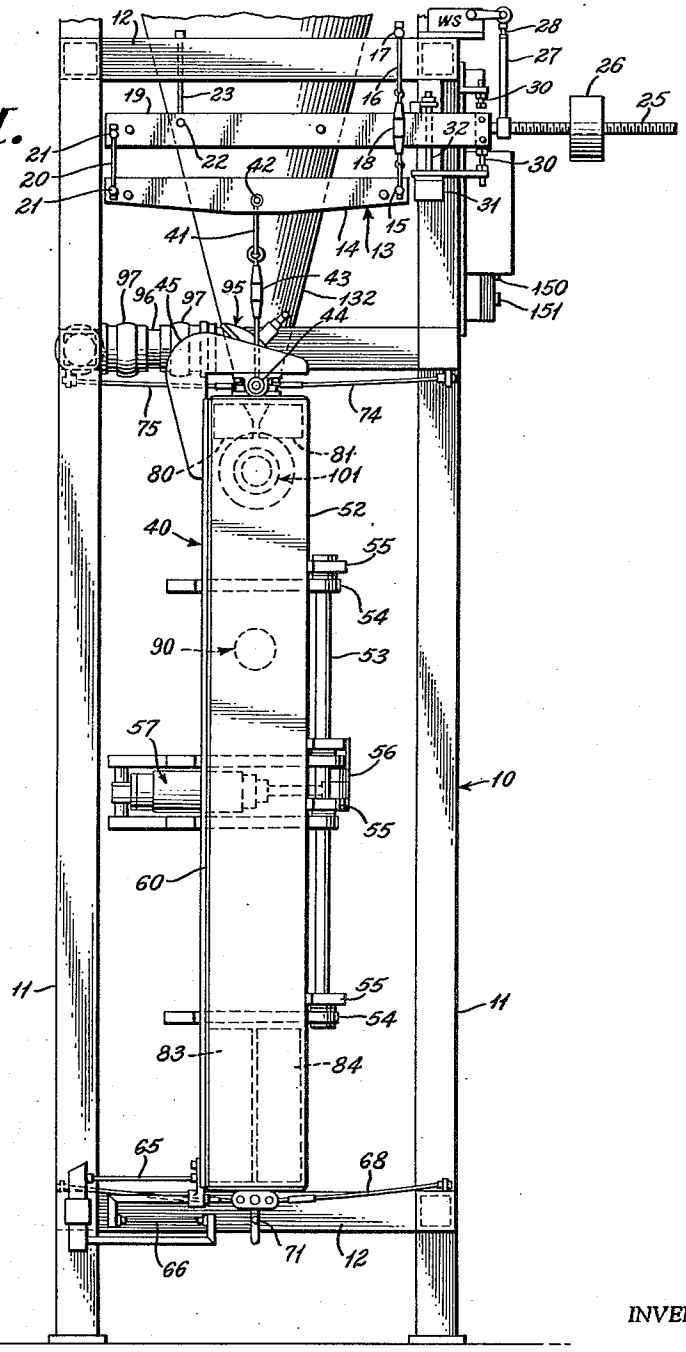
July 16, 1957 C. F. CARTER 2,799,465

METHOD AND APPARATUS FOR FILLING RECEPTACLES

Filed Feb. 28, 1955 5 Sheets-Sheet 1

Fig. 1.



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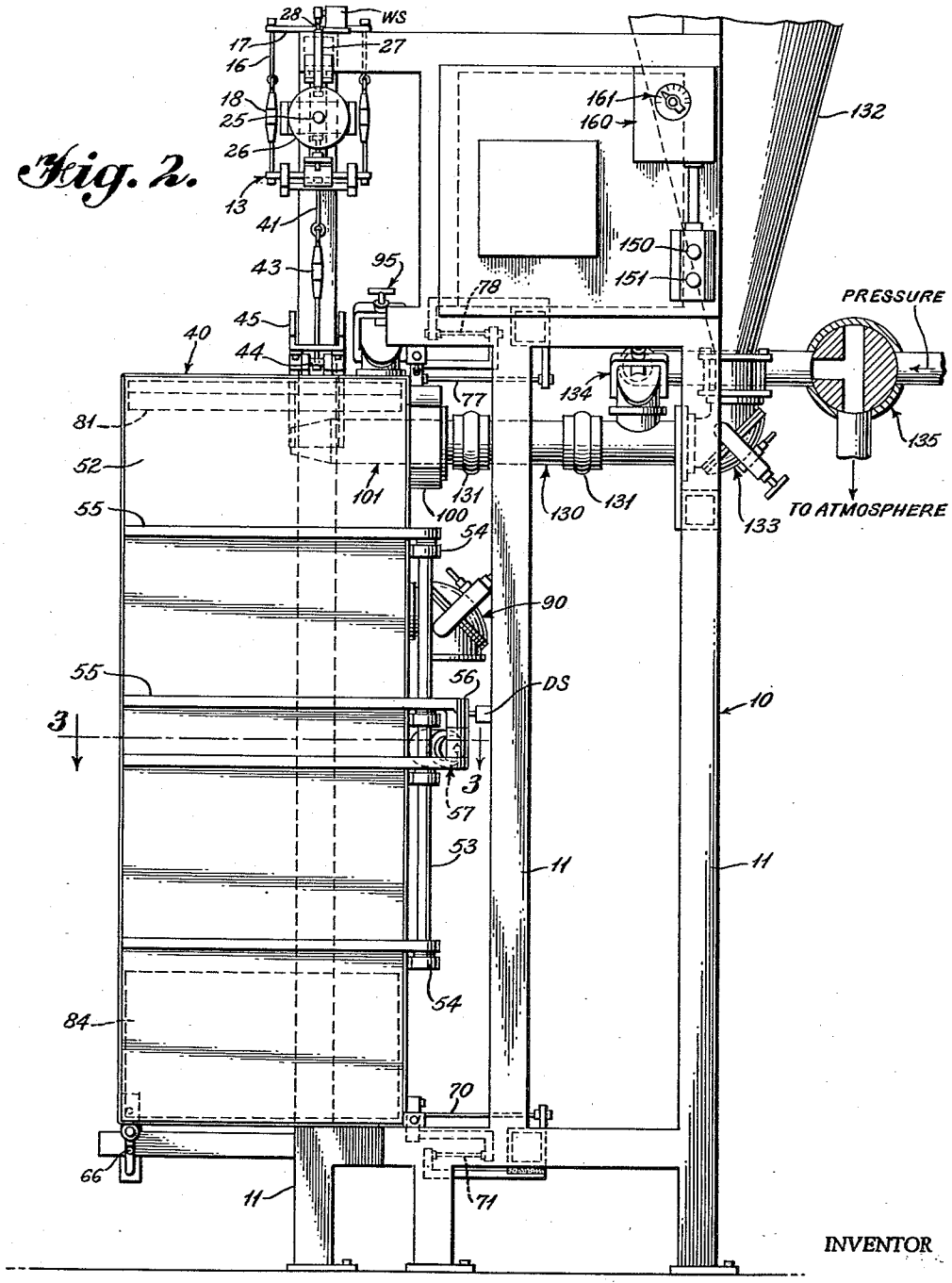
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METHOD AND APPARATUS FOR FILLING RECEPTACLES

Filed Feb. 28, 1955 5 Sheets-Sheet 2

Fig. 2.



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METHOD AND APPARATUS FOR FILLING RECEPTACLES

Filed Feb. 28, 1955 5 Sheets-Sheet 3

Fig. 3.

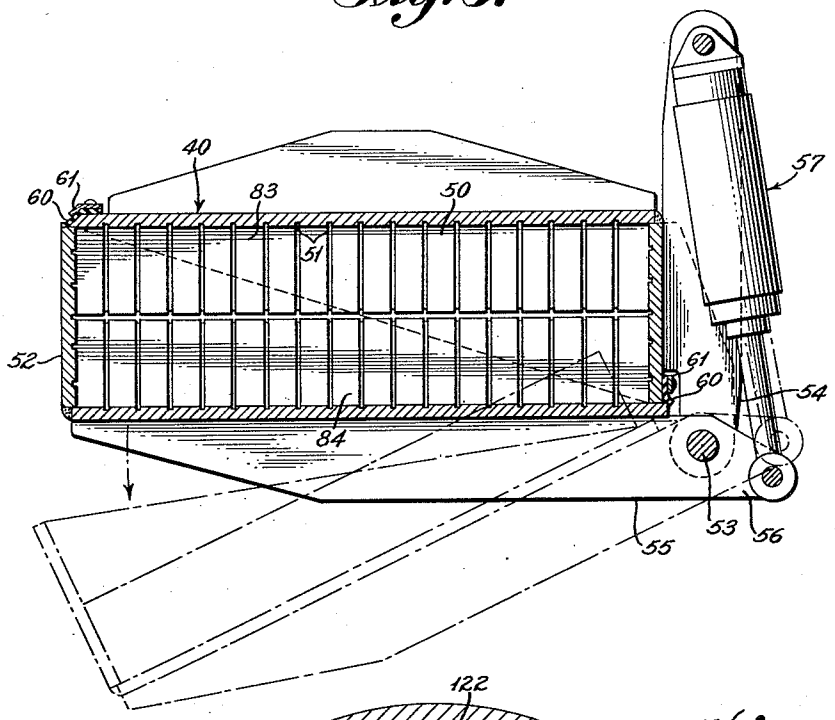
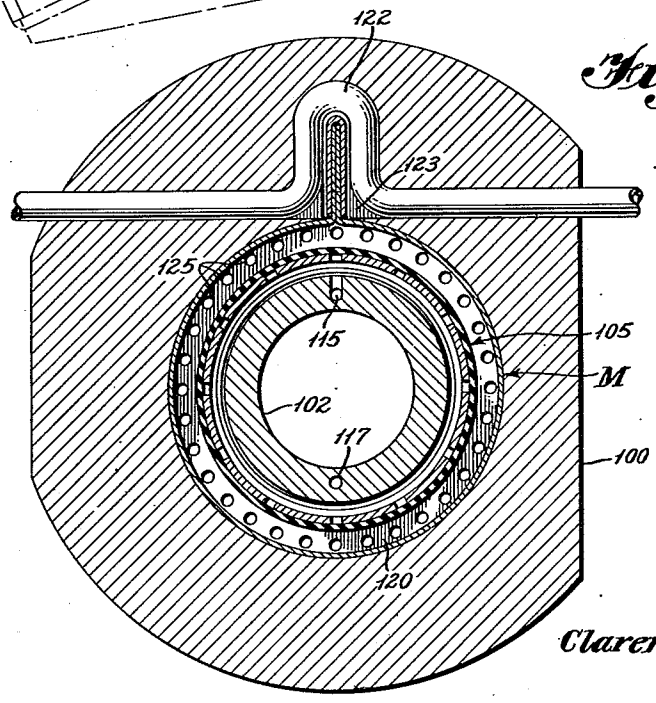


Fig. 5.



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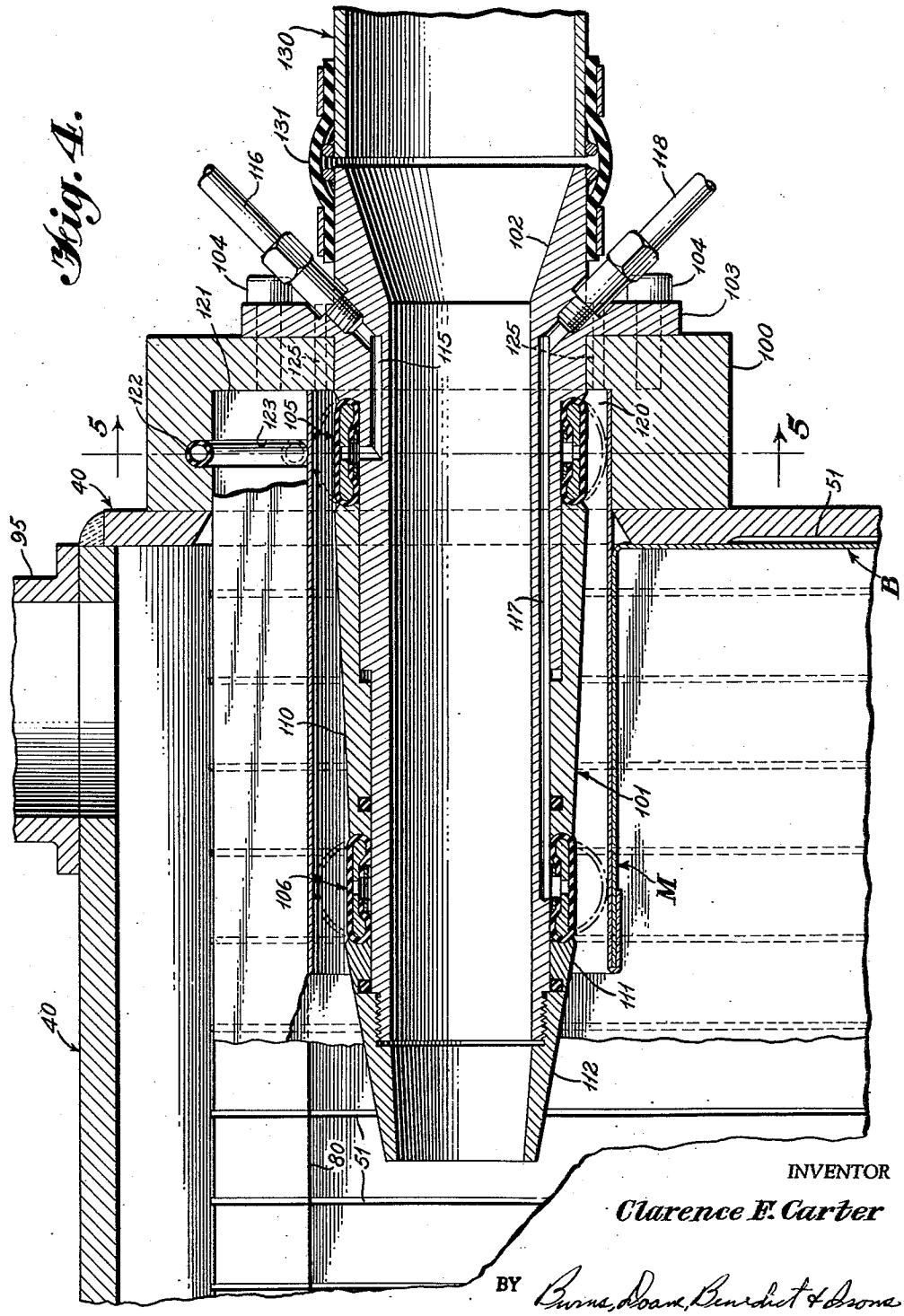
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July 16, 1957 C. F. CARTER 2,799,465

METHOD AND APPARATUS FOR FILLING RECEPTACLES

Filed Feb. 28, 1955 5 Sheets-Sheet 4

Fig. 4.



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July 16, 1957 C. F. CARTER 2,799,465

METHOD AND APPARATUS FOR FILLING RECEPTACLES

Filed Feb. 28, 1955 5 Sheets-Sheet 5

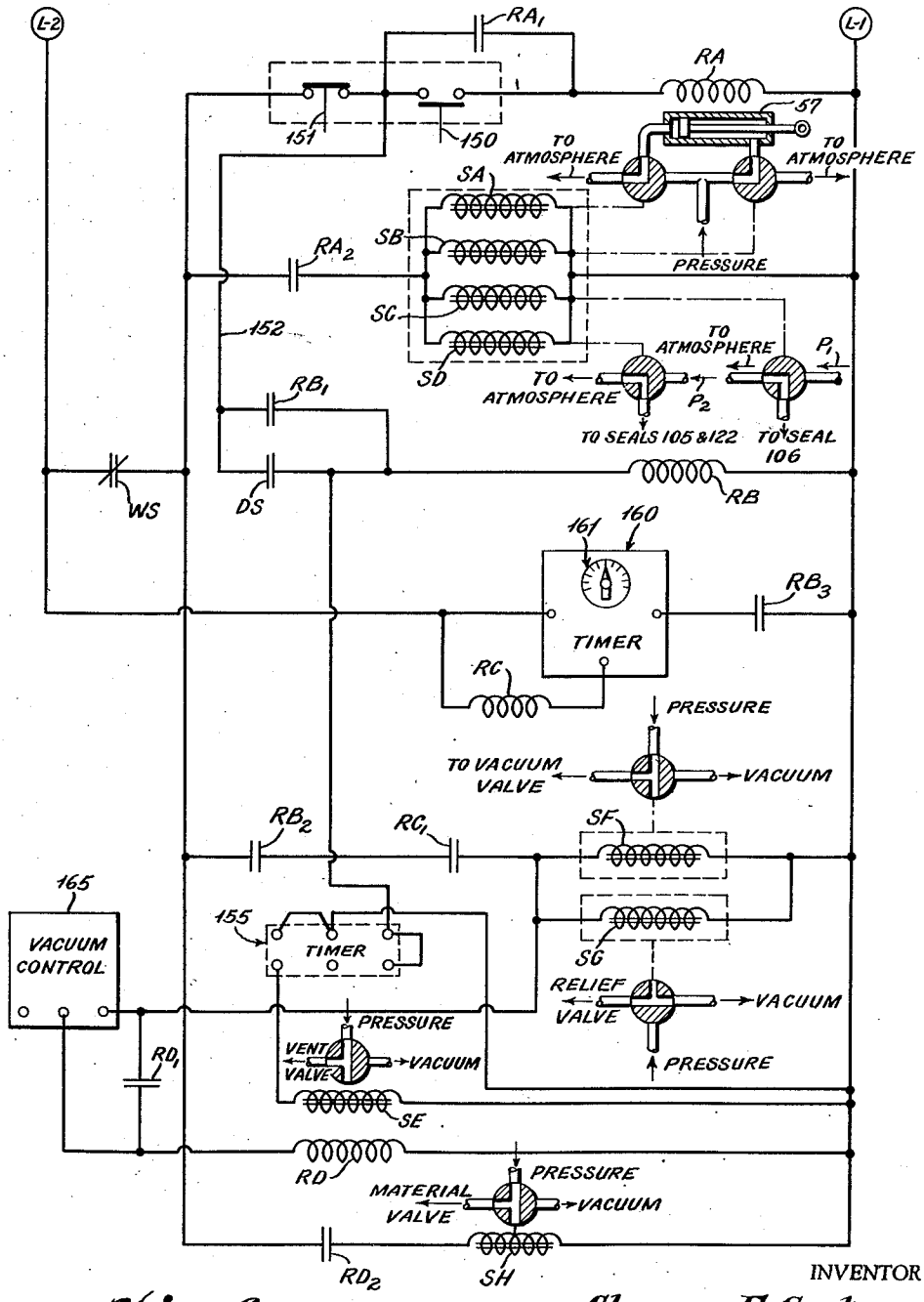


Fig. 6.

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2,799,465

METHOD AND APPARATUS FOR FILLING RECEPTACLES

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Application February 28, 1955, Serial No. 490,942

16 Claims. (Cl. 249—62)

This invention relates generally to a method of filling receptacles particularly adapted for use where very finely divided material is involved and to a filling machine particularly adapted for dispensing such finely divided material into receptacles such as valve type bags. More specifically, as set forth hereinafter, the invention is directed to an automatic bag filling machine which employs a reduced pressure or vacuum within a bag enclosing shroud to draw finely divided material into the bag and, further, to a method of filling receptacles in a series of increments with very finely divided material to produce highly compacted material as the final product.

Through the years a variety of different filling methods and machines for filling receptacles have been developed and have to varying degrees met with satisfactory acceptance in the receptacle filling industry. Although a number of acceptable proposals and machines have been developed for the handling of ordinary particulate materials, it is recognized that special problems are encountered in connection with the handling and dispensing of very finely divided or powdered materials such as powdered silica gel and carbon black. In working with these latter types of materials, presently available filling apparatuses and methods of filling have been found to be not entirely satisfactory.

With the very finely divided materials as referred to above, there is a tendency for the material to become fluffy by reason of air entrained between the powder particles. Whereas such entrained air may serve a useful purpose in facilitating freer flow of the material through the dispensing machine to the receptacle being filled, it is a distinct drawback from the standpoint of achieving the desired degree of material compacting within the filled receptacle. Removing this entrained air and thereby compacting the material presents a real problem in filling the receptacle with these powdered materials.

In the past, one suggested solution to compacting finely divided material by freeing it of air which becomes entrained between the powder particles has been to subject the receptacle during filling to rapid vibration. Under this filling method, as the particles tend to settle down, material is added to the receptacle until the receptacle contains the desired weight of material for its particular size. Whereas this filling method has been and is presently being used, it has a distinct disadvantage in that it may require a period of several hours of continuous receptacle vibration and repeated material additions to fill a drum with the desired weight of powdered material as for example in the case where silica gel or carbon black is being dispensed. In comparison with this length of time required for vibratory filling, the filling method of the instant invention can achieve the same degree of material compacting in filling the same size drum in a matter of one minute.

As a further problem encountered in the handling and dispensing of very finely divided powders, the characteristic of such powders to become dispersed in the atmosphere surrounding the filling machine and thereafter settle on the machine parts and areas adjacent the machine has been recognized as a definite problem in the development of filling machines. Accordingly, it is of the utmost importance that a filling machine for use in handling such finely divided powders be constructed to reduce to a minimum the escape of powders either from the machine mechanism itself or from the receptacle as it is being filled. The construction of the filling machine of the instant invention and its mode of operation have been developed to possess the required characteristics for the handling of finely divided powders. As a further advantage of the filling machine described in detail hereinafter, its automatic operation, commencing from the time of introduction of the bag to be filled into the shroud and continuing through the completion of the bag filling cycle, contributes to reducing the chance for escape of powdered material into the surrounding atmosphere.

It is a primary object of the instant invention to provide a method of filling receptacles with finely divided materials or powders, which method requires a minimum of time in the filling operation and produces a high degree of compacting of the material dispensed into the receptacle.

A further object of this invention is to provide a method of filling receptacles under vacuum in a series of increments wherein the vacuum which is effective to draw the material into the receptacle and simultaneously assist in withdrawing entrained air from the material is momentarily decreased between each increment of fill dispensed into the receptacle to permit an instantaneous reverse flow of air back into the receptacle while continuing to withdraw entrained air from the powdered material mass.

It is also a principal object of this invention to provide a bag filling machine having a shroud providing a chamber for enclosing the bag being filled to subject the bag exterior to a reduced pressure and further having a filling spout with a seal element actuatable to retain the bag on the spout so as to preclude seepage of powdered material from the bag interior during filling.

It is an additional object of the instant invention to provide a filling machine having a shroud suspended from a scale mechanism and providing a chamber for receiving the bags being filled, together with valves for controlling vacuum imparted to the shroud chamber, venting the bag interior, powdered material flow and relief to atmospheric pressure of the shroud interior, all actuatable in proper sequence to effect incremental filling of the bag.

Other and more specific objects, features and advantages of the instant invention will be apparent from the detailed description set forth hereinbelow. Such description given in connection with the accompanying drawings which form a part of this application is illustrative merely by way of example of a preferred form of the invention. It will also be appreciated that the method of the instant invention may be practiced in using a variety of different structures other than that specifically illustrated in this application. Accordingly, the invention consists of such novel method features, arrangements and combinations of parts as may be shown and described in connection with the apparatus herein set forth.

In the drawings:

Figure 1 is a front elevational view of a bag filling machine incorporating the features of the instant invention;

Figure 2 is a side elevational view of the machine of Figure 1;

Figure 3 is a sectional view taken on line 3—3 of Figure 2;

Figure 4 is a detailed section of the filling spout and its related parts;

Figure 5 is a sectional view taken on line 5—5 of Figure 4; and

Figure 6 is a schematic view of the circuitry employed in the automatic operation of the bag filling machine.

Referring specifically to the overall views of the bag filling machine as shown on Figures 1 and 2, such machine includes a support frame **10** having upright legs **11** interconnected by a plurality of transverse members **12**. A scale mechanism **13** is suspended from one of the upper transverse members **12**. This mechanism consists of a primary scale beam **14** fulcrumed at one end on a rod **15**, which rod in turn is suspended by means of parallel cables **16** from a bar **17** which extends across the supporting transverse member. To facilitate proper vertical location of the fulcrum for beam **14** a turn buckle **18** is interposed in each of the cables **16**.

The opposite end of primary scale beam **14** is interconnected with one end of a secondary scale beam **19** by means of a pair of cables **20** engaging with pins **21** carried in the adjacent overlying ends of beams **14** and **19**. The secondary scale beam **19** is fulcrumed on a rod **22** which is suspended from the upper transverse member by means of a cable **23** connected between the rod and such member.

The secondary scale beam **19** overlies beam **14** with the end thereof opposite pin **21** extending between cables **16** and carrying a threaded rod **25** having a counterweight **26**. It will be appreciated that adjustment of counterweight **26** by threading it along rod **25** will be effective to alter the response characteristics of the scale so that such mechanism may be adjusted to respond to different total weights of material dispensed into the bags being filled.

Adjacent threaded rod **25** and extending upwards from the end of scale beam **19** there is provided a pin **27** having a stud **28** threaded into its upper end to engage with the actuator of an electric switch WS. This switch contains a pair of normally closed contacts. Upon actuation of the scale mechanism in response to material dispensed into the receptacle being filled, the pin **27** and its stud **28** will be moved upwardly as carried by beam **19** to effect opening of switch WS.

To limit movement of the secondary scale beam **19**, a pair of studs **30** are mounted respectively above and below the beam end. These studs are threaded into their supports, each preferably with a locking nut provided thereon, so that adjustment as to the possible range of movement of the beam **19** may be made. Also coupled with the outer end of beam **19** is a dash pot device **31**. This device, secured on the skeleton frame **10**, has its shaft **32** connected to the outer end of beam **19** so as to retard movements of the beam as the material is dispensed into the receptacle being filled. Thus, the dash pot device tends to overcome the possibility of the scale mechanism partaking of undesirable rapid movement which might prematurely effect opening of the switch WS.

A shroud **40** is suspended from the scale mechanism **13** by means of a cable **41** connected medially of the ends of primary scale beam **14** by a pin **42**. Cable **41** has a turn buckle **43** interposed therein to facilitate adjustment of the position of shroud **40** relative to the scale mechanism. The cable **41** is coupled at its lower end to a pin **44**. The pin **44** engages beneath one leg of an angle **45** while the other leg of such angle is rigidly secured to the side wall of shroud **40**.

As shown more clearly in the sectional view of Figure 3, the shroud **40** provides a generally rectangular interior chamber **50** with the inner walls thereof grooved at **51** to promote application of vacuum to the exterior surface of the bag being filled. The shroud **40** is provided with an access door **52** which includes one half of the shroud, the door junction with the shroud extending diagonally of the shroud. This door is hingedly mounted on a pin **53** supported longitudinally of and adjacent one corner

of the shroud by means of hinge ears **54** and **55**, carried respectively by the shroud **40** and door **52**.

The hinge ears **55**, midway of the length of shroud door **52**, extend rearwardly of the door pivot to provide an arm **56**. Supported on the shroud adjacent the arm **56** is a pneumatic actuator **57** having the actuating rod thereof pivotally connected to the arm **56** with the cylinder of such actuator pivotally supported on the shroud. It will be readily appreciated that by appropriately directing pressurized fluid to the actuator **57**, the door **52** will be opened or closed accordingly. To seal the joint between door **52** and shroud **40**, there is provided a flexible seal strip **60** which is secured along the edge of the shroud by means of a metal strip **61**.

As shown on Figure 2 an electric switch DS is mounted on frame **10** with its actuator positioned so as to be engaged by arm **56** when the door is in its closed position. The contacts of switch DS are normally open and therefore such switch contacts are closed only when the door **52** is closed under control of the pneumatic actuator **57**.

To restrict lateral sway of the shroud **40** while permitting free unrestricted longitudinal movement of the shroud under the yielding movements of the scale mechanism, there are provided a series of flexible cables connected between the support frame and the shroud. Thus, cables **65** and **66** are connected between elements secured respectively to the lower forward end of the shroud **40** and support frame **10**. Likewise, the rear lower end of shroud **40** is restrained by flexible cables **68** connected to the bottom of the shroud and the transverse members on opposite sides of the shroud. To restrain backward and forward movement of the shroud, flexible cables **70** and **71** are connected to elements carried respectively by the lower rear end of the shroud and one of the lower transverse members. Similar restraining cables at the upper rear corner of the shroud are provided in the form of cables **74** and **75** to restrain side to side sway and cables **77** and **78** to restrain back and forth movement of the upper end of the shroud. It will be appreciated that a limited amount of slack in all the hereinabove-mentioned anti-sway cables is provided so as to permit limited up and down movement of the shroud as the scale mechanism responds to the material dispensed into the bag being filled.

A pair of parallel members **80** and **81** are mounted interiorly of and at the upper end of the shroud with member **80** being rigidly secured to the shroud **40** and member **81** being secured to and carried by the shroud door **52**. Likewise, a pair of parallel members **83** and **84** are provided adjacent the lower end of the shroud interior with member **83** being secured to the shroud and member **84** being mounted on and carried by the shroud door **52**. In the closed position of door **52** the pairs of parallel members are positioned as shown in Figure 1 so as to leave a space extending longitudinally between each pair to receive the respective upper and lower seams of the bag being filled. These members are grooved so as to promote application of vacuum to the entire exterior surface of the bag being filled.

It will be noted that the members **83** and **84** have a comparatively large height, substantially greater than the width of the seam of the bag which will be inserted between them. The size of these two members may be varied as desired to accommodate bags of different lengths. Thus, for example, where bags substantially as long as the shroud **40** are being filled, the members **83** and **84** would be substantially shorter to provide an open space above such members within the shroud which will accommodate such a long bag during the filling operation. Thus, it is a simple matter to appropriately vary the size of members **83** and **84** to adapt the bag filling machine of the instant invention to the handling of bags of different overall length.

A relief valve **90** is provided mounted in the rear wall of the shroud **40** to control communication of the shroud

interior with atmospheric pressure. As shown, this valve is of the diaphragm type wherein opening and closing of such valve is effected by regulating the flow of pressurized fluid to one side of a diaphragm within the valve. The timing of the opening and closing of relief valve **90** will be described in more detail with regard to the description of the schematic diagram of Figure 6.

A vacuum control valve **95** is mounted in the upper wall of the shroud **40** and controls communication of the shroud with a source of vacuum or low pressure through a conduit **96**. As part of the conduit **96** there are flexible sleeve sections **97** which permit relative movement between shroud **40** and the frame **10** as the scale mechanism responds to the weight of material dispensed into the bag being filled. As in the case of relief valve **90**, valve **95** is shown as being of the diaphragm type and its actuation is effected by appropriate control of a pressurized fluid admitted to such valve.

As shown more clearly in Figure 4, the shroud **40** is provided adjacent the rear upper corner thereof with a housing **100** which serves to mount the filling spout **101** that extends inwardly of the shroud interior. It will be appreciated that the bag to be filled when positioned for filling will have the filling spout extending through the bag mouth. The spout **101** consists of a main tubular member **102** having a flange **103** bolted to housing **100** by bolts **104**. A pair of seal elements **105** and **106** are carried on the periphery of tubular member **102**. Each of these seal elements includes a flexible resilient sleeve enclosing a ring which serves to support the resilient sleeve and hold it in position on the filling spout. A spacing tube **110** is disposed between the seal elements **105** and **106** and a ring **111** provided in engagement with the outer end of seal element **106**. The seal elements, spacing tube and ring are held on member **102** against the shoulder on such tubular member by a spout tip **112** threaded on to the outer end of tubular member **102**.

The tubular member **102** of the filling spout is provided with a longitudinal bore **115** communicating at its opposite ends with seal element **105** and a conduit **116** for the admission of pressurized fluid to the seal. A similar longitudinal bore **117** is provided in tubular member **102** and communicates at its opposite ends with the interior of seal element **106** and a conduit **118** for the admission of pressurized fluid to this seal. The regulation and control of the admission of pressurized fluid to the respective seal elements **105** and **106** is explained in more detail hereinafter in connection with the description of Figure 6. As to seal element **105**, it will be appreciated that within the scope of the instant invention the seal may be disposed in the wall of cavity **120** to expand into contact with the exterior of the spout instead of as shown on the drawing.

Generally, seals **105** and **106** perform the function of retaining the mouth of the bag being filled in proper cooperation with the filling spout. Figure 4 illustrates in section the relationship of a bag B and its mouth M to the filling spout when the bag is properly positioned for filling. Such figure also shows, with regard to seal elements **105** and **106**, the expanded relation of such elements in dotted lines, thus illustrating how the respective seals cooperate with the bag mouth M.

Attention is called to the fact that the seal element **105** is disposed within an annular cavity **120** formed within the housing **100**. Thus, when the bag to be filled is properly positioned within the shroud the valve mouth therein will extend into the cavity **120** so that upon the expansion of seal **105** by the introduction of pressurized fluid thereinto the outer end of the bag mouth will be rigidly clamped and held in engagement with the outer wall of cavity **120**. On the other hand, seal element **106** being disposed toward the outer end of the filling spout will engage with the bag mouth at a point where such mouth is not backed up or supported. Accordingly, it is contemplated that normally a lesser pressure will be applied to expand seal element **106** than that applied to seal element **105** since undue pressure and therefore excessive expansion of seal element **106** might result in tearing the tubular bag mouth M.

The housing **100** also provides an upstanding pocket **121** which communicates at its lower end with the annular cavity **120**. This pocket receives the upper bag seam as the bag is slid on to the filling spout for the filling operation. An expandable resilient tube seal **122** is provided in a groove **123** formed in the top and side walls of pocket **121**. It will be appreciated that upon the admission of pressurized fluid to seal **122** the expansion thereof will effect clamping of the upstanding top bag seam to assist seal elements **105** and **106** in retaining the bag in position on the filling spout and also to preclude escape of material from the bag as it is discharged thereinto through spout **101**.

It will be noted that a plurality of openings **125** are provided extending outwardly from the cavity **120** to communicate with the atmosphere exterior of the shroud. By providing such openings the high vacuum within the shroud, exterior of the bag being filled, will not tend to draw material from the bag outwardly through the bag mouth M past seal elements **105** and **106**. Instead the shroud vacuum and the presence of a low pressure within the bag results in any flow of air past the seal elements passing into the bag, thus precluding the escape of the powdered material into the shroud or atmosphere surrounding the filling machine.

The filling spout **101** through its tubular member **102** is connected to a material supply conduit **130**. As in the case of the vacuum conduit **96**, material supply conduit **130** includes a pair of flexible sleeves **131** to permit relative movement between the shroud and the stationary end of conduit **130**. A material supply hopper **132** is coupled to the outer end of conduit **130** with a material valve **133** interposed between the bottom of the hopper and conduit **130**. Also connected with conduit **130** is a vent valve **134** which, as will appear from the description given below, functions to admit gaseous fluid into conduit **130** and thence into the bag being filled through the filling spout to effect initial opening of the bag for receipt of the material. As illustrated, valves **133** and **134** are of the diaphragm type wherein opening and closing is effected by regulation of the admission of a pressurized fluid to one side of the valve's diaphragm.

A manually operated three-way valve **135** is shown on Figure 2, disposed in the line leading to vent valve **134**. This valve is manually operated to connect either a pressure source or atmospheric pressure with the inlet to vent valve **134**. Thus, when it is desired to open the bag to be filled as mounted within the shroud, valve **135** may be set to communicate atmospheric pressure to vent valve **134** and the vacuum created within the shroud, exteriorly of the bag, used to draw open such bag. On the other hand, if it be desired to employ positive bag opening pressure, valve **135** may be adjusted to communicate the pressure source with the inlet to valve **134** so that the bag within the shroud will be opened by application of positive pressure to the interior thereof.

Having described in detail the structural features of the instant invention as shown in the embodiment of the drawings, reference will now be had to the schematic diagram of Figure 6 which illustrates the manner in which automatic operation of the filling machine is secured. In this figure the leads from the power source as, for example, a 110 volt, 60 cycle alternating current source are designated at L–1 and L–2. As previously described, the contacts of the weight switch WS are normally closed and are not opened until such time as the weight of the material within a bag being filled causes the scale mechanism **13** to respond so that its pin **27** causes opening of the weight switch. The weight switch contacts designated WS are shown normally closed. On Figure 6 the remaining contacts of the various relays

and of door switch DS are shown in their open state as they exist prior to commencing of an automatic bag filling cycle.

A start push button **150** which is normally open and a normally closed stop button **151** are connected in series with the contacts WS and the coil of a relay RA. Contacts RA_1 of relay RA are connected in shunt across start button **150** so as to form a holding circuit for relay RA, once the contacts of push button **150** have been momentarily closed to energize the relay. Contacts RA_2 of relay RA are connected across the leads of the power source in series with contacts WS and the coils of solenoids SA, SB, SC, and SD. Thus, upon closing of contacts RA_2 the solenoids will be energized through contacts WS.

The solenoids SA and SB are connected to actuate separate 3-way valves which are operable to couple alternatively pressurized fluid or atmospheric pressure with the pneumatic door actuator **57**. As described above, door actuator **57** is connected to effect opening and closing of the shroud door **52**. In the relation shown on Figure 6, the valves controlled by solenoids SA and SB are disposed to retain the door actuator in its position for the door **52** to be fully opened. Upon energization of solenoids SA and SB, the valves controlled thereby are moved to couple pressure to the left side of the actuator piston and vent the right side of such piston, as shown on Figure 6, to atmosphere. Such action will cause the actuator to effect closing of door **52**.

Solenoids SC and SD are connected to actuate 3-way valves so as to either admit pressure to the filling spout seals **105**, **106** and **122** or to connect such seals with vacuum and thereby release the seals from their clamping action. As previously mentioned, due to the positioning of seals **105** and **106** a lower pressure is generally applied to seal **106** than that used in inflating seals **105** and **122**. Accordingly, as shown in Figure 6, solenoid SC when energized operates its 3-way valve to admit the desired inflating pressure to seal **106** and likewise solenoid SD when energized admits a somewhat higher pressure to inflate seals **105** and **122**.

As pneumatic actuator **57** closes the shroud door **52** as a result of the energization of solenoids SA and SB, such door, by means of arm **56**, closes the door switch contacts DS. Contacts DS are connected in series with the operating coil of a relay RB through a lead **152** extending through the normally closed contacts of stop button **151** and weight switch contacts WS. One pair of contacts RB_1 of relay RB are connected in shunt with relation to contacts DS to form a holding circuit for relay RB. A second set of contacts RB_2 of relay RB serve to set up a circuit extending through contacts WS for energization of solenoids controlling the vacuum valve, relief valve and material supply valve of the filling machine.

In addition to energizing relay RB, the closing of the door switch contacts DS effects energization of a timer **155**. This timer is set to energize the coil of a solenoid SE for a predetermined period of time, in the order of two or three seconds, after which such solenoid is de-energized. Solenoid SE is coupled to a 3-way valve which is effective to operate the vent valve **134** so as to admit alternatively pressurized fluid or vacuum to the diaphragm of valve **134** to either close or open such valve. As shown in Figure 6, pressure is communicated to the valve **134** with solenoid SE de-energized. Upon energization of solenoid SE, the 3-way valve is actuated to communicate vacuum to the vent valve so as to open such valve for the period of energization of the solenoid SE, after which time valve **134** is closed by pressure again being applied to its diaphragm.

Contacts RB_3 of relay RB are closed upon energization of such relay to start a timer **160**. The timer **160** connected in series with contacts RB_3 across the power source is operable to effect intermittent energization of a relay RC. The timer **160** may be of any suitable construction although preferably, for reliability and rapid operation, an electronic timer is used. As shown at **161**, the timer is provided with a dial and pointer which may be adjusted as desired to vary the interval of time during which relay RC is energized. The purpose and function of varying or controlling the interval of relay RC energization will be more apparent with reference to the stated operation of the invention as set forth hereinafter.

The contacts RC_1 of relay RC are connected in series with contacts RB_2 and upon the closing of contacts RC_1 after contacts RB_2 have been closed, solenoids SF and SG are energized through the weight switch contacts WS. Solenoid SF operates a 3-way valve which controls the opening and closing of the vacuum valve **95** and solenoid SG actuates a 3-way valve which in turn controls the opening and closing of relief valve **90**. In their de-energized state, as shown in Figure 6, the vacuum valve **95** will be closed by the admission of pressurized fluid to the diaphragm of such valve. At the same time the relief valve **90** is open by reason of a vacuum or low pressure being communicated with its diaphragm. Upon energization of solenoids SF and SG the vacuum valve is opened and the relief valve closed.

In addition to energizing solenoids SF and SG, upon closing of contacts RC_1 a circuit is set up leading to a vacuum control **165**. Vacuum control **165** includes a pressure responsive switch, the contacts of which close in response to the vacuum existent within the shroud. With the shroud door closed, the vacuum valve open and the relief valve closed, the pressure within the shroud will diminish. Initially, the bag positioned on the filling spout within the shroud will be opened with air being admitted to the bag interior by reason of the opening of vent valve **134** through the energization of solenoid SE. However, solenoid SE only remains energized for the relatively short period of, for example, 2 or 3 seconds, as determined by the setting of timer **155** and upon de-energization of solenoid SE and closing of the vent valve, the vacuum within the shroud tends to increase. The vacuum control **165** is set to close its contacts upon the shroud vacuum reaching a predetermined point. When such low pressure or vacuum obtains within the shroud, the vacuum control contacts close to complete the circuit through the coil of a relay RD.

Contacts RD_1 of relay RD close to set up a holding circuit bypassing the vacuum control **165**. The provision of contacts RD_1 shunting the contacts of the vacuum control **165** has been found to be desirable to prevent intermittent opening and closing of relay RD. This action, in the absence of holding contacts RD_1 might occur upon opening of the material supply valve accompanied by a drop in the shroud vacuum which in turn would cause a response in the vacuum control **165** resulting in opening of its contacts thereby de-energizing relay RD and closing the material supply valve until the shroud vacuum builds back up to operate the vacuum control.

A second set of contacts RD_2 are likewise closed upon energization of relay RD at which time a solenoid SH is energized. Solenoid SH is coupled to actuate a 3-way valve which controls the opening and closing of the material supply valve **133**. Preferably, material valve **133** operates after about a 2-second delay following the obtaining of the vacuum within the shroud for which control **165** is set. This permits the pressure within the shroud and bag interior to stabilize before admitting material into the bag. As shown on Figure 6 with solenoid SH de-energized, pressure is admitted to the diaphragm of valve **133** to maintain it closed. Upon energization of solenoid SH, vacum is admitted to the diaphragm of valve **133** to open such valve for the admission of material from the supply hopper into the bag to be filled through the filling spout.

Referring again to timer **160**, it has been stated that

this timer functions to intermittently energize relay RC. Thus, it will be seen that each time relay RC is energized, closing its contacts RC_1, the vacuum valve will open, the relief valve close and, when the vacuum within the shroud becomes sufficient to actuate the vacuum control **165**, the material valve will open. Likewise, when relay RC is de-energized, under the control of timer **160**, the vacuum valve will close, the relief valve open and the material supply valve close.

When the desired weight of material in the form of successive increments of material has been discharged into the bag retained within the shroud, the scale mechanism **13** will respond, resulting in its pin **27** actuating the weight switch. Thereupon, the weight switch contacts WS will open, de-energizing the various relays and solenoids in the control circuit and returning the apparatus, upon the opening of contacts RA_1, to a status in readiness for the next succeeding bag filling cycle. The next bag filling operation may be commenced after the filled bag is removed and an empty bag placed in the shroud on the filling spout.

By appropriately setting the timer **160**, the size of the material fill increments may be fixed. Thus, if a relatively large number of increments are to be dispensed to completely fill the bag, the timer **160** will be set to effect energization of relay RC for a shorter period than if larger and fewer material increments are desired to complete the bag filling. It will likewise be appreciated that the degree of vacuum used in operating the filling machine will determine to some extent the quantity of material drawn into the bag for a given time interval of energization of relay RC.

The interval of time between successive actuations of relay RC will determine the period during which the relief valve is opened and therefore the extent to which the vacuum within the shroud is diminished. It is critically important in connection with the instant invention that the relief valve does not remain open to return the shroud pressure to atmospheric between fill increments. If such is permitted in filling bags wih finely powdered material the inrush of air and pressure increase tends to fluff up the powdered material, producing a result directly contrary to the desired objective of compacting the material and withdrawing air entrained between the particles of the powdered material. Accordingly, the relay RC is only momentarily de-energized between filling increments so that the relief valve will only open for an instant to diminish the shroud pressure without returning it to atmospheric. To give specific figures, merely by way of example, the relief valve will open only for one-half second or less to drop the shroud pressure around 5 inches of mercury. Thus, where 20 inches of mercury vacuum is being used in the filling operation, so that this degree of vacuum exists within the shroud to draw the material into the bag, the relief valve will open momentarily to drop the shroud pressure to about 15 inches of mercury between each fill increment. This sudden pressure increase after each increment of material is discharged into the bag causes a reverse flow of air through the interstices of the bag wall to clean the bag and momentarily wrinkle the wall to free it of powder which accumulates as air is withdrawn through the porous bag during introduction of powdered material. At the same time, there is continuously maintained a vacuum above the material tending to withdraw entrained air from the powdered material mass within the bag. The existence of the vacuum promotes compacting of the material while the bag wall pores are cleaned of powder preparatory to receiving the next increment of fill.

The degree of compacting achieved by utilization of the principles of the herein disclosed invention may be varied in several ways. First, if a high degree of final product density in the receptacle is desired, a greater number of smaller size increments may be combined to complete the filling of the receptacle than would be used if a lower density product is wanted. Secondly, the degree of vacuum used in the filling operation may be selected to secure the desired compacting or density of product from the filling operation. Thus, where a high vacuum is employed, the filled receptacle will have a higher density of their fill than where a lower vacuum is used in the filling operation. Also, in connection with filling machines, the final fill product density may be altered by changing the orifice characteristics of the filling spout.

With regard to the vacuum preferably used in the filling operations, a range of from 4 inches to 28 inches of mercury may be employed depending to some extent on the specific material being handled. With most finely divided powdered materials a vacuum of from 22 inches to 25 inches has been found to be ideal. However, as a specific example, in filling with carbon black a vacuum of 18 inches has proved desirable, since at higher vacuums undue compacting and caking of the carbon black material may occur.

The overall operation of the apparatus will be understood with reference to the description of the schematic diagram of Fig. 6. By way of general summary, however, a brief review of the operations that take place will be given. Assuming that an empty bag, usually in a flattened condition, has been placed in the shroud with the filling spout extending into the mouth of the bag, the start button **150** is pressed to initiate the automatic filling cycle. This action energizes relay RA which closes a relay holding circuit through contacts RA_1 and through contacts RA_2 energizes solenoids to effect closing of the shroud door and inflation of the various filling spout seals to retain the bag on the spout. The closing of the shroud door closes contacts DS which results in energizing relay RB and timer **155**. Timer **155** energizes the vent valve solenoid to maintain such vent valve open for a relatively short period to admit air to open the bag prior to commencing introducing the fill material.

Relay RB through its contacts RB_3 starts operation of timer **160** which intermittently energizes relay RC. Contacts RC_1 of relay RC complete with contacts RB_2 the circuit to solenoids SF and SG which control operation respectively of the vacuum valve and the relief valve. Contacts RC_1 also set up a circuit to the pressure responsive vacuum control **165**, which control closes its contacts when the shroud pressure reaches the desired degree of vacuum. Upon closure of the vacuum control contacts, which takes place after the vent valve has admitted bag opening air to the bag and thereafter closed to permit build-up of the vacuum within the shroud, relay RD is energized. Contacts RD_1 of this latter relay close a holding circuit around the vacuum control and contacts RD_2 of relay RD complete a circuit for energization of solenoid SH. Solenoid SH effects opening of the material valve which preferably takes place about 2 seconds after the vacuum control has responded to shroud vacuum, permitting material to flow into the bag under the influence of vacuum present within the shroud and bag. It may be noted here that the vacuum within the shroud exists to generally the same degree within the bag by reason of seepage of air through the pervious walls of the bag.

Each time relay RC is de-energized under control of timer **160** the flow of material will be termined by closing of the material valve and the vacuum within the shroud diminished by momentary opening of the relief valve with the vacuum valve closed. When timer **160** re-energizes relay RC, the sequence of operations of the relief valve, vacuum valve and material valve repeats. Such repetition for incremental-filling of the bag continues until the scale mechanism responds to a full material load within the bag. At the occurrence of this, the contacts WS are opened by the scale mechanism and the circuits to the various control relays and solenoids de-energized. De-energization of solenoids SA and SB causes actuator

57 to open the shroud door while de-energization of solenoids SC and SD causes deflation of the filling spout seals to release the bag from the filling spout.

Having thus described my invention, what I claim is:

1. A method of filling a receptacle with finely divided particulate material which comprises creating a vacuum within the receptacle to be filled, admitting material into the interior of said receptacle, terminating the admission of material after only an increment of the quantity of material required to fill the receptacle has been dispensed into the receptacle, momentarily diminishing the vacuum within the receptacle to cause an instantaneous reverse flow of air back into the receptacle while continuously maintaining a substantial sub-atmospheric pressure within the receptacle to withdraw air from between the material particles to compact the material, and repeating the above recited steps until the increments of material fill the receptacle to the desired degree.

2. A method of filling a receptacle with finely divided particulate material which comprises creating a vacuum within the receptacle to be filled, admitting an increment of material into the receptacle under the effect of the vacuum within the receptacle, terminating the flow of material into the receptacle, momentarily diminishing the vacuum within the receptacle while continuously maintaining a substantial sub-atmospheric pressure within the receptacle to withdraw air from between the material particles to compact the material, and repeating the above-recited steps until the increments of material fill the receptacle to the desired degree.

3. A method of filling a collapsible receptacle with finely divided particulate material which comprises creating a vacuum within and surrounding the receptacle to be filled, admitting gaseous fluid into the interior of the receptacle to expand same to its fully opened condition, discharging an increment of material into the receptacle while the vacuum is maintained within the receptacle, terminating the flow of material into the receptacle, momentarily diminishing the vacuum within the receptacle while continuously maintaining a substantial sub-atmospheric pressure within the receptacle to withdraw air from between the material particles to compact the material, repeating the third, fourth and fifth steps recited above to dispense a series of increments of material into the receptacle, and terminating the repetition of the third, fourth and fifth steps when a predetermined weight of material has been dispensed into the receptacle.

4. In a bag filling machine, a shroud providing a chamber for receiving a bag during the filling thereof and having an access door to permit introduction and removal of the bags being filled, a scale mechanism supporting said shroud whereby said mechanism will indicate the weight of material dispensed into the bag within the shroud, a feed spout carried by said shroud with the outlet end thereof disposed within said shroud for insertion into the mouth of a valve type bag, a seal element encircling said feed spout adjacent the entrance of said spout into said shroud and adapted to be actuated to retain the valve bag on said spout within said shroud and preclude escape of material from the bag into said shroud, a material supply hopper, a material supply conduit connecting said feed spout and said material hopper and having a valve interposed therein actuatable to control the flow of material from the hopper to said feed spout, a second valve operable to control admission of a gaseous fluid through said spout and into the bag to effect opening of the bag retained on said spout, and means for applying a vacuum to the interior of said shroud to draw material from said hopper into the bag retained on said spout.

5. In a bag filling machine as recited in claim 4 wherein said seal element includes an expandable resilient member having an interior space which may be subjected to fluid pressure to expand said member into engagement with the mouth of the bag to be filled.

6. In a bag filling machine as recited in claim 4 wherein pairs of parallel members are provided adjacent the top and bottom interior of said shroud with one of each of said pairs of members being mounted on and movable with said access door whereby upon opening of said door said pairs of members will be moved apart to facilitate positioning of the upper and lower bag seams to be disposed between the members on closing of the access door.

7. In a bag filling machine as recited in claim 6 wherein the interior surfaces of the chamber of said shroud and the surfaces of the seam members exposed to the shroud interior are grooved to promote application of vacuum to the entire exterior surface of the bag being filled.

8. In a bag filling machine as recited in claim 4 wherein an annular cavity is provided surrounding the feed spout adjacent its point of entry into said shroud, and said seal element encircling the feed spout is disposed within said cavity to clamp the mouth of the valve bag between the periphery of said feed spout and the wall of said cavity.

9. In a bag filling machine as recited in claim 8 wherein an upstanding pocket communicating at its lower end with said annular cavity is provided adjacent the point of entry of said feed spout into said shroud, and an expandable seal element extends around the top and sides of said pocket to clampingly retain the upper bag seam within said pocket.

10. In a bag filling machine as recited in claim 8 further having an expandable seal embedded in the periphery of the outer end of said spout to function when expanded as a preliminary seal in retaining the valve bag on the spout.

11. In a bag filling machine, a supporting frame, a scale mechanism suspended from said supporting frame consisting of a primary scale beam fulcrumed adjacent one end thereof, a secondary scale beam fulcrumed intermediate the ends thereof and overlying said primary scale beam, means interconnecting the opposite end of said primary beam and one end of said secondary beam for transmission of forces between said beams, the opposite end of said secondary scale beam having a counterweight adjustable to alter the response of the scale mechanism, a shroud suspended from a point intermediate the ends of said primary scale beam and providing a chamber for receiving a bag during the filling thereof with an access door to permit introduction and removal of the bags being filled, a feed spout carried by said shroud with the outlet end thereof disposed within said shroud for insertion into the mouth of a valve type bag, a seal element encircling said feed spout adjacent the entrance of said spout into said shroud and adapted to be actuated to clampingly retain the valve bag on said spout within said shroud, a material hopper, a material supply conduit connecting said feed spout and said material hopper and having a valve disposed therein actuatable to control the flow of material from the hopper to said feed spout, a vent valve operable to control admission of a gaseous fluid through said spout and into the bag to effect opening of the bag clamped on said spout, and means for applying a vacuum to the interior of said shroud to draw material from said hopper into the bag clamped on said spout.

12. In a bag filling machine as recited in claim 11 further having a dash pot device connected to said opposite end of said secondary scale beam to retard movements of such beam during filling of the bag retained within said shroud.

13. In a bag filling machine as recited in claim 11 wherein said shroud is yieldably connected with said frame to restrict lateral movement of said shroud relative to

said frame while permitting limited vertical movement of said shroud as said scale mechanism responds to the introduction of material into the bag being filled.

14. In a bag filling machine as recited in claim 11 wherein means is provided adjacent said opposite end of said secondary scale beam operative in response to movements of such end to terminate the bag filling operation when the desired weight of material has been dispensed into the bag within the shroud.

15. In a bag filling machine, a shroud providing a chamber for receiving a bag during the filling thereof and having an access door to permit introduction and removal of the bags being filled, switch means mounted to have the contacts thereof closed upon closing of said access door, a scale mechanism supporting said shroud and having means operable upon introduction of the desired weight of material into bag being filled to terminate the filling operation, a feed spout disposed within the upper end of said shroud and having a seal element actuatable to engage with the mouth of the bag being filled to retain same on said spout, a material supply hopper, a material supply conduit interconnecting said feed spout and said hopper and having a material valve interposed therein actuatable to control the flow of material through said feed spout, a vent valve operable to control admission of a gaseous fluid through said spout and into the bag to effect opening of the bag retained on said spout, a vacuum valve for coupling the interior of said shroud with a source of vacuum, a relief valve for communicating the interior of said shroud with atmospheric pressure, means operable upon closing of said switch means to open said vent valve for a predetermined time period, timer means actuated upon closing of said switch means to close said relief valve and open said vacuum valve and after a predetermined time interval to open said relief valve and close said vacuum valve, and pressure responsive means connected to open said material valve when the pressure within said shroud reaches a predetermined vacuum.

16. In a bag filling machine as recited in claim 15 further having a fluid driven actuator connected to effect opening and closing of said access door, and means for selectively controlling flow of pressurized fluid to said actuator to open and close said door.

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