# United States Patent [19]

**Reuter**

[11] **3,727,985**

[45] **Apr. 17, 1973**


[54] **PNEUMATIC CONVEYING APPARATUS AUTOMATICALLY OPERABLE SUCCESSIVELY FOR WEIGHT RESPONSIVE FILLING, AND FOR ACTIVATION, DISCHARGING, PURGING AGAINST BACK PRESSURE, AND VENTING**


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[73] Assignee: **Consolidated Engineering Company,** Houston, Tex.



[22] Filed: **Jan. 3, 1972**

[21] Appl. No.: **214,668**

[52] **U.S. Cl.** ..... **302/53**

[51] **Int. Cl.** ..... **B65g 53/40**

[58] **Field of Search** ..... 302/52, 57, 53, 41



[56] **References Cited**

UNITED STATES PATENTS

2,668,085 2/1954 Baresch ..... 302/53



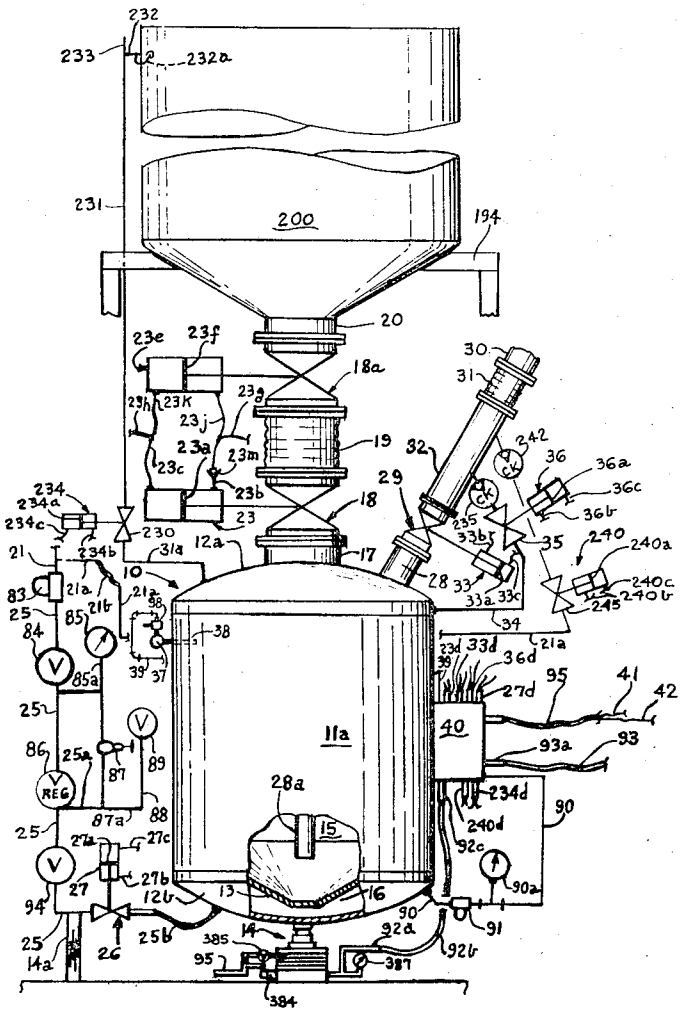
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[57] **ABSTRACT**

The pressure vessel or fluid flow pump cycle of Reuter U.S. Pat. No. 3,355,221, issued Nov. 28, 1967, which has steps of filling, activation, discharging and purging, is disclosed as load cell or scale supported and vented, and is thus further adapted for lifting certain types of pulverulent material against back pressure, by placing check valve means in the purge line and/or in a pressurized gas line from source, the check valve means being substantially in adjacent communication with the discharge line downstream of the discharge valve. Thus the check valve may close and protect against back pressure urging material, (normally destined to be purged down the discharge line), back into the pressure vessel. The additional step of venting to atmosphere and/or to hopper any residual material not carried away by the purge step, is thus disclosed as an added step. The admission of pressurized gas from source can enter as when back pressure in some excess may be encountered. As check valves are subject to wear and failure, the employment of pressurized gas from source can act as a safeguard against the effects of back pressure. The added features set forth hereinabove may be employed with a variety of fluid flow pump structures, as agitator equipped pumps; also with pumps suspended below a load cell.


**6 Claims, 8 Drawing Figures**



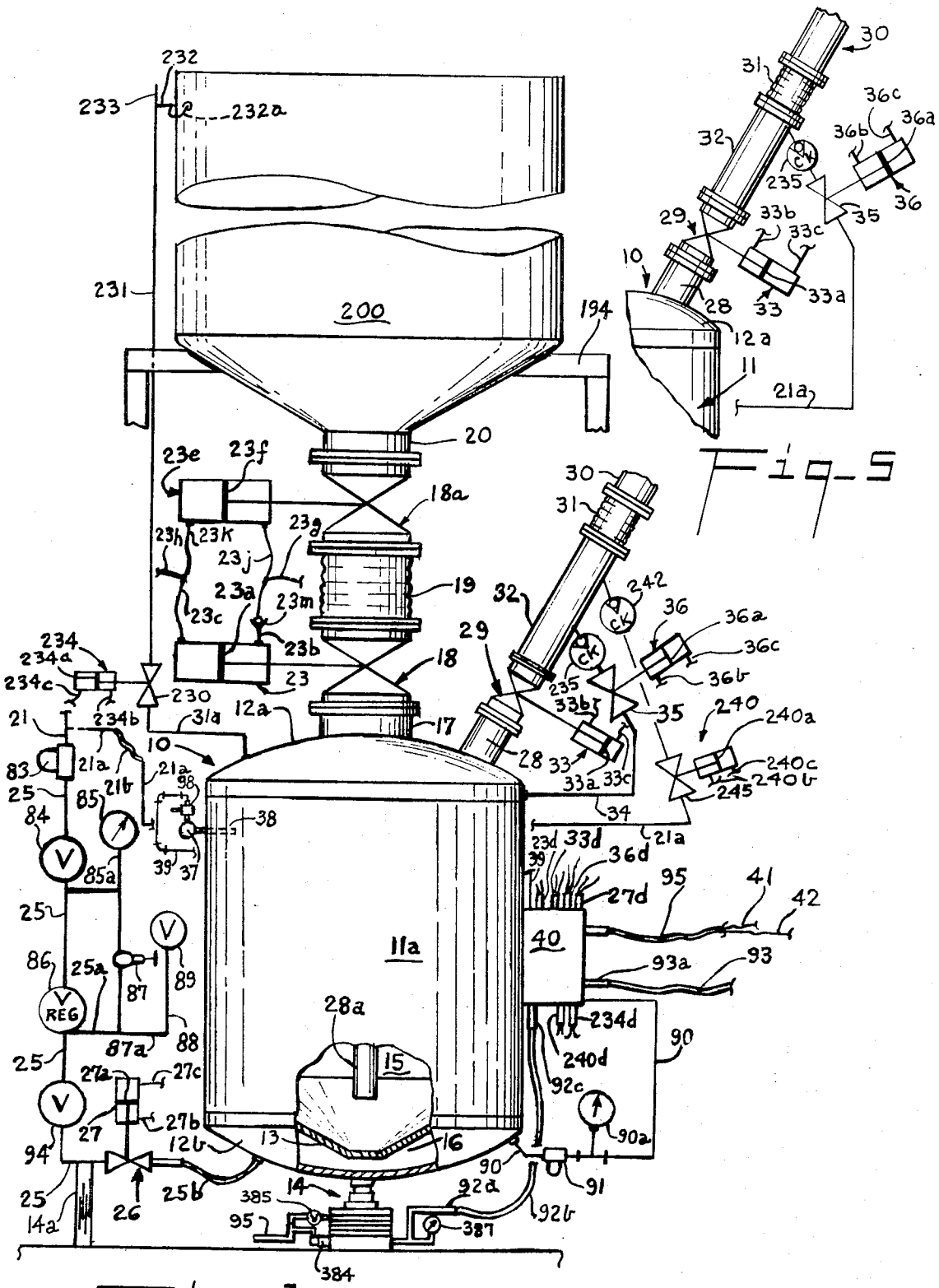

232
233
232a
231
200
194
20
23e
23f
18a
23h
23K
23g
23j
23a
23m
23c
23b
23
19
18
17
234
234a
234c
230
234b
21
31a
12a
10
83
21a
21a
25
21b
85
84
85a
38
39
37
98
25
86
25a
87
89
REG
88
87a
25
27a
27c
27
27b
94
12b
25
25b
26
14a
385
14
95
384
387
92a
92b
90
91
13
16
15
28a
11a
40
23d
33d
36d
27d
95
41
42
93a
93
234d
240d
92c
90a
90
30
31
32
242
36
36a
36c
36b
235
33b
33c
35
29
33
33a
34
240
240a
240c
240b
245
21a
10
28
12a
11
21a
30
31
36c
36a
36b
36
32
235
35
29
33b
33c
10
28
33
33a
12a
11
21a

Fig-5

Fig-1

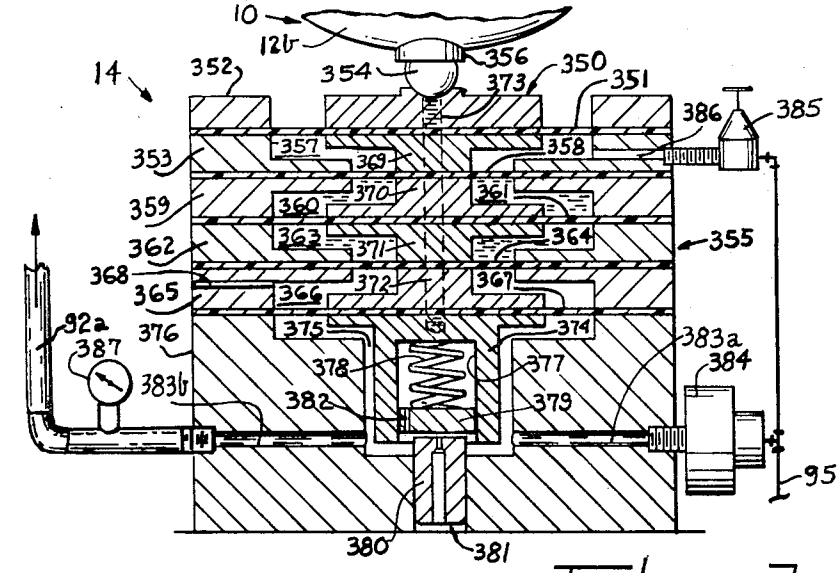



Fig. 3

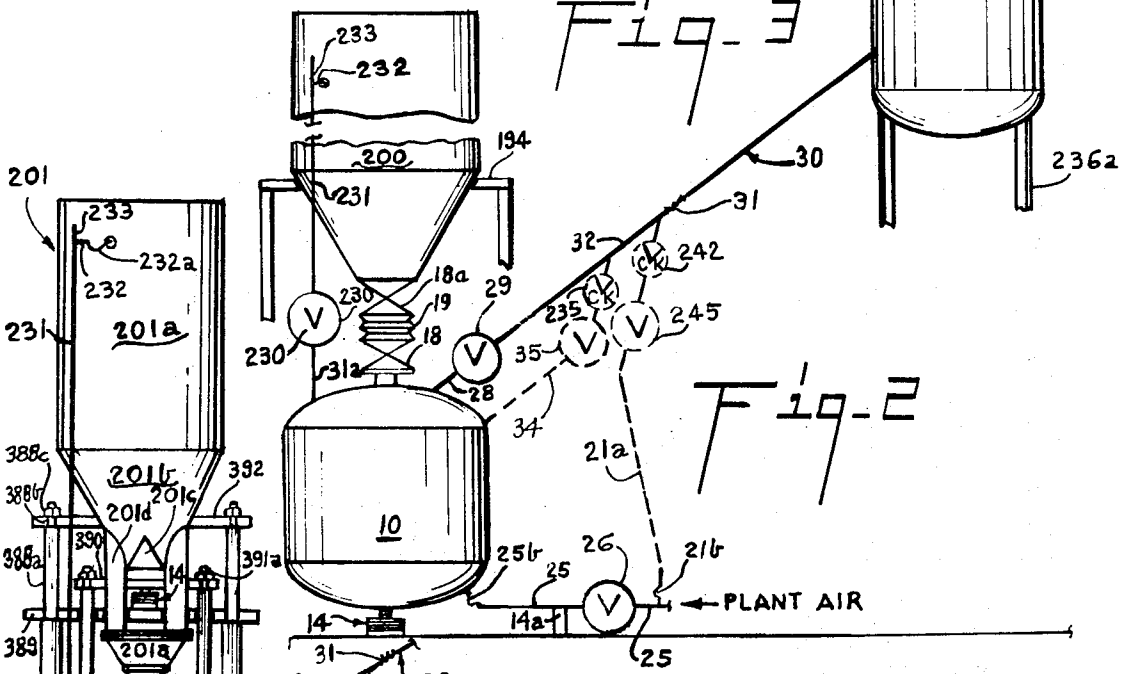



Fig. 2




Fig. 6

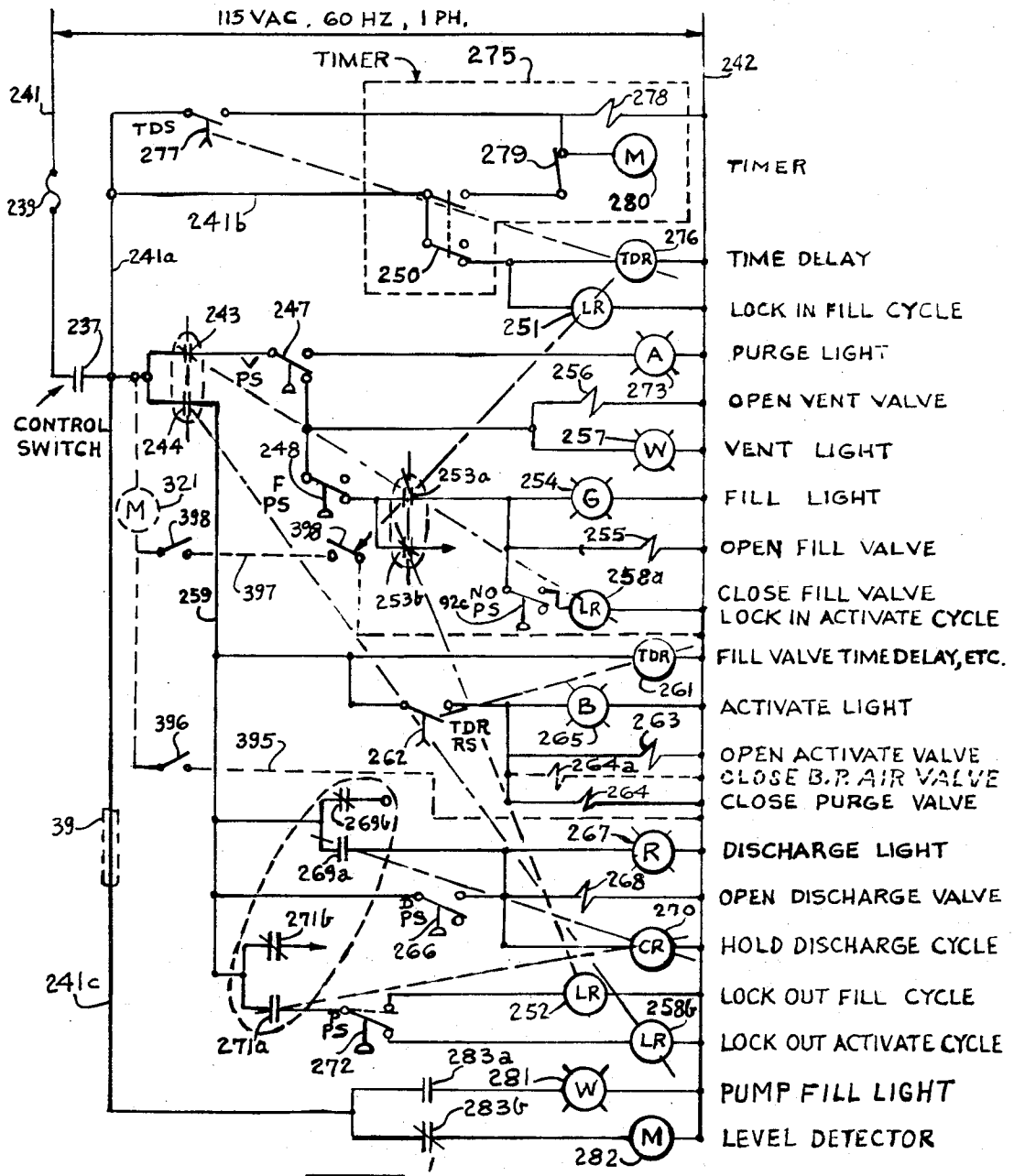
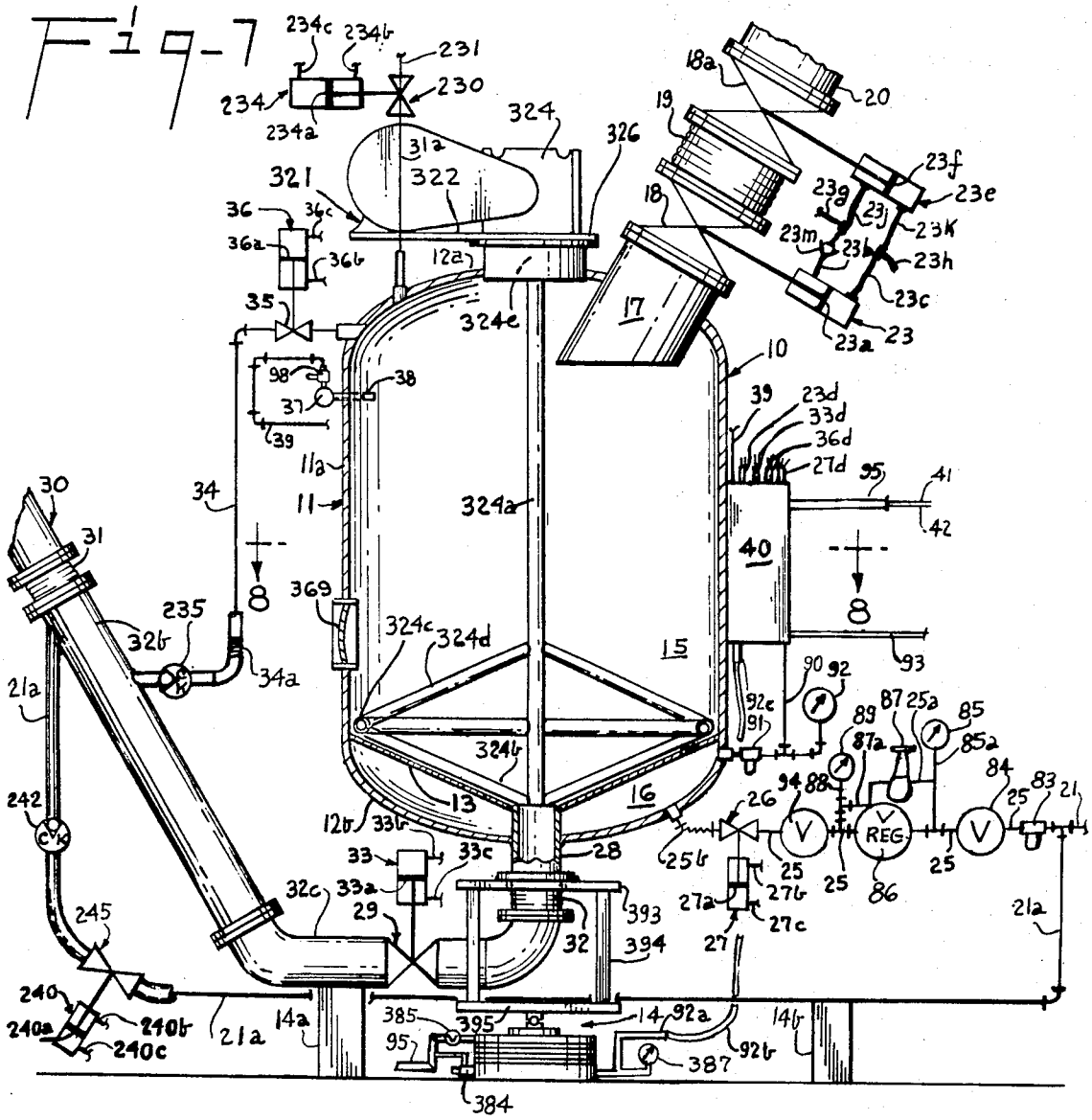

115 VAC, 60 HZ, 1 PH.
TIMER
275
242
241
278
TDS
277
279
M
280
TIMER
239
241b
276
241a
250
TDR
TIME DELAY
LR
LOCK IN FILL CYCLE
251
237
243
247
A
PURGE LIGHT
PS
256
273
OPEN VENT VALVE
CONTROL SWITCH
244
248
257
W
VENT LIGHT
F PS
253a
254
G
FILL LIGHT
321
M
398
398
255
OPEN FILL VALVE
259
397
253b
92c NO PS
258a
LR
CLOSE FILL VALVE
LOCK IN ACTIVATE CYCLE
TDR
FILL VALVE TIME DELAY, ETC.
261
B
ACTIVATE LIGHT
396
395
TDR RS1
262
263
265
OPEN ACTIVATE VALVE
264a
CLOSE B.P. AIR VALVE
264
CLOSE PURGE VALVE
39
269b
267
R
DISCHARGE LIGHT
269a
268
OPEN DISCHARGE VALVE
271b
PS
266
270
CR
HOLD DISCHARGE CYCLE
241c
LR
252
LOCK OUT FILL CYCLE
258b
271a
PS
272
LR
LOCK OUT ACTIVATE CYCLE
283a
281
W
PUMP FILL LIGHT
283b
M
LEVEL DETECTOR
282

Fig-4

Fig-7


234c
234b
231
230
234
234a
324
326
312
322
321
36
36c
36a
36b
12a
324e
35
98
38
37
39
11a
11
324a
30
31
34
8
369
235
326
34a
21a
242
245
240
240a
240b
240c
14a
385
395
95
384
14
92a
387
92b
14b
324c
324d
15
16
13
12b
33b
33
33c
28
32c
33a
29
32
393
394
27
27a
27b
27c
25b
26
94
88
90
92
92c
91
89
87
87a
25a
85
85a
84
83
21
25
V
V REG
86
40
41
42
93
10
39
23d
33d
36d
27d
95
18a
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23f
23e
23g
23j
23K
23m
23l
23h
23c
23
23a

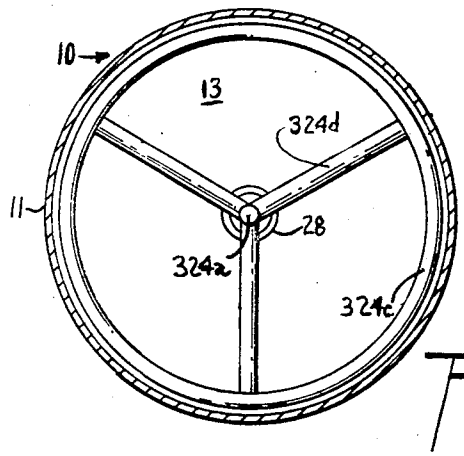

10
13
324d
11
28
324a
324c

Fig-8

# PNEUMATIC CONVEYING APPARATUS AUTOMATICALLY OPERABLE SUCCESSIVELY FOR WEIGHT RESPONSIVE FILLING, AND FOR ACTIVATION, DISCHARGING, PURGING AGAINST BACK PRESSURE, AND VENTING

## BACKGROUND OF THE INVENTION

Kennedy et al. U.S. Pat. No. 2,032,367 issued Mar. 3, 1936, to Pneumatic Transport System disclosed valves controlling material inlet, the fluid pressure connection, and the exhaust outlet; Vogel-Jorgensen U.S. Pat. No. 2,124,018 issued July 19, 1938, disclosed circuitry operated by material level sensitive devices to operate valves corresponding with selective material levels; Vogel-Jorgensen U.S. Pat. No. 2,221,741 issued Nov. 12, 1940, disclosed mechanical operation of valves by level sensitive equipment; and Baresch U.S. Pat. No. 2,668,085, issued Feb. 1954, disclosed in particular, fill valve closure responsive to material level actuating the level sensitive equipment to control the fill valve. Reuter U.S. Pat. No. 3,555,221, issued Nov. 28, 1967, showed circuitry time actuated, pressure actuated, and electrically operated, to open fill valve, close fill valve, open activate valve and close purge valve, open discharge valve, close discharge valve and open purge valve, and as pressure drops to atmospheric, to repeat the cycle.

Before the Reuter U.S. Pat. No. 3,555,221 issued Nov. 28, 1967, a continuation-in-part Application Ser. No. 686,018 was filed on Nov. 28, 1969, with the "-fluid flow pump" structure of Reuter U.S. Pat. No. 3,555,221 mounted on a beam scale. While this application was still pending a continuation-in-part application was filed on May 6, 1969, (issued Dec. 22, 1970 as U.S. Pat. No. 3,549,206) showing the Reuter "fluid flow pump" with an agitator driven from a motor mounted centrally on top and with hopper filling the vessel through one side of the top, the discharge being from the bottom of the vessel. Also this application repeated the disclosure of the "fluid flow pump" on a beam scale. With the aforesaid application still pending a continuation-in-part application was filed on Oct. 21, 1969, which will issue Jan. 4, 1972, as U.S. Pat. No. 3,632,173. This patent covers the condition when the "fluid flow pump" discharges with falling pressure of discharge being opposed by back pressure action down the discharge line in direction of the pump.

Thus a check valve was installed in the purge line downstream from the purge valve and discharge valve, so that the check valve would close the purge line as the back pressure began to equal the purge line pressure. This necessitated a vent in the cycle to be opened, shortly after purge valve opening and then being check valve closed, thus to vent the vessel or pump so the pressure therein could drop to atmospheric, so the cycle could begin again. In this form of "fluid flow pump" the vessel was claimed as being mounted on a scale means to transmit a net weight or batch weight proportionate signal to set in operation fill valve closure.

Also, on Dec. 16, 1970, just before the issuance of U.S. Pat. No. 3,549,206 on Dec. 22, 1970, a continuation-in-part application was filed showing a wide range of improvements, with a load cell replacing the beam scale formerly disclosed as the means of transmitting a weight proportionate signal to close the fill valve. As



this application is filed the continuation-in-part application for U.S. Pat. No. 3,632,173, that issues Jan. 4, 1972, is still pending, along with the aforesaid Application Ser. No. 98,567, filed Dec. 16, 1970.

This application improves upon the invention of the patent that will issue Jan. 4, 1972, in that it either adds to, or substitutes for, the check valve protected purge line, a conduit from pressurized gas, or plant air source, that connects into the discharge line downstream of the discharge valve. This source air or gas conduit has a valve therein that is opened at the same time the purge valve is opened and closed. Also it has a check valve therein adjacent the point where it connects into the discharge line downstream from the discharge valve. Since the details of fill valve opening and closure are carried out by a load cell with much greater efficiency than by a beam scale, the structure of a load cell is injected into this application correspondingly as such is shown in the immediately preceeding application. Also, the agitator equipped fluid flow pump is shown supported upon a load cell, and with a check valve guarded, additional source air line provided.

As a primary object the invention provides a load cell mounted, vent equipped, pressure vessel or pump which either substitutes for, or adds, parallel with the purge line, a conduit from plant air or source of compressed gas, this conduit having a valve therein turned on and off with the purge line valve, and a protective check valve being provided in this conduit at its connection into the discharge line, downstream from the discharge valve.

As another important object, this invention provides a fluid flow pump type pressure vessel or pump, of the class discribed, which is supported by a load cell.

It is yet a further object of this invention to provide a fluid flow pump type pressure vessel, of the class described, which additionally includes a motor driven agitator, and which is supported upon a load cell.

It is still another object of this invention to provide a fluid flow pump type pressure vessel, of the class described, which is adapted to be seated upon a load cell, or which alternately may be adapted to be suspended below a platform supported load cell.

It is also another and additional object of the invention to provide safe guarding, or alternatively, level probe means with the types of fluid flow pump type pressure vessels, hereinabove described, to close the fill valve.

Other and further objects will be apparent when the specification herein is considered in connection with the drawings, in which:

## SPECIFICATION DETAIL

Other and further objects of the invention will be apparent when the specification hereunder is considered in connection with the drawings, in which:

FIG. 1 is an elevational view, partially diagrammatic, showing a fluid flow pump, on load cell equipped with vent valve, and with purge valve with check valve downstream thereabove communicating with discharge line downstream of discharge valve, thus to oppose back pressure; also as an alternative compressed air from source is shown additive to oppose back pressure;

FIG. 2 is smaller scale elevational view, substantially diagrammatic, showing fluid flow pump as shown in

FIG. 1 and also the tower for receiving discharge; back pressure compressed air and purge line between pressure vessel and purge valve, both being shown in broken lines, as optionally employed features;

FIG. 3 is a sectional elevational view of the load cells shown supporting pressure vessels in FIGS. 1 and 2;

FIG. 4 is an electrical and pressure circuitry diagram of the circuitry operative with the structures shown in FIGS. 1–3;

FIG. 5 is a fragmentary elevational view, partially diagrammatic, showing a check valve with purge valve upstream therefrom, with compressed air from source indicated as the only purge and back pressure opposing fluid;

FIG. 6 is an alternative arrangement of hopper and pressure vessel as supported in suspension upon a load cell;

FIG. 7 is a sectional elevational view, partially diagrammatic, showing an agitator equipped pressure vessel in an arrangement including features shown in FIG. 6; and

FIG. 8 is a sectional elevational view taken along line 8—8 of FIG. 7.

Referring now to the drawings in which like reference numerals are applied to like elements in the various views, a material container, housing, pump or activator **10** is shown in FIG. 1 comprised of a shell **11** including a cylindrical main body **11a** with upper end closed by a top comprised of a spherical segment or dome **12***a* and a bottom comprised of a spherical segment or lower closure **12***b*, the container being constructed after the general manner of conventional pressure vessels, and designed with safety factors, to withstand the highest pressures that may be developed therein.

The pressure vessel or container **10** is supported on a load cell **14** which receives instrument air thereinto through an inlet conduit **95** and discharges air therefrom through a discharge conduit **92***a* at a predetermined signal intensity corresponding with the deposit of a predetermined batch weight of pulverulent material upon a gas permeable membrane or diaphragm **13** separating the container into an upper, or material plenum **15**, and a lower, or gas plenum **16**.

The dome **12***a* has an inlet flange or neck **17** connected centrally into the top thereof with an inlet gate valve or lower fill valve **18** being mounted thereon. A flexible nipple **19** is shown connecting the lower fill valve **18** to the lower flange of an upper fill valve **18***a* having its upper flange connected with a discharge flange **20** from a hopper **200**. The nipple **19** is shown as a flexible member since the load cell **14** functions as a weight scale whereby the pump **10** supported thereon changes slightly in elevation between an upper, empty elevation and a lower, or batch material filled elevation.

Valve operators **23**, **23***e*, are shown diagrammatically, as disposed to open and close, respectively, the lower and upper fill valves **18**, **18***a*. Pistons **23***a*, **23***f*, are shown in the respective valve operators **23**, **23***e*. Conduits **23***g*, *h*, extend from a discharge tube or pipe **23***d* from the instrument panel box **40** mounted on the pump body **11***a*. The conduit **23***g* branches into conduits **23***b* and **23***j*, respectively, to admit instrument air into the respective valve operators **23**, **23***e*, under the respective pistons **23***a*, **23***f*, to open the respective fill valves **18**, **18***a*.

Also the conduit **23***h* branches into conduits **23***c*, **23***k*, for air passage from the outer ends of the valve operators **23**, **23***e*, back in the closed compressed air circuit to its pressurized reservoir. Otherwise, such reservoir may be selectively supplied with compressed air, to carry out the respective compressed air functions hereinabove recited.

As indicated in FIG. 1, the vessel **10** is mounted on the load cell **14**, to "float" thereon in elevation, and consequently, since the hopper **200** is supported stationarily by the support frame **194**, float allowance must be made in all connections between hopper **200** and vessel **10**. Thus the compressed air or gas conduit **25** is shown connected to discharge into the gas plenum **16**, through a flexible conduit **25***b*, the gas conduit **25** being supported above floor level by a support post **14***a*.

Also, since the instrument panel **40** is rigidly carried by the shell **11***a* of the vessel **10**, the air pressure signal emitting pipe **92***a*, which emits a pressure signal proportionate to batch weight of material impressed upon the load cell **14**, has a flexible tubing **92***b* connecting it with pipe section or nipple **92***c*, that extends from the panel **40**.

In like manner the aforesaid flexible nipple **19**, between upper and lower fill valves **18***a*, **18**, permits the lower fill valve **18** to move with some relation to the fixedly supported upper fill valve **18***a*. Hence the aforesaid conduits **23***g*, **23***h*, from the pipe nipple **23***d* above the panel **40** are indicated as being flexible, and also their respective branches **23***b*, **23***j*, and **23***c*, **23***k*, are indicated as being flexible. Since it is desirable in operation that the upper fill valve **18***a* should close before the lower fill valve **18**, a check valve **23***m* is provided in the branch conduit **23***b* thus to check the rate of fluid forced upwardly through the branch conduit **23***b* with relation to the rate of fluid forced downwardly through the unobstructed conduit **23***j*.

As shown in FIG. 1, the gas, as compressed air, which activates and transports the material which enters the container, shell, or pressure vessel **11**, arrives from its source, as a compressor or pressurized reservoir, and passes, via a source conduit **21**, through a strainer **83** and a globe valve **84**, on its way through a main conduit **25**, to be regulated by pressure regulating valve **86**, to the pressure at which it is to be supplied. Thus the gas is first measured by a high pressure gauge **85**, in the top of a gauge pipe **85***a*, which upstands from the main gas line **25**, through which the strained gas passes on downstream. Thus the gas is first measured by a high pressure gauge **85** in the top of the gauge pipe **85***a* which upstands from the main gas line **25** through which the strained gas passes on downstream. A smaller sized by-pass line **25***a* extends between the gauge pipe **85***a* and the aforesaid pressure regulating valve **86** in the main conduit **25**, and has a pilot regulating valve or regulator **87** therein, thus to permit a finer and more responsive control of the pressurized gas on its way to the pressure vessel **11**.

A by-pass line **87***a* conveys the reduced pressure gas from the pilot regulator **87**, and connects with an upstanding gauge pipe **88** above the main conduit **25**, a low pressure gauge **89** being mounted on top of the

gauge pipe **88** to indicate the lowered pressure of the gas. Finally, a valve **94**, downstream of the regulating valve **86** and upstream of the gas inlet control valve **26**, may be opened to permit plant gas, as compressed air, to pass to the aforesaid valve **26**, as controlled by the valve operator **27**.

Since the pressure vessel or pump **10** is supported on a load cell or scale **14** which is depressed in elevation in correspondence with batch weight deposited in the pump, while the main gas conduit **25** is rigidly supported, as by support post **14***a*, a flexible conduit **25***b* is employed as that part of the main gas conduit **25**, which connects the plant air or compressed gas into the spherical segment or bottom closure **12***b* of the pressure vessel **11** to discharge into the gas plenum **16**.

A smaller sized by-pass line **25***a*, extends between the gauge pipe **85***a*, and the aforesaid pressure regulating valve **86**, in the main conduit **25**, and has a pilot regulating valve or regulator **87**, therein, thus to permit a finer and more responsive control of the pressurized gas on its way to the pressure vessel **11**. A by-pass line **87***a*, conveys the reduced pressure gas from the pilot regulator **87**, and connects with an upstanding gauge pipe **88**, above the main conduit **25**, a low pressure gauge **89**, being mounted on top of the gauge pipe **88** to indicate the lowered pressure of the gas.

A pressure fluid conduit **90** extends from the lower closure **12***b* of the pressure vessel **11**, to convey pressurized fluid therefrom through a strainer **91**, a pressure gauge **90***a* downstream of strainer upstanding from the conduit **90**, and the conduit **90** then being rigidly connected into the instrument panel **40**. Via this means the pressurized fluid from within the vessel is brought to bear upon, and to cause switch actuation of switch means within the instrument panel **40**, to be hereinbelow described. The instrument air required by the pressure sensitive switches, as contra-distinguished from the actuating air or gas, and any other air or gas required to actuate any of the apparatus, including that required to operate the valve operators shown in FIG. **1**, may be carried to the panel box **40** by means of a conduit **93**, which is connected through the connection nipple **93***a* into the panel box **40** for selective distribution. Also, the power conductors **41**, **42**, from a source of electrical power, as a 60 cycle, 115 A.C. voltage source, may be brought to the panel box **40** through an insulated conductor cord **95**.

Thus operative air, gas or fluid, is admitted selectively into the conduits **27***b* or **27***c*; selectively into the conduits **33***b* or **33***c;* and selectively into the conduits **36***b* or **36***c*; selectively to open or close the aforesaid compressed gas valve **26**, materials delivery valve **29**, and purge valve **35**. Also, to be hereinbelow described, a solenoid actuates a valve within the panel box **40** to open or close the aforesaid upper and lower fill valves **18***a*, **18**, as above explained.

The pressure vessel or pump **10**, shown in FIGS. **1** and **2** discloses a vent conduit **31***a* extending from the top closure or dome **12***a* of the pump **10** to a vent valve **230** from which rises a vent pipe **231** to discharge via a connection nipple **232** into the hopper **200**, against atmospheric pressure usually prevailing in hopper. Optionally, the discharge may be into the atmosphere, as indicated by reference numeral **233**. Although not shown, conventional means as stop cocks, caps or chokes may be provided whereby all, non, or any part of the discharge may be directed through either nipple **232**, selectively, into the hopper **200**, or to the atmosphere through the nipple **233**.

The vent valve **230** is shown as opened and closed by a valve operator **234** with piston **234***a* therein moved outwardly to open the valve **230**, as pressure fluid enters conduit **234***b* behind the piston **234***a* to move it outwardly, the pressure fluid outwardly of the piston **234***a* being returned to the panel box **40** by way of conduit **234***c*. Closing of the valve **230** by the valve operator **234** obviously entails reversal of direction of fluid movement.

As shown in FIG. **1**, a conduit **34** extends from the upper portion of the pressure vessel **11** to convey purge materials under falling pressure, to be hereinbelow described, to and through a purge valve **35** and then through a check valve **235**, (yieldably urged seated in direction of the purge valve **35**), into a pipe section **32**, **31**, upwardly flexible in FIG. **1**. The pipe section **32** is just downstream of the discharge valve **29**, which communicates with a discharge nipple or outlet **28** from the upper closure or dome **12a** of the pressure vessel **11**. In FIG. **2** the purge conduit **34** is shown in broken lines as conveying purge material to the purge valve **35** having the check valve **235** just downstream thereof and communicating into the lower portion **31** of the discharge conduit **30**. Also in FIG. **2** the discharge conduit lower portion **31** includes the flexible section **32**, and also the check valve **235** communicates in FIG. **2** into the rigid conduit portion **31**.

As shown more or less diagrammatically in FIG. **2**, a pressure vessel or pump **10** is shown weighed for predetermined net weight by a load cell **14**, shown in small scale detail in this view. Plant air is indicated as entering the bottom of the vessel **10** via the compressed air line **25**. Also, the material, as granular or pulverulent material, is admitted from the hopper **200** to the pump **10** by means of the upper fill valve **18***a*, flexible nipple **19**, and lower fill valve **18**. The discharge valve **29** operates to discharge through conduit system **30**, to discharge the activated material from the pump **10** upwardly into a catalyst regenerator tower **236**.

In FIG. **1**, respective conduits **27***b*, **33***b*, and **36***b* connect into the respective compressed gas, materials delivery and purge valve operator cylinders **27**, **33**, and **36**, under the respective piston heads **27**a, **33***a*, and **36***a*, while respective conduits **27***c*, **33***c*, and **36***c* connect into such cylinders above the respective piston heads therein. Thus, conductor cords or sleeves **27***d*, **33***d*, and **36***d* for the respective conduits for the respective valve operator cylinders aforesaid, are provided to extend from the control or panel box **40**, where conventional instrument air, as from the instrument air conduit **93**, may pass through respective conventional solenoid actuated valves, now shown, within the panel box **40**, as operated by respective solenoids to be hereinbelow described.

Having set forth the background for operation of the pump **10** when discharge is to be made against back pressure, and when the net weight of material, as batches, from the hopper **200** into pump **10** is to be impressed upon a load cell **14**, reference may now be made to FIG. **3** which sets forth the details of load cell construction and operation.

Referring now to FIGS. 1, 2 and 3, the load cell 14 on which the pump 10 is supported, is shown as a scale of the type disclosed in co-pending Application Ser. No. 98,567, filed Dec. 16, 1970, the last of the preceding applications from which this application is a continuation-in-part. This type of load cell is also set forth in details of Bullivant and Kane U.S. Pat. No. 3,425,503, issued Feb. 4, 1969. Such a load cell 14 is shown comprising a weighing anvil 350 connected centrally to an upper tare weight space defining diaphragm 351 and held peripherally between upper or hold-down ring 352 and the peripheral annular area of a bored and counterbored tare weight ring 353 comprising the two uppermost structural rings of the load cell body 355. The weighing anvil 350 is dished for the lower portion of a ball member 354 to seat therein, while as best shown in FIG. 3, the lower or gas plenum closure spherical segment 12b of a pressure vessel or fluid flow pump 10 has an inverted, dished out cup member 356 on the lowermost area thereof to guide the pump 10 into a centered seated position on the ball member 354.

The tare weight ring 353 peripheral annular area serves as hold-down for, and seats upon a lower defining diaphragm 358 of a tare weight chamber 357, with the peripheral annular area of the diaphragm 358 seating upon the peripheral annular area of an inverted bored and counterbored section or ring 359 of an upper dampening chamber 360. The peripheral annular area of the inverted bored and counterbored ring 359 serves as hold-down for, and seats upon, a lower defining diaphragm 361 of the upper dampening chamber 360. A bored and counterbored ring or body section 362 has the peripheral annular area of the diaphragm 361 supported thereon, and this diaphragm 361 defines in part the upper surface of a second dampening chamber 363.

The ring or body section 362 comprises the hold-down for a diaphragm 364 which in part defines the second dampening chamber 363 thereabove, with the vent chamber 366 being disposed immediately therebelow, the annular peripheral area of the diaphargm 364 seating upon the inverted bored and counterbored ring or body section 365. This ring 365 acts as hold-down upon the annular peripheral area of a lowermost diaphragm 367 which in part defines the vent chamber 366 thereabove. A vent passage 368 is shown from the vent chamber 366 through the ring 365 to the exterior of the load cell body 355.

Alternately inverted and upright solid flange shaped guide members 369, 370, 371 and 372 are disposed centrally of the load cell body 355, with flange members of the same diameter as the anvil 350, with flange of member 369 under diaphragm 351, with flange of member 370 upon diaphragm 361, and with flange of member 371 under diaphragm 361, and with flange of member 372 upon diaphragm 367. Thus the heads of flanges 369, 370 abut across diaphragm 358 and the heads of flanges 371, 372 abut across diaphragm 364.

A connection screw 373 passes threadably through the anvil 350, and through central bores through the diaphragms, and through central bores through the flange members 369, 370, 371, 372, for threaded connection centrally into the upper portion of a cage 374 on which bears centrally the lowermost diaphragm 367. The cage 374 extends downwardly with clearance into a balancing chamber 375 formed by boring and counterboring a lowermost body section or housing member 376 on which seats the peripheral annular area of the lower diaphragm 367. The cage 374 is bored upwardly from its lower end to provide a chamber 377 for a spring 378 which seats upon a plunger 379 that serves as the valve seating member of a balancing chamber escape valve, with the valve seat thereof comprising a nozzle 380 fixed in a bore directed centrally upwardly through the bottom of the housing member 376, and above an escape slot 381 thereacross. Preferably a bleed passage 382 is provided through the valve member or plunger 379 to relieve against cushioning.

A horizontally extending passage 383*a*, 383*b*, is shown as being drilled diametrically across the housing member 376 at a predetermined elevation therein, as with axis at some predetermined elevation with relation to the fixedly located upper surface of the nozzle 380. A pressure regulator 384, of conventional design as shown in the aforesaid Bullivant and Kane U.S. Pat. No. 3,425,503, or as shown in Stein U.S. Pat. No. 3,371,732, is shown connected to discharge into the balancing chamber passage 383*a*, with instrument air being supplied from an instrument air conduit 95 for the rate of flow therefrom into the load cell 14 to be regulated by the aforesaid pressure regulator 384.

A conventional outlet pressure regulator 385, as shown in the above identified U.S. Pat. Nos. 3,425,503 and 3,371,732, is connected to receive instrument air from conduit 95, and the regulated air communicates through a passage 386 through the tare weight ring 353 which provides therein the tare weight chamber 357. The pressure regulator 385 is opened at the start of operation to permit the introduction of pressurized gas, as air, into the tare weight chamber 357 to offset the weight of any container or the like so that only a net load is transmitted for effectiveness in the balancing or net load chamber 375.

An air signal that is proportionate to net weight or batch weight, as will be hereinbelow described, passes from the balancing chamber 375 through passage 383*b* and leaves the housing member 376 through a discharge pipe 92*a*, a pressure gauge 387 being connected into the discharge pipe 92*a* to display indicia of the force of the signal transmitted. The under surface of the valve element 379 in the cage 374 provides a valve seating surface to seat upon the top, flat surface of the nozzle 380 when a minimum air is to be bled off through the nozzle 380 to the atmosphere, or when a maximum force air signal is to be transmitted in correspondence with the maximum batch weight or net weight transmitted through the anvil to the cage 374. Conversely, the less net or batch weight impressed through the anvil 350, the greater distance between nozzle and plunger surfaces, the more air that is bled to atmosphere, and the weaker the signal transmitted through the conduit 92a and on to the panel box 40, FIG. 1.

Referring now to FIG. 4, the operation of the apparatus hereinabove described may be described, in accordance with the immediately preceding structure, now under issue, the circuitry of the preceding invention being in substantial correspondence with the circuitry for the continuation-in-part features added by this application:

A normally open control switch **237** in the positive power line **241**, having the fuse **239** therein, is closed. Current is thus admitted through normally closed switch **243** of latch relay **258***a*, **258***b*; also through normally closed vent pressure switch VPS or **247**; also through normally closed fill pressure switch FPS or **248**; and also through conductors **241***a*, **241***b* to double pole, double throw switch **250** and relay LR or **251** of timer latch relay **251**, **252**. Also current is admitted to flow in the TIME CIRCUIT containing TDR or time delay relay **276**, which urges TDS or TIME DELAY switch **277** closed, thus energizing the clutch solenoid **278** to start the MOTOR **280** or M that runs according to the preselected numbers of hours or parts of hours batches of material are to be successively delivered by the pump **10**.

The energized timer latch relay **251** now actuates the closing of normally open switch **253***a* of the switches **253***a*, **253***b* and thus the fill light or green light G or **254** goes on and the solenoid **255** in the panel **40** actuates valve operators **23**, **23***e* to open fill valve or fill valves **18**, **18***a*, FIG. **1**. Also the solenoid **256** in the panel **40** actuates the valve operator **234**, FIG. **1**, to open VENT VALVE **230**, and the VENT LIGHT or white light W or **257** goes on. Material now enters the vessel **10** from the hopper **200**.

The pressure signal that now passes from the load cell **14** via the succession of conduits **92***a*, **92***b*, **92***c*, FIG. **1**, is indicated by the reference numeral **92***c* being applied to the pressure switch NOPS, thus indicated as being normally open, FIG. **4**. This switch NOPS, **92***c*, is closed upon this predetermined "preset" say 15 p.s.i. being attained as batch load is built up on the diaphragm **13**, as aforesaid. This energizes the latch coil **258***a* of the fill latching relay **258***a*, **258***b*, to open the normally closed relay switch **243** and close the normally open relay switch **244**. This operates to CLOSE FILL VALVE and also serves to lock in ACTIVATE CYCLE, the whole fill circuitry being broken. Thus the solenoid **256** closes the vent valve **230**, FIGS. **1–2**, and the white light **257**, indicating vent open, goes out. Also the solenoid **255** closes the fill valves **18** and **18***a*, as aforesaid, and the green light **254** goes out.

As the relay switch **244** closes circuit from the positive side, parallel positive conductor **259** carries circuit to the FILL VALVE TIME DELAY relay TDR designated **261**, which, after a preset time interval, closes the time delay relay TDRS or switch **262**, whereby the solenoid **263** in the panel **40** operates to shift fluid direction to the valve operator **27**, FIG. **1**, to OPEN ACTIVATE VALVE or the valve **26**, (FIGS. **1** and **2**), to admit plant air into the gas plenum chamber beneath the diaphragm **13**, FIG. **1**, thereby to activate the material, or full batch, that is supported above the diaphragm, as aforesaid. Also, as the solenoid **263** has operated to open the compressed air supply or plant air valve **26**, at the same time, the solenoid **264**, adjacent thereto in the panel **40**, has shifted fluid direction to the valve operator **36**, FIG. **1**, to CLOSE PURGE VALVE **35**. Thus, at this point the fill valve(s) **18**, **18***a*, the vent valve **230**, the purge valve **35**, and the discharge valve **29** are all closed, while the plant compressed air is entering the vessel **10** to build up pressure therein, and to activate the granular or pulverulent material, or set it in violent motion above the diaphragm **13**. Circuit has also been completed so that the blue light B or **265** is turned on as the ACTIVATE LIGHT.

The pressure continues to rise in the vessel until a pressure approaching say 50 p.s.i. is attained therein, whereupon the discharge pressure switch DPS indicated by reference numeral **266** closes, as has been predetermined. As this switch **266** closes, circuit is completed through the red DISCHARGE LIGHT R or **267**, which comes on, and through the solenoid **268**, in the panel **40**, which changes fluid direction to and from the valve operator **33** to OPEN DISCHARGE VALVE **29**, FIGS. **1** and **2**.

Also, circuit through the control relay **270** is closed to energize this relay to HOLD DISCHARGE CYCLE by closing the normally open switch **269***a* of the pair of switches **269***a*, **269***b*. Also, the control relay **270** operates to close the normally open switch **271***a* of the pair of switches **271***a*, **271***b*, thereby circuit is completed through the purge pressure switch PPS or **272** which is set to close at a lower pressure, say 28 p.s.i., than the discharge pressure switch **269***a*. Thus, at this point the purge pressure switch PPS or **272** is open, as indicated in dotted lines in FIG. **4**. Therefore it is closing circuit through the time latch (LR) relay **252**, whereby this relay is actuated to put the contacts of the time latch relay switches **253***a*, **253***b* in their original positions with switch **253***a* open, thus to LOCK OUT FILL CYCLE.

The material now flows out through the open discharge valve **29** and through the discharge conduit **30** to the predetermined point of delivery, as up into the catalyst regenerator **236**. As the materials are in good part removed from the vessel **10**, the pressure therein starts to drop, and falls to the preset pressure at which the purge pressure switch PPS or **272** is set to close to full line position shown in FIG. **4**. As this occurs, the unlatch coil **258***b* of the fill latch relay **258***a*, **258***b*, is energized to put the fill latch relay contacts **243**, **244** back into their original position, with contacts of switch **243** closed, contacts of switch **244** open to LOCK OUT ACTIVATE CYCLE.

Since the vent pressure signal **247** is still open, the amber light A or PURGE LIGHT **273** comes on when the contacts of switch **243** are latched closed, and since the purge valve **35** is a normally open valve, the falling pressure sweeps clean the purge line **34** and discharge line **30** until such time as the back pressure in the discharge line **30**, acting through the purge line **34**, builds up back pressure to seat the check valve **235**. When the pressure in the vessel **10** now falls to say 20 p.s.i. the vent pressure switch **247** closes, to full line position shown in FIG. **4**, thus activating the solenoid **256** to change fluid direction in the panel **40** to OPEN VENT VALVE **230**, FIGS. **1** and **2**, the light W or VENT LIGHT in parallel circuit also turning on. Then the residual material may be vented through the vent pipe **231** and through its upper end **232** to the atmosphere, or into the hopper **200** by way of the alternate vent path **233**.

When the pressure drops to say 0.5 p.s.i. the fill valve pressure switch **248** may close, thus activating the solenoid **255** to open the fill valve(s) **18**, **18***a* once more, again to start the fill cycle, the green light **254** going on.

The timer **275** has TIMER CIRCUIT which is preset, when started, to run for any predetermined time inter-

val it may be desired to deliver batches of material of predetermined weight, to any preselected container, as to the catalyst regenerator tower **236**. When the control switch **237** is first closed, with the double pole, double throw switch **250** in the position shown in FIG. **4**, the time delay relay TDR, or **276**, closes the timer switch **277** which actuates the motor clutch **278** into driving engagement, so that the Motor M, or **280**, runs for the period of its preset cycle, while circuit is complete through the latch relay LR or **251** so that it can operate once during each single batch handling period to close the normally open switch contact **253***a*, as aforesaid.

Then when the motor times out, the switch **279** is thrown open, to break circuit through the motor **280**, the switch **250** then being moved to up position by the timing out of the motor **280**, thus circuit cannot be made through the fill cycle lock in relay LR or **251** to actuate it. Thus when the motor **280** times out, the fill valve solenoid **255** cannot be energized to open the fill valve until the motor running cycle has been reset, and until the double pole double throw switch **250** is manually returned to the position shown in FIG. **4**. At this time the motor **280** is again reset to run for some selected cycle exit ending over a number of batch transferring operations by the pressure vessel **10**.

A "fail safe" or warning safe guard is provided against the pump or pressure vessel **10** being over filled by an entering batch. This resides in a PUMP FILL LIGHT, as a white light W or **281**, and a motor M or **282** or LEVEL DETECTOR, these being connected in parallel circuits which extend between the negative power line **242** and the positive side conductor **241***c*. A normally open switch **283***a* is shown in circuit with the white light W or **281** and a normally closed switch **283***b* is shown in circuit with the motor M or **282**. The motor **282** may have conventional paddle means thereon to be contacted by the material of a batch rising to the safeguarding level of the motor **282**, whereby the paddle is stopped. Then, conventionally, there may be overtravel of parts related with the motor shaft, as the paddle mounting part stops, so that by this overtravel or lost motion movement, the normally closed switch **283***b* is opened to stop the motor **282**, while the normally open switch **283***a* is closed, to turn on the white light **281** or W to indicate that the material set for a batch rises too high in the pressure vessel or pump.

The motor **282**, FIG. **4**, may be considered as disposed in the value support body **37**, FIG. **1**, with the conductor **241***c*, FIG. **4**, being contained in the insulative conductor cord **39** which encloses the particular circuitry for the motor vibrated paddle **38**, and carries such circuitry, for operation, to the panel box **40**, FIG. **1**.

A vibratory paddle type safeguarding or "fail safe" device is shown in FIG. **3** of Reuter U.S. Pat. No. 3,355,221, issued Nov. 28, 1967, and other disclosures thereof have been repeated in subsequent applications in the chain. In particular, at least two separate types of level detector type safeguarding, or "fail safe" devices are disclosed in the immediately preceding application Ser. No. 98,567, filed Dec. 16, 1970. In the use of any form of devices of this class the circuitry diagram will be as shown in FIG. **4**.

In the form of invention shown in FIG. **5**, the purge valve **35** is shown in the source gas or plant compressed air line **21***a*, and the purge line **34**, shown in FIGS. **1** and **2**, is this form of the invention. However, this change involves no change in the circuit diagram of FIG. **4** except that the solenoid **264** in the panel board or panel box **40**, FIG. **1**, may be disconnected, or redesignated **246***a*, as for the broken line printed CLOSE B.P. AIR VALVE. In this form of invention it is found to be more expedient to have available the full opposing force of the plant air or source compressed gas, to protect the check valve **235**, and to oppose the back pressure from acting down the discharge conduit system **30**, **31**, **32**, and back purging material that otherwise should be forced onwardly down, or rather up the discharge system.

As shown in FIG. **6**, the purge line **34**, purge valve **35**, and the check valve **235**, and also the source gas line **21**, source gas control valve **245**, and check valve **242**, both check valves of which connect into the discharge line section **32** downstream of the discharge valve **29**, are shown in broken lines, indicative that either, or both of the back pressure opposing structures may be employed with this form of load cell supported, fluid flow pump structure **10**. In this form of the invention, the pump **10** is supported below, or suspended beneath a load cell **14**, a novel type of hopper **201** being provided to make this possible, with the hopper being designed for disposition, centrally, axially above the load cell **14** and pump **10** therebelow. This comprises a decided improvement over the type of pump-hopper arrangement whereby the hopper must be disposed to the side of the pressure vessel or pump **10** to discharge thereinto at a spaced distance from the otherwise occupied pump top central area.

This arrangement is arrived at by providing uprights or posts **388** with successively reduced upper portions **388***a*, **388***b*, the posts **388** being spaced symmetrically outwardly of the periphery of the pump **10**. Next, a lower platform **389** is provided with openings therethrough snugly to fit guidably over the post sections **388***a* to shoulder on top of the posts **388**. Then the load cell **14** may be disposed exactly axially and centrally above the pressure vessel or pump **10**. Then a central platform **390** having openings therethrough snugly to fit over the turned down upper ends of pressure vessel suspension rods **391**, may be positioned to shoulder upon the rods **391**, the pressure vessel **10** being jacked up from beneath to the proper elevation for this disposition, nuts **391***a* then being threaded upon the reduced diameter, threaded upper ends of the rods **391** to take the pump weight off of the jacks, thus to place the pump **10** in concentrically disposed suspension below the load cell **14**.

Then the lower fill valve **18**, flexible nipple **19**, upper fill valve **18***a* may be installed above the pump **10**, and a lower hopper section **201***a*, of inverted, frusto-conical shape may be installed upon top of the upper fill valve **18***a*. Then downspouts **201***d* from the hopper central section **201***b*, may be passed downwardly through concentrically disposed openings through the center platform **390**, and through openings therebelow through the lower platform **389**, for connection to a closure plate upon the top of the lower hopper section **201***a*, whereby the hopper is disposed axially, centrally above

the pressure vessel or pump **10**. However, to prevent the weight of the hopper **201***a* to be disposed upon the lower hopper section **201***a*, an upper platform **392** is first disposed with corner openings therethrough to fit snugly over the upper post sections **388***b* to shoulder upon the tops of the post sections **388***a*.

A tapered, central opening is provided through the upper platform **392** to receive the inverted frusto-conical portion of the hopper central section **201***b* to bear for support upon the platform **392** which is firmly and rigidly post supported above floor or ground line. This platform **392** is concentrically fixed with relation to vertical axis of hopper, load cell, and pump, by nuts **388***c* threaded upon the upper ends of the post sections **388***b* to bear upon the upper surfaces of the upper platform **392**. Noticeably, a cone **201***c* is included centrally to upstand from the bottom of the hopper section **201***b* equally to disperse the descent of material into the four downspouts **201***d*, two of the downspouts diametrically disposed with relation to the two that are shown, being omitted from the elevational view of FIG. **6** for purposes of clarity.

With the arrangement hereinabove described for FIG. **6**, the piping, electrical, timer, and pressure switch circuitry are the same as set forth with relation to FIGS. **1**, **2** and **4**, a signal proportionate to batch weight or net weight being transmitted from the load cell **14** to panel box, not shown, to actuate fill valve closing. Also as the pressure in the pressure vessel falls to a predetermined value, there is pressure switch actuation within the panel box, not shown, for valve operator actuation to open the vent valve **230**, benting occurring through the discharge nipple **233** to atmosphere, or through discharge nipple **232** and flexible connection **232***a* into the upper section **201**a of the hopper **201**, or in part through both of these vent paths.

Referring now to FIGS. **7** and **8**, a conventional fluid flow pump pressure vessel **10** is shown with exception that the discharge **17** from the hopper is into the vessel top segment **12***a* to one side of the central area thereof to permit an agitator drive motor support flange **324***e* to be installed through a central opening through the dome **12***a*. A top plate **326** is installed upon the flange **324***e* and a base **322** extends therefrom to support the agitator drive motor **321** which drives a gear, reducer **324** which is connected to drive a vertical shaft **324***a* that extends centrally downwardly in the pressure vessel or pump **310**.

The vertical shaft **324***a* is indicated as being centered at its lower end by connection thereto of three equally, angularly spaced apart agitator blades or pipes **324***b* which extend upwardly and outwardly at the slope of the diaphragm **13**. Below the junction of these three pipes **324***b* a discharge pipe or nipple **28** extends downwardly through the diaphragm **13** and through the inverted spherical segment **12***b* comprising the bottom of the gas plenum **16**, and also the bottom of the pressure vessel **11**. The flange of the discharge nipple **28** is connected to an upper platform **393** supported by posts **394** which are connected to a lower platform **395**. This lower platform **395** carries on its under surface the hereinabove described upwardly dished, inverted cup, FIG. **3**, that receives the upper portion of the ball member that, in turn, bears upon the central, downwardly dished cup member of the anvil of a load cell **14** that supports the pressure vessel or pump **10** thereabove.

This hereinabove described arrangement permits a central bore through the upper platform **393**, of diameter to permit a flexible nipple **32** to extend upwardly therethrough for connection with the material discharge nipple **28**, thus to transfer material downwardly into the receiving end or elbow of a horizontally extending discharge conduit member **32***c* which carries centrally therein the discharge valve **29**. This conduit member **32***c* is shown in FIG. **7** as rigidly supported upon post **14***a*.

In this form of the invention the purge line **34** extends downwardly from conventionally disposed purge valve **35**, operated by purge valve operator **36**, and has a flexible section or nipple **34***a* at the lower end thereof which connects with the pipe section **34***b* carrying the conventional purge line check valve **235** which in turn is connected into the discharge pipe section **32***b* of the discharge line **30**. Noticeably a flexible nipple **31** is shown installed in the discharge line **30** because it is indicated that there is some substantial length of discharge line to the point of discharge, such as a tower, corresponding with the tower **236** shown in FIG. **2**. Thus such flexible nipple **31** can accommodate expansion or contraction of such length of line, respectively, in hot or cold weather.

Correspondingly, as shown in FIGS. **1**, **2**, **5** and **6**, a compressed air or source gas line **21***a*, extending horizontally for support above ground or floor level, as by post **14***b*, FIG. **7**, has back pressure control valve **245** therein, operated by valve operator **246**, as shown in FIG. **1**, with a check valve **242** downstream of the control valve **245**, and connected into the aforesaid pipe section **32***b* of discharge line **30** downstream of discharge valve **29**. Also, in FIG. **7**, a vent line **31***a* is shown rising from the top or dome **12***a* of the pump **10**, with a vent valve **230** installed in the top thereof and operated by a valve operator **234**, correspondingly as shown in FIG. **1**. Also, in this view of FIG. **7**, a "fail safe" or safeguarding structure is shown in level detector paddle or sensor **38**, motor housing **37**, (for motor **282** shown in FIG. **4**) and conductor cored or sheath **39** which includes therein the conductor **241***c*, FIG. **4**.

The electrical diagram for the form of invention shown in FIG. **4**, with the exception of that for the agitator drive motor **321**, is the same as for the apparatus disclosed in FIGS. **1**, **2**, **3**, **5** and **6** hereinabove. A conductor **395** connects the motor **321** between the positive side **241** and the negative side **242** of the source of electrical power and has a switch **396** therein whereby the agitator motor may be turned on, selectively, to run as desired.

Alternately, a parallel line **397** may be employed, with the switch **396** open, and the switch **398** in the line **397** closed, and the movement of the latching relay LR or **251**, that closes the latching relay switch **253***a*, may close the switch **398**, to start the motor **321** at the same time the fill valve opens. Then as the purge valve **235**, FIG. **1**, is opened, by reverse actuation of the latching relay switch **253***a*, the switch **398** is opened and the motor **321** is stopped.

The various features, as valve operators, safe guarding or "fail safe" features, may be used selectively as desired. Also in the form of invention shown in FIGS. **7**

and 8, the hopper, not shown, may be a hopper or the type shown in FIG. 6, with downspouts disposed to discharge directly through the dome 12*a*, into the pressure vessel, and in this case the pressure vessel, agitator driven, may be suspended below a load cell that is platform supported above the pressure vessel or pump 10.

The invention is thus shown as adapted to be practiced through a variety and range of structural variations and circuitry changes as involve manner of valve opening and closing, and treatment and handling of material. The invention is thus set forth in exemplary detail and spirit, with the appended claims being in outline.

I claim:

1. Material transporting apparatus comprising a pressure vessel including a gas permeable diaphragm bridging the lower part of said vessel above the bottom thereof and dividing it into a material plenum thereabove, and a gas plenum therebelow, a fill valve to admit flowable material through the top of said vessel into said material plenum to upstand from said diaphragm, a compressed gas inlet including a gas valve into said gas plenum, a discharge connection from the upper part of said material plenum including a discharge valve disposed in said discharge connection, a purge by-pass connecting said material plenum and said discharge connection downstream from said discharge valve, a purge valve disposed in said purge by-pass, also a check valve therein downstream of said purge valve and adapted to be urged closed in direction of said purge valve by back pressure acting thereagainst from downstream thereof, a vent discharge from said vessel including a vent valve, pressure sensitive control means including weight responsive means, operative circuitry including said pressure sensitive control means and being automatically operable to open said fill valve, said circuitry then being actuated by said weight responsive means to close said fill valve, said circuitry then closing said purge valve while opening said gas inlet valve to admit pressurized gas substantially uniformly through said diaphragm and to activate said material to a high state as the pressure rises in excess of a predetermined high pressure to actuate said pressure sensitive control means to open said discharge valve for said material to pass upwardly and onward through said discharge connection, the pressure falling below a predetermined lower pressure to actuate said pressure sensitive control means to close said discharge valve and said gas inlet valve and to open said purge valve, the compressed gas at falling pressure purging through said purge by-pass including said purge valve and said check valve, and onwardly through said discharge connection, the pressure continuing falling to a still lower predetermined level to act through said circuitry to close said purge and to open said vent valve, said check valve guarding against back pressure urging gas bearing purge material back up said purge connection, the residual compressed gas purging upwardly through said vent discharge, and the pressure falling to approximately atmospheric whereby to open said fill valve, as aforesaid.

2. The method of transporting pulverulent material comprising the steps of, disposing by weight one predetermined batch of the material at a time into a container for support upon a gas permeable diaphragm, closing the material inlet upon a pressure signal responsive to the batch weight attained therein, and, with the container closed, admitting a pressurized gas thereinto below the diaphragm to pass upwardly therethrough to activate the material therein, opening a discharge conduit from the container while closing gas admission, a closeable by-pass conduit being provided from container to the container discharge conduit and being closed prior to gas admission; as the pressure in the container drops to predetermined value, closing the discharge conduit and opening the by-pass conduit to by-pass the material to be purged through the by-pass and back into the discharge conduit downstream from the container, and as the pressure in the container falls to a still lower predetermined value, employing a check valve in the by-pass conduit between by-pass conduit closure and discharge conduit to protect against back pressure from the discharge conduit downstream thereof, closing the by-pass and opening a vent from the container through which the residual pressurized gas and any residual material may be vented as the container pressure returns to substantially atmospheric, then repeating the aforesaid cycle of steps.

3. Material transporting apparatus comprising a pressure vessel including a gas permeable diaphragm bridging the lower part of said vessel above the bottom thereof and dividing it into a material plenum thereabove, and a gas plenum therebelow, a fill valve to admit flowable material through the top of said vessel into said material plenum to upstand from said diaphragm, a compressed gas inlet including a gas valve into said gas plenum, a discharge connection from the upper part of said material plenum including a discharge valve disposed in said discharge connection, a purge by-pass connecting said material plenum and said discharge connection downstream from said discharge valve, a purge valve disposed in said purge by-pass also a first check valve therein downstream of said purge valve and adapted to be urged closed in direction of said purge valve by back pressure acting thereagainst from downstream thereof, a back pressure opposing connection from compressed gas inlet source and connecting with said discharge connection downstream from said discharge valve, a back pressure gas control valve disposed in said back pressure opposing connection, also a second check valve therein downstream from said back pressure gas control valve and adapted to be urged closed in direction of said back pressure gas control valve, a vent discharged from said vessel including a vent valve, pressure sensitive control means including weight responsive means, operative circuitry including said pressure sensitive control means and being automatically operable to open said fill valve, said circuitry then being actuated by said weight responsive means to close said fill valve, said circuitry then closing said purge valve and said back pressure gas control valve while opening said gas inlet valve to admit pressurized gas substantially uniformly through said diaphragm and to activate said material to a high state as the pressure rises in excess of a predetermined high pressure to actuate said pressure sensitive control means to open said discharge valve for said material to pass upwardly and onward through said discharge connection, the pressure falling below a predetermined lower pressure to actuate said pressure

sensitive control means to close said discharge valve and said gas inlet valve and to open said purge valve and said back pressure gas control valve, the container compressed gas at falling pressure purging through said purge by-pass including said purge valve and said first check valve and onwardly into said discharge connection, and the back pressure control gas passing from source through said back pressure opposing connection including said back pressure gas control valve and said second check valve and onwardly into said discharge connection, the pressure continuing falling to a still lower predetermined level to act through said circuitry to close said purge valve and said back pressure gas control valve and to open said vent valve, said check valves guarding against back pressure urging back pressure gas and purge material down said purge connection and said back pressure opposing connection, the residual compressed gas purging upwardly through said vent discharge, and the pressure falling to approximately atmospheric whereby to open said fill valve, as aforesaid.

4. The method of transporting pulverulent material comprising the steps of, disposing by weight one predetermined batch of the material at a time into a container for support upon a gas permeable diaphragm, closing the material inlet upon a pressure signal responsive to the batch weight attained therein, and, with the container closed, admitting a pressurized gas thereinto below the diaphragm to pass upwardly therethrough to activate the material therein, opening a discharge conduit from the container while closing gas admission, a closeable first by-pass conduit being provided from container to the container discharge conduit and being closed prior to gas admission, pressurized gas being connected for selective admission to pass through a second by-pass conduit to discharge conduit; as the pressure in the container drops to predetermined value, closing the discharge conduit and opening the by-pass conduits respectively, to by-pass the material to be purged through the first by-pass conduit and into the discharge conduit downstream from discharge conduit closure, as abetted by the aforesaid pressurized gas also selectively admitted into the second by-pass conduit at this point, and into the discharge conduit downstream from discharge conduit closure; and, as the pressure in the container falls to a still lower predetermined value, employing check valves in the by-pass conduits between by-pass conduit closures and discharge conduit to protect against back pressure from the discharge conduit downstream thereof, closing the by-pass conduits, and opening a vent from the container through which the residual pressurized gas and any residual material may be vented as the container pressure returns to substantially atmospheric, then repeating the aforesaid cycle of steps.

5. Material transporting apparatus comprising a pressure vessel including a gas permeable diaphragm bridging the lower part of said vessel above the bottom thereof and dividing it into a material plenum thereabove, and a gas plenum therebelow, a fill valve to admit flowable material through the top of said vessel into said material plenum to upstand from said diaphragm, a compressed gas inlet including a gas valve into said gas plenum, a discharge connection from the upper part of said material plenum including a discharge valve disposed in said discharge connection, a compressed gas by-pass connecting compressed gas and said discharge connection downstream from said discharge valve, a valve operator actuated, compressed gas by-pass valve disposed in said compressed gas by-pass, also a check valve therein downstream of said compressed gas by-pass valve and adapted to be urged closed in direction of said compressed gas by-pass valve by back pressure acting thereagainst from downstream thereof, a vent discharge from said vessel including a vent valve, pressure sensitive control means including weight responsive means, operative circuitry including said pressure sensitive control means and being automatically operable to open said fill valve, said circuitry then being actuated by said weight responsive means to close said fill valve, said circuitry then closing said compressed gas by-pass valve by valve operator actuation while opening said gas inlet valve to admit pressurized gas substantially uniformly through said diaphragm and to activate said material to a high state as the pressure rises in excess of a predetermined high pressure to actuate said pressure sensitive control means to open said discharge valve for said material to pass upwardly and onward through said discharge connection, the pressure falling below a predetermined lower pressure to actuate said pressure sensitive control means to close said discharge valve and said gas inlet valve and to open said compressed gas by-pass valve by valve operator actuation, whereby compressed gas may pass through said compressed gas by-pass including said compressed gas by-pass valve and said check valve, and onwardly through said discharge connection in opposition to back pressure, the pressure continuing falling to a still lower predetermined level to act through said circuitry to close said purge and to open said vent valve, said check valve guarding against back pressure urging gas bearing purge material back up said purge connection, the residual compressed gas purging upwardly through said vent discharge, and the pressure falling to approximately atmospheric whereby to open said fill valve, as aforesaid.

6. The method of transporting pulverulent material comprising the steps of, disposing by weight one predetermined batch of the material at a time into a container for support upon a gas permeable diaphragm, closing the material inlet upon a pressure signal responsive to the batch weight attained therein, and, with the container closed, admitting a pressurized gas thereinto below the diaphragm to pass upwardly therethrough to activate the material therein, opening a discharge conduit from the container while closing gas admission, a valve operator valve closed by-pass conduit being provided from compressed gas source and including a check valve therein at connection to container discharge conduit, said by-pass conduit being closed prior to gas admission; as the pressure in the container drops to predetermined value, closing the discharge conduit and opening the by-pass conduit by valve operator valve opening to by-pass compressed gas therethrough, including through the check valve and back into the discharge conduit downstream from the container in opposition to back pressure, and as the pressure in the container falls to a still lower predetermined value, closing the by-pass by valve operator valve closing and opening a vent from the container

through which the residual pressurized gas and any residual material may be vented as the container pressure returns to substantially atmospheric, then repeating the aforesaid cycle of steps.

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