

[54] **SELF-PURGING, PNEUMATIC CONVEYING APPARATUS INCLUDING FLUID FLOW PUMPS ON SCALES, WITH AGITATOR, VACUUM FILLED, WITH MATERIAL DRYER, AND OF VARIED MEANS OF SEQUENTIAL VALUE OPERATION**

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[*] Notice: The portion of the term of this patent subsequent to Nov. 28, 1984, has been disclaimed.

[22] Filed: **Dec. 16, 1970**

[21] Appl. No.: **98,567**

Related U.S. Application Data

[63] Continuation-in-part of Ser. Nos. 518,533, Jan. 3, 1966, Pat. No. 3,355,221, and Ser. No. 686,018, Nov. 28, 1967, abandoned, and Ser. No. 822,126, May 6, 1969.

[52] U.S. Cl. 302/3, 302/53, 222/195

[51] Int. Cl. B65g 53/00

[58] Field of Search 302/3, 52, 53, 56;
222/195, 56, 58; 141/59

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[57] **ABSTRACT**

The disclosure, for classification, is to a pressure vessel with fill valve admitting thereto material to drop onto a perforate diaphragm, thereafter to be transferred, the gas plenum below the diaphragm having activating gas, as compressed air, controlled to communicate therewith. When a batch of material has been drawn in, the fill valve is automatically closed, the activating gas inlet valve is opened to admit activating gas, as compressed air, to pass upwardly through diaphragm and activate the material to a highly flowable state. A discharge valve is then opened to let the pressurized material flow out through a discharge line to point of transfer. As the pressure in material plenum drops, the discharge valve is closed, the activating gas valve is closed, and a purge valve in a by-pass line, around the discharge valve, is opened, and residual pressure purges the residual material as this pressure falls substantially to atmospheric, for a succeeding cycle to begin. The disclosure is to pressure vessels where the material drops onto the diaphragm via gravity when the fill valve opens, such vessels also being shown equipped to close fill valve responsive to at least one of time actuated means, material lever sensor actuated means, and batch weight actuated, vessel supporting scale generated, pressure fluid signal operated circuitry; also variations of circuitry are shown whereby various steps may be controlled by at least one of pressure, time, level probe position, weight and limit switch position.

32 Claims, 30 Drawing Figures

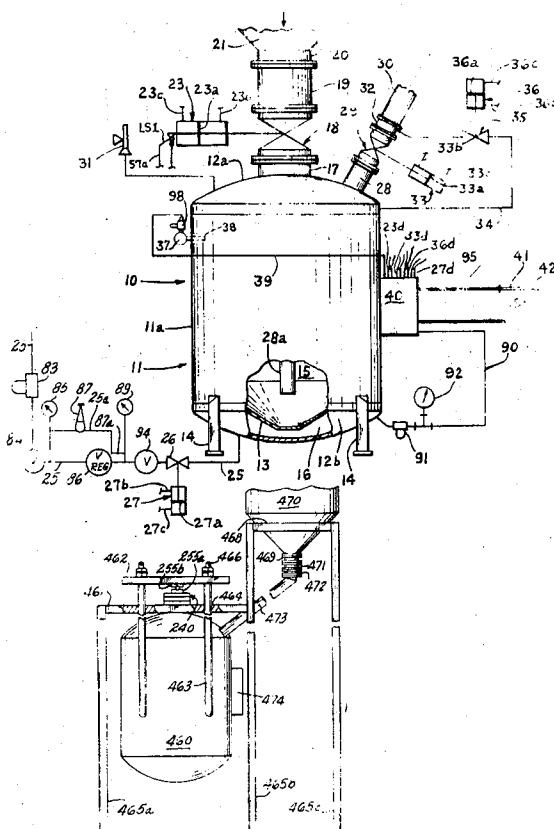
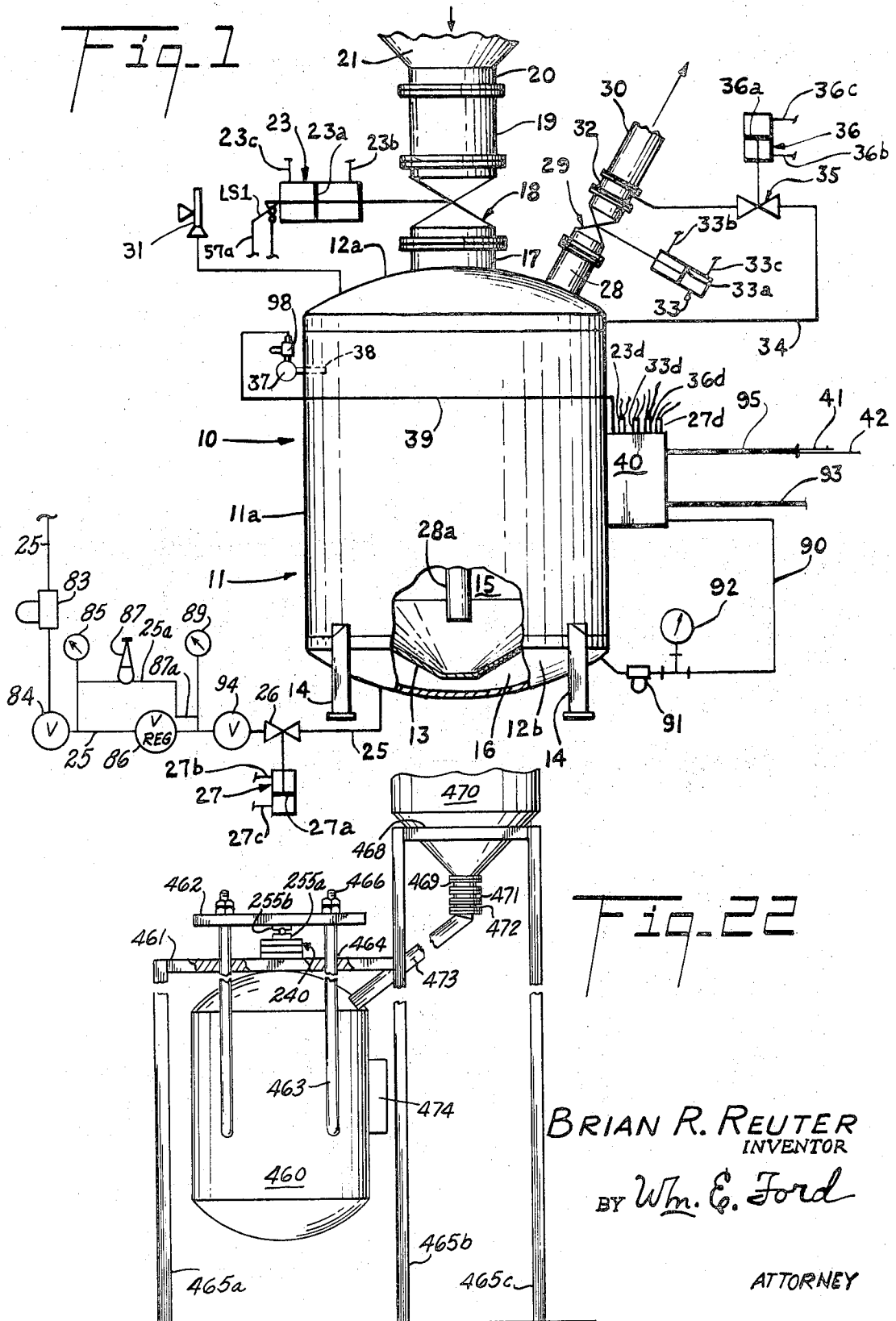


Fig. 1

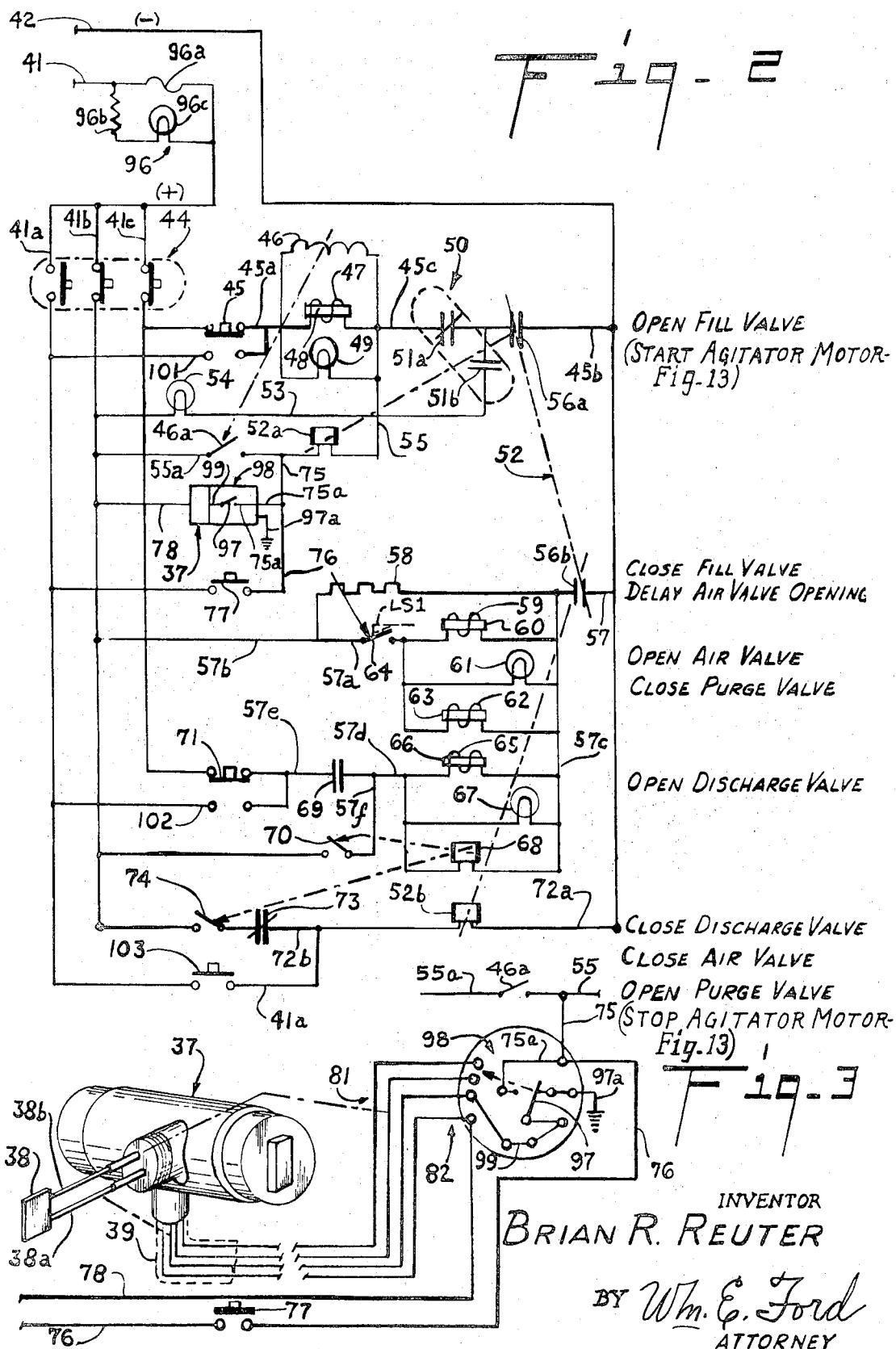


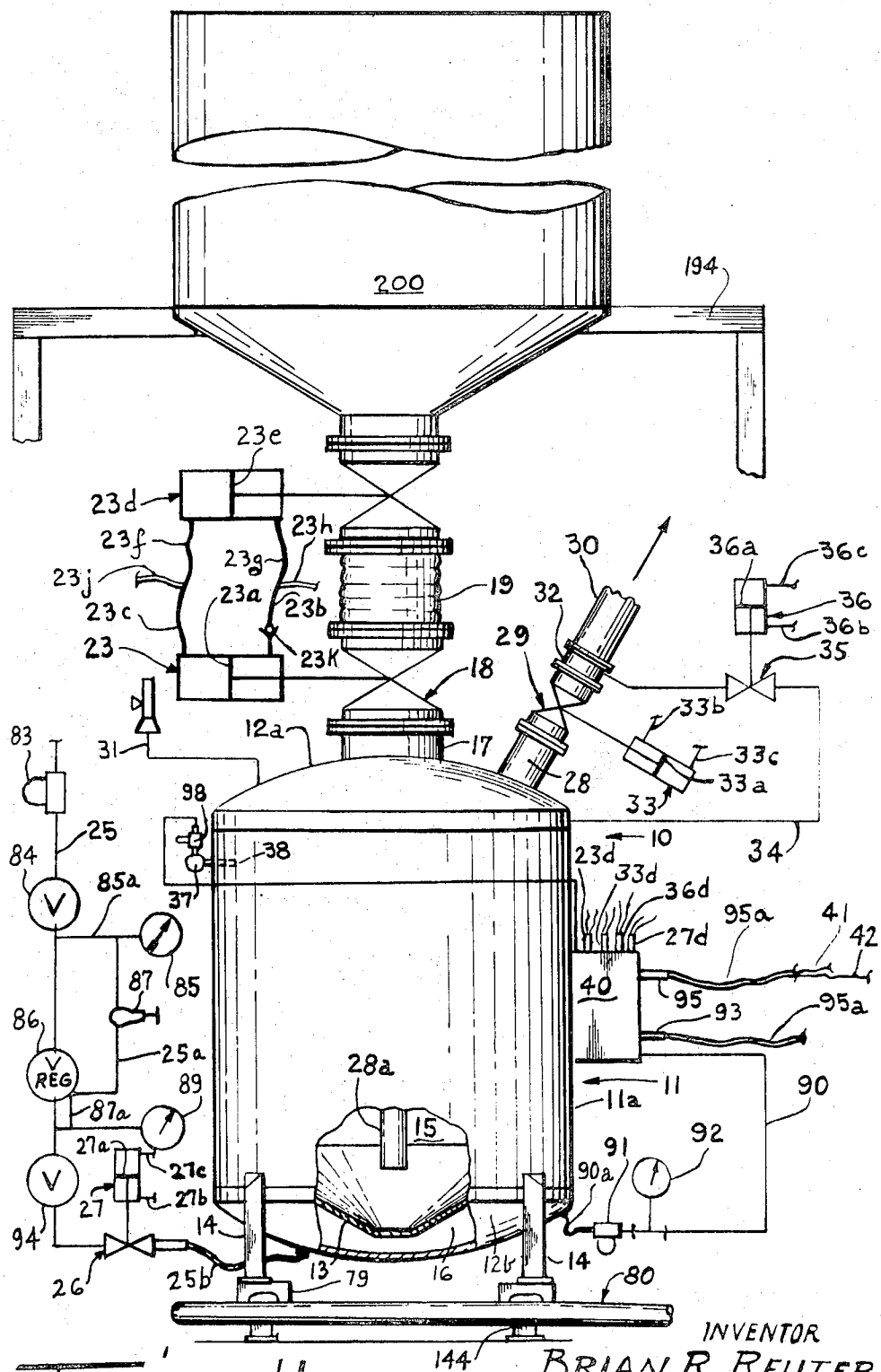
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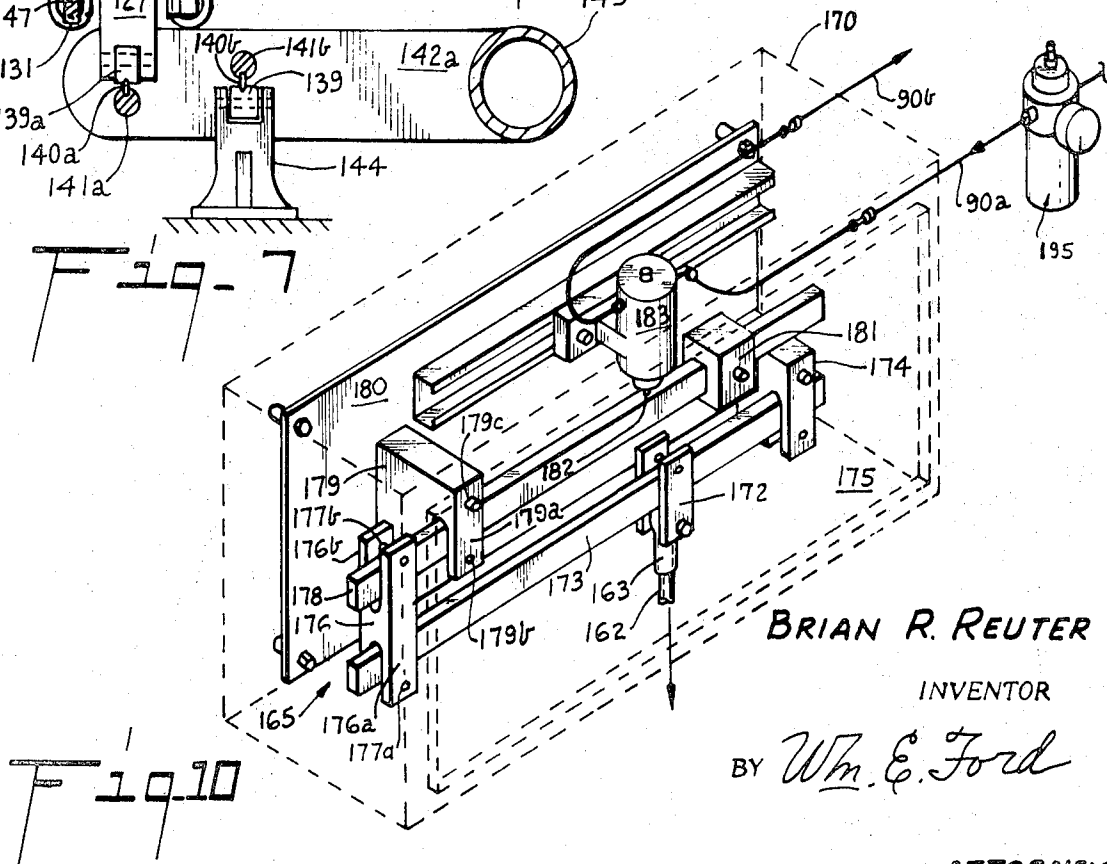
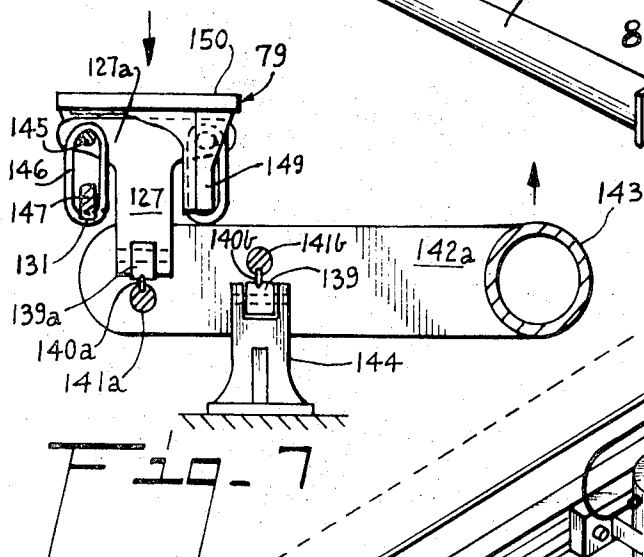
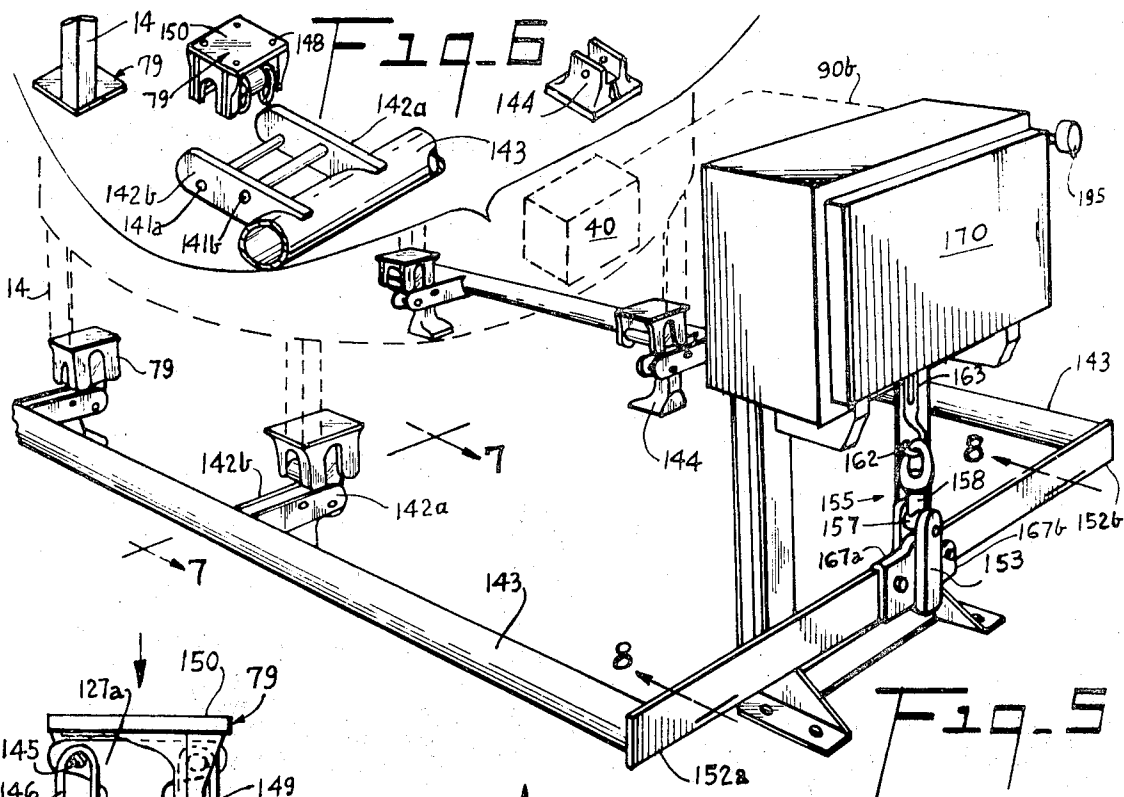




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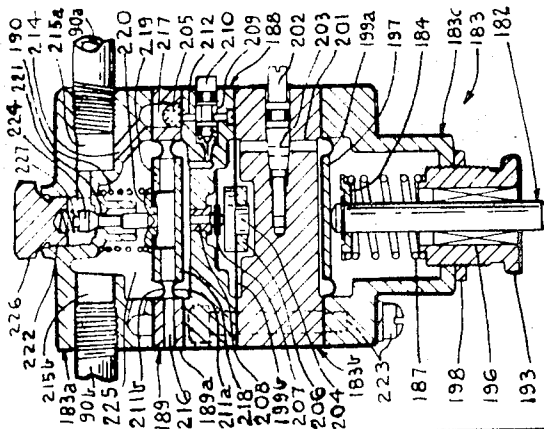


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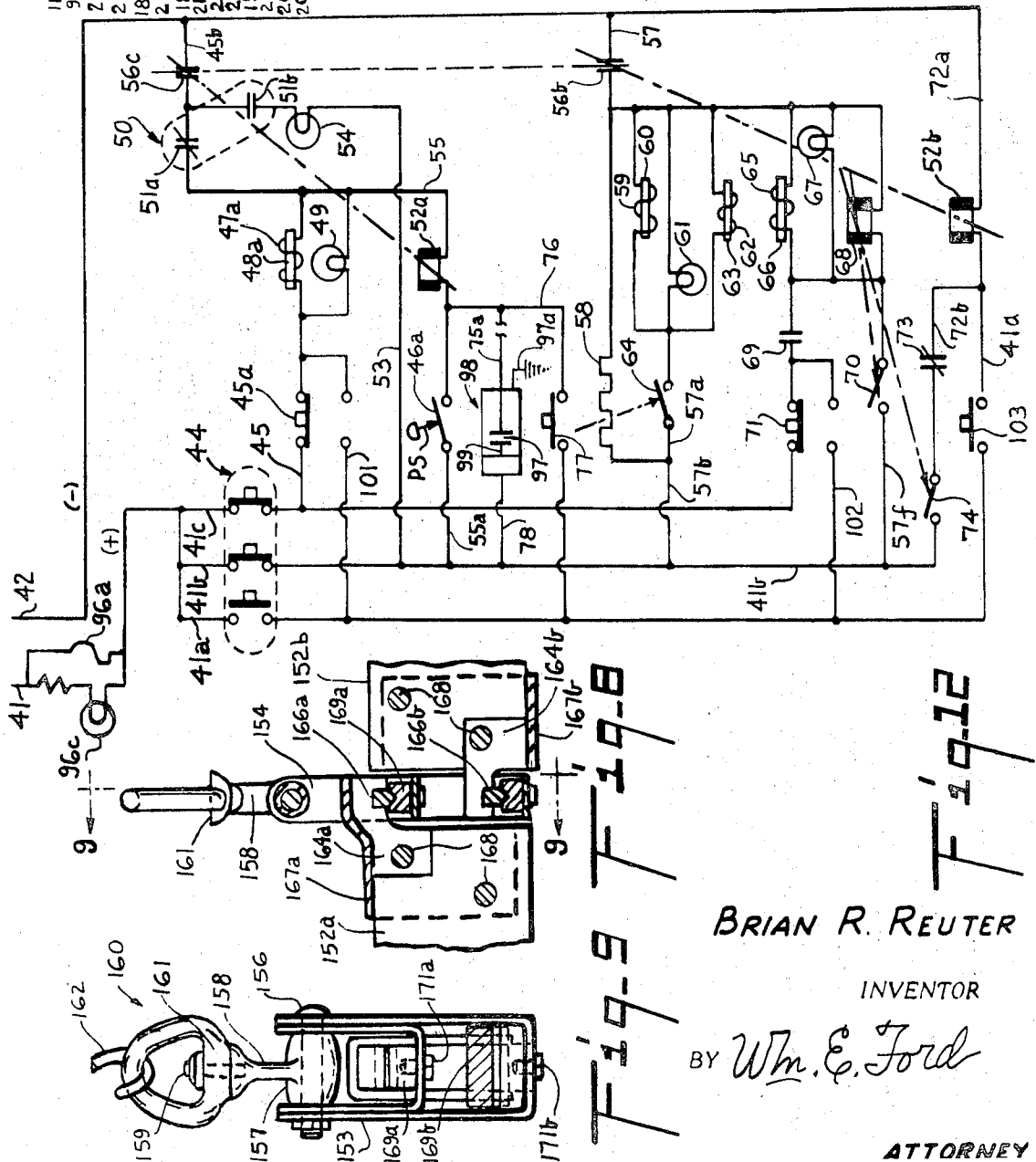


CLOSE FILL VALVE
DELAY AIR VALVE OPENING

OPEN AIR VALVE
CLOSE PURGE VALVE

OPEN DISCHARGE VALVE

CLOSE DISCHARGE VALVE
CLOSE AIR VALVE
OPEN PURGE VALVE



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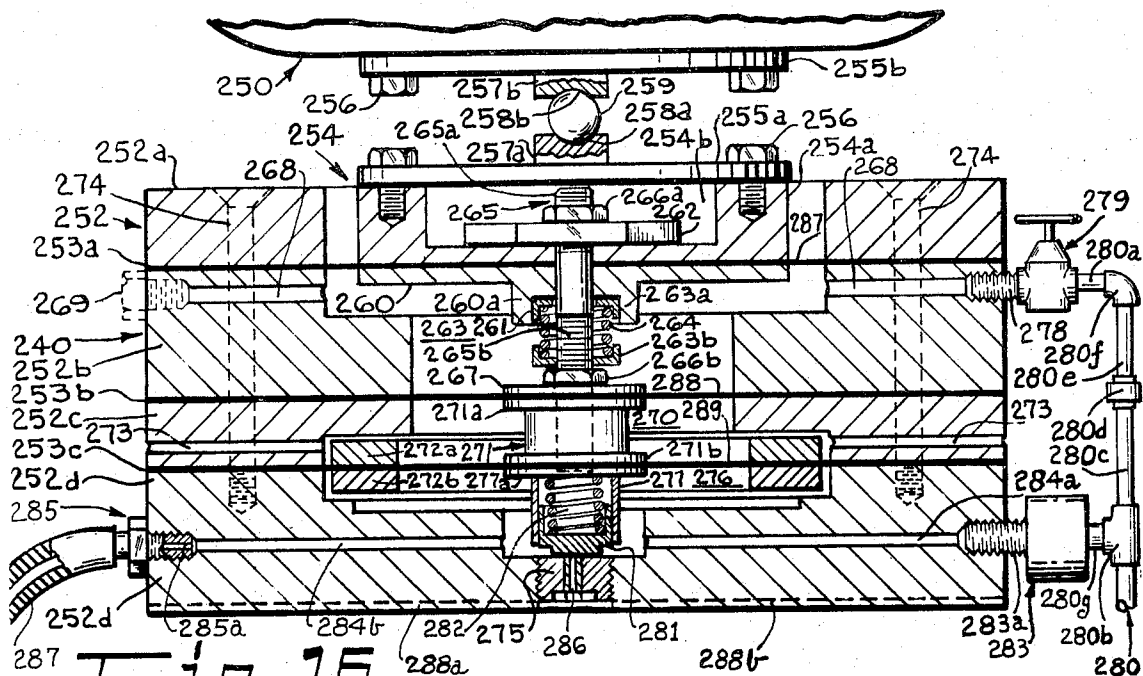


Fig. 16

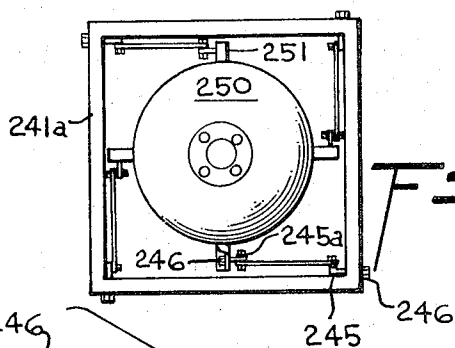


Fig. 14

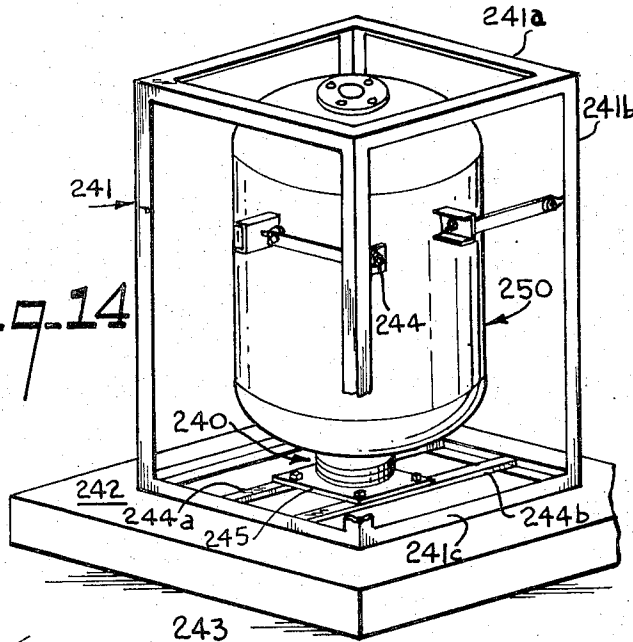


Fig. 13

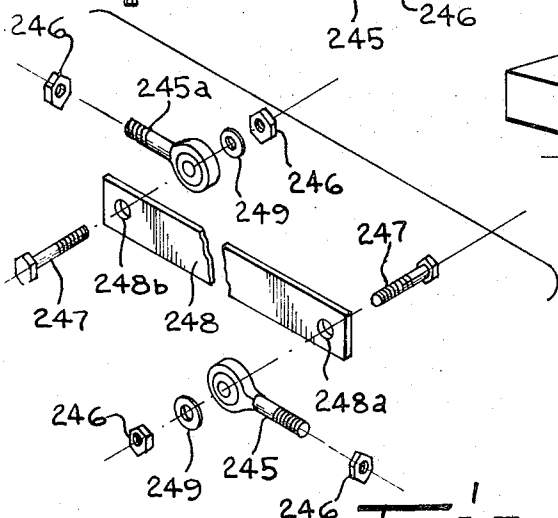
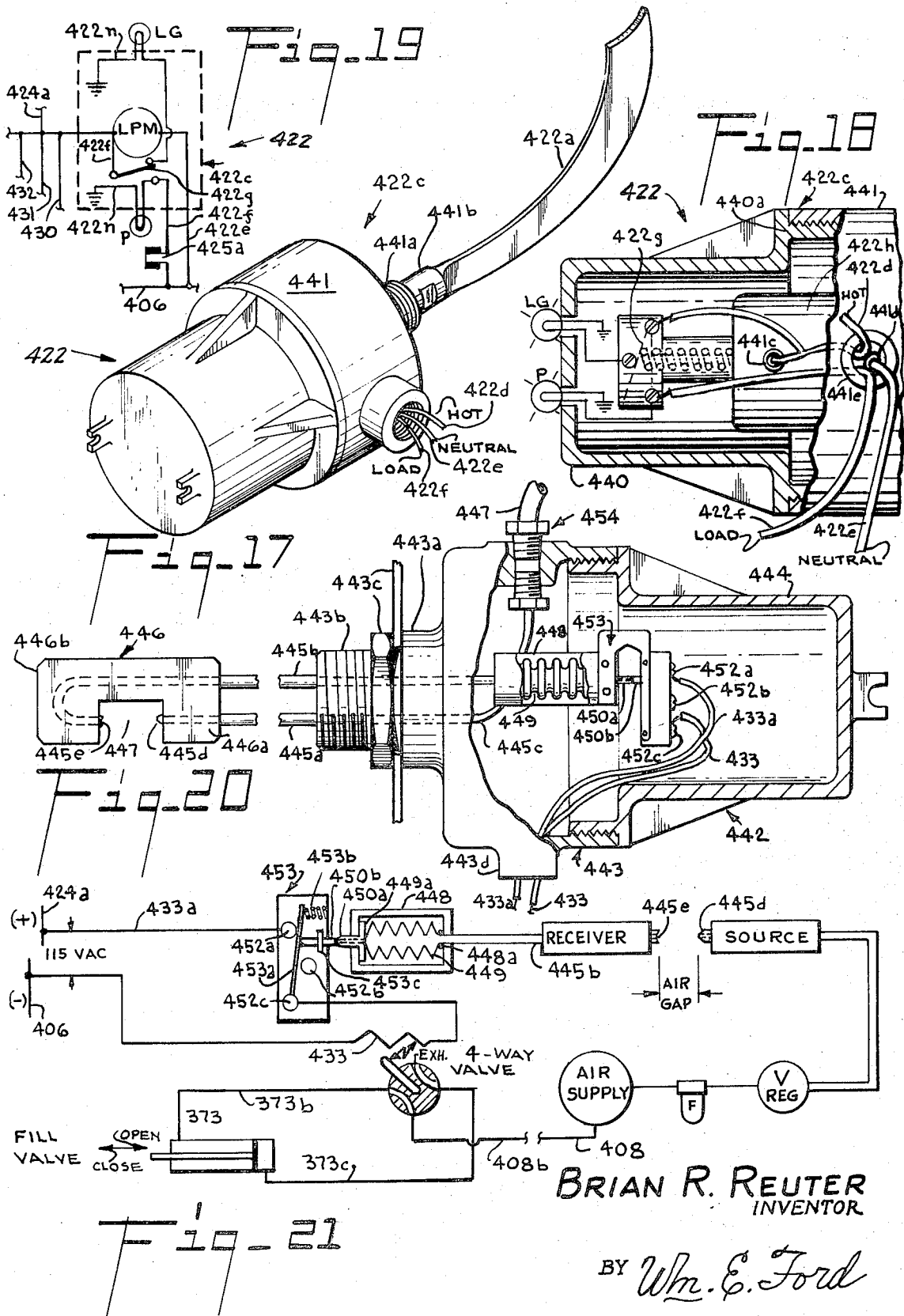


Fig. 15

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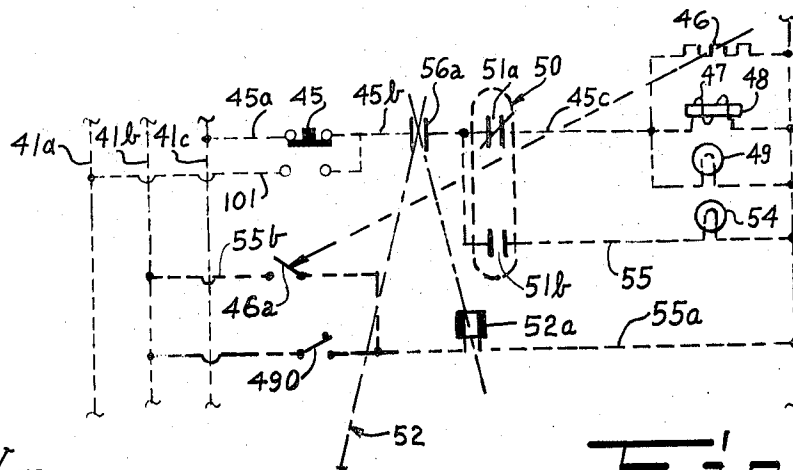


Fig. 23

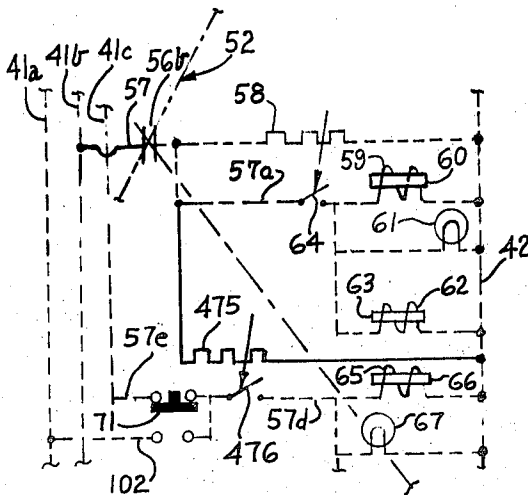


Fig. 24

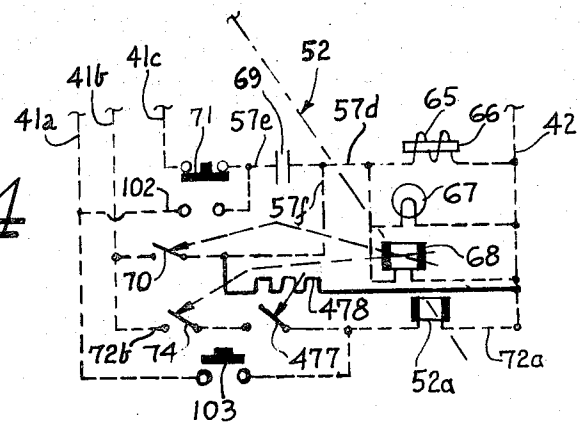
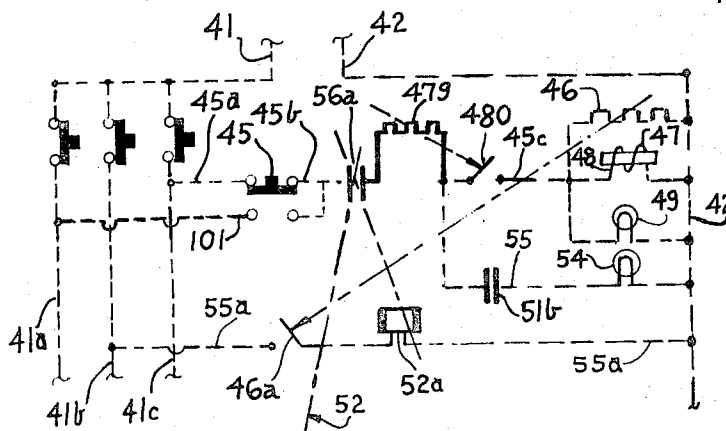


Fig. 25



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Fig. 26

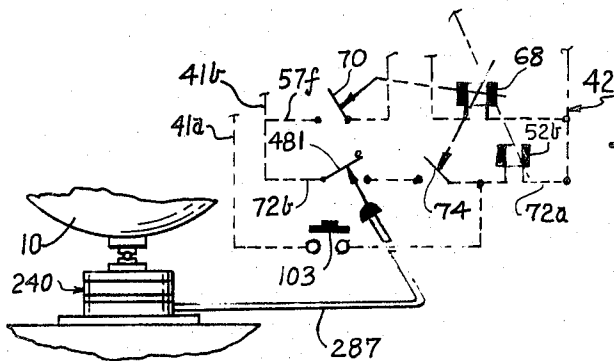
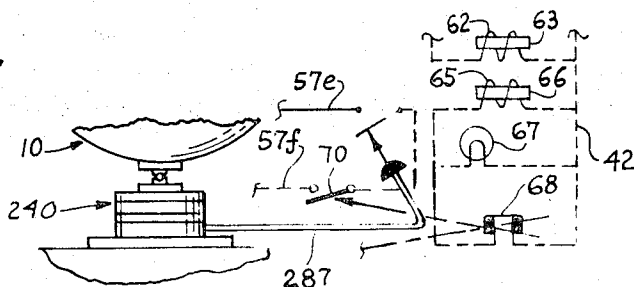


Fig. 27

Fig. 28

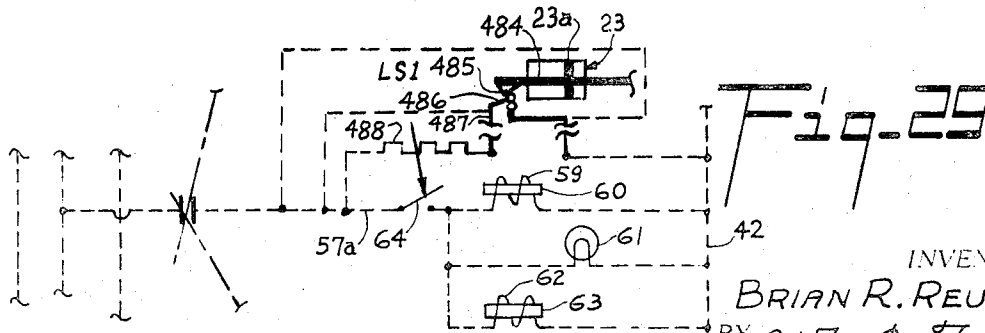
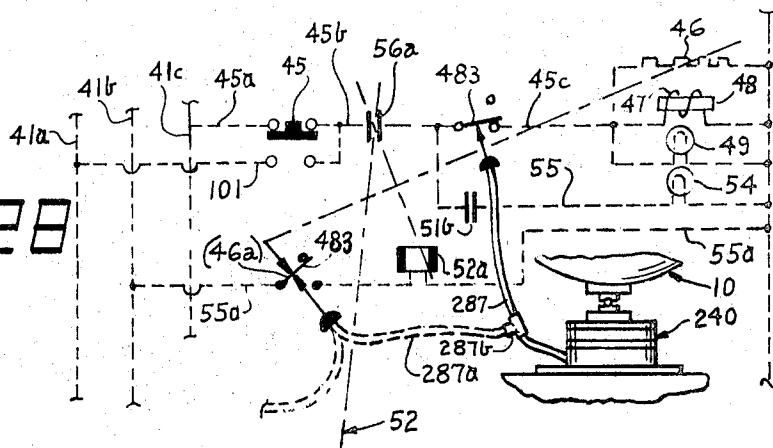


Fig. 29

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**SELF-PURGING, PNEUMATIC CONVEYING
APPARATUS INCLUDING FLUID FLOW PUMPS
ON SCALES, WITH AGITATOR, VACUUM FILLED,
WITH MATERIAL DRYER, AND OF VARIED
MEANS OF SEQUENTIAL VALUE OPERATION**

The invention relates to various combinations predicated on the basic fluid flow pump sequence of fill, activate, discharge, and purge disclosed in U. S. Pat. No. 3,355,221, issued Nov. 28, 1967, and this application is a continuation-in-part application of application Ser. No. 518,533, filed Jan. 3, 1966, which issued as the aforesaid U.S. Pat. No. 3,355,221; of application Ser. No. 686,018, filed Nov. 28, 1967, and now abandoned; and of co-pending application Ser. No. 822,126, filed May 6, 1969.

The inventions relate generally to various fluid flow pump combinations based upon the cycle of material deposit through fill valve on diaphragm, pressurized gas passage through perforate diaphragm to activate material, discharge of pressurized material down discharge line, purge of residual material by residual pressure through a by-pass line around closed discharge valve, pressurized gas valve also being closed; and the re-opening of fill valve at start of a succeeding cycle as the vessel pressure falls substantially to atmospheric pressure.

It is also an object of the invention to provide a fluid flow pump of the class described in U.S. Pat. No. 3,355,221, in which the vessel is supported by a load cell type scale with a compressed air signal from the tare weight adjusted load cell controlling fill valve operation.

It is another object of the invention to provide a fluid flow pump of the class described, in which the closure of the fill valve may be actuated by material level effect upon a probe disposed above the diaphragm and of at least one of vibration sensitive, revolved blade stoppage, and air gap occlusion types.

Also it is a further object of the invention to provide fluid flow pump pressure vessels of the various types hereinabove disclosed in which circuitry changes may be made to accomplish various steps by various means, as fill valve closure by level probe position, discharge valve opening by a timer, discharge valve and activating gas valve closure and purge valve opening by timer, fill valve opening by timer, discharge valve opening by load cell signal, discharge valve and activating gas valve closure and purge valve opening by load cell signal, fill valve opening by load cell signal, fill valve closure by pressure fluid signal from the top of the pressure vessel, and activating gas valve opening by fill valve operator limit switch.

Other and further objects will be apparent when the specification herein is considered in relation to the drawings, in which the figures of the continued part of the application are first described, as follows:

FIG. 1 is an elevational view, partially diagrammatic, showing the parent, fluid flow pump form of the invention;

FIG. 2 is an electrical diagram of circuitry and apparatus employed in the operation of the form of the invention shown in FIG. 1; also in FIGS. 13 and 14.

FIG. 3 is an isometric view, partially diagrammatic, of a vibration type level sensor or probe, employable as an alternative means of controlling or safeguarding fill

valve closure in the various forms of the invention shown, or to be shown herein;

FIG. 4 is an elevational view, partially diagrammatic, showing substantially the invention of FIGS. 1 and 2, but adapted to weigh material being handled and to reflect a weight responsive pressure signal to actuate closing of the fill valve;

FIG. 5 is an isometric view of a beam scale, as one form of weighing apparatus on which a pressure vessel pump is indicated as being mounted, the fill valve thereof being closed as actuated by chain set in motion by weight responsive pressure signal emanated from the beam scale;

FIG. 6 is an isometric view of beam scale apparatus, showing details of girder chair construction on which the legs of the pressure vessel pump, shown in FIG. 4 and indicated in FIG. 5, are mounted;

FIG. 7 is a transverse sectional elevation through a girder chair, as indicated taken along line 7—7 of FIG. 5;

FIG. 8 is a sectional elevational view showing details of shackle and nose-on beam connections, as taken along line 8—8 of FIG. 5, and thus looking rearwardly;

FIG. 9 is a sectional elevational view, taken along line 9—9 of FIG. 8, looking to the left;

FIG. 10 is an isometric view of beam scale mechanism and associated apparatus for imparting weight responsive signals, shown in FIGS. 4—9, inclusive, the housing or cover therefor shown in FIG. 5, having been removed;

FIG. 11 is a sectional elevational view, partially diagrammatic, of the proportionate force transmitter for reflecting weight in terms of pressure, as shown exteriorly in isometric view in FIG. 10.

FIG. 12 is an electrical diagram of the apparatus and circuitry shown in FIGS. 4—11, inclusive;

The figures of the parts of the application directed to new or partially new structures added herein, are described, as follows:

FIG. 13 is an isometric view of a fluid flow pump, as shown in FIGS. 1 and 2, mounted to be weighed on a preferred type of scale termed a load cell, which emits a weight responsive pressure signal to actuate the fill valve closure;

FIG. 14 is a plan view of the fluid flow pump shown in FIG. 13;

FIG. 15 is an isometric, development view, of parts indicated in FIGS. 13 and 14, for removably connecting the fluid flow pump to the scaffold or mounting frame shown in such figures;

FIG. 16 is a sectional elevational view, partially diagrammatic, through a load cell shown isometrically below the fluid flow pump in FIG. 13;

FIG. 17 is an isometric view, partially diagrammatic, of a rotated paddle type level sensor or probe, employable preferably in place of the level sensor shown in FIG. 3, or shown in FIGS. 20 and 21, to be hereinbelow described, as an alternative means of controlling or safeguarding fill valve closure in the various forms of the invention shown or to be shown herein;

FIG. 18 is a fragmentary sectional elevational view, partially diagrammatic, showing connections, including connections within the sensor housing;

FIG. 19 is an electrical diagram of the circuitry for the form of sensor or probe shown in FIGS. 17 and 18;

FIG. 20 is an elevational view, part in section; of an air gap type level sensor or probe, employable alterna-

tively in place of the level sensor or probe shown in FIG. 3 or in FIGS. 17-19;

FIG. 21 is a diagrammatical view of apparatus, circuitry, and connection means therefor, as entailed in operation of the air gap type level probe or sensor shown in isometric view of FIGS. 19 and 20;

FIG. 22 is an isometric view, partially diagrammatic, showing a pressure vessel of any of the types shown in FIGS. 1 and 2; in FIGS. 4-12; or in FIGS. 13-14; as suspended from a load cell that is rigidly supported above floor level, to receive material from a hopper, also rigidly supported from the same level;

FIG. 23 is a fragmentary circuit diagram showing circuitry for any of the aforesaid pressure vessels altered for discharge valve opening by time actuated circuitry;

FIG. 24 is a fragmentary circuit diagram showing circuitry for any of the aforesaid pressure vessels altered for discharge valve and gas inlet valve closing and purge valve opening by time actuated circuitry;

FIG. 25 is a fragmentary circuit diagram, showing circuitry for any of the aforesaid pressure vessels altered for fill valve opening by time actuated circuitry;

FIG. 26 is a fragmentary circuit diagram showing circuitry for any of the aforesaid pressure vessels altered for opening the discharge valve by a fluid pressure signal actuated responsive to material and gas weight in pressure vessel;

FIG. 27 is a fragmentary circuit diagram showing circuitry for any of the aforesaid pressure vessels altered for closing the discharge valve and the gas inlet valve for opening the purge valve by a fluid pressure signal actuated responsive to material and gas weight in pressure vessel;

FIG. 28 is a fragmentary circuit diagram showing circuitry for any of the aforesaid pressure vessels altered for opening the fill valve by a fluid pressure signal actuated responsive to depletion of material and gas weight in pressure vessel; the diagram also indicating that an early such signal actuated from a different source, the top of the pressure vessel, may serve alternatively for closing the fill valve;

FIG. 29 is a fragmentary circuit diagram showing circuitry involved in opening the gas inlet valve by a time cycle only after closing the fill valve by limit switch action; and

FIG. 30 is a fragmentary circuitry diagram, showing any of the level probes shown in FIG. 3, in FIGS. 17-19, and in FIGS. 20-21, serving in any of the hereinabove described pressure vessel operative structures, to close the fill valve upon receipt of batch load.

Referring now to the drawings of background or continued parts of the inventions, 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 12a and a bottom comprised of a spherical segment or lower closure 12b, 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 legs 14 which upstand from a conventional base or grout, not shown. A gas permeable membrane or diaphragm 13 separates the container into an upper, or material plenum 15, and a lower, or gas plenum 16.

The dome 12a has an inlet flange or neck 16 connected centrally into the top thereof with an inlet gate valve or fill valve 18 being mounted thereon. A flexible nipple 19 is shown connecting the fill valve 18 with a discharge flange 20 from a hopper 21, the nipple being shown as a flexible member for carrying out an optional function, to be hereinbelow described.

A valve operator 23 is shown diagrammatically, as disposed to open and close the gate valve 18, a piston 23a being shown provided in the valve operator 23, with instrument air admissible under the piston 23a through a conduit 23b to open the fill valve, and with instrument air being admissible through a conduit 23c above the piston 23a to close the fill valve. Obviously, the conduits 23b and 23c must be in a closed compressed air circuit with a pressurized reservoir, or otherwise selectively supplied with compressed air, to carry out their respective functions.

A compressed gas conduit 25 is shown connected into the lower end closure 12b of the shell or pressure vessel 11 and such compressed gas inlet line 25 has a gas inlet valve 26 therein, which is shown connected to be opened and closed by a valve operator 27, constructed and equipped in correspondence with the valve operator 23.

Also, a discharge outlet pipe 28 extends downwardly through the dome 12a to terminate in a pick-up end 28a disposed slightly above the gas permeable or air permeable membrane 13. A valve 29 is shown connecting this discharge outlet pipe 28 with a discharge conduit 30 disclosed in FIG. 1 as being connected by a purge line connection nipple 32 to the outlet side of the purge valve 32. The discharge valve 29 is shown operated by a valve operator 33, which is indicated as being constructed, and as having connections thereto, in correspondence with the fill valve operator 23.

A purge line 34 extends between the purge line connection nipple 32 and the material plenum or chamber 15 and has a purge valve 35 therein to control its opening and closing, a valve operator 36 being shown connected to the purge valve 35 for this purpose, such valve operator 36 being constructed, and having connections in correspondence with the fill valve operator 23. However, it may be pointed out, in this regard, that the purge valve 35 should be a normally open valve, whereas, the fill valve 18, gas inlet valve 26, and discharge valve 29 are normally closed valves.

Noticeably in FIG. 1, and in FIG. 4 (to be hereinbelow described) a support body 37 for a vibratory paddle 38, operative on the tuning fork principle, is shown connected into the cylindrical body 11a of the shell 11, the material sensitive paddle 38 being indicated in dotted lines in each of FIG. 1, and FIG. 4 as extending within the housing 10 near the top thereof, such paddle being operative to actuate the valve operator 23, (FIGS. 1 and 4,) to close the fill valve 18, as will be hereinbelow described.

An insulative cord 39, having therein the electrical conduits to the paddle 38, extends from the paddle support body 37 to a control box 40, to be hereinbelow described, and shown mounted on the exterior of the activator shell body 11a. As shown in FIG. 2, a positive line 41 and a negative line 42 extend from a source of electrical power, the positive line 41 having three parallel lines 41a, 41b and 41c branching therefrom with the line 41a serving when manual control is to be used as will be hereinbelow described with the line 41b

serving as a neutral third positive conductor and with the line 41c serving as the positive conductor when automatic control is to be employed. A three-way switch, indicated generally by reference numeral 44, is provided to control the selection of automatic or manual control, as desired, and as shown, the switch 44 indicates that automatic control has been selected, the conductors 41b, 41c thus being closed and the conductor 41a being open.

A conductor 45 extends from the conductor 41, and a push-button switch 45a is shown in FIG. 2 as closing circuit in this conductor, the conductor 41 continuing to a junction with three parallel circuits including the circuit of a variable time delay relay 46, the circuit 47 for a solenoid 48 which operates the fill valve operator 23, (FIGS. 1 and 4,), and the circuit of an indicator light 49 which may be designated as a green light for illustrative purposes.

The conductor 45 continues as the conductor 45c and has contacts 51a therein of a double acting pressure actuated switch 50, such contacts 51a being normally closed at atmospheric pressure and opening upon increase of pressure in the gas plenum 16. The conductor 45c continues from the contacts 51a to a junction with a conductor 45b having therein the normally closed relay contacts 56a of a latching relay 52, the conductor 45b terminating at its connection to the negative power line 42.

A parallel circuit 53 extends from the neutral or central positive conductor 41b, to the junction of the conductors 45c, 45b, such parallel circuit also including therein the contacts 51b of the aforesaid pressure actuated switch 50, such contacts 51b being normally open at atmospheric pressure and closing upon increase of pressure in the aforesaid gas plenum 16. The circuit 53 also has therein an indicating light 54, designated as a yellow light for indicating purposes, as will be hereinbelow described.

Another parallel circuit 55 from the positive conductor 41b has the switch 46a therein which is closed by the variable delay relay 46 at the end of its pre-selected cycle, the circuit 55 also having therein the coil 52a of the latching relay 52, and the circuit 55 being continued by the circuit 45c, as aforesaid. The circuit 55, as thus closed, energizes the latching relay coil 52a to open the normally closed relay contacts 56a to break the aforesaid parallel circuits 46, 47, 49 and 55, and upon the solenoid circuit 47 being de-energized, the solenoid 48 retracts and moves the valve operator 23 to close the fill valve 18, both valve operator and fill valve being shown in FIG. 1, also in FIG. 4.

The latching relay 52 is of the well known type, which, when its coil 52a is energized, it actuates conventional switching means which opens the normally closed contacts 56a, and pulls closed the normally open contacts 56b in a parallel circuit 57 extending from the negative conductor 42, in manner that the latching relay mechanism latches against any movement except that which may be imparted to the switching means to pull open the normally open contacts 56b, which can only be effectuated by the energization of the latching relay coil 52b, to be hereinbelow described as to operation.

The normally open contacts 56b are disposed in a circuit 57 from the negative power line 42, and which branches into four parallel circuits: 58, including a fixed time delay relay of the thermal delay type; a cir-

cuit 59 which includes the coil for operating a solenoid 60 connected to actuate the valve operator 47, (FIGS. 1 and 4,), to open and close the compressed gas inlet valve 26, a circuit which includes the light 61 therein, which is designated as a blue light, for purposes of illustration; and a circuit 62 including the coil for operating a solenoid 63 connected to actuate the valve operator 36, (FIGS. 1 and 4,), to open and close the purge valve 35.

A circuit 57a continues from the junction of the circuits 59, 61 and 62, and has a switch 64 therein which is closed by the fixed time relay 58 when its circuit has been closed for its fixed period of time, while a circuit 57b continues from the junction of the circuit 57a and the fixed time delay relay circuit 58, to the aforesaid neutral or positive conductor 41b.

Also, a circuit 57c continues from the junction of the circuits 59, 61 and 62 with the circuit 57, and branches into: a circuit 65 including the coil which operates a solenoid 66 which actuates the valve operator 33, FIGS. 1 and 4, to open and close the discharge valve 29 13); a circuit including a light 67 therein, which is designated as a red light, for purposes of illustration; and a circuit having a relay 68 therein; a circuit 57d continues from the positive side junction of the circuits 65, 67 and 68, and branches into a circuit 57e having a normally open pressure actuated switch 69 therein, to be hereinbelow described, the positive side connection being completed with the conductor 41c; and into a circuit 57f having a pair of contacts 70 therein operated by the relay 68, and terminating by connection with the neutral or positive conductor 41b. A pushbutton switch 71 is shown in FIG. 2 closing the circuit 41c adjacent its connection to the circuit 57e.

Additionally a circuit 72b, 72a connects the positive or neutral conductor 41c with the negative power line or conductor 42; the circuit 72b having in series therein a pair of contacts 74 (operated by the relay 68 substantially simultaneously with its operation of the contacts 70 on the circuit 57f, and a normally closed pressure sensitive switch 73, as will be hereinbelow described;) the circuit 72a having therein the latching relay coil 52b which operates to break circuit closed by the hereinabove described relay contacts 56b.

As shown in FIGS. 1 and 4, respectively, the gas, as compressed air, which activates and transports the material which enters the container, shell, or pressure vessel 11, 311, arrives from its source, as a compressor or pressurized reservoir, and passes through a strainer 83 and a globe valve 84 on its way to being regulated as 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 85a which upstands from the main gas line 25 through which the strained gas passes on downstream. A smaller sized by-pass line 25a extends between the gauge pipe 85a 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 87a 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 conduit 90 extends from the lower closure 12b to conduct pressurized gas from the gas plenum 16 to the

control box 40, there to bear upon and cause actuation of the pressure sensitive switch 50, operative as hereinabove described, and to bear upon and cause actuation of pressure sensitive switches 69 and 73, to be further described hereinbelow as to operation.

Such switch actuating gas, from within the pressure vessel 11, 311, enters the conduit 90 and passes through a strainer 91 therein, and on to the panel box 40, a gauge 92 being provided to indicate the pressure of the actuating gas as it passes downstream of the strainer 91 on its way to the panel box pressure sensitive switches, as aforesaid. The instrument air required by the pressure sensitive switches, as contradistinguished from the actuating air or gas, and any other air or gas required to actuate any of the apparatus, as that shown in FIG. 2, or as that required to operate the valve operators shown in FIG. 1 and 4, and may be brought to the panel box 40 through a conduit 93 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.

A conventional fuse 96 is provided in the positive power line 41, indicated as comprising the conventional fuse strip 96a, and in a parallel circuit therewith, the conventional resistance 96b and indicating light 96c.

Also, as hereinabove referred to with relation to FIGS. 1 and 4, and a material sensitive, frequency change, actuated, control assembly 37 is provided to insure the closing of the fill valve 18 in case the variable time delay relay 46 may not function to close the time-out switch 46a at the end of the time cycle period selected, as indicated diagrammatically in FIG. 2, and as shown partially diagrammatically and in greater detail in FIG. 3.

The "fail-safe" circuit 75 is shown extending from a point on the conductor 55 between the time-out switch 46a and the latching relay coil 52a, and is continued to a solids state relay housing 98, there to be connected to the junction between a conduit 75a to the normally open side of a relay switch 97, and a circuit 76 which extends to the positive conductor power line 41a, the circuit 76 having the pushbutton switch 77 therein, to be hereinbelow described. Normally, the relay switch 97 closes contact between a grounded conductor 97a, (and thus the negative power line side 42), and a conductor means 99 between the relay switch 97 and the negative terminal of a coil 82 in the control housing 37.

The coil 82, within the housing 37, is indicated externally thereof, by its connections 82a, 82b which terminate within the plug 98. Within the housing 37 the coil 81 energizes a plunger or armature, not shown, in manner that it normally vibrates 120 cycles per second to impart vibration at this frequency to the lower tuning fork tine 38a which is connected to the paddle or vibrator 38. Thus normally the tine 38b also vibrates with the paddle 38 at 120 cycles per second. The vibrations of the tine 38b are imparted to an armature, not shown, which normally actuates a second coil 81, at an imparted voltage, at 60 cycles per second frequency.

An induction coil, not shown, is imposed across the terminals of the coil 81 within the plug so disposed with relation to the switch 97 that this switch may be shifted when the differential between the line voltage and the imparted voltage achieves a certain value, as in the case when material entering the container or pump 10 ex-

tends at such an angle of repose to interfere with, reduce, or stop the vibrations of the paddle 38.

When the aforesaid induction coil between the terminals of the coil 81 thus shifts the switch 97 to close circuit from the neutral or positive side conductor 41b, by way of the conductor 78, the coil 82, and the conductor 99, through the switch 97, as thus shifted, and by way of the conductors 75a, 85, 55 (including the latching relay coil 52a), and on through the conductor 45c, the closed switch contacts 51a, and the circuit 45b, (including the latching relay closed contacts 56a), to the negative power line 42. The energization of the latching relay coil 52a in the circuit 55 results in the latching relay breaking the circuit 45b by shifting open the contacts 56a, whereby the solenoid winding 47 is de-energized to actuate the solenoid 48 to operate the valve operator 23 to close the fill valve 18.

Obviously the quicker the "fail-safe" switch 97 is operated after a failure of the variable time delay relay 46 to close the time-out switch 46a, the less the material from the hopper 21 can over fill the container 10, and the closer the delivered batches of material may be controlled to deliver a desired lesser volume per batch.

Also, it is obvious that the variable time delay relay 46 may be omitted entirely, together with its time-out switch 46a, and in this case the frequency control device 37 alone can be relied upon to actuate the valve operator 23 to close the fill valve 18.

On occasion it may be desirable to operate the filling and evacuation of a vessel 10, 310, by manual control of the sequence of steps, rather than automatically, as hereinabove described. For such occasion, it may be considered that the variable time delay relay 46 and its timing out switch 46a are immobilized. Then a circuit 101 is provided, parallel with the circuit 45, to extend from the positive conductor 41a and to connect with the circuit 45 between the pushbutton 45a and the circuit junction 46, 47, 49. Also, in this case there also serves the aforesaid circuit 76 from the circuit 41a to the junction of the circuits 75, 75a, and having the pushbutton 77 therein; also the circuit 102, parallel with the circuit 57e and connected thereto between the pushbutton 71 and the normally open pressure sensitive switch 69; also the positive power circuit 41a is extended to connect with the junction of the circuits 72a, 72b, and to have the pushbutton 103 therein.

Thus, with the three-way switch controlling the parallel conductor lines 41a, 41b and 41c turned from the position shown in FIG. 2, in manner that the conductors 41a, 41b are closed, the conductor 41c thus being left open. Beginning with the container 10 empty and at atmospheric pressure, the pushbutton 45a may be pushed downwardly and held to close the circuit 101. The circuit 47 is thus energized so that the solenoid 48 actuates the valve operator 23 to open the fill valve 18. Then, the pushbutton 45a may be released from closing the circuit 101, thus breaking circuit through the solenoid coil 47 so that the solenoid 48 actuates the valve operator 23 to close the fill valve 18.

With a batch of material delivered into the container 10 in amount determined by the length of time the pushbutton 45a has closed the circuit 101, activation of the material may be started, after the pushbutton 45a has been released, by manipulating the pushbutton 77 to close the circuit 76. Circuit is thus closed through the circuit 75, the circuit 55 including the latching relay coil 52a, and to the negative power line side 42,

by way of circuit 45c, closed contacts 51a of the pressure sensitive switch 50, and the circuit 45b, including the latching relay closed contacts 56a therein. This energizes the latching relay coil 52a to operate the latching relay 52 to break the contacts 56a and close the contacts 56b.

Circuit is thus closed to the fixed time delay relay 58, which actuates the "time out" switch 64 to close the solenoid coil circuit 59, thus to actuate the valve operator 27 to open the compressed air valve 26; also the solenoid coil circuit 62 is closed whereby the solenoid 66 actuates the valve operator 35 to close the purge valve 36.

Thus, the operator of the apparatus may observe the gauge 92 and when the pressure indicates that the vessel is ready to discharge, or when the operator appreciates that a proper time interval after the opening of the gas inlet or compressed air valve 26 has taken place, the pushbutton 71 may be pushed to close the circuit 102, the normally open, pressure switch 69 being closed by the pressure that has built up in the vessel.

Thus, as aforesaid, the armature 65 may move to set in operation the opening of the discharge valve 29, while circuit is closed to operate the second relay 68 so that it closes the circuit 57f, and closes the contacts 74 to partially close the circuit 72b. Discharge may thus continue as long as the pushbutton 71 is held closing circuit 102, or even if the operator may now release the pushbutton 71, since in this case the circuit continues completed through the contacts 70 in the circuit 57f, even after the pressure has fallen enough to cause the pressure sensitive switch 69 to open.

Thus to purge a pump 10, after the pushbutton 71 has been released, or thereafter, or at any time, with the three-way switch 44 turned to manual operation, (41a, 41b, closed), it is only necessary to push the pushbutton 103 to close circuit with the circuit 72a to energize the latching relay coil 52b, which, when energized, operates, as aforesaid, to close the circuit 45b and to break the circuit 57, whereby the purge valve 35 is opened and the compressed air valve 26 and discharge valve 29 are closed. Then, as the purge pressure diminishes the normally closed, pressure sensitive switch 73 opens, and as the pressure falls further to substantially atmospheric pressure, the contacts 51a of the pressure sensitive switch 50 close, and the pushbutton 45a may again be pushed to close the circuit 101 to admit material into the container 10.

In FIGS. 1 and 4, respective conduits 23b, 27b, 33b and 36b connect into the respective fill, compressed gas, materials delivery and purge valve operator cylinders 23, 27, 33 and 36, under the respective piston heads 23a, 27a, 33a and 36a respective conduits 23c, 27c, 33c and 36c, connect into such cylinders above the respective piston heads therein. Thus, conductor cords or sleeves 23b, 27d, 33d, and 36d, 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, not shown, as operated by the aforesaid solenoids 48, 60, 66 and 63, to admit the operative air, gas or fluid, selectively into the conduits 23b or 23c; into the conduits 27b or 27c; into the conduits 33b or 33c; and into the conduits 36b or 36c; selectively to open or close the

aforesaid fill valve 18, compressed gas valve 26, (326), materials delivery valve 29, and purge valve 35.

As shown in FIG. 2, a light 49 is in circuit parallel with the solenoid circuit 47 and the variable time delay relay circuit 46, and thus the light 49 is on when the fill valve 18 is open; also a light 61 is in a circuit parallel with the solenoid circuit 59 which actuates the valve 26 which admits the material activating compressed gas, and with the solenoid circuit 62 which closes the purge valve; and also a light 67 is in a circuit parallel with the solenoid circuit 65 which actuates the opening of the materials delivery valve 29. Additionally, a light 54 is shown in a circuit 53 which is complete when the latching relay 52 is actuated to close the contacts 56a while the pressure within the container is still high enough to maintain closed the contacts 51b of the pressure sensitive switch 50. Thus, this occurs after the purge valve 35 has been re-opened by opening of the latching relay contacts 56b, to permit the purging of the container by the residual pressure therein until such pressure drops to substantially atmospheric so that the pressure sensitive switch 50 is actuated to open the contacts 51b and close the contacts 51a, thereby breaking the circuit 53 which contains the light 54 therein.

The lights 49, 61, 67 and 54 may have selectively differently colored bulbs, as, respectively, green, blue, red and amber, thus to indicate, respectively, that filling, activating, discharging and purging are taking place.

The respective valve operators 23, 27, 33 and 36, may be used to operate the respective fill valve 18, compressed gas delivery valve 26, material delivery valve 29, and purge valve 35, but it is often not necessary, in the case of light duty installations, and/or in the case of the valves 26, 29 and 35, that special valve operators may be required for their operation. In such cases the solenoids 60, 66 and 63 may thus be connected directly to the respective valves 26, 29 and 35, to effectuate their operation.

As to the gas permeable membrane 13, this may be variously constituted to carry out various requirements. The membrane 13, (313), may be a flexible diaphragm as of a heavily woven cloth, as of cotton, or of a synthetic or plastic cloth as of nylon or dacron. Also instead of being flexible the membrane may be rigid or substantially rigid. Thus it may be of woven metal, or of non-corrosive woven metal, such as stainless steel, to combat corrosion. Also it may be of a porous ceramic, also to avoid corrosion, as well as to provide a stable membrane. An additional advantage is there being selectivity in the synthesis of the membrane resides in the fact that a wider range of materials can be handled to pass through the membrane under the most advantageous conditions where this selectivity is available.

Also, as to the "fail-safe" feature of the vibrating paddle 38, the sensitivity of this feature is such that it can be regulated to operate almost instantaneously as a container first starts to overfill, so that the relay 52a is energized to operate the latching relay 52 immediately the variable time delay relay 46 fails to function.

Additionally, as set forth hereinabove, the vibratory paddle 38 may be used instead of the variable time delay relay 46, as the primary functional element to actuate the closure of the fill valve 18. In such case the sensitivity of the paddle 38 to adjustment, can determine the promptness of sensitivity to material to close the relay switch 97.

A popular embodiment of the invention is shown in FIGS. 4-12, in which the pump 10, shown in FIG. 1, is mounted on a floor stand scale hopper, FIGS. 4 and 5, and adapted to transfer a batch of material when the batch weight entering the pump attains a predetermined weight. The hopper scale 80 is thus adapted to reflect weight in terms of pressure and thus the time delay relay 46 shown in FIG. 2 is replaced in the circuitry shown in FIG. 12 by the symbol PS indicating that the switch 46a is closed responsive to pressure.

The floor stand hopper scale 80 on which the pump 10 is shown mounted in FIGS. 4 and 5 provides for each leg 14 of the pump 10, a girder chair 79. The support block 127 of each girder chair 79 has a pivot block 139a pin-connected to extend therebelow, centrally thereof, and an inverted V-shaped groove in the lower surface of the pivot block 139a is provided to seat upon the beveled edge of a pivot bar 140a, (FIG. 7) which extends upwardly from a cross-connecting rod 141a between two longitudinally spaced apart, transversely inwardly extending lugs 142a, 142b, the outer ends of the lugs being rigidly connected to a respective main lever pipe 143. The hopper scale 80 thus provides a pair of these lugs 142a, 142b for each girder chair 79 and corner stand 144, to be hereinbelow described.

Each corner stand 144 supports the weight transferred thereto from a pump leg 14, as the corner stands 144 in turn seat upon the floor or grout. For this reason, each corner stand 144 is slotted in direction longitudinally of the pump or machine 10 to receive a pivot block 139b pin-connected thereto. Each pivot block 139b, as thus mounted, has a V-shaped groove extending longitudinally, centrally thereof, to provide a seat for the bevel edge or blade edge of a pivot bar 140b which is carried by a cross-connecting rod 141b which extends between the two lugs 142a, 142b.

It may be seen that each corner stand 144 provides a fulcrum which extends longitudinally of the hopper scale mounted pump 10, the lug units 142a, 142b which extend parallel to each other and transversely of the machine being mounted on such fulcrums, with the girder chairs 79 which transmit the load of the respective pump legs 14 thereabove being disposed inwardly of the fulcrums with relation to the longitudinal axis of the machine. Thus the main lever pipes 143, on the opposite or outer sides of the fulcrums from the impressed loads, will tend to be lifted upwardly but for restraining or counter balancing forces.

Referring again to the girder chair construction, each support block 127 is shaped substantially as a tee, with a hole bored through each end of the cross-arm 127a, to receive a pin 145 therethrough. A chain link 146 is fitted over the pin 145 just outwardly of the cross-arm 127a, a washer just outwardly of each chain link 46, and a retention pin is passed through the outer ends of each pin 145 to hold the washers and chain links 146 assembled to the support block 127.

For reasons of clarity the washers and retention pins are not shown in FIGS. 5, 6 and 7. A connection bar 147 is extended through the chain links 146 on each pin 145 and connected, as by machine screws, not shown, into the legs 149 of each girder chair 79. Also the seat plate 150 of the girder chair 79 is assembled by machine screws 148, FIG. 6, to the legs 149 in spaced relation above the support block 127. The retention pins on ends of the pins 145 are disposed to leave some play therealong for the washers and chain

links 146. Also, the connection bars 147 may have location lugs 131 (FIG. 7), on their underside on either side of the respective chain links 146, and slightly spaced therefrom. Thus, when the legs 14 of a vessel 10 seat upon the girder chairs 79 it may be said that the girder chairs 79 may "float" with relation to the lug units 142a, 142b on whose cross-connecting rod pivot bars 140a they are mounted, thus to pass along the load imposed by the vessel 10 to the floor stand hopper scale 80 in a balanced manner.

When the weight of the vessel 10 is balanced upon the four girder chairs 79 with the corner stands 144 providing what could be termed fulcrums, but for balance, there would be the greatest tendency to lift the main lever pipes 143 outwardly of the corner stand fulcrums 144. On the other hand, the main lever pipes 143 extend forwardly of the girder chairs and have the outer ends of respective transverse beam plates 152a, 152b, connected across the front ends thereof. The beam plates 152a, 152b are connected centrally across the front of the beam scale 80 by nose-irons, to be hereinbelow described, which are carried by a bracket shackle assembly 155, also to be hereinbelow described.

The bracket shackle assembly 155, as shown in FIGS. 8 and 9, comprises an outer U-shaped bracket 153 and an inner U-shaped bracket 154, with the upper ends of both brackets receiving the outer ends of a swivel pin 156 therethrough, the pin 156 also passing through the body 157 of a swivel assembly 160, as the swivel body 157 between the upper arms of the inner U-shaped bracket 153.

The shackle body 157 includes an upstanding member 158 into which is connected a connection bolt 159 which passes downwardly through the base 161 of a swivel link 160. The S-hook 162 which extends downwardly from the draft shackle 172 of the beam scale 165, as disposed in the beam box 170, is urged downwardly by the weight of the hopper scale 80, which transmits the weight of the vessel 10 to the beam scale 165.

This transmission of load or force components may be understood by a further consideration of FIGS. 8 and 9, as orientated by reference to FIG. 5. The inner end of the beam plate 152a is notched upwardly to receive an upper nose iron holder 164a, which carries a specially hardened nose-iron 166a therein, having a downwardly disposed bevel edge. An upper clamp plate 167a fits downwardly over the nose iron holder 164a, and around the inner end of the beam plate 152a, and bolts or screws 168 connect these members as the bolts extend from one side of the clamp plate 167a to the other side thereof.

Also, the inner end of beam plate 152b is notched downwardly to receive a lower nose iron holder 164b, which carries a specially hardened nose-iron 166b therein, having a downwardly disposed bevel edge. A lower clamp plate 167b fits upwardly over the nose holder 164b, and around the end of the beam plate 152b, and bolts or screws 168 connect these members as the bolts extend from one side of the clamp plate 167b to the other side thereof.

The upper, inner U-shaped bracket 154 mounts an upper swivel block 169a thereon, with a bolt 171a passed upwardly through the foot of the bracket into the swivel block providing a vertical pivot axis of swing, as the head of the bolt 171a below the bracket 154

holds the swivel block 169a in assembly. The upper nose-iron 166a fits into a beveled groove in the upper face of the swivel block 169a to complete the assembly of right transverse beam plate 152a and bracket shackle assembly 155. Also, the lower or outer U-shaped bracket 153 mounts a lower swivel block 169b thereon, also with a bolt 171b passed upwardly through the foot of the bracket into the swivel block providing a vertical pivot axis of swing, as the head of the bolt 171b below the bracket 153 holds the swivel block 169b in assembly. The lower nose-iron 166b fits into a beveled groove in the upper face of the swivel block 169b to complete the assembly of left transverse beam plate 152b and bracket shackle assembly 155.

As thus assembled the combination of knife-edge connections and swivel connections of the complementary transverse beam plates or bars 152a, 152b and bracket shackle assembly 155, is such to balance out any irregularities and keep the downward pull on the S-hook 162 substantially in proportion to the weight of the material in the vessel with the weight balanced out. With reference to FIG. 7, the balance of forces and construction can be considered on the premise that the weight on the draft shackle 172 is such, with tare weight adjusted, as to bear a direct proportion to the effective weight of material in the vessel 10 at any instant.

The shank of the draft shackle 172, shown in FIG. 10, from which the S-hook 162, shown in FIG. 9, extends downwardly, is mounted upon a primary lever 173 within the beam box 170, an end of the primary lever 173 extending into an inverted yoke or bearing bracket 174 upon the floor or base 175 of the beam box. At its opposite end the primary lever 173 extends slidably into a double yoke member 176 with a pin 177a through the lower, inverted yoke portion 176a supporting the primary lever therein. The upper yoke portion 176b of the double yoke member 176 receives an end of a secondary lever 178 therein, as retained by a pin 177b thereabove, and a bracket member 179 providing an inverted yoke 179a receives the secondary lever 178 therein in manner to provide a second fulcrum, the bracket member 179 being rigidly connected to an upstanding backing plate 180, as by a machine bolt 179c, the bracket member 179 being affixed to the beam box floor 175. Also, a retainer pin 179b is shown passed through the bracket member 179 below the secondary lever 178.

A tare weight 181 is disposed upon the right or free end of the secondary lever 178 to balance out the tare weight of the vessel 10, as may be accomplished in conventional manner. Now, considering motion, as the weight (equivalent to material weight in vessel) acts downwardly on the draft shackle 172, the left end of the primary lever 173 moves downwardly, and the left end of the secondary lever 178, (connected to the same double yoke member 176), also moves downwardly, whereby the part of the secondary lever 178 to the right of the fulcrum supplied by the inverted yoke 179a, moves upwardly. This results in an upwardly urging force being exerted on a plunger 182 in the lower end of a proportionate force transmitter 183, as will be hereinbelow described with relation to FIG. 11.

The proportionate force transmitter 183 has the mission of receiving filter instrument air at some predetermined pressure, as 30 p. s. i., via the conduit 90a from a filter regulator 195. Then, by proper pressure reduc-

tion adjustment and calibration, the force applied upwardly through the push rod 182 results in the air leaving the proportionate force transmitter 183 at pressure of say 3 p. s. i., as filling begins, up to say 12 p.s.i., when filling has been completed, to set in motion the closing of the fill valve 23, (FIGS. 1 and 4).

The proportionate force transmitter 183 comprises a body including a pilot housing 183a, a diaphragm assembly or exhaust ring 189, a pilot ring 188, a damper housing 183b, and a push rod housing 183c. A bushing 193 is threaded through a locknut 198 and into the push rod housing 183c, centrally thereof, with a ball bushing 196, within the bushing 193, comprising the element which actually establishes the journal for the push rod 182.

A spring 187 receives a spring seat 184 thereon and a retaining ring in a groove near the head of the push rod 182 seats upon the spring seat 184, as the spring 187 urges the head of the push rod 182 upwardly against the under sides of a diaphragm support disc or round plate 197 under a lower damper diaphragm 199a which extends across space between interior of push rod housing 183c and damper housing 183b, and outwardly between the aforesaid damper and push rod housings 183b, 183c.

An upper damper diaphragm 199b between pilot ring 188 and damper housing 183b extends across space therebelow in the damper housing 183b which connects by means of a vertical passage 201 with the space therebelow above the lower damper diaphragm 199a.

A restriction screw 202, having a transverse hole 203 therein, extends transversely into the damper assembly 183b and is adjustably threadable thereinto thus to adjust the amount of opening or passage space between the air space above and the air space below the adjustment screw 202. Thus the action, of upward thrust of the push rod 182, upon the air or compressed gas within the damper housing 183b, may be adjustably dampened, as the filling of the pressure vessel on a weight indicator results in a constantly increasing and normally fast acting force urging upwardly on the push rod 182.

Centrally of the upper damper diaphragm 199b, a pin 204, with round head upwardly, extends downwardly therethrough to be retained by a ring 206, as one that may be press-fitted around the pin 204 with upper surface of ring glued to the under side of the diaphragm 199b. The pin head or flange is disposed below a leaf spring 207 mounted within space within the pilot ring or leaf spring housing 188, a bushed bore 208 extending downwardly through the housing 188 to communicate with the space therebelow around the leaf spring 207 and above the upper damper diaphragm 199b. The leaf spring 207 carries a ball member centrally therein to be urged against by the pin head or flange to close the bore 208 to prevent overtravel of the pressure switch PS, FIG. 12, in closing the switch arm 46a to start fill valve closure, upon the pressure vessel 10, FIG. 4, reaching predetermined fill level.

A needle valve 210 extends into a transverse bore 209 in the pilot ring or leaf spring housing 188, with such bore including the needle valve seat therein, and at innermost end such bore joins a bore downwardly from space under the lower diaphragm 211a of the exhaust ring or diaphragm assembly 189.

A port 212 is provided to pass downwardly in the leaf spring housing 188 to communicate with the trans-

versely extending needle valve bore 209 outwardly of the needle valve elements and inwardly of the packed head of the needle valve. A set screw is shown provided in a threaded bore in the leaf spring housing 188, to communicate with the needle valve bore 209 to bear against the stem of the needle valve to maintain it as adjusted. The fluid (instrument air) to the needle valve 210 has passed through a screen or strainer 205 disposed in a cored passage 217 in the exhaust ring 189a of the diaphragm assembly 189, and upstream from the exhaust ring and diaphragm assembly body 189 it has passed through a passage 214 in the pilot body, base or top 183a, between the inlet 215a from the conduit 90a, and an opening through the upper diaphragm 211b of the aforesaid diaphragm assembly 189.

The exhaust ring 189a of the assembly 189 has a transverse port 216 therethrough to communicate with the space just inward thereof, and between the upper and lower diaphragms 211b, 211a. Centrally, the assembly 189 provides a lower disc or plate 218 upon the diaphragm 211a, and spaced thereabove by spacers, an upper, annular plate 219 under the diaphragm 211b. A spring base and valve seat 220 bears upon the upper diaphragm 211b and extends centrally therethrough to be retained by keeper means inwardly of the annular plate 219.

The inlet 215a in the pilot top or housing 188a communicates inwardly with a vertical counterbore 221 with a bore 222 concentric therewithin providing a valve seat for a tandem valve 224 with lower valve element to seat upon the valve seat 220 through the upper diaphragm 211b. A spring 190, within a low pressure or discharge space 225, bears downwardly upon the spring base and valve seat member 220 and upwardly against the pilot base or top body 183a within the discharge space 225. A retaining screw 226 is threadably adjustable into the counter bore 221 and is recessed to receive the upper end of a spring 227 therein, the lower end bearing upon a shoulder provided on the tandem valve 224 the upper seating member thereof.

By adjustment of restriction screw 202 the force exerted by the push rod 182 against the fluid above the diaphragm 199a is dampened so that there is no chatter and intermittent closing and then opening of the bushed bore 208 by the ball valve element carried by the leaf spring 207. The needle valve 210 is so moved to regulate the reduced pressure instrument air that is permitted to enter the space between the upper damper diaphragm 199b and the lower diaphragm 211a, that the fluid in this space is converted to act as a fluid piston. Also the leaf spring 207 is adapted to be raised by the pin 204 in the diaphragm 199b to close off further movement of the diaphragm assembly 211a, 211b at the end of travel to close the pressure switch that actuates switch arm 46a to close the fill valve.

As to the downstream fluid in the space 225, this is supplied instrument air past the upper valve element of the tandem valve 224 to show a predetermined reduced pressure, say 3 p.s.i., with the pressure vessel empty. Then, the travel produced by the fluid piston upon the diaphragm assembly 211a, 211b being known, needle valve adjustments sets the instrument air constituting the fluid piston at such pressure that this travel is obtained, the space 225 fluid thus being pressurized up to said 12 p. s. i. as the pressure sensitive switch P. S. actuates fill valve closure.

In case of excess pressure in instrument air supply line 90a, 215a lifting tandem valve 224, (as adjusted seated by spring 227 under retaining screw 226), the tendency to build up the low fluid pressure in space 225 is counter-balanced by the fact that the lower valve element of the tandem valve 224 will be lifted off the seat in the valve plate 220 to let the excess fluid bleed off through the plates 219, 218 and out the passage 216.

Details of construction heretofore not identified by reference numerals: a relief valve 31 is shown indicated above the pressure vessel top 12a in FIG. 1; also in FIG. 4i.

Noticeably, as has been heretofore explained, the frequency sensitive device 37 shown in FIGS. 1, 1 and 4, and in detail in FIG. 3, may be used alternatively to actuate fill valve closure in the forms of invention shown in FIGS. 1 and 2, but not in the form of invention shown in FIG. 4, due to the characteristics of the materials adapted to being weighed. However, in all three forms of FIGS. 1 and 2, FIG. 4, the frequency sensitive device may be used as a "fail-safe" or safeguarding device to serve if the predetermined first means for closing the fill valve does not work.

A form of scale termed a load cell 240 is shown in FIGS. 15-18, which has a number of advantages over the beam scale shown in FIG. 4 as supporting the fluid flow pump 10 of FIG. 1. Functionally and primarily such a load scale registers a very small displacement under great weight, with the displacement being capable of accurately responding to minute displacements, and with the load cell being the subject of accurate calibration of the pressure fluid signals it imparts.

The load cell is, in essence, a pneumatic weight transmitter comprising a weight measuring instrument or scale 240, on which a fluid flow pump or pressure vessel 250, FIG. 13, may be point mounted, in manner to be hereinbelow described. A frame 241 is shown in FIG. 13 upon a base 242, which seats on the floor or shop level 243, as of a plant or business. The frame 241 of structural angles is comprised of upper runners 241a, uprights 241b, and lower runners 241c affixed to the base 242. Channels 244a, 244b extend across between two opposed runners, and support a base plate 245 on which the load cell 240 is mounted.

The fluid flow pump 250 shown in FIG. 13 above the load cell 240 may be any of the pumps or vessels 10 or 310 hereinabove described, or any of the pumps to be hereinbelow described, as aforesaid. Balanced connection to the frame 241 is obtained as will be set forth. Lugs, as the lug 244, FIG. 13, are connected to the respective uprights centrally thereof, and successively around the frame in swastika pattern. Also four channels 251, in diametrically opposed pairs, are connected to the pressure vessel shell to extend radially outwardly therefrom, with directions of the channels facing in the same way, or in swastika fashion. Then the threaded end of each eyebolt 245 is passed outwardly through its respective lug 244, and has a nut 246 threaded thereon. See FIGS. 14 and 15 with relation to FIG. 13.

A connection bolt 247 has its threaded end passed in outward direction through a bore 248a in the outer end of a connection plate or strap 248 and then through the eye of the eyebolt 245, then through a washer 249 to have the nut 246 threaded upon the outer end of the connection bolt 247. A similar bolt 247 has its threaded end passed inwardly through a bore 248b in the inner end of the strap 248, then through the eye of a slightly

shorter eyebolt 245a, then through a washer 249 to have the nut 246 threaded upon the inner end of the bolt 247. The threaded end of the shorter eyebolt 248a is passed through a bore in the flange of the respective channel, and a nut 246 threaded upon the end of the eyebolt to complete the assembly. As may be seen, the pressure vessel 250 is thus assembled, with relation to the frame 241 in manner that adjustment to equalize any eccentricity of assembly, and inequalities of strains, as transmitted to the various frame elements.

The load cell 240 includes as housing 252, a top or assembly hold-down ring 252a, a tare weight and damper chamber plate 252b, a vent chamber plate 252c and a control chamber plate 252d. An upper diaphragm or flexible member 253a has its peripheral area confined between the plate 252b and the assembly ring 252a. Inwardly of the ring 252a, and concentrically spaced therefrom, an anvil or assembly hold-down plate 254a seats over the central area of the upper diaphragm 253a, with the central area of the upper diaphragm being supported underneath, as will be hereinbelow described. An anvil or cover disc 255a is installed upon the plate 254a by machine screws 256 with a central boss 257a thereon having a recess 258a centrally therein to receive a lower segment of a sphere or ball 259. The plate 254a and disc 255a together comprise the anvil 254.

The lower surface of the pressure vessel or fluid flow pump 250, FIG. 13, is indicated as being substantially flattened in FIG. 16 over a limited distance, whereby to receive an upper or connection plate or disc 255b thereagainst for connection to the bottom of the pressure vessel 250 as by machine screws 256. Such disc 255b has a central boss 257b thereon, having a recess 258b centrally therein, downwardly facing, to receive an upper segment of the sphere or ball 259. With this construction, in view of the relatively small size of the ball 259 with relation to the pressure vessel, it may be said that the pressure vessel 250 has substantially balanced, point supported contact on the load cell 240; this being true especially in view of the adjustably balanceable manner by which the pressure vessel 240 may be connected to the frame 241, as aforesaid.

A central diaphragm of flexible member 253b has its peripheral area confined between the plate 252b and the vent chamber plate 252c. A flange 260 shown in FIG. 16 as having substantially the same outer diameter as the hold-down plate 254a bears upwardly against the upper diaphragm 253a. Such flange 260 provides centrally, a downwardly facing, centrally recessed boss 260a to receive loose fitted into the recess 261 an upper spring retainercup 263a.

The hold-down plate 254a has a central recess 254b downwardly therein, and is centrally bored, as is the upper diaphragm 253a, and also the flange 260, to receive the assembly rod 265 therethrough. Within the recess 254b a large assembly nut 262 is threaded upon the upper end threaded portion 265a of an assembly rod or stud 265, with a lock nut 266a being threadable upon the threaded portion 265a to bear in locking relation upon the upper surface of the adjustably positionable aforesaid assembly nut 262.

The tare weight and damper chamber plate 252b has a large central bore therethrough and is counterbored thereabove, upwardly to the same diameter as the inner diameter of the hold-down ring 252a, thereby providing a measurable annular area of upper diaphragm

253a to be exposed to the tare weight adjustment fluid pressure to be hereinbelow described as provided in the damper and tare weight adjustment chamber 263.

The upper spring retainercup 263a, slidable upon the stud or rod 265, is borne upwardly to seat in the boss recess 261 by the spring 264 which bears downwardly within a lower spring retainercup 263b which is adjustably threadable upon the lower threaded portion 265b which of the assembly rod or stud 265.

A bearing ring 267 below the lower spring retainercup 263b receives the stud 265 therethrough, the stud 265 passing centrally through the central diaphragm 253b. Thus outwardly of the ring 267 and inwardly of the bore through the plate 252b there is provided a measurable annular area of central diaphragm 253b that is subject to the tare weight adjustment fluid pressure to be hereinbelow described. A retainer or locknut 266b is threadable upon the stud lower threaded portion 265b to retain the bearing ring or washer 267 against the central diaphragm 253b. An adjustment air passage 268 (right) is shown passing radially through the plate 252b to communicate with the chamber 263 and a corresponding radial passage 268 (left) is shown plugged with a closure plugged fitting 269, but which may be employed to serve additionally or alternatively with the passage 268 (right). The admission of adjustment air or fluid into the chamber 263, and the control thereof, will be described hereinbelow.

The vent chamber plate 252c is bored centrally to the same diameter as the plate 252b thereabove, and has a lower counterbore therein, whereby the aforesaid bore and counterbore provide a vent chamber 270. A spool 271, having upper and lower flanges 271a, 271b, thereon of the same diameter as the outer diameter of the washer or bearing ring 267, is provided to occupy the vent chamber 270, with the lower portion of the stud 265 threadably extending downwardly therethrough. The lower flange 271b of the spool 271 bears centrally upon a lower flexible diaphragm 253c which has its peripheral area retained between the vent chamber plate 252c and the control chamber plate 252d therebelow.

An annular upper bearing ring 272a, of slightly lesser outer diameter than the vent chamber counterbore, of substantially greater inner diameter than the spool flange diameters, and of slightly lesser thickness than the depth of the vent chamber counterbore, is shown concentrically disposed in the vent chamber 270 to bear upon the lower diaphragm 253c, and is preferably affixed thereto, as by glue or industrial cement. Between the inner periphery of the bearing ring 272a and the spool flange periphery, a measurable annular area of the lower diaphragm 253c, is provided that is subject to vent chamber, usually atmospheric, pressure thereabove, and to control chamber fluid pressure therebelow, to be hereinbelow described.

Radial vent passages 273 are shown in the vent chamber plate 252c for communicating the vent chamber 270 with ambient or atmospheric air. The load cell housing or body is indicated as being assembled by flat head machine screws 274 passed downwardly successively through ring 252a, diaphragm 253a, plate 252b, diaphragm 253b, plate 252c, diaphragm 253c, and plate 252d, with at least the lower, threaded portion of the screw being threadably engageable down into the control chamber plate 252d, and preferably threadably engageable through all or most of the parts thereabove.

The lower or control chamber plate 252d has lowermost a centrally threaded bore to receive an externally threaded valve seat member 275 therein, and thereabove three successively larger counterbores are provided, together to comprise the control valve chamber 276. The uppermost counterbore in the plate 252d is of substantially the same diameter as the diameter of the vent chamber counterbore immediately above the lower diaphragm 253c.

An annular, lower bearing ring 272b, corresponding in dimension with the upper ring 272a, and thus of thickness less than the depth of the uppermost counterbore in the control chamber plate 252d, is disposed concentrically within the uppermost control chamber plate counterbore, as by affixing to the underside of the diaphragm 253c, as by industrial cement or glue. Inwardly of the ring 272b, and centrally under the diaphragm 253c there is disposed a guide cup 277 having upwardly a flanged head 277a of the same diameter as the spool flange on the upper surface of the diaphragm 253c, thereabove. The lower end of the stud 265, which passes centrally through the diaphragm 253, is threadably engaged centrally downwardly to terminate in the guide cup head 277a, thus to bring the upper surface of the flange head 277a to bear in assuredly assembled relationship against the under surface of the aforesaid diaphragm 253c.

It can thus be seen that any weight placed on the load cell 240, as by the pressure vessel 250 thereabove, in empty state as to batch material, but with all operative apparatus and accessories thereon, as they reflect in weight, constitutes tare weight. Obviously this tare weight will tend to cause the upper diaphragm 253a to flex or yield downwardly, and by virtue of the assembly of elements within the load cell body or housing to the assembly rod or stud 265, a corresponding movement tendency is transmitted through to the central diaphragm 253b and the lower diaphragm 253c. Tare weight adjustment thus may be described as pressurizing the chamber 263 to cause the upper diaphragm 253a to move up a degree under tare weight so that only material weight or batch weight produced motion registers in the control or net weight chamber 276.

To accomplish such pressurization of the chamber 263, an adapter nipple 278 is shown threaded into the outer end of the fluid passage 268 (right) to have a tare control device or fitting 279 mounted thereonto which receives compressed air into the side thereof opposite the nipple 278 through an inlet nipple 280a. The tare control 279 comprises a regulator which may be immediately or remotely operated or controlled to place the compressed air inlet in communication with the chamber 263 to permit the introduction of compressed air thereinto to offset the tare weight, as aforesaid, so that only the weight of the net or material batch load may be reflected by the net load or control chamber 276, as will be hereinbelow described.

A valve element 281 has a lower face that seats upon the upper or inner surface of the valve seat 275 normally to occlude a bleed hole or relief passage through an orifice fitting 286 that is indicated in FIG. 16 as having been press-fitted centrally through the valve element 275. The upper part of the valve element 281 comprises a cup or spring retainer in which seats a control spring 282, the upper end of the spring 282 bearing upwardly against the under surface of the flange head or flange 277a comprising the upper member of the

aforesaid guide element 277 in the lower portion of which bears slidably the upper portion or spring retainer cup of the valve element 275.

As shown in FIG. 16 a source of pressure fluid supply, as compressed air, arrives through a conduit 280, and branches at a tee 280b, with part to pass via a nipple 280c, through a union 280d, a nipple 280e, and elbow 280f to the aforesaid inlet nipple 280a, into the tare control fitting 279. From the central or intersecting leg of the tee 280b, a nipple 280g connects into a flow regulator fitting 283 of simple and conventional design having the function of controlling or regulating the flow of pressure fluid that passes therefrom through an externally threader adapter member 283a via an inlet passage 284a, into the load cell control chamber 276.

Leading from the control chamber 276, on the opposite side thereof from the inlet passage 284a, there is shown in FIG. 16 an outlet passage 284b, with an adapter fitting 285 threaded into the outer end thereof, and with a rubber tubing 286 connected onto the outer end of the adapter fitting 285, to transmit the pressure fluid signal responsive to net load measured by the control chamber 276, as will be hereinbelow described. Noticeably in this regard, the orifice 285a through the adapter fitting 285 is substantially smaller in diameter than the passage 284b, and than the passage or conduit through the rubber tubing 287. Thus the adapter fitting 285 may be termed as choke adapter.

Any impact that otherwise might be imparted to the anvil 254, as by the rapid filling of the pressure vessel 250 with batch material, is adequately and forcefully opposed or dampened by the spring 264, thereby protecting the upper diaphragm from rupture anywhere along the annular area 287 where internal fluid pressure is opposed by the weight on the anvil 254 thereabove. Also, any downward movement imparted to the upper diaphragm area 287, (by way of the tare weight adjustment chamber 263, as pressurized to neutralize tare weight), on to the central diaphragm area 288, is not transmitted on to the lower diaphragm area 289, and to the control chamber therebelow, because the vent chamber 270 below this diaphragm area 288 is vented to atmosphere, as through the passageways 273.

Thus any downward movement caused by batch weight or net load build up in the pressure vessel 250 is only transmitted from anvil 254 via the connecting rod or stud 265 to the diaphragm 253c, including its area 289. Responsive to this downward urging under batch weight or net load impulse, the flange head 277a compresses the control spring 282, and the guide member 277 moves downwardly upon the valve element 281, thereby decreasing the volume of free, effective space for fluid flow between control chamber inlet and outlet.

The pressure fluid that flows through the flow regulator 283 into the chamber 276 builds up pressure therein, since the fluid enters much faster than it can escape through the choke passage 285a, and normally with fill valve closed, is at say 3 p.s.i. Excess fluid, tending to raise pressure in the chamber 276, being bled off through the bleed passage 286. Upon fill valve opening, as the volume of the chamber 276 is decreased under batch load, the pressure in the chamber 276 reaches a pressure that balances the net load, batch weight, or weight not neutralized by tare weight adjustment. Then the pressure remains constant and any excess air will

lift the valve seat 281 against the pressure of the spring 282, and let the excess air escape through the orifice fitting 286. Since the load cell 240 has its control chamber plate 252d adapted usually for installation flat upon a mounting plate 245, as shown in FIG. 13, the under surface of the plate 252d has radially extending grooves 288a, 288b, shown therein in FIG. 18, so that any air that escapes through the orifice fitting or nozzle orifice 286 into the central space below the valve seat member 286, may further escape through the grooves 288a, 288b, to the atmosphere.

The intensity of the fluid pressure signal that is transmitted through the conduit or flexible tubing 287, as to a pressure sensitive switch 46a, FIG. 12, bears linear relationship to net load or material weight, and such a switch 46a may be calibrated to close and set in motion fill valve closure when a predetermined batch weight has been deposited in the pressure vessel. Thus load cells of the type hereinabove described may be used, not only with the circuitry for the pressure vessels hereinabove described, but with circuitry for types of pressure vessels to be hereinbelow described, and in other usages. In all cases it may be used where it may be desired to effectuate fill valve closure responsive to the build up of a predetermined net load or batch weight on the diaphragm of the pressure vessel.

A revolved blade type level probe 422, as shown in FIGS. 17-19 may also be used in place of the type of level probe shown in FIG. 3, or in place of any other types of level, probes, including any to be hereinbelow described. Referring now to FIGS. 17 18 and 19, the housing 422c is shown in FIGS. 17 and 18, as including an outer, primarily switch enclosing housing section 440, which has an externally threaded enlarged flanged 440a designed for threaded engagement in, and to shoulder against the outer end of the housing section 441 for the aforesaid level probe motor 422h. The motor housing section 441 includes a reduced diameter, externally threaded portion 441a, on the side opposite the switch housing section 440, for engagement in the shell of a pressure vessel. An adapter, not shown, may be connected to the motor shaft whereby rotation is imparted to the blade 422a.

The motor 422h within the motor housing 441 therefor, is shown as having a positive terminal outlet 441c and a negative terminal 441d with an outlet fitting 441c being provided in the housing 441 through which conductors from both terminals may extend, and on through a common conductor cord, not shown in FIGS. 17, 18 and 19. A switch box 422j for the micro-switch 422h is shown in FIG. 18 as mounted within the switch housing 440 by three mounting screws 440b, 440c and 440d, which also serve, within the switch box 422j as the positive post, common post and negative post, respectively, of the micro-switch 422h.

In FIG. 18 the switch member 422g, pivoted on the positive post 440b, is indicated as urged closed against the common post 440c as by a spring 422h, and in this position the circuit 422f, is open. In the meantime circuit through the LPM motor 422h, from the conductor 422d on positive side, through the motor windings, now shown, to the conductor 422e on the negative side, is closed and the paddle or blade 422a is rotated by the motor 422h.

The spring member 422k has such relation to the speed of the shaft of the motor 422h, that as long as the motor rotates the blade 422a, the swing micro or switch

member 422g stays closed against the common post 440c. However, the micro-switch member 422g, incorporated with a conventional toggle action, should be able to kick loose from contact with the neutral post 440c, at the instant the blade or paddle 422a begins to stall or founder in its revolutions against material rising in the gas plenum 365. Thus the designed contraction of the spring 422k, as the motor shaft slows down, combined with the built-in toggle action also resulting in the micro-switch or swing member 422g, kicking over further to compress, or to let the spring 422k contract, results in the swing member 422g closing against the negative post 440d.

As has been set forth hereinabove, in pumps where level probe stoppage is designed as the main, and primary means for actuating fill valve closure, the load, or latching relay first coil 425A in the circuit 422f, is energized when level probe blade rotation is stopped by material, and circuit 422f, through switch member 422g, is completed to circuit 422f, therebelow, which contains the latching relay coil 425A, just adjacent to the negative power line 406.

In FIGS. 18 and 19, a light LG, light green, is in circuit extending from the common post 440c to ground, thus to stay on all the time the pressure vessel is filling, and to go off when the micro-switch member 422g shifts to the negative contact or post 440d. Also, in FIGS. 18 and 19, a light P, pink or purple, is in circuit extending from the negative side post 440d to ground, thus to stay off all the time the pressure vessel is filling, and to go on when the micro-switch member 422g shifts to the negative contact or post 440.

The diagram of FIG. 19 shows the wiring diagram to be identical with the circuitry described with relation to FIG. 22. Additionally the level probe 422c may be applied in relation to the environment of various pressure vessel pump structures, as in place of the level probe usage indicated in FIGS. 1-3, inclusive.

A form of level probe is shown in FIGS. 20 and 21 which requires less circuitry, and which may serve with bulk density of materials of a minimum of 15 pounds per cubic foot, minimum particle size of 20 mesh, with preferred 115 volt, 60 cycle, 15 amperes alternating current electricity. Such an air gap type level probe 442 is shown in FIG. 20 as comprising a bellows box housing 443 and a micro-switch housing 444. The micro-switch housing 444 includes an externally threaded, enlarged flange 444a which is designed for threaded engagement in, and to shoulder against the outer end of the bellows box housing 443. Oppositely the housing 443 has a reduced diameter boss 443a to shoulder against a vessel with which the level probe 442 is to be assembled, as at a predetermined elevation above the diaphragm corresponding with that elevation it is desired for the material to rise in the vessel. A still further reduced, externally threaded, hollow part 443b extends concentrically from the boss 443a and through a bore in the pressure vessel shell; and included with the shell, a lock washer, not shown, may be installed about the part 443b to bear against the inner surface of the shell, with a nut 443c, threaded upon the threaded part 443b to complete assembly. A rigid tube 445a is shown extending inwardly into the vessel through the lowermost area of the opening through the part 443b, and a corresponding rigid tube 445b is shown extending inwardly through the uppermost area of the opening through the part 443b, together such tubes 445a, 445b, at a prede-

terminated distance within the pressure vessel from the part 443b, one spaced above the other, enter into the outer end or face of a receiver 446, which may be termed an air gap providing block or probe.

Instrument air enters through a conduit 449, passed through suitable adapter fitting means 454, into the interior of the bellows box housing 443, and a reduced diameter flexible tubing 445c, which may extend as from a venturi tube or choke orifice provided within the adapter fitting means 454, is passed through the interior of the housing 443, and through a suitable bore therein, as through the boss 443a, to continue as the hereinabove described tube 445a. The receiver or probe block 446 is of modified, inverted U-shape in construction, to from an outer leg 446a through which extends the outer end portion of the tube 445a, with a discharge nozzle shaped nose 445d projecting slightly into the air gap 447 provided between the probe block or receiver outer leg 446a and inner leg 446b.

The hereinabove upper disposed tube 445b extends through the receiver or probe block 446 and is recurved therein to project outwardly from the inner leg 446b into the air gap 447. The slight projection 445c of the tube 446b into the air gap is disposed directly oppositely of, or in co-axial extension of the nozzle 445d. Noticeably this projection is concave, or could be slightly flared or streamlined better to receive high velocity air directed thereinto across the air gap 447 from the nose or nozzle 445d.

Within the housing 443 is disposed the bellows box 448 which is pressurized slightly above atmospheric pressure around the bellows 449, the inside of which is in communication with the tube 445b which passes sealably through the bellows box 448 prior to connection therewithin to the bellows, as aforesaid. The outer end of the box 448 has a bellows connected contact point 450a passed therethrough and through an inner wall of a micro-switch housing or bracket 451. Within the housing 451 the end of the bellows connected contact point 450a confronts a housing mounted contact point 450b that is mounted in manner to be positioned by the point 450a to close or let open a micro-switch, not shown, but carried by the bracket or housing 451.

The heads of three machine screws are seen on the forward or outer wall of the bracket or micro-switch housing 451, to serve as posts 452a, 452b, 452c, which serve, respectively, for positive conductor, common, and neutral (or negative) conductor connections. Two conductors designated 433a (positive), and 433 (neutral), in correspondence with the conductors of same function in FIGS. 17, 18, and 19, are shown extending through a common outlet bos 443d, FIG. 20.

FIG. 21 shows diagrammatically the air gap type level probe with its several operative parts arranged in sequence of operation from the right to the left of the upper part of the diagram, and with the apparatus operative in association therewith shown in alignment therebelow.

Instrument air starts from an AIR SUPPLY, as a compressor, to pass through a strainer or filter F, and through a V Reg. (386, FIG. 19) to be fed into a pressure vessel to activate the material therein, and with part passing to an instrument air location or SOURCE, as through a small tubing to a panel box. From this SOURCE the instrument air, at pressure to operate the air gap level probe 442, passes through conduit 447 and tubing 445c, (FIG. 20), not shown in FIG. 21, and

passes out the air nozzle 445d at velocity to extend straight across the AIR GAP into the shaped inlet 445e of the RECEIVER (tube 445b through block 446). Thence the compressed air passes within the tube 445b, into the bellows box 448 and from the tube 445b enters the interior of the bellows 449. As long as the flow across the air gap (445d to 445e) is not interrupted, as should be the case during the greatest part of the fill cycle, the force of the air in the bellows 449 is enough to keep it urged outwardly, thus to urge the stop bar 449a, across the outer end of the bellows 449, against the inner face of the outer wall of the bellows box 448.

As the bellows connected, hollow contact point or plunger rod 450a, also connected to the stop bar 449a, is thus urged to maximum outwardly extent, it forces the micro-switch bracket or housing mounted, insulated contact point or plunger rod 450b to urge the arm 453a of the micro-switch 453, pivoted on the neutral or negative post 452c, to maximum outwardly extents. At such maximum outwardly extent the switch arm 453a closes contact with the positive contact post 452a and circuit is completed, as from a positive side conductor 424a, (FIG. 20), through the post 452a, switch arm 453a, post 452c, circuit 433 containing solenoid windings for operating fill valve opening valve operator 373, and on to the negative power line circuit 406. Consequently by this arrangement, the closing of circuit to open the fill valve can take place by level probe actuation. Alternately fill valve closure may be independent of level probe actuation, or in parallel therewith, where these operations start in parallel by the closing of the positive side conductor circuit 424a by the pressure sensitive switch 428, as the purge cycle ends.

Now, as the material rises in the materials plenum of the pressure vessel, if in size above the minimum particle size necessary to interrupt the AIR GAP, the intensity of the air blast across the AIR GAP that enters the inlet 445e into the tube or passage 445b will be diminished so that the pressure within the bellows 449 drops off, while the air pressure upon the exterior of the bellows within the bellows box 448 remains unaffected. As a consequence the bellows is contracted, so the contact point or plunger 450a may retract. The bellows 449 when under the uninterrupted blast of AIR GAP crossing air, has urged the switch arm 453a to close circuit against the positive contact post 452a, and against the pull of a spring 453b. Then, as the hollow plunger 450a retracts, the plunger 450b at first follows it inwardly, as the spring draws the arm 453a out of contact with the positive post 452a until the switch arm 453a contacts the common post 452b as a stop collar 453c on the plunger 450b contacts the inner surface of the wall of the switch housing 453.

As the circuit 433a, 433, is thus broken, the solenoid windings 433 are de-energized to switch the 4-way valve handle 90° to the right in FIG. 21, thus to place instrument air conduit 408b in communication with the conduit 373c, to the outer end of cylinder of the fill valve operator 373, thus to close the FILL VALVE. The fill valve operator cylinder, under the piston 373a, can evacuate through the conduit 373b and exhaust through the 4-WAY VALVE. Note that in regard to 4-WAY VALVE operation, a symbolical designation indicates that the solenoid armature for the solenoid windings 433 is operatively connected to the handle of the 4-WAY VALVE.

A feature to be noted in FIG. 21 is an O-ring seal 448a, at the inner end of the bellows block 448, around the receiver or air gap air conduit 445b, thus to keep the air within the bellows box 448 from leaking out, whereby the bellows 449 remains under a constant pre-determined pressure above atmospheric. It is also a feature for observation that the contact point or plunger 450a is hollow and communicates with the interior of the bellows 449, and that when the bellows contracts and the outer end of the plunger 450a disengages contact with the plunger 450b, the bellows 449 may purge itself of any impurities brought in with the air that has first blown across the material first rising into the AIR GAP.

It is pointed out, that this type of level probe, which is generally subject to usage under conditions set forth hereinabove, but not limited to such usages, may be employed for "fail safe" or safe guarding fill valve closure, as well as for the purpose of primarily, or in the optional alternative, such probe may be used for closing the fill valve.

Referring now to FIG. 22, a fluid flow pump pressure vessel 460 is shown as the container for any of the types of pumps operative to include the basic fluid flow pump cycle shown in FIGS. 1-3, inclusive. The salient feature about this installation is that a fixed platform 461 supports a load cell 240, a platform 462 has the anvil upper part 255b mounted centrally thereunder to seat on the lower anvil part 255a comprising the uppermost member of the load cell 240 that is included in the load cell parts supported by the lower or fixed platform 461.

From the under side of the upper platform four stanchions or support pipes 463, symmetrically disposed from the vertical axis through the pressure vessel 460, are indicated as passing guidably through holes 464 through the lower platform 461 with the pipes or strong connection rods or stanchions 463 being thus spaced from the aforesaid vertical axis that they extend in line of contact against the pressure vessel 460 and may be affixed thereto, as by welding. In this manner, the mounting of the pressure vessel 460 is in balance with, and in co-axial vertical alignment with the vertical axis of the load cell 240 on which the weight of the pressure vessel 460 and of its associated and attached structures, bears in suspension. In FIG. 22 the left uprights 465a, that upstand, as from the factory floor, are shown connected to the left end of the lower or fixed platform 461. Also, central uprights 465b are shown as having the right end of the lower or fixed platform 461 connected thereto.

Consequently, nuts and bolts 466, above the respective upright posts or stanchions 463, indicate that an assured method of assembly may include providing studs at the top of each stanchion 463, to extend through appropriately located holes, concentrically about the vertical axis through the upper platform 462, with the nuts being threaded upon the upper ends of the bolts 466 to complete assured aligned and balanced assembly of pressure vessel with relation to platforms 461, 462. As the connection are then thus made the pressure vessel 460 will, of course, have to be supported by a temporary, removable supporting or lifting means, from below.

Spaced from the right of the central uprights 465b are shown right uprights 465c, both uprights 465b, 465c, being taller than the left uprights 465a, to support a hopper support frame 468 for a materials hopper

470. A bottom flange of the hopper 470 has an upper fill valve 469 connected thereto, with a flexible conduit section 471 connected therebelow. Then a lower fill valve 472, is shown connected below the flexible conduit section 471, with a downspout 473 extending downwardly and to the left from the lower fill valve 472 for connection into the top of the pressure vessel 460.

A suitable spacer and centering nipple or cap may be provided on top of the pressure vessel 460, or centrally under the lower platform 461, or for both lower platform and pressure vessel, thus for room for any apparatus that may be disposed on the upper part of the pressure vessel 460, under the lower platform 461, such as discharge valve and purge valve and their valve operators, or relief valves and the like. Illustrative of this feature, the uprights 465a, 465b, 465c, the stanchions 463, and the downspout 473 are shown broken. Also, the above enumerated apparatus may extend through suitable apertures in the lower platform 461, thus also permitting easier access for service from the lower platform 461, (or from the upper platform 462), as needs be.

Noticeably in FIG. 22, there can be allowed ample room for all of the apparatus including activating air, and piping necessary to complete operation of the pressure vessel 460 for any of the various types of usages hereinabove described. Also, the panel box 474 is indicated as being readily accessible as to an operator standing at factory floor level.

As hereinabove described, two fill valves 469, 472, are required to hold the weight of the material in the hopper from being imposed for tare weight adjustment, correspondingly while as shown in FIGS. 4, the fill valve 469, 472 should be connected through their valve operator conduits in manner that the upper fill valve 469 closes just a trifle sooner than the lower fill valve 472. The disclosure of FIG. 22 purposely omits showing complete apparatus and piping, since all necessary, and obvious, for the various types of pump usages that can be made from the platform and hopper dispositions of FIG. 22, have been fully disclosed, and in full detail hereinabove.

Making reference to the basic circuitry of FIG. 2 of the basic fluid flow pump patent, this circuitry may be modified for better wiring practice by shifting the latching relay coils and switches toward the "hot" or positive side of the circuitry without in any way changing function, various minor modifications of wiring may be made, whereby the demands of usage may call for a change in the means or factor controlling any special cyclic step in the basic fluid flow pump cycle, or in any of the more involved cycles which include the fluid flow pump basic cyclic steps.

Considering FIG. 23, a timer circuit 475 is shown in parallel with the circuit 57a, conventionally having a switch 64, closed by timer after the latching relay 52 shifts right at the end of the filling and fill valve closing cycle. This circuit 475 is indicated as closing a switch 476 at a predetermined time after the activating air valve opening is actuated by energization of the solenoid windings 59, thus the switch takes the place of the pressure sensitive switch 69, FIG. 2, in circuit 57e, 57d, and actuates the opening of the discharge valve by energizing the solenoid windings 65 to actuate the opening of the discharge valve, not as a function of pressure, but as a FUNCTION OF TIME, controlling the period of activation.

Now considering FIG. 24, the switch 73 in circuit 72b (that closes when the pressure in the pressure vessel, under discharge, drops to say 18 p.s.i., to introduce the purge cycle), is shown as having, in circuit 72b, a switch 477 substituted therefor that is closed by actuation of a timer circuit 478 in series with the switch 70 in the circuit 52f, and set operative at the same time the solenoid windings 65 are energized to actuate opening of the discharge. Thus by this means the discharge cycle duration is controlled, not as a function of pressure, but as a FUNCTION OF TIME.

Referring now to FIG. 25, the opening of the fill valve, at the end of the purge cycle, is shown obtained by the injection of a timer circuit 479 in the circuit 45b which contains the first latching relay switch 56a therein which is closed when the latching relay 52 shifts right, beginning the purge cycle. At this point the pressure sensitive switch 51b closes as the pressure vessel pressure has fallen, say below 18 p.s.i., and circuit is completed from positive to negative side, by way of circuit 45a, 45b, with the re-latched relay switch 56a and the timer circuit 479 therein, and thence via circuit 55, with the now closed pressure switch 51 and purge light 54 therein, to the negative power line circuit 42. The timer circuit 479 thus can be set to time out before the purge light circuit switch 51b opens, at say 0.5 p.s.i. pressure vessel pressure, and thus closes a switch 480, (substituted in the circuit 45c for the pressure sensitive switch 51a), to carry circuit to parallel circuits, one including the solenoid windings 47 that actuate the closing of the fill valve. Thus the closing of the fill valve can be controlled, not as a function of pressure (by switch 51a), but as a FUNCTION OF TIME.

In FIG. 26 an arrangement is shown whereby the normally open pressure sensitive switch 69 that closes the circuit 57e, 57d, to start the discharge cycle, is replaced by a pressure sensitive switch 481 operative by a pressure fluid signal from the control chamber of a load cell 240. The conduit 287 that transmits the signal thus extends from the load cell to the panel box, where the control circuitry is located. The pressure switch 481 is set to close responsive to the intensity of a signal that reflects full batch weight plus the additional small fraction of weight above batch weight that is representative of the weight of air or gas that is required to pressurize the batch weight for discharge. The closure of the circuit 57e, 481, 57d, results in the energiation of the solenoid windings 65 that actuates the opening of the discharge valve. As occurs conventionally, the control or latching in relay 68 latches in the discharge cycle by closing the switch 70 in the circuit 57f, so that when the intensity of the signal in the conduit 287 drops off as discharge begins, the discharge valve remains opened, as aforesaid. Thus the discharge cycle may be controlled, not as a function of pressure, but as a FUNCTION OF WEIGHT.

Also, the fluid pressure signal responsive to net weight effective in a load cell 240 may be employed, as shown in FIG. 27, to let a pressure sensitive switch 482, (that is substituted in place of the pressure sensitive switch 73, shown in FIG. 2), close as the weight of load cell affecting material and activating air drops under discharge to a predetermined amount. As the switch 482 closes to close circuit 72b, 72a, (the switch 74 having previously been closed by the control or latching in relay 68), the second latching relay coil 52b is energized to open the latching switch 56b, whereby the dis-

charge and activating air valve close, and the purge valve opens. Thus the discharge cycle, with the circuitry just disclosed, is not controlled a function of pressure, but as a FUNCTION OF WEIGHT.

In FIG. 28, a load cell 240 is shown with conduit 287 extending to the position of a pressure sensitive switch 483 that takes the place of the normally closed pressure sensitive switch 51a, that opens after the fill cycle and stays open until the pressure in the pressure vessel drops to say 0.5 p.s.i., or to substantially atmospheric pressure at the end of the purge cycle. The intensity of the pressure fluid signal from the load cell control chamber bearing against the pressure sensitive switch 483, diminishes during the discharge and purge cycles. When the second or left latching relay coil 52b has been energized at the start of the purge cycle, to shift right and unlatch the left or second latching relay switch 56b, the first or right latching relay switch 56a has been latched, so during the purge cycle circuit has been completed through the circuit 45a, 45b, 55, (with switch 51b closed at pressures above say 0.5 p.s.i. and purge light 54 therein) to the negative main power line circuit 42. Then, at the end of the purge cycle, as the pressure in the pressure vessel drops to say 0.5 p.s.i. or substantially atmospheric, the intensity of the weight responsive pressure fluid signal imparted to the newly substituted, pressure sensitive switch 483, diminishes, as the batch load is substantially all transferred on down the discharge line. Thus the switch 483 is permitted to close whereby circuit is completed through the solenoid windings 46 to actuate the opening of the fill valve. Consequently by this substitution, the opening of the fill valve cannot be said to result as a function of pressure, but as a FUNCTION OF WEIGHT.

As indicated in FIG. 28, a branch conduit 287a may extend from a tee 287b in the load cell signal conduit 287, to the switch 46a in the circuit 55a that includes the latching relay first or right coil 52a that is energized at the end of the fill cycle. Thus this switch may be converted from a switch 46a that closes at the end of a time cycle as originally indicated in FIG. 2, to a switch 482 that closes when the intensity of the load cell weight signal builds up to that commensurate with the predetermined batch weight that is to be deposited within the pressure vessel before the fill valve is closed. By this means the closing of the fill valve can be said to be converted to a closure effected not as a function of time, but to a closure effected as a FUNCTION OF WEIGHT.

FIG. 29 is a circuit diagram indicative of the use of the valve operator 23, FIG. 1, as a means of closing circuit resulting in opening the activating valve 26 assuredly not before full closure of the fill valve 18. This feature has been hereinabove described as for instance, as applicable to the closure of the vacuum filled pump fill valve, FIGS. 19 and 20, but this feature can be employed to close circuit leading to the opening of the compressed air or activating gas inlet valve in any form of fluid flow pump structure. In the particular form shown in FIG. 37 it is indicated that a delay may be desired, even after the fill valve has been fully closed.

As shown in FIG. 37, the piston rod for the piston 23a of the valve operator 23 that closes the fill valve, is shown as having a forward extension 484 thereon that passes sealably through the outer end of the valve operator cylinder. Outwardly of the outer end of the cylin-

der, an insulative closure cam 485 is attached to piston rod extension 484 in a precalculated location.

Thus, when the piston rod extension 484 is in fill valve closed position, the cam 485 will have urged the switch arm 486 to close a circuit 487 that is shown in FIG. 29 as including a timer 488 in series therein. In this case the circuit 487 is in parallel with a circuit 57a, 59, FIG. 2, which includes the timer actuated switch 64 therein, and the solenoid windings 59 of the solenoid 60 which actuates the opening of the compressed air or gas inlet or activating valve 26, FIG. 1. Optionally, the limit switch LSI may be in series circuit with the solenoid windings 59, as indicated in dotted lines in FIG. 2, such arrangement being employed when it may not be desired to impose a further time delay after fill valve closure, before actuating the opening of the air valve 26. This feature is indicated in FIG. 29 by dotted lines that would place the limit switch LSI in series with the second latching switch 56b of the latching relay 52, such switch 56b being closed by operation of the first latching relay coil 52a at the end of the fill cycle. Under any arrangement the assurance that the fill valve is fully closed before actuation of the air or activating valve opening, is first a FUNCTION OF LIMIT SWITCH POSITION AT FILL VALVE CLOSURE.

Referring finally to FIG. 30, a normally open switch 490, which may be of the vibrated paddle, air gap, revolved blade or any other type of level probe types, is shown in the circuit 55a in series with the first relay coil 52a of the latching relay 52. Thus when the level of material in any type of fluid flow pump reaches level probe or sensor level during the fill cycle, as the level probe means of sensing is interrupted by material, the switch 490 closes to close the circuit 55a.

Upon closure of the circuit 55a the first latching relay coil 52a is energized to unlatch, open or break open the circuit 45b containing the first or right latching relay latch switch 56a, thus to break circuit through the solenoid windings 47 which, when deenergized, actuate the closing of the fill valve 18. When the level probe is relied upon solely to cause fill valve closure, the arrangement is as indicated in the circuit 55a, FIG. 30. If a level probe is to serve as an alternative feature, or as a "fail safe" or safeguarding feature for assuring fill valve closure, then a circuit 55b in parallel with the level probe, may contain another means of setting in motion fill valve closure may be employed, as the switch 46a closed by the timing out of the timer 46, FIG. 2.

The improvements claimed are all predicated on the original fluid flow pump apparatus and cyclic circuitry, with the inventions herein disclosed being predicated on various novel re-arrangements of circuitry, inclusion of scale usage for fill valve closure, especially the service of a new load cell in various combinations of usage, with the load cell also being claimed per se as a sub-combination invention. Especially the inventions disclose a unique method and apparatus for suspending various modifications of the basic fluid flow pump upon a load cell whereby access to all associated parts is more readily obtained. The application is completed by the appended claims, not submitted in undue multiplicity, but to cover the various patentably distinct combinations entailed is this comprehensive disclosure of a wide range of improvements.

I claim:

1. Material transporting apparatus comprising a pressure vessel including a gas permeable diaphragm bridg-

ing 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 valve communicating into said gas plenum, a discharge valve controlled discharge conduit with discharge valve disposed exteriorly of and in communication with the upper part of said material plenum, a purge valve controlled by-pass conduit with purge valve disposed in communication with the upper part of said material plenum adjacent and around said discharge valve, operative circuitry including control means, and being operable to open said fill valve, said circuitry including at least one of time actuated means, material lever sensor actuated means, and batch weight actuated, vessel supporting scale generated, pressure fluid signal operated circuitry, to close said fill valve, said operative circuitry then being automatically operable sequentially to close 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 to open said discharge valve for material to pass through said discharge valve and outwardly through said discharge conduit, then to close said discharge valve and open said purge valve for the residual compressed gas to purge residual material through said purge valve and said by-pass conduit, and material outwardly through said discharge conduit, then to open said fill valve, as aforesaid, said operative circuitry including time actuated means to function in at least one of the opening of said discharge valve, the closing of said discharge valve and of said gas inlet valve and the opening of said purge valve, and in the opening of said fill valve.

2. Material transporting apparatus as claimed in claim 1, in which said operative circuitry includes pressure sensitive means, operative as the pressure rises in excess of it, high control pressure, to open said discharge valve; in which said operative circuitry includes, as the material plenum pressure falls with discharge below a lower control pressure, a pressure sensitive means to actuate the closing of said discharge valve and said gas inlet valve and the opening of said purge valve; and in which said operative circuitry includes time actuated means to function in opening said fill valve.

3. Material transporting apparatus as claimed in claim 1, in which said operative circuitry includes pressure sensitive means, operative as the pressure rises in excess of it, high control pressure, to open said discharge valve; in which said operative circuitry includes time actuated means to function in closing said discharge valve and said gas inlet valve and opening said purge valve; and in which said operative circuitry includes pressure sensitive means operative as the material plenum pressure falls substantially to atmospheric, to open said fill valve.

4. Material transporting apparatus as claimed in claim 1, in which said operative circuitry includes pressure sensitive means, operative as the pressure rises in excess of it, high control pressure, to open said discharge valve; in which said operative circuitry includes time actuated means to function in closing said discharge valve and said gas inlet valve and opening said purge valve; and in which said operative circuitry includes time actuated means to function in opening said fill valve.

open said discharge valve; in which said operative circuitry includes time actuated means to function in closing said discharge valve and said gas inlet valve and opening said purge valve; and in which said operative circuitry includes pressure sensitive means operative as the material plenum pressure falls substantially to atmospheric, to open said fill valve.

18. Material transporting apparatus as claimed in claim 1, in which said operative circuitry includes material and gas weight actuated, vessel supporting, scale generated pressure fluid signal operated circuitry to open said discharge valve; in which said operative circuitry includes time actuated means to function in closing said discharge valve and said gas inlet valve and opening said purge valve; and in which said operative circuitry includes substantially pressure vessel weight supporting scale generated pressure fluid signal operated circuitry to open said fill valve.

19. Material transporting apparatus as claimed in claim 1, in which said operative circuitry includes material and gas weight actuated, vessel supporting, scale generated pressure fluid signal operated circuitry to open said discharge valve; in which said operative circuitry includes time actuated means to function in closing said discharge valve and said gas inlet valve and opening said purge valve; and in which said operative circuitry includes time actuated means to function in opening said fill valve.

20. Material transporting apparatus as claimed in claim 1, in which said operative circuitry includes material and gas weight actuated, vessel supporting, scale generated pressure fluid signal operated circuitry to open said discharge valve; in which said operative circuitry includes material and gas weight actuated, vessel supporting, scale generated pressure fluid signal operated circuitry to close said discharge valve and said gas inlet valve and open said purge valve; and in which said operative circuitry includes time actuated means to function in opening said fill valve.

21. 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 valve communicating into said gas plenum, a discharge valve controlled discharge conduit with discharge valve disposed exteriorly of and in communication with the upper part of said material plenum, a purge valve controlled by-pass conduit with purge valve disposed in communication with the upper part of said material plenum adjacent and around said discharge valve, operative circuitry including control means, and being operable to open said fill valve, said circuitry including at least one of time actuated means, material level sensor actuated means, and batch weight actuated, vessel supporting scale generated, pressure fluid signal operated circuitry, to close said fill valve, said operative circuitry then being automatically operable sequentially to close 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, to open said discharge valve for material to pass through said discharge valve and outwardly through said discharge conduit, then to close said discharge valve and

said gas inlet valve and open said purge valve for the residual compressed gas to purge material through said purge valve and said by-pass conduit, and material outwardly through said discharge conduit, then to open said fill valve, as aforesaid, said operative circuitry including material weight actuated, scale generated pressure fluid signal operated circuitry to function in at least one of the opening of said discharge valve, the closing of said discharge valve and said gas inlet valve and the opening of said purge valve, and in the opening of said fill valve.

22. Material transporting apparatus as claimed in claim 21, in which said operative circuitry includes pressure sensitive means, operative as the pressure rises in excess of its high control pressure, to open said discharge valve; in which said operative circuitry includes to function, as the material plenum pressure falls with discharge below a lower control pressure, a pressure sensitive means to actuate the closing of said discharge valve and said gas inlet valve and the opening of said purge valve; and in which said operative circuitry includes substantially pressure vessel weight supporting scale generated pressure fluid signal operated circuitry to open said fill valve.

23. Material transporting apparatus as claimed in claim 21, in which said operative circuitry includes pressure sensitive means, operative as the pressure rises in excess of its high control pressure, to open said discharge valve; in which said operative circuitry includes material and gas weight actuated, vessel supporting, scale generated pressure fluid signal operated circuitry to close said discharge valve and said gas inlet valve and open said purge valve; and in which said operative circuitry includes pressure sensitive means operative as the material plenum pressure falls substantially to atmospheric, to open said fill valve.

24. Material transporting apparatus as claimed in claim 21, in which said operative circuitry includes pressure sensitive means, operative as the pressure rises in excess of its high control pressure, to open said discharge valve; in which said operative circuitry includes material and gas weight actuated, vessel supporting, scale generated pressure fluid signal operated circuitry to close said discharge valve and said gas inlet valve and open said purge valve; and in which said operative circuitry includes substantially pressure vessel weight supporting scale generated pressure fluid signal operated circuitry to open said fill valve.

25. Material transporting apparatus as claimed in claim 21, in which said operative circuitry includes material and gas weight actuated, vessel supporting, scale generated pressure fluid signal operated circuitry to open said discharge valve; in which said operative circuitry includes to function, as the material plenum pressure falls with discharge below a lower control pressure, a pressure sensitive means to actuate the closing of said discharge valve and said gas inlet valve and the opening of said purge valve; and in which said operative circuitry includes pressure sensitive means operative as the material plenum pressure falls substantially to atmospheric, to open said fill valve.

26. Material transporting apparatus as claimed in claim 21, in which said operative circuitry includes material and gas weight actuated, vessel supporting, scale generated pressure fluid signal operated circuitry to open said discharge valve; in which said operative circuitry includes to function, as material plenum pressure

falls with discharge below a lower control pressure, a pressure sensitive means to actuate the closing of said discharge valve and said gas inlet valve and the opening of said purge valve; and in which said operative circuitry includes substantially pressure vessel weight supporting scale generated pressure fluid signal operated circuitry to open said fill valve.

27. Material transporting apparatus as claimed in claim 21, in which said operative circuitry includes material and gas weight actuated, vessel supporting, scale generated pressure fluid signal operated circuitry to open said discharge valve; in which said operative circuitry includes material and gas weight actuated, vessel supporting, scale generated pressure fluid signal operated circuitry to close said discharge valve and said gas inlet valve and open said purge valve; and in which said operative circuitry includes substantially pressure vessel weight supporting scale generated pressure fluid signal operated circuitry to open said fill valve.

28. In combination with a pressure vessel having up- rights extending upwardly thereabove, an upper platform for supporting a load cell thereon with openings therein to receive said uprights guidably slidably there- through, a lower platform providing the load cell upper anvil centrally thereunder to seat upon the lower anvil carried at top of said load cell, and means to connect said uprights at top to said upper platform, material transporting apparatus comprising said pressure vessel and said pressure vessel further including a gas perme- able diaphragm bridging the lower part of said vessel above the bottom thereof and dividing it into a material plenum therabove and a gas plenum therebelow, fill valve means to admit flowable material into the upper portion of said vessel to upstand from said diaphragm and controlling an inlet conduit, a valve controlled, pressurized gas entry conduit into said gas plenum, a discharge valve controlling a discharge conduit and dis- posed in said discharge conduit exteriorally of said

pressure vessel, a valve controlled, purge conduit from said pressure vessel and by-passing said discharge valve to join into said discharge conduit downstream of said discharge valve, automatically operative circuitry in- cluding at least one of a level probe, timer means, and a load cell emanated signal transmitting means to actu- ate opening of fill valve means, including at least one of a limit switch closed by fill valve closure and timer means to actuate opening of said gas entry valve, and including at least one of pressure sensitive switch means, load cell emanated signal transmitting means and timer means to accomplish at least one of opening said discharge valve, of closing said discharge valve and said gas entry valve while opening said purge valve, and of opening said fill valve to start again the aforesaid cy- cle.

29. Material transporting means as claimed in claim 28, which additionally includes a purge valve con- trolled by-pass conduit with purge valve disposed in communication with the upper part of said material plenum and to connect into said discharge conduit downstream of said discharge valve.

30. Material transporting means as claimed in claim 28, in which said pressure vessel discharge is down- wardly, and in which a motor driven agitator is pro- vided to sweep through the material is it upstands above said diaphragm.

31. Material transporting means as claimed in claim 28, which additionally includes a hopper for material, at a higher elevation than said upper platform, and in which said inlet conduit includes a downspout.

32. Material transporting means as claimed in claim 28, in which said fill valve means comprises an upper and lower fill valve above said downspout with a flexi- ble connection therebetween, and in which said cir- cuitry includes means to insure that said upper fill valve closes slightly before said lower fill valve closed.

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