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DUPLEX LIQUID HANDLING APPARATUS HAVING IMPROVED ELECTRODE-TYPE CONTROL SYSTEM

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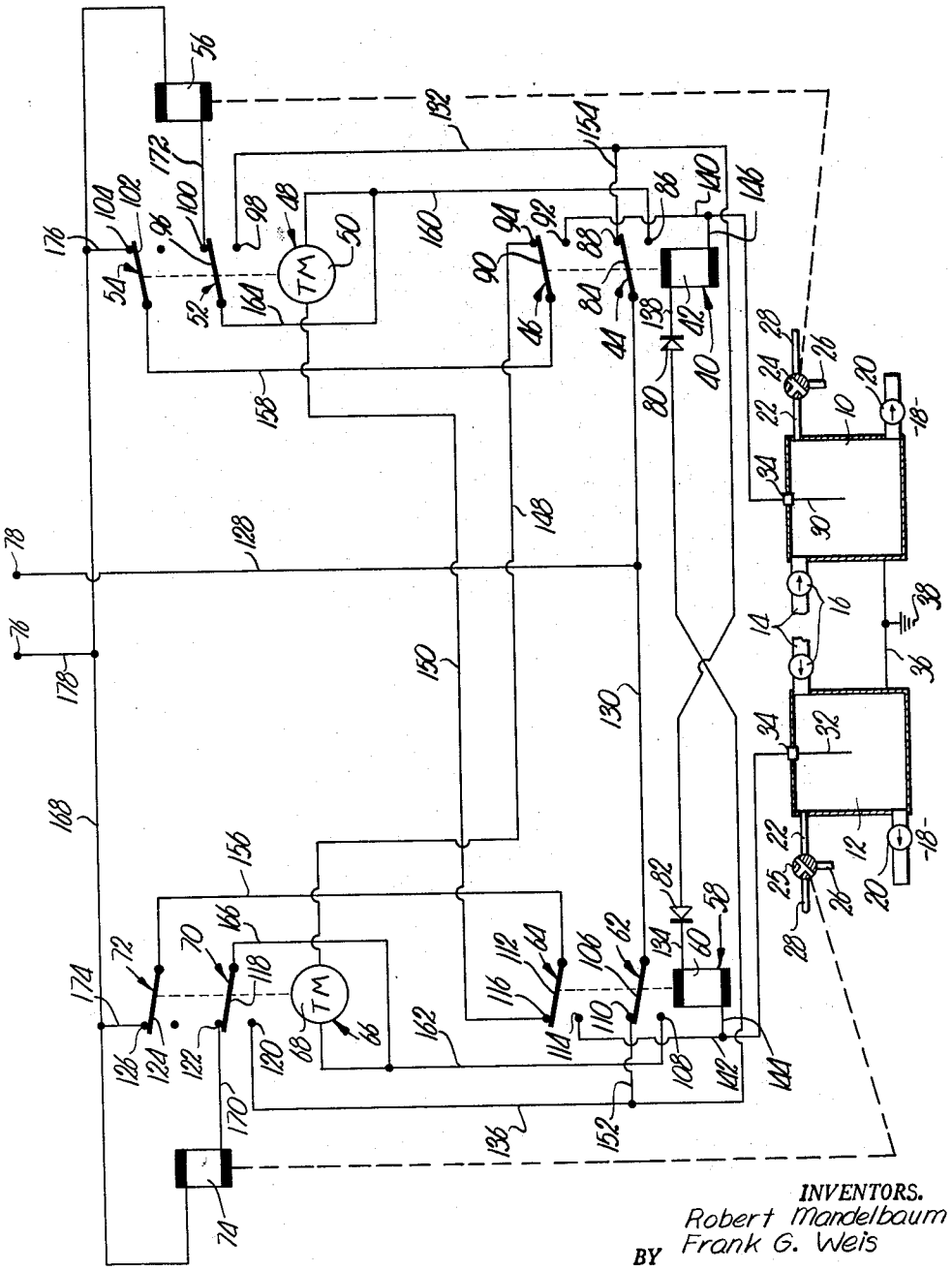

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DUPLEX LIQUID HANDLING APPARATUS HAVING IMPROVED ELECTRODE-TYPE CONTROL SYSTEM

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This invention relates to material-handling apparatus, and more particularly, to apparatus having a pair of material-receiving vessels from which the material is ejected by force. Such apparatus is particularly useful in the handling of flowable material such as sewage or the like, in systems where the material must be collected at a point at a lower elevation from the point of discharge.

It is absolutely imperative that such systems be designed to continue the operation of receiving and handling the material even during temporary malfunctioning of some of the components. It is desirable that a pair of receptacles be provided so that should one receptacle fail ot function properly, the other could carry out the material-handling operation. Heretofore, no effective control has been provided for interconnecting dual material receptacles so that an auxiliary receptacle is available for instant operation upon failure of operation of the primary receptacle.

Accordingly, it is the primary object of this invention to provide apparatus having an auxiliary material-handling component interlocked with the primary component to immediately assume the material-handling function upon failure of the primary component.

Another equally important object of our invention and assisting in the achievement of the foregoing objects, is the provision of apparatus having dual handling components interlocked in a manner so that the primary and the auxiliary components cannot be in the ejection cycle of the material-handling operation at the same time.

Still a further object of the instant invention is the provision of apparatus where either the primary or the auxiliary component is individually capable of handling the material during peak load to the apparatus, thereby preventing an overload to the system should one component fail to function properly.

Yet another object of this invention is to provide apparatus for handling material where the primary and the auxiliary components alternate in the material-handling function to thereby distribute the wear evenly between the components.

Still a further object of this invention is the provision of an electrical control for the apparatus to continue the alternate cycling between the two material-handling components, even when the material-sensing element of either or both components becomes fouled.

The drawing is a circuit diagram for the electrical control of the system with the material-receiving vessels shown diagrammatically coupled with the control.

The material-handling apparatus includes a pair of normally closed, material-receiving vessels 10 and 12 with each vessel being provided with a material inlet 14 adapted to be coupled with a source of material to be handled. A check valve 16 in each inlet 14 permits the flow of material to a respective vessel 10 or 12 and prevents the flow in the opposite direction. Outlet means 18 for each vessel communicates therewith and each is provided with a check valve 20 to permit material to pass from the respective vessels through the outlet, but to prevent flow in the opposite direction.

A pipe 22 for each of the vessels communicates there-

with and each is provided with a 3-way valve 24 and 25 respectively communicating the respective pipes 22 with vents 26 so that when valves 24 and 25 are in their normal positions, the interior of the vessels 10 and 12 are in fluid communication with the atmosphere. Additionally, valves 24 and 25 have alternate positions communicating with conduits 28 extending from the respective valves 24 and 25 and each conduit 28 is adapted to be coupled with a source of fluid under pressure.

The vessels 10 and 12 have material-sensing elements 30 and 32 respectively extending into the vessels and disposed in position to be engaged by the material within a respective vessel when the material reaches a predetermined accumulation. The elements 30 and 32 are insulated from the walls of the vessels by insulators 34 precluding electrical connection between the element and the wall of the vessel. The two vessels 10 and 12 are interconnected by an electrical line 36 which is in turn grounded as at point 38.

Vessel 10 is provided with an electrically responsive switching device 40 having a coil 42, and a pair of coil-operated, single-pole, double-throw switches 44 and 46. Additionally, vessel 10 has a timer 48 comprising a time delay mechanism 50 which may be of any suitable type such as an electrically operated motor. Timer 48 is provided with a single-pole, double-throw switch 52, and a single-pole, single-throw switch 54, which are operated by mechanism 50 and may be disposed to be operated by the electrical motor through cam means or the like, whereby the motor operates the switch after a predetermined lapse of time following energization of the motor. Timer 48 is constructed so that the switches thereof remain in their operated condition so long as energy is applied to mechanism 50 and immediately upon de-energizing of mechanism 50, the switches return (through spring action or the like) to their original positions.

An electrical solenoid 56 is operably coupled with valve 24 so that when solenoid 56 is energized, valve 24 is shifted from its normal position to its alternate position precluding communication of vessel 10 with the atmosphere and permitting fluid from the source (not shown) to be admitted into vessel 10 for ejecting the material therein through outlet 18.

Vessel 12 is provided with an electrically responsive switching device 58 similar to device 40, and device 58 has a coil 60 and a pair of single-pole, double-throw switches 62 and 64. Also, vessel 10 has a timer 66 having a time delay mechanism 68 and a mechanism-operated, single-pole, double-throw switch 70, and a single-pole, single-throw switch 72. A solenoid 74 is operably coupled with valve 25 for shifting the latter from its normal to its alternate position, thereby shutting off communication of vessel 12 with the atmosphere and permitting the interjection of fluid under pressure into vessel 12 for forcing the material therefrom through outlet 18. Manifestly, when solenoids 56 and 74 are de-energized, the respective valves 24 and 25 return to their normal positions under the bias of spring means or the like (not shown).

In addition to the devices and timers, the electrical control for the material-handling apparatus includes a source 75 of electrical energy that is connected to contacts 76 and 78. It is contemplated that such energy will be of the normal, commercially available, alternating current type and, for purposes to be made clear hereinafter, the system includes a pair of rectifiers 80 and 82 capable of converting the alternating current into direct current.

Switch 44 is provided with a pole 84 and a pair of fixed contacts 86 and 88. Switch 46 has a pole 90 and contacts 92 and 94. Switch 52 has a pole 96 and fixed contacts 98 and 100, while switch 54 has a pole 102 and a single contact 104. Switch 62 has a pole 106, a

fixed contact 108 and a second contact 110, while switch 64 of device 58 has a pole 112, a fixed contact 114 and a second fixed contact 116. Switch 70 of timer 66 has a pole 118, a fixed contact 120 and a second fixed contact 122, while switch 72 has a pole 124 and a single fixed contact 126.

Main line 128 connects contact 78 with a line 130 interconnecting pole 106 of switch 62 with pole 84 of switch 44. A line 132 interconnects contact 98 of switch 52 with rectifier 82, and a lead 134 connects the other side of the rectifier 82 with coil 60. A line 136 interconnects fixed contact 120 of switch 70 with rectifier 80, and a lead 138 extends from rectifier 80 to coil 42. A line 140 extends from contact 92 of switch 46 and is coupled with element 30 of vessel 10, while a line 142 extends from fixed contact 114 of switch 64 and is coupled with element 32 of vessel 12. A lead 144 connects line 142 with one side of coil 60, while a similar lead 146 connects line 140 with coil 42.

The fixed contact 94 of switch 46 is electrically coupled with mechanism 68 of timer 66 by a line 148, while a similar line 150 interconnects fixed contact 116 of switch 64 with mechanism 50 of timer 48. Line 136 is electrically coupled with fixed contact 110 of switch 62 by lead 152, and a similar lead 154 interconnects line 132 with fixed contact 88 of switch 44. Pole 112 of switch 64 and pole 124 of switch 72 are intercoupled with line 156, and a similar line 158 interconnects pole 102 of switch 54 with pole 90 of switch 46. Contact 86 of switch 44 is electrically coupled with one side of timer mechanism 50 by line 160, and mechanism 68 of timer 66 is connected with contact 108 of switch 62 by line 162. Line 160 is coupled with pole 96 of switch 52 by line 164, and a line 166 couples pole 118 of switch 70 with line 162. Solenoid 74 is electrically coupled with solenoid 56 through line 168, and solenoid 74 is in turn coupled with contact 122 of switch 70 by line 170.

A line 172 interconnects solenoid 56 with contact 100 of switch 52. A lead 174 extends between contact 126 of switch 72 and line 168, while a similar lead 176 couples the line 168 with contact 104 of switch 54. Line 168 is in turn, electrically coupled with contact 76 of the source through line 178.

In operation, material is admitted into the vessels 10 and 12 through the respective inlets 14 until the material in one of the vessels reaches an accumulation where the material touches an element such as 30. The touching by the material of element 30 completes a circuit for energizing coil 42 which may be traced from contact 78, through line 128, line 130, pole 106, lead 152, line 136, rectifier 80, lead 138, coil 42, lead 146, line 140, element 30, through the material to line 36 and thence to ground 38. In passing rectifier 80, the alternating current is converted to direct current which permits the utilization of a much more sensitive coil 42 than would be possible with alternating current and thus insures ready response when the material within vessel 10 engages element 30.

When coil 42 is thus energized, the poles 84 and 90 of switches 44 and 46 respectively, are switched from their normal positions to positions engaging contacts 86 and 92 respectively. Such switching completes a second circuit energizing mechanism 50 of timer 48. The second circuit is traceable from contact 78, through line 128, line 130, pole 84, contact 86, line 160, mechanism 50, line 150, contact 116, pole 112, line 156, pole 124, contact 126, lead 174, line 168, line 178, to contact 76 of the source. Such energizing of mechanism 50 initiates the time delay mechanism of timer 48 but has no immediate effect upon switches 52 and 54 of the timer.

Simultaneous with the energizing of timer 48, solenoid 56 is energized through a third circuit which may be traceable from contact 78, through line 128, line 130, pole 84, contact 86, line 160, line 164, pole 96, contact 100, line 172, solenoid 56, line 168, line 178, to contact 76. When solenoid 56 is thus energized, it shifts valve 24 from its normal position to its alternate position, thereby permitting pressurized fluid to enter vessel 10 and eject the material therefrom. As the material clears element 30, the first circuit which initially energized coil 42, is thus broken. However, coil 42 remains energized through a holding circuit which may be traced from contact 78, through line 128, line 130, pole 106, contact 110, leads 152, line 136, rectifier 80, lead 138, coil 42, lead 146, line 140, contact 92, pole 90, line 158, pole 102, contact 104, lead 176, line 168 and line 178 to contact 76.

Thus, so long as switch 54 remains in its position with pole 102 engaging contact 104, the holding circuit for coil 42 remains closed, and the switches 46 and 44 of device 40 are in their operated positions. However, after the lapse of a predetermined period of time which may be adjustably set in the timers 48 and 66 and will be calculated from the normal period of time necessary for the pressurized fluid to eject material completely from the containers 10 or 12, the mechanism 50 operates the first and second mechanism-operated switches 52 and 54 respectively.

The opening of the second mechanism-operated switch 54, breaks the holding circuit previously described and, inasmuch as there is no material contacting element 30, coil 42 is de-energized and the switches 44 and 46 are permitted to return to their initial position.

Normally, while vessel 10 is discharging material, vessel 12 will have completed its filling and the material will have accumulated to a position where it engages element 32. This completes a first circuit for energizing coil 60 which may be traced from contact 78, through line 128, line 130, pole 84, contact 88, lead 154, line 132, rectifier 82, lead 134, coil 60, lead 144, line 142, element 32, and through the material to line 36 and then to ground 38.

It will be readily understood that rectifier 82 is identical with rectifier 80 and permits the utilization of direct current through coil 60 for the same purposes discussed with respect to coil 42. By using a direct current to both elements 30 and 32, the elements have a longer life because there is not so great a problem of electrolysis as would be present if alternating curent were in contact with the elements.

Upon energization, coil 60 operates switches 62 and 64 and the components of vessel 12, namely, the timer 66 with its first and second mechanism-operated switches 70 and 72 respectively, and solenoid 74, perform identical operations in the ejecting of material from within vessel 12 as has heretofore been detailed with respect to vessel 10. In the interest of brevity, the respective energizing circuits for these steps will not be enumerated inasmuch as they are similar with the circuits described for vessel 10. It should be noted, however, that in normal operation the components for the respective vessels continue to operate alternately, and since the circuit for energizing the coil 42 or 60 of one vessel passes through a coil-operated switch of the other vessel, only one coil can be energized at a time during such normal operation. Thus, the coil-operated switches 62 and 44, together with the energizing circuits for the coils, comprise interlock means to prevent both vessels 10 and 12 from ejecting material at the same time. However, the elements 30 or 32 may become fouled by material or the like clinging thereto and contacting the walls of a respective vessel to establish a contact with ground which is not broken upon the accumulation of material being ejected from the particular vessel. If this should occur, for example, within vessel 10, coil 42 would remain energized upon the shifting of the contacts of switch 54 by mechanism 50 of timer 48 after the completion of the ejection cycle.

The circuit which maintains the energy to coil 42 is the

first circuit previously enumerated, and may be traced from contact 78, through line 128, line 130, pole 106, contact 110, lead 152, line 136, rectifier 80, lead 138, coil 42, lead 146, line 140, element 30 through the material to ground at 38. With coil 42 energized, pole 84 is maintained out of contact with fixed contact 88 and, coil 60 is thereby prevented from becoming energized. This prevents the shifting of pole 106 into engagement with contact 108 of switch 62 by coil 60, and precludes the energizing of solenoid 74 through the third circuit for vessel 12. Thus, solenoid 74 cannot be energized and there is no way for ejecting the material which has accumulated within vessel 12 because coil 42 is maintained in its energized condition by the fouling of element 30. However, to remedy this situation, the control for the apparatus includes energizing means to provide energy to the coil for one of the vessels when the element of the other of the vessels is fouled.

From an inspection of the circuit diagram, it is apparent that, for example, when vessel 10 has completed its ejection cycle and timer 48 has been energized for the predetermined interval of time, pole 96 of switch 52 is shifted from engagement with contact 100 and into engagement with contact 98. At the same time, pole 102 of switch 54 is shifted from engagement with contact 104. Engagement of pole 96 with the contact 98, completes a circuit for energizing coil 60 even though coil 42 remains energized because of the fouling of element 30.

This fourth circuit may be traced from contact 78, through line 128, line 130, pole 84, contact 86, line 160, line 164, pole 96, contact 98, line 132, through rectifier 82, lead 134, coil 60, lead 144, line 142 to element 32. Assuming that vessel 12 is full of material, the contact between the material and element 32 completes the circuit to ground 38 through line 36. Thus, when coil 60 is energized, switches 62 and 64 are operated to provide energizing current for solenoid 74, through a circuit which may be traced from contact 78, through line 128, line 130, pole 106, contact 108, line 162, line 166, pole 118, contact 122, line 170, solenoid 74, line 168, line 178 to contact 76. This, of course, turns the pressurized fluid into vessel 12 to effect ejection of the material therefrom.

The operating of switch 62 through the energizing of coil 60, moves pole 106 into engagement with contact 108 and out of engagement with contact 110, thereby breaking the energizing circuit which has been maintaining electrical energy to coil 42 because of the fouled element 30. This immediately releases the coil-operated switches 44 and 46 to return to their normal positions. At the same time, a circuit energizing timer 66 is completed from line 162, through mechanism 68, line 148, contact 94, pole 90, line 158, pole 102, contact 104, lead 176, line 168, through line 178 to contact 76. This initiates the timed sequence of the ejection of material from vessel 12 and at the conclusion of the predetermined period of time, switches 72 and 70 shift, thereby de-energizing solenoid 74 and releasing the holding circuit through switch 72 for holding coil 60 energized after the material clears element 32.

It should be pointed out at this juncture that when coil 60 was operated by the material within vessel 12 contacting element 32, the shifting of pole 112 of switch 64 out of engagement with contact 116, broke the energizing circuit for timer 48 and permitted switches 54 and 52 to return to their normal positions. Thus, when timer 66 causes the breaking of the energizing circuit for coil 60, thereby permitting switch 62 to return to its normal position with pole 106 contacting contact 110, coil 42 again may be immediately energized through the connection of the fouled element 30 to ground. The ejection cycle for vessel 10 is then immediately initiated and continues through the steps which have been previously outlined. Upon the conclusion of the ejection of whatever material may have accumulated into vessel 10, vessel 12 is again permitted to go into its ejection cycle if the material has accumulated sufficiently to cause contact between element 32 and ground.

It is apparent that the sequence of events and the energizing of circuits which has been explained in detail, assuming the fouling of element 30, would be equally applicable if elements 32 were fouled rather than element 30. It will, of course, be understood that the circuits which are energized, should element 32 be fouled, will be the similar counterparts coupled with the components for the other of the vessels instead of those coupled with the respective vessel described relative to the fouling of element 30. In the interest of brevity, the detailed steps and the energizing of the various circuits will not be further described.

Should both elements 30 and 32 become simultaneously fouled, the apparatus will still function to eject material. Assuming, after the sequence of events described above terminating in the ejection of the material from within vessel 12 with element 30 fouled, the components for vessel 10 enter into the ejection cycle and assuming further, that element 32 remains fouled, timer 48 will cause the breaking of the holding circuit for coil 42 upon the completion of the ejection cycle. However, if element 32 maintains contact with the ground, and coil 60 remains energized, the energizing circuit for coil 42 may not be completed through switch 62 inasmuch as pole 106 is held in contact with contact 108. However, when this occurs, a circuit-energizing coil 42 is established upon the closing of switch 70 at the end of the ejection cycle for vessel 12.

This circuit may be traced from contact 78, through line 128, line 130, pole 106, contact 108, line 162, line 166, pole 118 and contact 120 of closed timer switch 70, line 136, through rectifier 80, lead 138, coil 42, lead 146, line 140 to element 30 which makes contact to ground through the fouled condition of element 30. Thus, coil 42 is again energized to initiate the ejection cycle for vessel 10. Manifestly, upon the completion of ejection cycle for vessel 10, if element 32 remains fouled, the ejection cycle for vessel 12 is immediately initiated. This process will be continued, one vessel ejecting immediately upon the completion of the other vessel ejecting, until the necessary maintenance is performed to remove the fouling from the elements 30 and 32.

From the foregoing, it is obvious that what has been provided is apparatus having an electrical control which automatically prevents, through the switching of electrically responsive components, the ejection of material from one vessel during the ejection cycle of the other vessel. Such control is maintained despite the fact that a material-sensing element becomes fouled and continues to complete a circuit with ground. When one element is fouled and the other is not, the mechanism continues to operate with the vessel having the fouled element initiating the ejection cycle therefor immediately upon the completion of the ejection cycle of the other vessel. When both vessels have fouled elements, means is provided in the form of a switch operated by either of the timers 66 and 48 respectively for energizing the control for a respective vessel so that the ejection cycle for each vessel is automatically initiated immediately upon the completion of the ejection cycle for the other vessel. In this manner, no material is permitted to back up into the system merely because one of the vessels fails to function properly. Each vessel and the components therefor, is preferably selected to be able to handle the material during peak load operation so that one operable vessel may successfully maintain the material-handling operation even though the other is ineffective. The alternate operation of first one vessel and the components therefor, followed by the other vessel and the components for it, distribute the wear and corrosion between the two dual components of the system and insure greater maximum life for the apparatus.

Although this apparatus has been described for use in pumping sewage or the like, it will be readily discernible to those skilled in the art that the principles of this

invention will have a wide range of utility and there is no intention to limit the use to such sewage handling purposes.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. Material handling apparatus which comprises a pair of closed material-receiving vessels; a vent for each of said vessels; a conduit connected to each of said vessels and adapted to be coupled to a source of fluid under pressure; valve means disposed in the respective conduits and vents of each of said vessels; each of said valve means having a normal position that permits communication between each of said vessels and the associated vent and precludes communication with said associated conduit, said valve means being shiftable to an alternate position that permits communication between each of said vessels and the associated conduit and precludes communication with said associated vent; inlet means connected to each of said vessels and adapted to be coupled to a source of material to be handled so as to permit the flow of material only in the direction of said corresponding vessel; outlet means connected to each of said vessels so as to permit the flow of material therefrom; means connected to each of said valve means for effecting the selective shifting thereof; sensing means disposed within each of said vessels so as to be contacted and grounded by the material therein when a preselected level of material accumulation has been reached; circuit means connected to said valve shifting means for each vessel so that the corresponding one of said shifting means is actuated in response to the energization of said circuit means connected thereto; said circuit means being energized when the accumulated material within the corresponding vessel makes contact with and grounds the sensing means of that vessel and being maintained in an energized state when said sensing means continues to be grounded due to the fouling thereof; time delay circuits electrically connected to each said circuit means and being actuated thereby along with the corresponding one of said shifting means in response to the energization of said circuit means; each of said time relay circuits including means electrically connected to said corresponding one of said shifting means so as to effect the deactuation of said corresponding shifting means after being actuated for a preselected period of time; said preselected period of time corresponding to the period required to effect the discharge of a substantial portion of accumulated material from a vessel after the valve means associated with that vessel has been shifted to the alternate position; each of said time delay circuits also including means electrically connected to said circuit means so as to effect the deenergization of said corresponding circuit means concomitantly with the deactuation of said corresponding shifting means under normal conditions and in the absence of the fouling of said corresponding sensing means; at least a portion of said circuit means and said time delay circuit of each of the vessels defining a path for energizing current for said circuit means of the other of the vessels so that the actuation of the shifting means of the other vessel and the ejection of accumulated material therefrom can be effected subsequent to the lapse of the preselected period of time and notwithstanding the fouling of the material sensing means of the one vessel, the energization of said circuit means for the other vessel simultaneously interrupting the energizing path for the circuit means of the one vessel so that the ejection of material therefrom is transiently precluded.

2. Material handling apparatus which comprises a pair of closed material-receiving vessels; a vent for each of said vessels; a conduit connected to each of said vessels and adapted to be coupled to a source of fluid under pressure; valve means disposed in the respective conduits and vents of each of said vessels; each of said valve means having a normal position that permits communication between each of said vessels and the associated vent and precludes communication with said associated conduit, said valve means being shiftable to an alternate position that permits communication between each of said vessels and the associated conduit and precludes communication with said associated vent; inlet means connected to each of said vessels and adapted to be coupled to a source of material to be handled so as to permit the flow of material only in the direction of said corresponding vessel; outlet means connected to each of said vessels so as to permit the flow of material therefrom; means connected to each of said valve means for effecting the selective shifting thereof; sensing means disposed within each of said vessels so as to be contacted and grounded by the material therein when a preselected level of material accumulation has been reached; and a control circuit including first and second actuating circuit means electrically connected to said valve shifting means and to each other so as to actuate said valve shifting means of one of said vessels when accumulated material within that vessel makes contact with and grounds said corresponding sensing means and so as to preclude the actuation of said valve shifting means of the other of said vessels; said control circuit also including first and second timing circuit means electrically interconnected with said first and second actuating circuit means so as to effect the deactuation of said valve shifting means a preselected period of time after the actuation of said valve shifting means under normal conditions and in the absence of the fouling of said corresponding sensing means; said first and second timing circuit means being further electrically interconnected with said first and second actuating circuit means so as to control the alternate actuation of said valve shifting means when the sensing means of said vessels continues to be grounded due to the fouling thereof whereby material handling operations are alternately and automatically carried out in the material receiving vessels notwithstanding the fouling of the sensing means associated with said vessel.

3. In combination with material handling apparatus that includes a pair of closed material receiving vessels, each of which has a vent that communicates with the surrounding environment and a supply conduit that is coupled to a source of fluid under pressure, each vessel also having a selectively operable valve which has a normal position that establishes communication between the vessel and the associated vent and an alternate position that establishes communication between the vessel and the source of fluid through the associated upply conduit, each vessel being further provided with inlet means that permits the flow of material to the vessel and outlet means that permits the flow of material out of the vessel after a preselected level of material accumulation has been reached as indicated by the material contacting and grounding sensing means that extends into each vessel; a control circuit which comprises means operably connectable to the valve means of each of the vessels so as to effect the shifting thereof from the normal to the alternate position; circuit means connected to said valve shifting means for each vessel so that the corresponding one of said shifting means is actuated in response to the energization of said circuit means connected thereto; said circuit means being energized when the accumulated material within the corresponding vessel makes contact with and grounds the sensing means of that vessel and being maintained in an energized state when said sensing means continues to be grounded due to the fouling thereof; time delay circuits electrically connected to each of said circuit means and being actuated thereby along with the corresponding one of said shifting means in response to the energization of said circuit means; each of said time delay circuits including means electrically connected to said corresponding one of said shifting means so as to effect the deactuation of said corresponding shifting means after being actuated for a preselected period of time; said preselected period of time corresponding to the period required to effect the discharge of a substantial portion of accumu-

lated material from a vessel after the valve means associated with that vessel has been shifted to the alternate position; each of said time delay circuits also including means electrically connected to said circuit means so as to effect the deenergization of said corresponding circuit means concomitantly with the deactuation of said corresponding shifting means under normal conditions and in the absence of the fouling of said corresponding sensing means; at least a portion of said circuit means and said time delay circuit of each of the vessels defining a path for energizing current for said circuit means of the other of the vessels so that the actuation of the shifting means of the other vessel and the ejection of accumulated material therefrom can be effected subsequent to the lapse of the preselected period of time and notwithstanding the fouling of the material sensing means of the one vessel, the energization of said circuit means for the other vessel simultaneously interrupting the energizing path for the circuit means of the one vessel so that the ejection of material therefrom is transiently precluded.

4. A circuit for controlling the operation of material handling apparatus that includes a pair of closed material receiving vessels, each of which has a vent that communicates with the surrounding environment and a supply conduit that is coupled to a source of fluid under pressure, each vessel also having a selectively operable valve which has a normal position that establishes communication between the vessel and the associated vent and an alternate position that establishes communication between the vessel and the source of fluid through the associated supply conduit, each vessel being further provided with inlet means that permits the flow of material to the vessel and outlet means that permits the flow of material out of the vessel after a preselected level of material accumulation has been reached as indicated by the material contacting and grounding sensing means that is secured to and extends into each vessel; which control circuit comprises means operably connectable to the valve means of each of the vessels so as to effect the shifting thereof from the normal to the alternate position when actuated; circuit means connected to said valve shifting means for each vessel so that the corresponding one of said shifting means is actuated in response to the energization of said circuit means connected thereto; said circuit means being energized when the accumulated material within the corresponding vessel makes contact with and grounds the sensing means of that vessel and being maintained in an energized state when said sensing means continues to be grounded due to the fouling thereof; time delay circuits electrically connected to each of said circuit means and being actuated thereby along with the corresponding one of said shifting means in response to the energization of said circuit means; each of said time delay circuits including means electrically connected to said corresponding one of said shifting means so as to effect the deactuation of said corresponding shifting means after being actuated for a preselected period of time; said preselected period of time corresponding to the period required to effect the discharge of a substantial portion of accumulated material from a vessel after the valve means associated with that vessel has been shifted to the alternate position; each of said time delay circuits also including means electrically connected to said circuit means so as to effect the deenergization of said corresponding circuit means concomitantly with the deactuation of said corresponding shifting means under normal conditions and in the absence of the fouling of said corresponding sensing means; at least a portion of said circuit means and said time delay circuit of each of the vessels defining a path for energizing current for said circuit means of the other of the vessels so that the actuation of the shifting means of the other vessel and the ejection of accumulated material therefrom can be effected subsequent to the lapse of the preselected period of time and notwithstanding the fouling of the material sensing means of the one vessel, the energization of said circuit means for the other vessel simultaneously interrupting the energizing path for the circuit means of the one vessel so that the ejection of material therefrom is transiently precluded.

5. A circuit for controlling the operation of material handling apparatus that includes a pair of closed material receiving vessels, each of which has a vent that communicates with the surrounding environment and a supply conduit that is coupled to a source of fluid under pressure, each vessel also having a selectively operable valve which has a normal position that establishes communication between the vessel and the associated vent and an alternate position that establishes communication between the vessel and the source of fluid through the associated supply conduit, each vessel being further provided with inlet means that permits the flow of material to the vessel and outlet means that permits the flow of material out of the vessel after a preselected level of material accumulation has been reached as indicated by the material contacting and grounding sensing means that is secured to and extends into each vessel; which control circuit comprises means operably connectable to the valve means of each of the vessels so as to effect the shifting thereof from the normal to the alternate position when actuated; and a control circuit including first and second actuating circuit means electrically connected to said valve shifting means and to each other so as to actuate said valve shifting means of one of said vessels when accumulated material within that vessel makes contact with and grounds said corresponding sensing means and so as to preclude the actuation of said valve shifting means of the other of said vessels; said control circuit also including first and second timing circuit means electrically interconnected with said first and second actuating circuit means so as to effect the deactuation of said valve shifting means a preselected period of time after the actuation of said valve shifting means under normal conditions and in the absence of the fouling of said corresponding sensing means; said first and second timing circuit means being further electrically interconnected with said first and second actuating circuit means so as to control the alternate actuation of said valve shifting means when the sensing means of said vessels continues to be grounded due to the fouling thereof whereby material handling operations are alternately and automatically carried out in the material receiving vessels not withstanding the fouling of the sensing means associated with said vessels.

6. Material handling apparatus which comprises a pair of closed material-receiving vessels; a vent for each of said vessels; a conduit connected to each of said vessels and adapted to be coupled to a source of fluid under pressure; valve means disposed in the respective conduits and vents of each of said vessels; each of said valve means having a normal position that permits communication between each of said vessels and the associated vent and precludes communication with said associated conduit, said valve means being shiftable to an alternate position that permits communication between each of said vessels and the associated conduit and precludes communication with said associated vent; inlet means connected to each of said vessels and adapted to be coupled to a source of material to be handled so as to permit the flow of material only in the direction of said corresponding vessel; outlet means connected to each of said vessels so as to permit the flow of material therefrom; means connected to each of said valve means for effecting the selective shifting thereof; sensing means disposed within each of said vessels so as to be contacted and grounded by the material therein when a preselected level of material accumulation has been reached; and a control circuit including electrically interconnected first and second actuating circuit means

and first and second timing circuit means; said electrically interconnected actuating circuit means and timing circuit means being electrically connected to said sensing means and valve shifting means so that said valve shifting means of said vessels are alternately actuated under the control of both said electrically interconnected circuit means and said sensing means so as to discharge material alternately from said vessels under normal conditions and in the absence of the fouling of said sensing means, said valve shifting means being alternately actuated under the control of said electrically interconnected circuit means and independently of said sensing means when said sensing means continues to be grounded due to the fouling thereof.

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