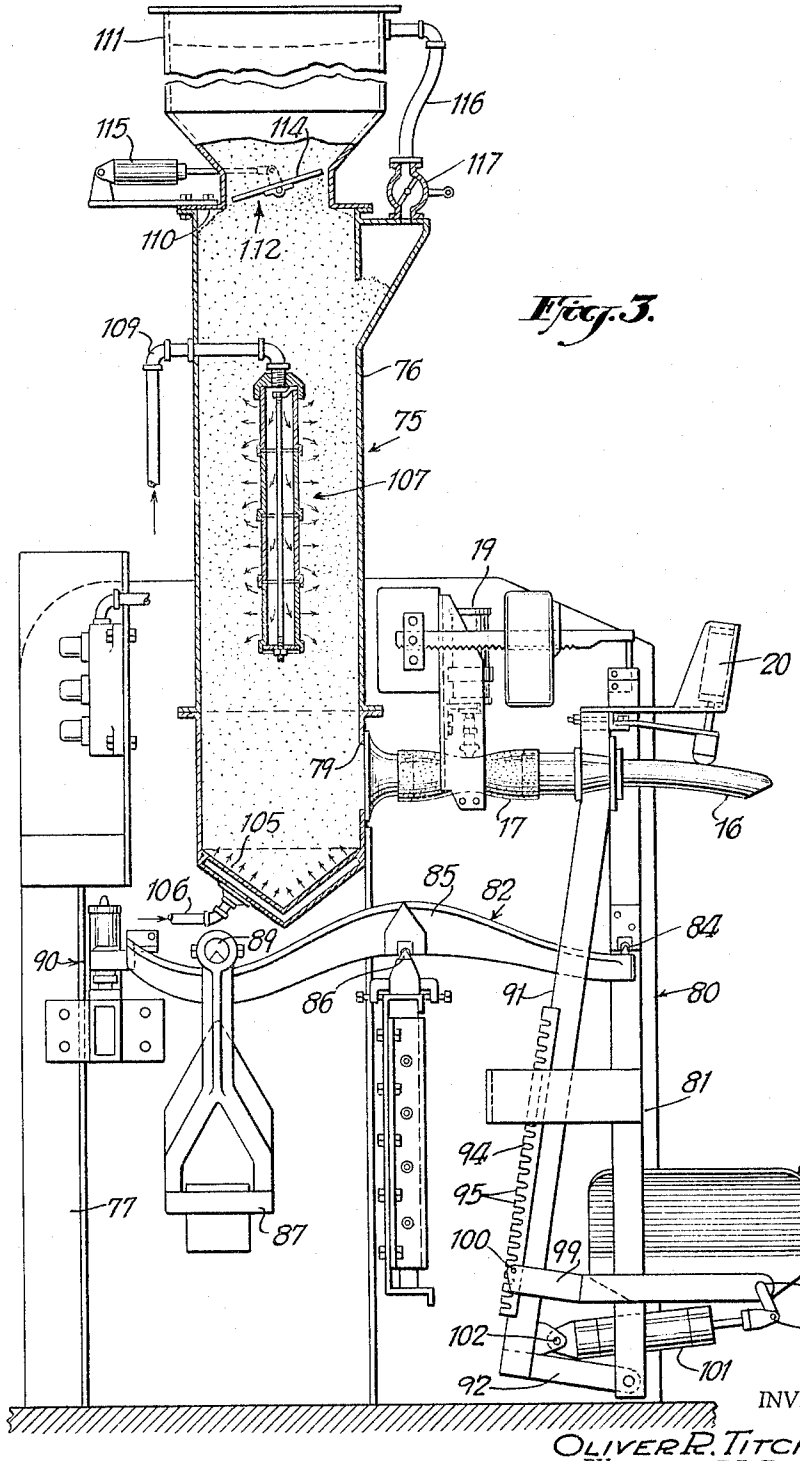


Fig. 3.

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METHOD FOR PACKAGING DRY DIVIDED SOLID MATERIALS

Filed Oct. 10, 1961 5 Sheets-Sheet 3

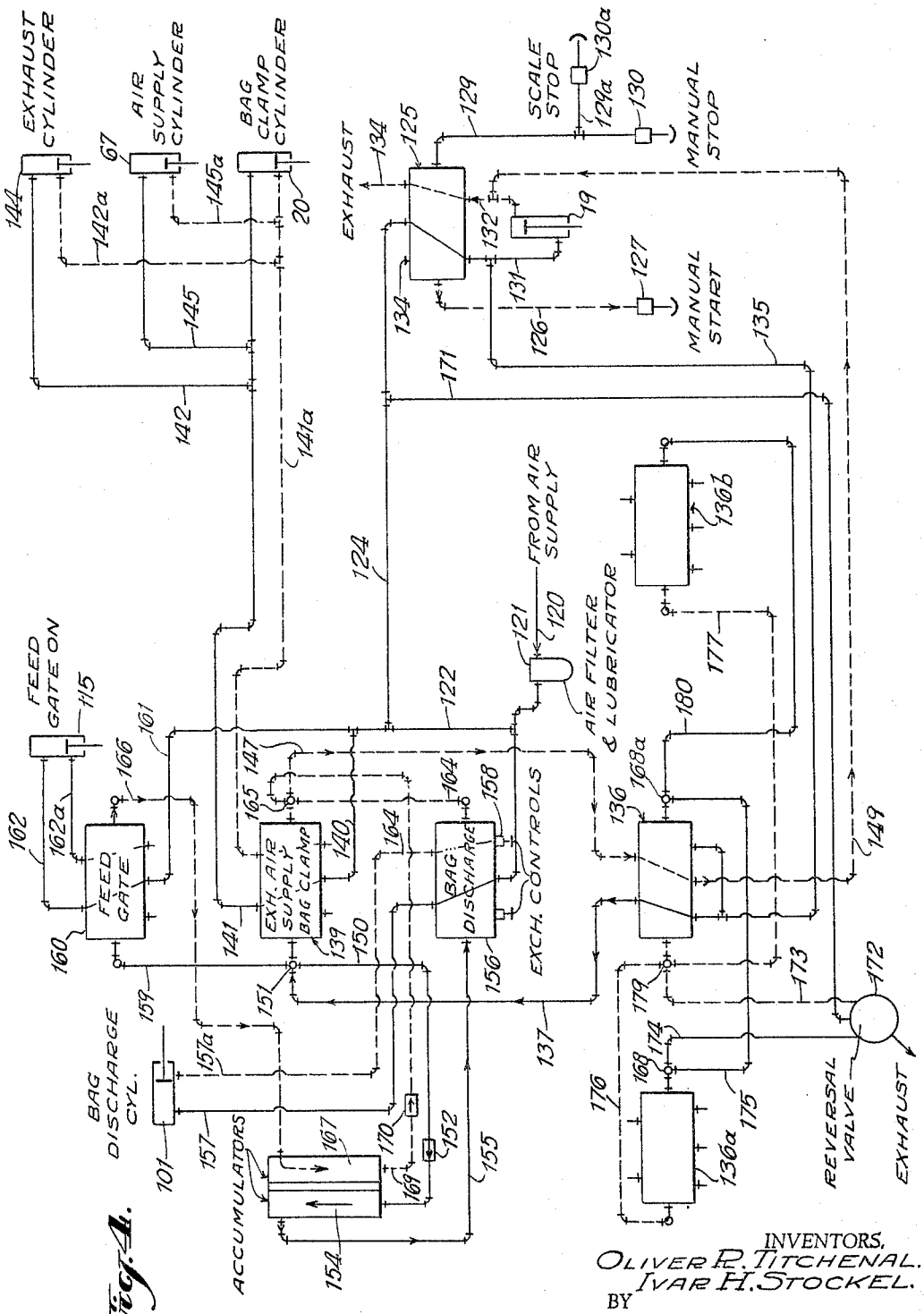


Fig. 4.

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METHOD FOR PACKAGING DRY DIVIDED SOLID MATERIALS

Filed Oct. 10, 1961 5 Sheets-Sheet 4

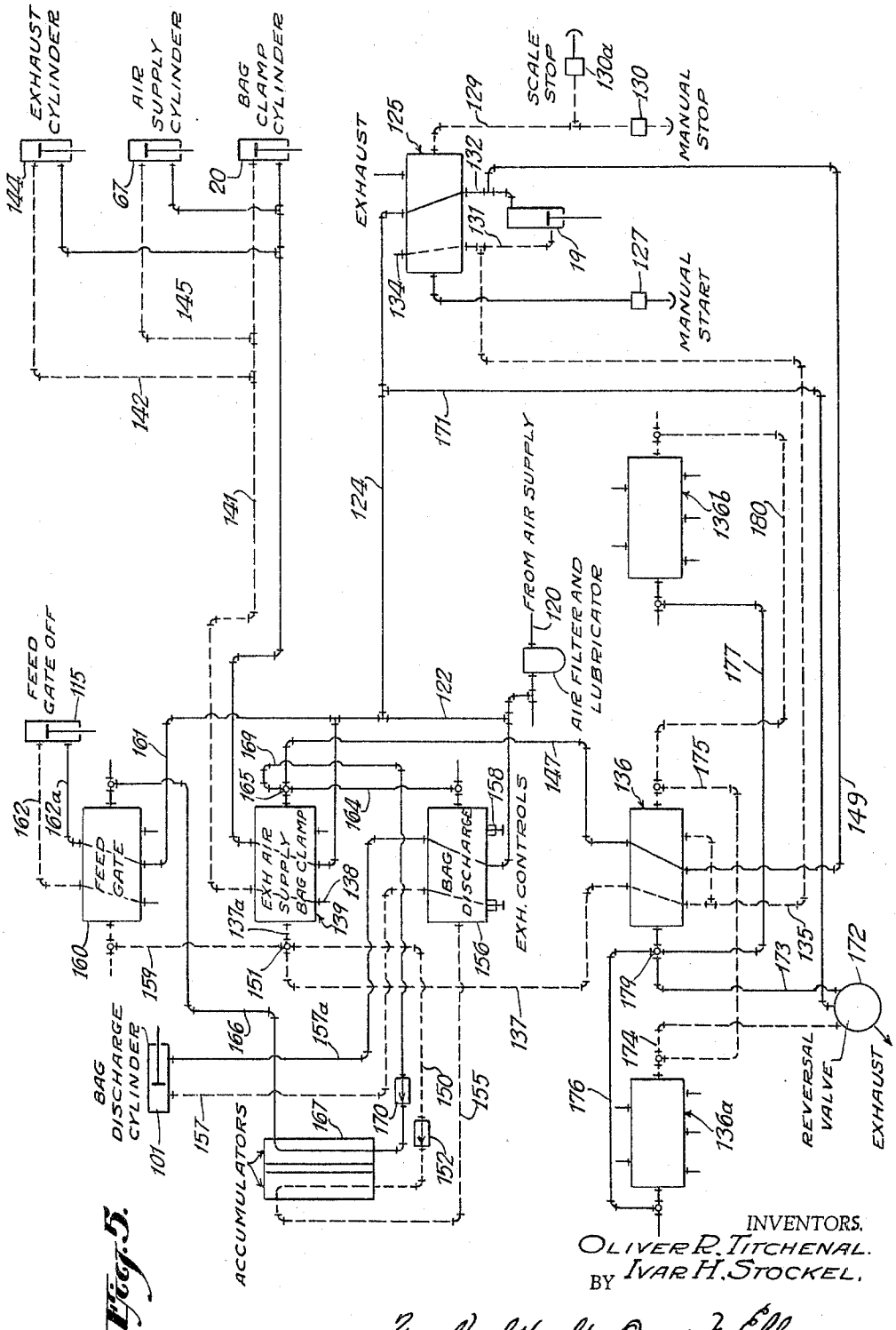


Fig. 5.

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METHOD FOR PACKAGING DRY DIVIDED SOLID MATERIALS

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Fig. 6.

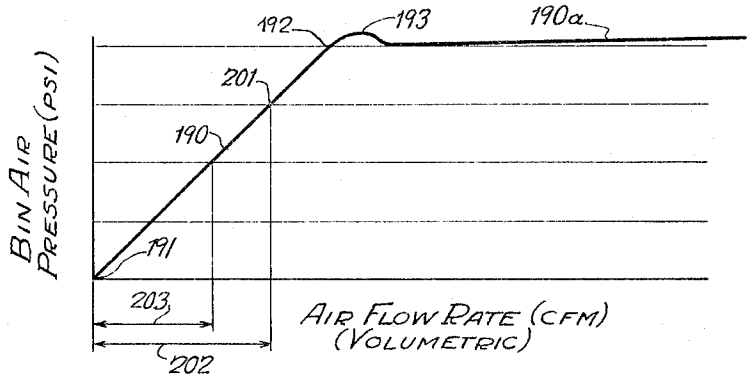


Fig. 7.

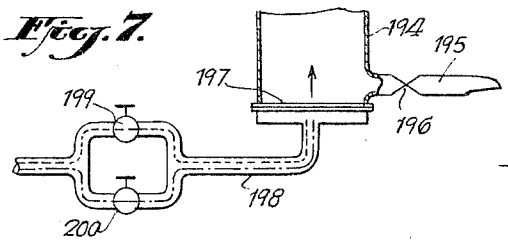


Fig. 8.

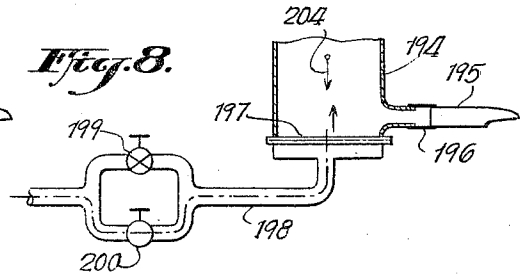


Fig. 10.

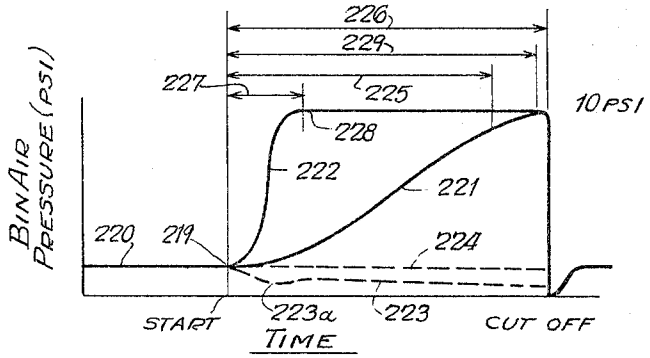
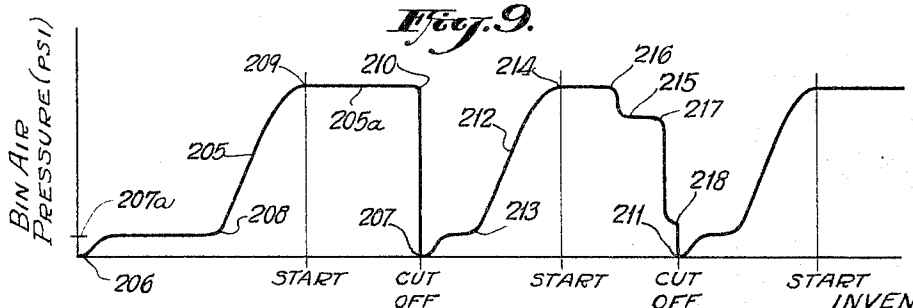


Fig. 9.



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United States Patent Office 3,269,428 Patented August 30, 1966

3,269,428

METHOD FOR PACKAGING DRY DIVIDED SOLID MATERIALS

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Filed Oct. 10, 1961, Ser. No. 144,142
Claims priority, application Belgium, Oct. 24, 1960, 474,115, Patent 596,334
14 Claims. (Cl. 141—10)

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

This application is a continuation-in-part of our copending application Serial No. 810,465, filed May 1, 1959.

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 appaartus 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 packaging equipment of the class described to obtain good weight results, as dust-free operation as possible, and good filling sped, 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 upwardly acting drag support on 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 downflowing 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. Unfortu-

nately, 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 compact, but fluid material in the region just before it flows through the discharge or package filling spout. In accordance with their 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 enclosed type are subdivided into the batch infeed type and the continuous infeed 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 change in the bin during bag filling (2–15 p.s.i.g., for example). It should be noted that the time lost during 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 a 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 value 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 spourt 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 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;

FIG. 6 is a graphical representation of bin air pressure plotted against volumetric air flow rate with respect to that embodiment of the invention having a bin open to the atmosphere;

FIGS. 7 and 8 are schematic representations in side elevation of a packer as described in connection with FIG. 6 and indicating two different conditions therein;

FIG. 9 is a graphical representation of bin air pressure plotted against time in an embodiment of the invention wherein the bin is closed to the atmosphere during the time of the filling of a container and illustrating several novel aspects of this embodiment;

FIG. 10 is also a graphical representation of bin air

pressure plotted against time showing on a single graph curves typifying the operation of the embodiment which is closed and pressurized during the filling of the container and also the embodiment which is open to the atmosphere during such filling of the container.

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***a* that closes the bin to atmosphere. The plate **45***a*, however, has a feed opening **46***a* 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 start 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 **43***a*, **43***b* and **52***a*, **52***b*, respectively. Each line **43***a* and **43***b* 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 **57***a* and **59***a*. A main air supply line **60** delivers air through branch lines **60***a* and **60***b* to the chambers **55** and **56**, a valve **61** being provided to control the flow through one branch or the other.

The branches **52***a*, **52***b* 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 **61***a* and **64***a* 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***a* 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 spaced 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 valve **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 **124** 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 **129***a* with a manual stop button **130** and a scale stop button **130***a*, 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 **142***a*, **145***a* and **141***a*, 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 **114**, the cylinder **115** exhausting through line **162***a* 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 **157***a*, 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**, maybe tapped by a cross-connector **168** to feed pressurized air to the right side of the chamber of a valve **136***a* similar to valve **136**. A similar cross-connector **168***a* enables air to be brought from cross-connector **168** through line **175** to line **180** to valve **136***b*, 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 **130***a* 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 **141**, 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 **157***a* 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 **156** and adjustable exhaust **158** which is set to slow the action of the cylinder **101**.

Air also flows from the cross-connector **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 **162***a* 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 **137***a*, **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 **136***a* and **136***b* 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 **156**, to discharge the full bag.

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

ing 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 material 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.

Referring now to FIG. 6, there is shown a graphical representation of bin pressure plotted against the volumetric flow rate of the air in cubic feet per minute injected into an atmospheric type of packer, that is, one having a bin which is open to the atmosphere and of the type as shown in FIG. 1. The graph of FIG. 6 illustrates the point that in such open or atmospheric type of packer it is possible to have a preselected succession of volumetric flow rates but normally there is but a single energy level therein. However, such single energy level may not at all times exist but may in fact vary somewhat when the air flow rate is changed.

As shown in FIG. 6, a curve **190** is employed for illustrating the change of bin air pressure with change in volumetric air flow rate of the fluidizing air in an atmospheric type of packer which in this particular instance does not have a secondary air supply, that is, an air supply for injecting air into the divided material which is located above the primary or fluidizing source of air. The curve **190** has its beginning point at **191**, the pressure rising substantially linearly up to the incipient point of fluidization at **192**, then following such point, in the direction of increased air flow rate, there exists a small hump **193** characteristic of such pressure vs. air flow rate curves in this type of packer. The curve **190** thereafter at **190***a* is substantially level which indicates the condition that the value of the volumetric air flow rate of the fluidizing air injected into this packer is selected to be between a value not substantially in excess of that which occurs at the incipient point of fluidization **192** and a value which occurs below such point. The packer is controlled whereby it is responsive to the condition that an increase in volumetric air flow rate of the fluidizing air beyond the aforementioned incipient point of fluidization produces insignificant change in pressure in the bin in the region of the outlet. By so adjusting and so selecting the volumetric air flow rate as aforementioned the packer is controlled so that there is neither an excessive infeed of material nor a starving infeed of such material into the bin.

FIG. 7 shows schematically a bin of the open or atmospheric type, the bin being designated **194** and having an outlet or container filling spout **195** which is under the control of a valve **196** schematically shown here to be shut. Fluidizing air is directed into the bin from the bottom via an air pervious pad **197** which is fed thereto via a conduit **198** having two valves **199** and **200** for controlling the air flow therethrough. By closing off either one of these two valves the air flow through the conduit **198** can be substantially diminished or by adjusting either one of these valves the flow rate through the conduit **198** can be adjusted.

FIG. 7 represents schematically the conditions in the bin when the fiilling tube or outlet **195** is closed, that is, when the valve **196** is closed.

FIG. 8, on the other hand, represents the bin **194** when the filling tube **195** has material passing therethrough by virtue of the opening condition of the valve **196**. Thus when the filling tube **195** is open and the fluidized material is flowing to and through the filling spout, a different pressure condition occurs. The pressure condition of FIG. 7 is represented by the point **201** on the curve **190** which represents the energy level of the material in the bin of FIG. 7 and this is the energy level, which it is desired to maintain in this particular packer, not only when the spout is closed, but also when it is open.

But when the filling spout **195** is open by the opening of the valve **196** and the condition of FIG. 8 exists, then, in order to maintain the energy level of point **201** (FIG. 6), it is necessary to diminish the supply of air into the bin, for example, by shutting off one of the valves **199** or **200** or by adjusting one of such valves. This, for example, reduces the voulmetric air flow rate from the value **202** back to a value **203**, and by virtue of the falling movement of the divided particles downwardly in the bin **194** there will be maintained or approximately the aforementioned energy level at the point **201**, this by virtue of the movement as schematically represented at **204**, as shown in FIG. 8, which is symbolic of the activity of a particle while falling and moving toward the filling spout **195**. While it is desired to maintain the energy level represented by the point **201** it is not always possible actually to stay on the target so to speak and to maintain this exact energy level. Hence when the volumetric flow rate is reduced to the value **203**, the energy level may not remain precisely at the point **201** but may be slightly above or below. Hence to this extent there may be a selected succession of energy levels in this atmospheric type of packer.

However, in the closed bin type of packer, such as that shown in FIG. 3, there is in fact a preselected succession of energy levels which is symbolized by FIG. 9 representing bin air pressure plotted against time, the packer having an infeed of the batch type, that is, increments or batches of divided material are fed into the bin between each container filling cycle.

In FIG. 9 there is shown the curve **205** which starts at atmospheric pressure at point **206** and terminates at the end of the filling cycle at point **207** also at atmospheric pressure. This curve represents the changes in pressure within a bin of the type as shown in FIG. 3 during a typical filling cycle.

In the cycle represented in FIG. 9, there is employed the so-called "prepressurizing technique" wherein the bin is brought to a selected relatively high air pressure prior to the initiating of the filling of the container and such pressure is maintained substantially constant during the filling of such container, with the exceptions noted below.

Thus at the outset of this particular cycle, namely, at the commencing point **206**, the pressure in the bin is zero (or atmospheric) and thereatfer the pressure at first

rises to substantially the value indicated at 207*a* which, for example, may be 2 p.s.i. and may remain at this value up to point 208 at which time the pressure rises relatively abruptly, by virtue of the control of the volumetric air flow rate into the packer, up to the starting point 209 of the container filling cycle. At this point the bin air pressure has achieved the target value, for example, 10 p.s.i. Also, at this point when such target pressure has been reached, the operator of the apparatus will press a starting button.

However, prior to this pressure having been reached and reverting to the point 208, at, for example, 2 p.s.i. within the closed bin, there may automatically occur the following: The bin is automatically closed by suitable control means, namely, the valve (for example, the closure 114 (FIG. 3)) is closed; also the exhaust valve, for example, 117 of FIG. 3 is closed, and hence the pressure then can build up to the point 209 as aforementioned. The automatic closure of the bin by the closure of the valves 114 and 117, that is, the closure of the exhaust valve and of the top infeed valve, can be effected by means of a material level sensitive device in the bin or in response to time or alternatively in response to pressure.

After the pressure has built up to the point 209 and the operator has pressed the button to start the container filling cycle, the filling spout automatically opens by the opening of the valve of the filling spout. Thereafter the bag fills in the manner aforementioned while the curve 205 follows the substantially constant pressure region 205*a* which in this case remains substantially at 10 p.s.i. during the filling of the bag. When the point 210 has been reached, the bag is filled whereupon the spout is closed and the exhaust valve is opened. Alternatively, the exhaust valve may be opened in order to stop the feeding but in this particular case the filling spout is closed and the valves in the upper portion of the bin are opened thereby causing the sudden drop of the pressure to atmospheric, namely, to the point 207 comprising the righthand extremity of the curve 205.

The curve to the right of the point 207 and between the points 207 and 211 is designated by the numeral 212 and is substantially similar to curve 205 in that a point 213 is reached which is analogous to 208, and also a point 214 is reached which is analogous to 209 which signifies the starting of the container filling cycle by the opening of the filling spout. However, during the container filling cycle, that is, while a container such as a bag is being filled, and in order to render the divided material more fluid, it is possible suddenly to drop the pressure in the bin by some selected increment, for example, from 10 p.s.i. of the point 214 down to, for example, 8 p.s.i. of the portion of the curve designated by the numeral 215. Such dropping of the pressure was initiated at point 216 by, for example, an opening of a valve in the top of the bin. This opening of the valve and thus the lowering of the pressure is not enough to prevent an adequate flow rate but, as aforementioned, may be employed for artificially enhancing the fluidity of the material. Commencing at a point 217, the pressure may be further dropped to the value 218 which is adequate for a dribble flow into the bag thereby achieving such a flow by a control of the valves of the bin and not of the spout.

Following the completion of such dribble flow, the container or bag having received the selected weight of material, the filling spout is closed and the pressure is abruptly dropped to the point 211 (atmospheric) of FIG. 9 simultaneously with the opening of, for example, the bin exhaust valve and also the top infeed valve of the bin.

Referring now to FIG. 10, there are illustrated several curves for indicating the pressurizing of the closed type of bin having the batch type of infeed, such pressurizing being accomplished by the injection of air well above the level of the outlet and by means of the so-called secondary or top air. The pressurizing of such batch infeed type of packer of the closed pressurized type is not in this form of the invention accomplished by primary air and in fact it is one of the objectives of this form of the invention to avoid the pressurizing of the bin by such primary or fluidizing air which is fed into the bin via the lowermost air previous membrane. The employment of the so-called primary or fluidizing air for the pressurizing of this type of packer has not proved satisfactory because it has over-aerated the material and it has slowed down the filling time substantially.

The overaeration occurs principally in the bin and in an undesired location near the filling tube if such primary or fluidizing air is employed for the pressurizing of the bin.

It is necessary to inject into this type of bin large volumes of air to cause it to reach the desired pressure during the container filling cycle and since it has been found disadvantageous to inject these volumes of air via the lowermost air previous membrane, such pressurizing air is directed, for example, via the element 107 (FIG. 3) above the level of the membrane 105.

When such air via the secondary air injecting means 107 is employed for this purpose in the batch infeed type of packer, it is scheduled to flow into the packer, that is, it is fed into the packer at a selected volumetric flow rate as shown, for example, in FIG. 10 which is a plot of air pressure in the bin against time. FIG. 10 indicates, by way of example, a pressure of 2 p.s.i. in the bin initially up to the container filling cycle starting point 219, the latter being the righthand extremity of the initial portion 220 of this graphical representation.

At the point 219, the initiation of the container filling cycle takes place, for example, by the pressing of a starter push button on the packer, at which time air under pressure is fed in at the upper region of the bin via the upper conduit system, for example, via the conduit 109 and the upper or secondary air membrane 107 (FIG. 3). Such air can be fed into the closed bin at selected volumetric flow rate and, for example, this can be 50 c.f.m. which products the curve 221 and which has a gradual pressure gradient prior to the reaching of a selected target pressure in the bin, for example, 10 p.s.i.

Alternatively, the volumetric air flow rate can be much higher, for example, 200 c.f.m. which produces the curve 222 which is of substantially greater slope, the target pressure of 10 p.s.i. being reached early in the container filling period.

By way of comparison, an atmospheric or open bin type of packer of this class may produce a pressure vs. time curve, as indicated at 223, which, due to a pecularity, has a slight dip or depression at 223*a*. Alternatively, reverting to a closed batch infeed type of packer of the type shown in FIG. 3, it is possible to inject the air into the upper region of the material via the secondary air injection means, such as 107, thereby to produce the line 224 which is at or near the initial pressure of 2 p.s.i. This may be desirable with certain types of material, for example, in filling an asphalt lined bag, or any bag, with a fluid or air impervious lining and which type of bag may be used, for example, for containing a hygroscopic type of material requiring this kind of protection.

Thus in the batch infeed type of pressurized packer which is closed to the atmosphere during the container filling cycle, it is possible to select the volumetric flow rate of the air into the bin and this should be directed therein via the upper or secondary air injecting means and not via the lowermost air pervious membranes at the bottom of the bin.

Assume, for example, that a common conduit directs air to the closed type of bin of FIG. 3, this common conduit being in communication with the conduits 106

and **109**. Such common conduit directs air under pressure to the bottom portion of the bin and thus also to the upper region thereof. The air flow rate to the bottom early in the filling cycle drops substantially to zero and such air follows the path of least resistance and the bulk of its volume thereupon is directed to the upper region of the bin via the secondary air injecting means **107**.

Reverting to the curve **222** (FIG. 10), there is illustrated that the higher volumetric flow rate into the bin, for example, 200 c.f.m., shortens the filling time, there being indicated a container filling cycle over the span **225** as opposed to the length of such filling time when the flow rate is 50 c.f.m. as indicated by the curve **221** and which is over a slightly longer span **226**.

The curves of FIG. 10 represent what may be termed a "pressure transient period" which refers to the period of changing pressure in the bin during the time of the filling of the container. Such transient period, referring to the steep portion of the curve **222**, would be during the time span **227**, namely, from the point of the 2 p.s.i. pressure at **219** up to the point **228** where the pressure in the bin reached its target value, for example, 10 p.s.i. and there became stabilized.

However, with respect to the other curve **221**, the transient period is represented by the time span **229** which is slightly less than the span **226** and represents the length of time required from the starting of the filling cycle at point **219** up to the point where the pressure in the bin reached the target value, namely, 10 p.s.i.

Although it has been found advantageous to inject the principal pressurizing air flow into the bin via the secondary air injecting means, that is, means located as in FIG. 3 above the level of the lower membrane **105** and the tube **106**, this is applicable only to the batch infeed type of packer which is closed to the atmosphere during the container filling time and is not applicable to the continuous infeed type of packer, such as that shown in FIG. 2. In fact, it is desirable to achieve the desired pressure in the type of packer of FIG. 2 via the air previous pad in the bottom of the bin although this embodiment of the invention is not limited to this characteristic. The reason for this is that it is possible to pressurize with air the continuous infeed type of bin at relatively low flow rates, the bin already having been pressurized and it is only required to add or inject into the bin a volumetric air flow rate that is being lost due to the infeed of divided material or, for example, due to a leak past the material infeed valve plus whatever volume of air is being lost during the filling.

Assume, for example, that the target value of pressure within the bin of the type of FIG. 2 is 10 p.s.i. and it is desired to maintain it continuously at this pressure despite a continuous infeed of divided material via the top of the bin. For example, there may be required a volumetric air flow rate of injection into the bin of 1 c.f.m. This preferably should be done via the air pervious pad in the bottom of the bin because it facilitates the maintenance of the fluidity of the divided solid material in the bin. While such 1 c.f.m. is desirable to be fed into the bin via its bottommost air pervious membrane, this injection of air may not be adequate to maintain the target pressure of 10 p.s.i. This may be because there is a leak past the infeed valve **50** of, for example, 5 c.f.m. which will require additional air to be fed into the bin in order to maintain the pressure. Thus, for example, an additional 4 c.f.m. may be added and this can be done via the secondary air injecting means in the upper part of the bin as by the air pervious membrane **51**.

In lieu of an air leak past the infeed valve, as aforementioned, there may be an escape of air past an adjustable exhaust passage, for example, **69**, and this may be in an amount, for example, of 1 c.f.m.

It is, of course, possible to have an injection of air into the bin for both fluidizing the divided material and pressurizing the bin and in the amount of 1 c.f.m., via the air pervious pad in the bottom of the bin to replace a loss of air of 1 c.f.m. at the top or upper region, this presupposing that there is no air leakage past the main infeed valve in which event there would be no need to add an additional volume of air via the secondary or upper air injecting means.

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 ¼ inch pellets. Most bags can be packed with a free top as low as 1 to 1½ inches.

Reverting to the batch feed type of packer shown in FIG. 3, a preferred method of operating the same in the filling of bags with the fluidizable, comminuted material is as follows. Assume at the start of operations, the bin **75** is completely empty. The vent valve **117** is set at the open position to vent the bin to atmosphere, and air under fluidizing pressure is continuously introduced through the lower air pressure line **106** and the fluidizing air pad, this pressure being such as to produce a relatively low pressure in the comminuted material of about 2 p.s.i. as represented by the line **208** in FIG. 9. The bin inlet valve **114** is now opened and a batch of the comminuted material charged from the upper storage bin **111** into the lower bin **75**. Before the bin **75** is completely filled, however, the vent valve **117** is closed to prevent the comminuted material from entering and possibly plugging the vent line **116**. When the bin **75** is filled to the desired extent, the inlet valve **114** is closed, and supplemental air under pressure is introduced through the upper air inlet pressure line **109** until the pressure has built up to a relatively high value of, for example, 10 p.s.i., as indicated by the point **209** of FIG. 9. At this point the filling cycle is initiated by depressing the start button to open the outlet valve **19** of spout **16** and thus fill a bag attached to the spout. When the bag is filled to the preselected weight, the valve **19** of the filling spout **16** is closed as is also the valve supplying the air to line **109**, this being the valve corresponding to valve **64** of FIG. 2. The vent valve **117** is also opened to vent the bin **75** to atmospheric pressure, and the filling cycle thereafter repeated for the next bag filling as above described.

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 method for packaging dry divided solid material comprising: introducing material to be packaged into bin means having a material discharge outlet, introducing air under pressure into said bin means in the region of said discharge outlet to fluidize the material in said bin means, opening said material discharge outlet while shutting off said fluidizing air, and admitting air under pressure into said bin means in a region above said first mentioned region in an amount greater than is required for fluidizing, the surplus air effecting compression of the material at the discharge outlet without prejudicing the flowability of said material out of said bin means through said material discharge outlet.

2. A method for evacuating a plurality of intercon-

nected bins each having dry divided solid material in an amount insufficient to constitute a package thereof and each having a package fill spout and at least one of said bins having a normally closed clean-out opening, said method comprising: fluidizing the material in some of said bins and causing it to flow into one of said bins having a clean-out opening to increase the amount of material therein, closing the interconnection between bins, discharging said material through the fill spout of said one bin into containers therefor until an amount remains in said bin insufficient to constitute a package thereof, opening said clean-out opening, and pressurizing said bin to cause said remaining material therein to flow out through said clean-out opening.

3. The method of dispensing fluidized comminuted material by means of an apparatus comprising a closed bin having an upper charging inlet and closure means therefor, and a normally closed lower dispensing outlet together with a first air injection and fluidizing means adjacent said outlet and a second air injection means disposed above said outlet, said method comprising the steps of: charging said material through said inlet while injecting air under pressure through said first air injecting means at a volumetric rate such as to fluidize said material, opening said outlet to discharge said material, and while said outlet is open, injecting sufficient supplemental air under pressure through said second air injection means to compress said material at said dispensing outlet.

4. The method of dispensing fluidized, comminuted material by means of an apparatus comprising a closed bin having an upper charging inlet and closure means therefor, and a normally closed lower dispensing outlet, together with a first air injection and fluidizing means adjacent said outlet and a second air injection means disposed above said outlet, and means independent of said inlet and outlet for venting said bin to atmospheric pressure, said method comprising the steps of: charging said material through said inlet while injecting air under pressure through said first air injection means at a volumetric rate such as to fluidize said material, opening said outlet to discharge said material, and while said outlet is open, injecting sufficient supplemental air under pressure through said second air injection means to effect compression of the material adjacent said lower dispensing outlet, and venting said bin to atmospheric pressure after a preselected weight of said material has been dispensed.

5. The method of dispensing fluidized, comminuted material by means of an apparatus, comprising a closed bin having a normally closed upper charging inlet and a normally closed lower dispensing outlet, together with a first air injection and fluidizing means adjacent said outlet and a second air injection means disposed above said outlet, said method comprising the steps of: opening said inlet, charging a batch of said material therethrough and closing while injecting air through said first means at a rate to fluidize said material, opening said outlet to dispense said material and while so doing injecting surplus supplemental air under pressure into said bin through said second air injection means the surplus air effecting compression of the material at the lower dispensing outlet without prejudicing the flowability of said material.

6. The method of dispensing fluidized, comminuted material into a container by means of an apparatus comprising a closed bin having a normally closed upper charging inlet, a normally closed lower dispensing spout, and normally closed bin venting means together with a primary air injection and dispersing means adjacent said outlet, and secondary air injection means disposed above said outlet, said method comprising the steps of: injecting air through said primary means at a rate to fluidize said material, opening said inlet, charging a batch of said material therethrough and closing, opening said spout with said container attached and injecting surplus air through said secondary means for discharging compressed material into said container to a preselected weight, and prior to attainment of said weight, opening said venting means to atmospheric pressure to dribble-feed said material until said preselected weight is attained, and thereupon closing said spout and discontinuing said secondary air injection.

7. The method of dispensing fluidized, comminuted material into a container by means of an apparatus comprising a closed bin having a normally closed upper charging inlet, a normally closed lower dispensing spout, and normally closed bin venting means together with a primary air injection and dispersing means adjacent said outlet, and a secondary air injection means above said outlet, said method comprising the steps of: injecting air through said primary means at a rate to fluidize said material, opening said inlet, charging a batch of said material therethrough and closing, opening said spout with said container attached and injecting air through said secondary means for densifying and thence discharging said material into said container to a preselected weight, and thereupon opening said venting means to atmospheric pressure, closing said spout and discontinuing said secondary air injection.

8. The method of dispensing fluidized, comminuted material into a container by means of an apparatus comprising a closed bin having a normally closed upper charging inlet, a normally closed lower dispensing spout, and normally closed bin venting means together with a primary air injection and dispersing means adjacent said outlet, and a secondary air injection means above said outlet, said method comprising the steps of: injecting air through said primary means at a rate to fluidize said material, opening said inlet, charging a batch of said material therethrough and closing, opening said spout with said container attached and injecting sufficient air through said secondary means for compressing the material at at least in the region of the lower dispensing spout and for discharging said material into said container to a preselected weight, thereupon opening said venting means to atmospheric pressure, closing said spout and discontinuing said secondary air injection, thereupon again opening said inlet to charge a second batch of material into said bin, closing said venting means prior to completion of said charge, and closing said inlet upon completion of said charge.

9. The method of dispensing fluidized, comminuted material by means of an apparatus, comprising a bin therefor having a normally closed lower dispensing outlet and fluidizing air injection and dispersing means adjacent thereto, said method comprising the steps of: charging said material into said bin, injecting air under pressure into said fluidizing means at a volumetric flow rate sufficient to fluidize said material with said dispensing outlet closed, opening said outlet to dispense said material, and while said outlet is open, injecting air through said fluidizing means at a different volumetric flow rate such as to maintain said material fluidized while discharging the same through said outlet.

10. The method of dispensing fluidized, comminuted material by means of an apparatus comprising a bin open to atmospheric pressure and having a normally closed lower dispensing outlet, together with means for injecting air under pressure into the base of said bin, said method comprising the steps of: charging said bin with said material with said outlet closed and injecting air into said material at a pressure sufficient to fluidize said material but insufficient to produce boiling thereof, opening said outlet to discharge said material and while said outlet is open, reducing said air pressure to a value such as to maintain substantially the same state of fluidization of said material as obtained at the higher pressure aforesaid with said outlet closed.

11. The method of dispensing fluidizable, comminuted material into a container by means of an apparatus comprising a closed bin having a normally closed upper charging inlet, a normally closed lower dispensing outlet, and normally closed bin venting means, together with means for injecting and dispersing fluidizing air under pressure into said bin, which comprises: opening said inlet and charging a batch of said material into said bin while injecting air therein at a rate to establish a relatively low

air pressure in said material, closing said inlet and increasing the air pressure within said bin to a relatively high pressure, opening said outlet to discharge a batch of said material into said container while maintaining said relatively high air pressure within said bin, closing said outlet when said container is filled to a preselected extent and venting said bin substantially to atmospheric pressure while reducing the rate of air injection into said bin.

12. The method of dispensing fluidized, comminuted material into a container by means of an apparatus comprising a closed bin having a normally closed upper charging inlet, a normally closed lower dispensing spout, and normally closed bin venting means together with a primary air injection and dispersing means adjacent said outlet, and a secondary air injection means above said outlet, said method comprising the steps of: injecting air through said primary means at a relatively low rate to fluidize said material, opening said inlet, charging a batch of said material therethrough and closing, opening said spout with said container attached and injected air through said secondary means to pressurize said bin to a relatively high value for discharging said material into said container to a preselected weight, and thereupon opening said venting means to atmospheric pressure, closing said spout and discontinuing said secondary air injection.

13. The method of dispensing fluidized, comminuted material into a container by means of an apparatus comprising a closed bin having a normally closed upper charging inlet, a normally closed lower dispensing spout, and closeable bin venting means, together with a primary air injection and dispersing means adjacent said outlet, and a secondary air injection means above said outlet, said method comprising the steps of: injecting air through said primary means at a rate to fluidize said material, opening said inlet with said bin venting means open and charging a batch of said material into said bin, closing said bin venting means before said bin is filled and thereupon closing said inlet, thereupon opening said spout with said container attached and injecting air through said secondary means to pressurize said bin to a relatively high pressure for rapidly discharging said material into said container to a preselected weight, thereupon opening said venting means to atmospheric pressure, closing said spout and discontinuing said secondary air injection, and repeating said method for the filling of additional containers.

14. The method of dispensing fluidized, comminuted material into a container by means of an apparatus comprising a closed bin having a normally closed upper charging inlet, a normally closed lower dispensing spout, and normally closed bin venting means together with a primary air injection and dispersing means adjacent said outlet, and secondary air injection means disposed above said outlet, said method comprising the steps of: injecting air through said primary means at a rate to fluidize said material, opening said inlet, charging a batch of said material therethrough and closing, opening said spout with said container attached and injecting air through said secondary means at a rate to establish a relatively high pressure in said bin for rapidly discharging said material into said container to a preselected weight, and prior to attainment of said weight reducing the pressure in said bin to a value such as to dribble-feed said material until said preselected weight is attained, and thereupon opening said venting means, closing said spout, and discontinuing said secondary air injection.

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