May 13, 1952 C. E. WUENSCH 2,596,352

DENSITY RESPONSIVE INDICATING AND CONTROL DEVICE

Filed Feb. 21, 1945 2 SHEETS—SHEET 1

Fig. 1.

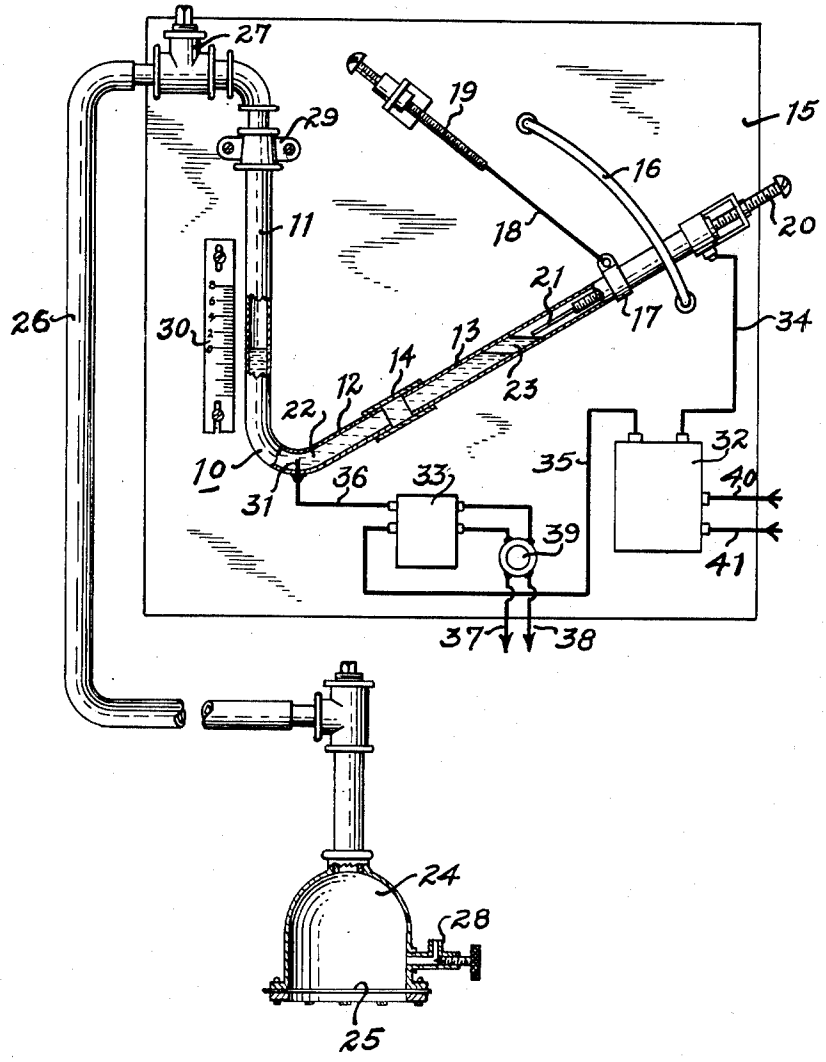

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Fig. 2.

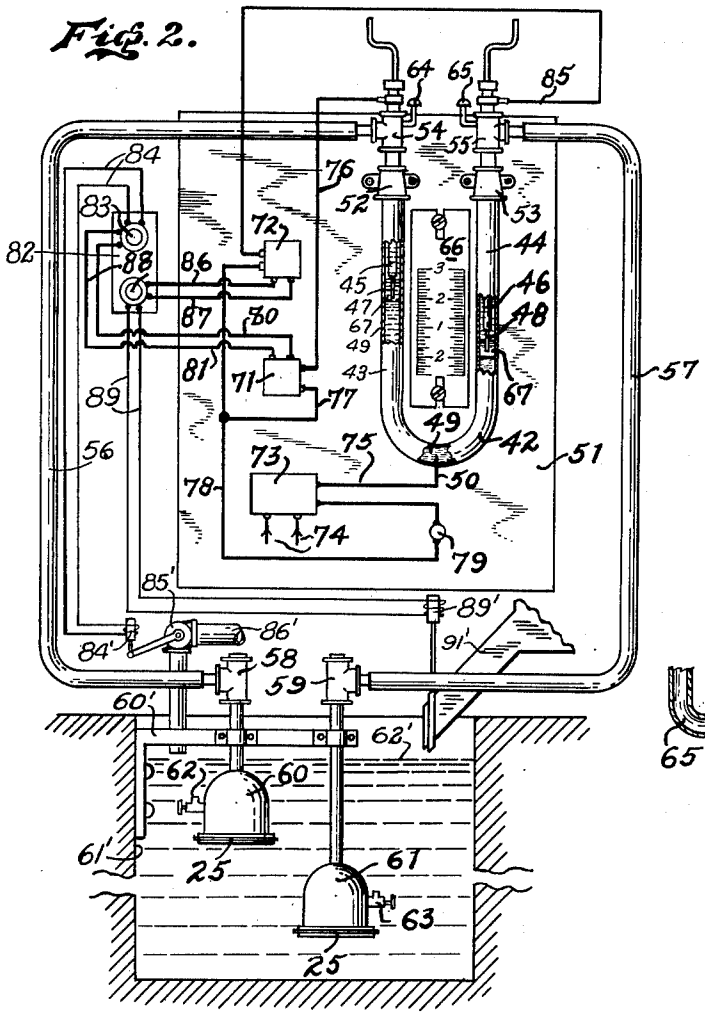


Fig. 4.

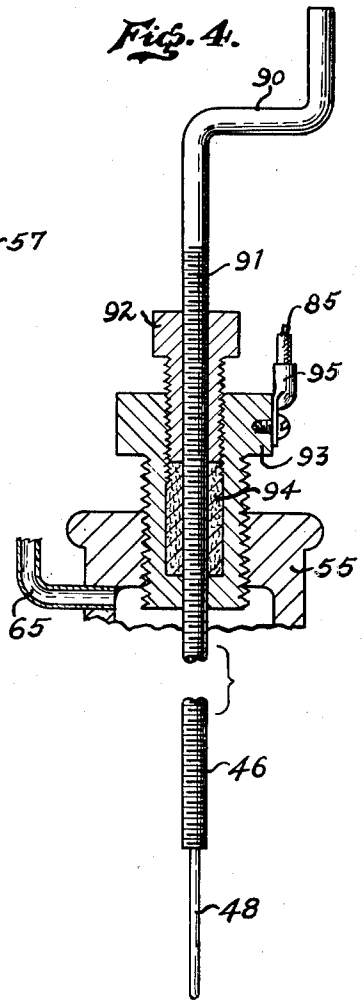
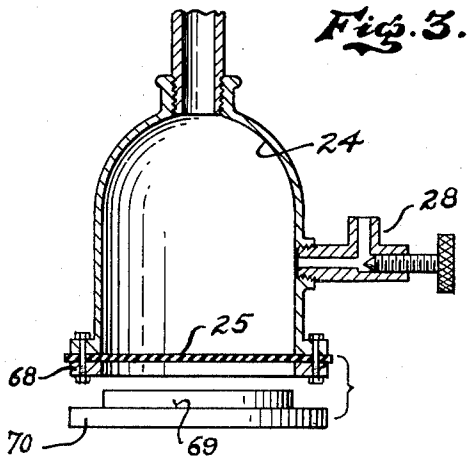


Fig. 3.



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Patented May 13, 1952

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UNITED STATES PATENT OFFICE

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DENSITY RESPONSIVE INDICATING AND CONTROL DEVICE

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7 Claims. (Cl. 137—78)

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My present invention relates to fluid density responsive apparatus, and more particularly to a new device and arrangement that will be found useful in determining and controlling the density of a pulp, such as is present in classifiers, thickeners, heavy media "sink and float" plants and the like which are used in many chemical and industrial manufacturing plants.

The principal object of my invention is to provide a means by which the density of a pulp or other fluid mass may be determined and controlled in a new and novel manner.

Another object of the invention is to provide a new and improved density responsive device and system of control which will be particularly adapted for use with pulp classifiers, thickeners and "sink and float" plants, such as are used in the mining and like industries.

Another object of the invention is to provide a new and novel form of U-tube having mercury and circuit controlling contacts in which the cooperating relation of the mercury and circuit controlling contacts may be varied in a new and novel manner.

Other objects and advantages of my invention will be in part evident to those skilled in the art, and in part pointed out hereinafter in the following description taken in connection with the accompanying drawings, wherein there is shown by way of illustration and not of limitation preferred embodiments of the invention.

In the drawings;

Figure 1 shows a modification of my invention in which a U-tube of novel design is connected to operate in conjunction with a single pulp density pressure responsive producing means,

Figure 2 illustrates another embodiment of the invention in which two pulp density pressure responsive devices are employed,

Figure 3 is an enlarged view showing the details of a preferred form of pressure responsive device, and

Figure 4 is a fragmentary enlarged view showing other details of construction of my improved device.

For a more detailed description of the invention, reference is now made to the drawings where in Figure 1 there is shown an embodiment of the invention that will be found particularly well adapted for measuring and/or controlling the density of pulp contained in a vessel where the level of the pulp is maintained substantially constant. In this arrangement there is shown a U-tube, designated generally by the numeral 10 and which may be of glass or of any suitable transparent plastic material. The U-tube 10 has a relatively long vertical leg 11 and a shorter leg 12 that is disposed at an angle. To complete this latter leg of the U-tube 10 there is an extension tube 13 of similar material which is hingedly attached to the end of the shorter leg 12 of the U-tube 10 by means of a length of rubber tubing 14. As here shown, the extension tube 13 is held against a panel-like supporting base 15 by means of an outwardly spaced arcuate guide member 16 that is secured at its ends to the panel-like member 15. The extension tube 13 carries a band 17 to which a flexible cord 18 extending from an adjusting screw 19 is attached. With this arrangement it will be seen that the extension tube 13 may be positioned and held in any desired angular position with respect to the vertical leg 11 of the U-tube 10. Extending into the open end of the extension tube 13 there is an adjustable screw 20 which carries a projecting electrode 21 of tungsten or other suitable material that is adapted to be engaged by the end of a column of mercury 22 which is carried by the U-tube 10. At this point it should be stated that in order to prevent evaporation or volatilization, the surface of the mercury disposed within the extension tube 13 is preferably covered by a relatively thin layer of non-volatile oil or other arc quenching medium 23, such as will hereinafter appear. In order to render the movement of the mercury 22 within the U-tube 10 operative in the manner contemplated and responsive to the changes in density of a pulp, the vertical leg 11 of the U-tube is shown as having a non-compressible fluid connection with the interior of a closed pressure responsive chamber 24 that has an elastic or flexible wall 25 which is adapted to respond to pressure changes when submerged within a pulp the density of which is to be indicated and/or controlled. This non-compressible fluid connection, in addition to the required metal fittings, also includes a fabric-walled flexible rubber tubing 26 which should be only of sufficient length to permit the pressure responsive chamber 24 to be positioned in the pulp and adjusted to various depths in a convenient manner. In other words, for sensitivity the panel 15 should be located at a point closely adjacent the vessel containing the pulp into which the fluid pressure responsive chamber 24 is to be submerged. At the upper end of the flexible tubing 26 there is a normally closed vent valve 27, and mounted in a wall of the fluid pressure chamber 24 there is a normally closed valve 28 through which a non-compressible fluid may be introduced into this connection to the complete exclusion of all air.

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The U-tube 10 is secured upon the panel 15 by means of a bracket 29 which will also serve as a support for the upper end of the rubber tubing 26.

Mounted upon the panel 15 and adjacent the vertical leg 11 of the U-tube 10 there is a graduated scale 30 upon which the changing level of the mercury 22 may be observed during the operation of the apparatus. For convenience this scale is shown as vertically adjustable and it will, therefore, be seen that the zero point of this scale may be adjusted, as during a calibration of the device, to correspond with the level of the mercury under the desired conditions. In this connection it will be readily seen that because of the novel construction of the U-tube 10, it will be possible to also change the level of the mercury 22 with respect to both the electrode 21 and the graduated scale 30 by an operation of the adjusting screw 19 which will vary the angular disposition of the extension tube 13 with respect to the vertical leg 11 of the U-tube 10. With this adjustment it will also be possible to compensate for other variables, as for example, any influence which changes in the length of the non-compressible fluid connection may have upon the calibration of the device. In order to render this particular device operative in connection with an electrical control circuit, the U-tube 10 is provided with a submerged electrode 31 which is sealed into the bottom thereof where the mercury 22 will at all times contact therewith. With the electrode 31 so placed, it will be seen that when the mercury 22 is forced outwardly into the angularly disposed extension tube 13 of the U-tube 10 and into contact with the electrode 21 carried by the adjustable screw 20, there will be established a connection which, in the present instance, will establish a control circuit that will include the output terminals of a power transformer 32 and the operating coil of a relay 33. This circuit can be traced from the electrode 21 through a conductor 34 to one side of the secondary of the transformer 32. The other side of the transformer 32 is then connected through a conductor 35 to one side of the operating coil of the relay 33 while the other side of the operating coil of the relay 33 will be connected to the electrode 31 by a conductor 36. At the control side of the relay 33 there are two additional conductors 37 and 38 with an indicating lamp 39 connected thereacross and which may be connected with any suitable electrically controlled device, such as a pump or solenoid operated valve to thereby regulate the flow of one or the other, or both the fluid or solid ingredients which go to make up the pulp. For a source of electric power it will be noted that the primary or input terminals of the transformer 32 are connected to a power line circuit indicated by conductors 40 and 41.

It is believed that the operation of this embodiment of my invention will be readily understood from the above. However, it may be added that during the time the device is being calibrated, the diaphragm 25 will be supported and held in a normal or neutral position in a manner to be hereinafter described so that when in operation the movements produced in the mercury 22 by the diaphragm 25 through the non-compressible fluid column will not be influenced by the elasticity or any inherent resilience of this diaphragm. In practice, after the apparatus has been set up with the non-compressible fluid column established between the diaphragm 25 and the surface of the mercury 22 in the leg 11 of the U-tube 10, the calibrated scale 30 may be adjusted to bring the zero graduation thereof in alignment with the surface of the mercury. For convenience in reading the density of a pulp, it has been found that where the diaphragm 25 is submerged to a depth of 13.6 inches, which value corresponds to the specific gravity of 13.6 for mercury, a change of one unit in the density of the pulp will result in a rise or fall of one inch in the level of the mercury 22. From this it will be obvious that after having established the zero mark on the scale 30 and with proper calibrations, the density of the pulp may be read at any time upon the scale 30. And similarly, by establishing a proper location for the electrode 21, it will be possible to control related apparatus as the mercury level rises above or recedes from any predetermined or established level which, for example, may represent the pulp density which it is desired to maintain. Such related apparatus may be in the nature of valves, pumps or other electrically controlled means operating to maintain a predetermined density of pulp.

Reference is now made to Figure 2 of the drawings wherein there is shown an embodiment of the invention which will be found particularly suited to determining and/or controlling the density of a pulp contained in a vessel, wherein the level of the pulp may vary from time to time. In this arrangement there is employed a conventional U-tube, designated generally by the numeral 42, having vertical legs 43 and 44 into which there extends adjustably mounted supports 45 and 46 that respectively carry electrodes 47 and 48. Sealed in the bottom wall of the U-tube and in contact with mercury 49 disposed within the U-tube 42 there is also a fixed contact 50. The upper ends of the legs 43 and 44 of the U-tube are secured to a panel-like support 51 by means of reducing couplings 52 and 53 which in turn also support suitable pipe couplings 54 and 55 to which the upper ends of fabric-walled flexible rubber tubes 56 and 57 are connected. At their lower ends these fabric-walled flexible rubber tubes 56 and 57 are connected through fittings 58 and 59 which respectively form connections with pressure responsive chambers 60 and 61. These pressure responsive chambers 60 and 61 are here shown as supported at different levels by a bracket 60' that extends outwardly from a wall 61' of a vat containing a batch of pulp 62'. The pressure responsive chambers 60 and 61, like the pressure chamber 24, are respectively provided with normally closed fluid input valves 62 and 63, and at their lower open ends they, as in the case of the pressure responsive chamber 24, have similar elastic or resilient diaphragms 25. In order to facilitate the exhaust of all air from the non-compressible fluid columns associated with pressure responsive chambers 60 and 61, there is also provided respectively upon the pipe couplings 54 and 55 normally closed air venting means 64 and 65. In addition to the above described features, this device, like the previously described embodiment, also has a vertically adjustable scale 66 with calibrations which may be moved relative to the level of the mercury 49 in either of the legs 43 or 44 of the U-tube 42. It will also be noted that the surfaces of the mercury column 49 in the legs 43 and 44 of the U-tube 42 are covered by a small amount of dielectric fluid or liquid 67. The purpose of this fluid or

liquid 67 is primarily to quench any electric arc which may be drawn between the electrodes 45 and 46 and the surface of the mercury column 49 as the mercury moves with respect thereto. A further advantage and function of the fluid 67 is that it will retard or prevent evaporation or volatilization of the mercury 49. This fluid or liquid 67 should have a higher specific gravity than water or other non-compressible fluid used and should be immiscible with it and also chemically inert with respect to mercury. Among examples of such a fluid or liquid 67 which might be mentioned are—acetylene-tetra bromide, acetylene-tetra chloride, carbon-tetrachloride and nitro-benzine. There are, of course, other fluid 67 which might also be used in this manner.

As previously stated, when the device is being calibrated for operation in any particular installation, it is a prerequisite that the diaphragms 25 of each of the pressure responsive chambers be held in a neutral position so that when the pressure chambers have been submerged in a pulp and density conditions are normal, the diaphragms 25 will not be stretched or stressed out of their normal plane. This will avoid the introduction of any error which might otherwise result from the exertion of a force on the non-compressible fluid connection due to the elasticity or resilience of the diaphragms. In this figure of the drawing the pressure responsive chambers 60 and 61 are shown as submerged in a pulp 60' that is contained in a vat or other form of vessel 61'.

As is more clearly shown in Figure 3 of the drawings, the pressure responsive chamber 24 is in the form of bell with a flange about its lower open end against which the diaphragm 25 is secured by means of a clamping ring 68. With the pressure chambers 24, 60 and 61 constructed in this manner, the problem of supporting and holding the diaphragms 25 in a neutral or unstretched condition during calibration may be accomplished by the use of a disc-like member 69 having a flange 70 which may be held against the diaphragm of the pressure chamber 24. When the member 69 is thus used, a non-compressible fluid may be introduced into the pressure chambers and the connecting tubes associated therewith until the space between the surface of the mercury in the particular leg of the U-tube and the diaphragms 25 is completely filled with the pressure transmitting fluid.

When the device constructed in accordance with this embodiment of my invention is in operation, the fluid pressure responsive chamber 60 with its associated electrode 47 will be adjusted and calibrated to respond to a pressure condition corresponding to the upper limit of density which it is desired to maintain in the pulp, and the pressure responsive chamber 61 with its associated electrode 48 will be adjusted and calibrated to respond to a pressure condition corresponding to the lower limit of density which it is desired to maintain in the pulp. This adjustment and calibration may be accomplished in the following manner: With the diaphragms 25 of the pressure responsive chambers 60 and 61 disposed at the same level, and with the disc-like members 69 operating to hold the diaphragms against deflection, water will be introduced through the valves 62 and 63 into the chambers 60 and 61 until the respective flexible connecting tubes 56 and 57 and the legs of the U-tube 42 are completely filled with water. During this operation the vent valves 64 and 65 at the upper ends of the legs of the U-tube 42 will be open so that all air can escape and thus provide a non-compressible connection between the diaphragms 25 and the mercury in the legs of the U-tube. During this operation the introduction of water into the connecting tubes 56 and 57 will be so regulated that when the two diaphragms 25 are at the same level and with no air in the connections, the mercury 49 in the U-tube will rise to the same level in each of the legs of the tube 42. Now, if the disc-like diaphragm holding members 69 are removed from the chambers 60 and 61, and these chambers are then positioned at different levels, it will be readily understood that the mercury in the U-tube 42 will be caused to move in one direction or another by the difference in the weight of the water column between the upper ends of the U-tube 42 and the diaphragms 25 and cause the mercury to become unbalanced and rise in the leg thereof, which leg is connected to the uppermost of the pressure responsive chambers 60 and 61. As has been pointed out hereinbefore, it has been discovered that when the U-tube 42 is connected in this manner with the pressure responsive diaphragms 25 exposed to atmospheric pressure, and with the difference in levels between the two diaphragms maintained at a distance of 13.6 inches, which corresponds to the specific gravity of mercury, the displacement of the mercury in the U-tube 42 will be one inch from its normal level. Therefore, it will be possible to employ an ordinary inch ruler, graduated in tenths of an inch, to read directly thereupon the specific gravity of the pulp. If the two diaphragms are now submerged in water at these corresponding levels, the mercury column will again become balanced, as the water head outside of the pressure chambers 60 and 61 will counterbalance the water within the non-compressible tube connections 56 and 57. However, when the pressure responsive chambers 60 and 61 are submerged in a pulp, with the same difference in levels, it will be seen that the pulp, due to its greater specific gravity, will overbalance the weight of the water within the non-compressible fluid connecting tubes 56 and 57 and thus again unbalance the mercury 49 in the U-tube 42. Therefore, when the difference in level between the diaphragms 25 carried by the pressure responsive chambers 60 and 61 is maintained at a distance of 13.6 inches, it will be seen that the pressures exerted upon each of the diaphragms 25 will correspond to the difference between the water and pulp head at the two levels plus the additional pressure which will be exerted by the pulp head between the two diaphragms. As a result, the mercury in the U-tube 42 will be displaced a distance of one inch from its normal level in each of the legs of the tube 42 for each full unit of increase in the density of the pulp. For example, as shown in Figure 2 of the drawings, the scale indicates a displacement of the mercury equal to one inch from its normal level in each of the legs of the U-tube 42 and this, with the diaphragms 25, as here shown, arranged at levels equal to 13.6 inches apart, indicates that the density of the pulp 62' is 2.0, or twice that of the standard of comparison, which is water. With this in mind, it should be pointed out that while the positioning of the diaphragms 25 at a distance of 13.6 inches apart, in point of level, in air will produce the same unbalance in the mercury column of

the U-tube 42 as will occur when the chambers 60 and 61 are submerged in a pulp, it will be readily seen that this latter unbalance in the mercury will be in a reverse direction. By the same token, when the two diaphragms 25 are submerged in pure water at the levels indicated, there will be no differential of force exerted upon the two diaphragms which can unbalance the mercury column 49. This is explained by the fact that the water head external to the pressure responsive chambers 60 and 61 will counterbalance the weight of the water column acting upon the inner sides of the diaphragm 25. In like manner, it will be seen that when the diaphragms are submerged in a pulp, it will be only the difference in the weight of the pulp over the weight of the water in the non-compressible fluid columns which will operate to unbalance the mercury in the U-tube 42. In this arrangement the diaphragms 25 of the pressure responsive chambers 60 and 61 may be submerged in the pulp to any desired depth but, as indicated hereinbefore, in order to render the mercury column 49 more sensitive, it will be desirable to establish a difference in level between the diaphragms 25 carried by the pressure responsive chambers 60 and 61 at a value of 13.6 inches, or some multiple thereof. Then, as pointed out hereinbefore, for each change in density of one full point, the level of the mercury column 49 will vary a distance of one inch in each leg of the U-tube 42 and, as a result, a closer control and reading upon the calibrated scale 66 will be possible. With the device thus set up and calibrated and with the pressure responsive chambers 60 and 61 with their diaphragms 25 submerged in a pulp, as shown, it will be seen that when the pressure exerted upon either of the diaphragms 25 are equal, there will be no unbalance in the mercury column 49. By the same token, should the pulp density vary beyond within the limits desired, the mercury column 49 will be caused to move in one direction or the other in the U-tube 42, depending upon which one of the diaphragms 25 comes into operation. If the mercury column 49 is thus moved either to the left or right, the surface thereof will contact one or the other of the electrodes 47 or 48 and thus establish a circuit between said contact and the fixed contact 50 at the bottom of the U-tube 42. In operation, the electrode 47 associated with the pressure responsive chamber 60 will be adjusted and calibrated to respond and close its circuits when the higher limit of density which it is desired to maintain prevails, while the electrode associated with the pressure responsive chamber 61 will be adjusted and calibrated to respond and close its circuit when the lower limit of density of pulp which it is desired to maintain prevails. In this manner when the density of the pulp reaches the lower limit, a circuit will be established between the electrode 48 and the contact 50 which will energize a relay 72 that, as will hereinafter appear, will provide for the control of associated apparatus that will be arranged to raise the density of the pulp. And in a similar manner, when the density of the pulp reaches the higher limit, a circuit will be established between the electrode 47 and the contact 50 by the movement of the mercury column 49 which will complete a circuit that will energize a relay 71 and control apparatus which will operate to lower the pulp density with which the device is associated. As here shown, a transformer 73, connected to a power circuit 74, is employed to provide the current necessary for the operation of the relays 71 and 72 and the controlled apparatus. The above circuits may be traced from the transformer 73 through a conductor 75 to the contact 50 and thence through the mercury 49 to the electrode 47. At its upper end the electrode 47 is connected through its support 45 to a conductor 76 which leads to one side of the relay 71. At its other side the relay 71 is connected by means of a conductor 77 to a bus conductor 78 which connects through an indicating lamp 79 to the other side of the transformer 73. For its control circuit the relay 71 is shown as having a circuit comprising conductors 80 and 81 which leads to a terminal board 82 and through an additional indicating lamp 83 to conductors 84 which form a control circuit for the associated apparatus which will operate to lower the pulp density. This associated apparatus is here illustrated as comprising an electromagnet 84' that operates a valve 85' to control the introduction of a dilute which is supplied from any suitable source through a pipe 86'. At the other side of the mercury column 49 the electrode support 46 is connected by means of a conductor 85 to one side of the relay 72, while the other side of the relay 72 is connected through the bus conductor 78 to the other side of the transformer 73. For its control circuit the relay 72 is shown as having conductors 86 and 87 which extend through a further indicating lamp 88 to the conductors 89 that provide a control circuit for the other associated apparatus which will operate to raise the density of the pulp. The control apparatus associated with this latter circuit comprises an electromagnet 89' that is arranged to operate a gate valve 90' which will control the additions of concentrate or solids to the pulp 60' contained in the vat 61'.

In Figure 4 of the drawings there is shown a further detail of construction which it will be understood may take many forms. In this showing the manner of mounting the electrode supporting rod 46 is illustrated, it being understood that the electrode supporting rod 47 will also be supported in a similar manner. As here shown, the electrode 48, which is preferably of tungsten, is pressed into the end of the electrode supporting rod 46. At its upper end the electrode supporting rod 46 is provided with a crank-like extension 90 by means of which it may be turned. Throughout the length of its straight portion it is threaded, as at 91, so that it may be moved axially by a turning thereof relative to a packing nut 92 which is in turn threaded into a stuffing box 93 that is threaded into the top of the pipe coupling 55 at the upper end of the leg 44 of the U-tube 42. In this showing the air vent 65 is indicated as associated with the extreme upper part of the fluid column at this end of the U-tube 42. It will also be noted that the stuffing box 93 carries a packing 94 which will preferably be composed of bees wax and cotton. This will insure against the entrance of air or the escape of any fluid at this point as the electrode support 46 is being adjusted. A terminal 95 is also provided upon the stuffing box 93 as a means for connecting the conductor 85 to the electrode supporting rod 46.

While I have, for the sake of clearness and in order to disclose the invention so that the same can be readily understood, described and illustrated specific devices and arrangements, I desire to have it understood that the invention is

not limited to the specific means disclosed, but may be embodied in other ways that will suggest themselves to persons skilled in the art. It is believed that this invention is new and it is desired to claim it so that all such changes as come within the scope of the appended claims are to be considered as part of this invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a pulp density responsive device of the character described, the combination of a vat containing a pulp the density of which is to be controlled, a U-tube having a column of mercury therein, a circuit terminal at the bottom of said U-tube and connecting with said mercury, an electrical circuit contact extending into each end of said U-tube adapted to establish a circuit through said mercury to said circuit terminal as it is displaced by changes in pressure exerted at the ends thereof, a non-compressible fluid connection extending from one end of said U-tube, a pressure chamber at the outer end of said fluid connection having a pressure responsive diaphragm in a wall thereof and submerged at one level in the pulp of said vat, a second non-compressible fluid connection extending from the other end of said U-tube, a second pressure chamber at the outer end of said second fluid connection having a pressure responsive diaphragm in one wall thereof and submerged in the pulp of said vat at a different level, whereby said diaphragms will be rendered responsive to changes in pulp density occurring within the pulp between the two levels at which said diaphragms are positioned, electrically controlled means associated with the circuit established through said mercury column by the circuit controlling contact in the leg of said U-tube connected with the upper one of said pressure chambers for adding a dilute to the pulp in said vat when its density reaches a predetermined high point, and a second electrically controlled means associated with the circuit controlling contact in the leg of said U-tube connected with the lower one of said pressure chambers for adding fresh pulp to said vat when the density of the pulp therein reaches a predetermined lower density.

2. In a system of control for maintaining the density of the pulp at a predetermined value, the combination of a pair of pressure responsive chambers having flexible diaphragms adapted and arranged to be exposed to pressures existing at different levels in a batch of pulp, means for supporting said pressure chambers with their flexible diaphragms at different fixed levels within the pulp, a U-tube mounted above said pulp having a column of mercury therein, a water containing conduit extending from one leg of said U-tube to the interior of the upper one of said pressure responsive chambers, a similar water containing conduit extending from the other leg of said U-tube to the interior of the lower one of said pressure responsive chambers, whereby movements of said diaphragms caused by pressures exerted thereupon will be positively transmitted to the ends of the mercury column in said U-tube, an electrical circuit terminal extending through the bottom of said U-tube connecting with said mercury column intermediate its ends and forming one side of an electric power supply circuit, a circuit controlling contact extending into the leg of said U-tube connected to the upper one of said pressure responsive chambers adapted when in contact with said mercury to establish a circuit from said power supply circuit that will control means for adding water to said pulp when the density thereof exceeds said predetermined value, and a second circuit controlling contact extending into the leg of said U-tube connected to the lower one of said pressure responsive chambers adapted when in contact with said mercury to establish another circuit from said power supply circuit that will control other means which will add pulp when the density of the original pulp falls below said predetermined value.

3. In a system of control for maintaining the density of a pulp at a predetermined value, the combination of a pair of pressure responsive chambers having flexible diaphragms adapted to be exposed to pressures existing at different levels in a batch of pulp, means for supporting said pressure chambers with their flexible diaphragms at different fixed levels within the pulp, a U-tube mounted above said pulp having a column of mercury therein, a non-compressible fluid containing conduit extending from the mercury in one leg of said U-tube to the flexible diaphragm of one of said pressure responsive chambers, a similar non-compressible fluid containing conduit extending from the mercury in the other leg of said U-tube to the flexible diaphragm of the other of said pressure responsive chambers, whereby movements of said diaphragms due to differences in pressures exerted thereupon will be positively transmitted to the ends of the mercury column in said U-tube, an electrical circuit terminal extending through the bottom of said U-tube connecting with said mercury column intermediate its ends and forming one side of an electric power supply circuit, a circuit controlling contact extending into the leg of said U-tube to which the upper one of said pressure chambers is connected adapted when in contact with said mercury to establish a control circuit from said power supply circuit for means that will operate to add water to said pulp when the density thereof exceeds said predetermined value, and a second circuit controlling contact extending into the leg of said U-tube to which the lower one of said pressure chambers is connected adapted when in contact with said mercury to establish a control circuit from said electric power supply circuit for other means that will add fresh pulp when the density of the pulp under control falls below said predetermined value.

4. In a pressure responsive measuring system of the character described, the combination of a U-tube with mercury therein as a current conducting medium, an adjustable terminal electrode extending downwardly into each of the legs of said U-tube, a third terminal electrode at the bottom of said U-tube and in contact with the mercury therein, a non-compressible fluid containing conduit connected to each of the legs of said U-tube adapted and arranged to unbalance the mercury therein when the pressures in said conduits are unequal, whereby a circuit will be established between one or the other of said adjustable terminal electrodes and the terminal electrode at the bottom of said U-tube when unequal pressures are transmitted through said non-compressible fluid to the mercury in the respective legs of said U-tube, and a barrier of an immiscible and chemically inert arc extinguishing fluid disposed between the surface of the mercury in said U-tube and the non-compres-

sible fluid in said conduits as an arc quenching dielectric.

5. In a pressure responsive measuring system of the character described, the combination of a U-tube with mercury therein as a current conducting medium, an adjustable terminal electrode extending downwardly into each of the legs of said U-tube, a third terminal electrode at the bottom of said U-tube and in permanent contact with the mercury therein, a conduit containing water as a non-compressible fluid connected to each of the legs of said U-tube adapted and arranged to unbalance the mercury therein when the pressures transmitted through the water in said conduits are unequal, whereby a circuit will be established between one or the other of said adjustable terminal electrodes and the terminal electrode at the bottom of said U-tube when unequal pressures are transmitted through said non-compressible fluid to the mercury in the respective legs of said U-tube, and a quantity of acetylene-tetra-bromide as an immiscible barrier between the surface of the mercury in said U-tube and the water in said conduits acting as an arc quenching dielectric.

6. In a pressure responsive measuring system of the character described, the combination of a U-tube with mercury therein as a current conducting medium, an adjustable terminal electrode extending downwardly into each of the legs of said U-tube, a third circuit terminal contact on the bottom of said U-tube and in contact with the mercury therein, a conduit containing water as a non-compressible fluid connected to each of the legs of said U-tube adapted and arranged to unbalance the mercury therein when the pressures transmitted through the water in said conduits are unequal, whereby a circuit will be established between one or the other of said adjustable terminal electrodes and the terminal electrode at the bottom of said U-tube when unequal pressures are transmitted through said non-compressible fluid to the mercury in the respective legs of said U-tube, and a quantity of acetylene-tetra-chloride as an immiscible barrier between the surface of the mercury in said U-tube and the water in said conduits acting as an arc quenching dielectric.

7. In a pressure responsive measuring system of the character described, the combination of a U-tube with mercury therein as a current conducting medium, an adjustable terminal electrode extending downwardly into each of the legs of said U-tube, a third terminal electrode at the bottom of said U-tube and in permanent contact with the mercury therein, a conduit containing water as a non-compressible fluid connected to each of the legs of said U-tube adapted and arranged to unbalance the mercury therein when the pressures transmitted through the water in said conduits are unequal, whereby a circuit will be established between one or the other of said adjustable terminal electrodes and the terminal electrode at the bottom of said U-tube when unequal pressures are transmitted through said non-compressible fluid to the mercury in the respective legs of said U-tube, and a quantity of carbon-tetrachloride as an immiscible barrier between the surface of the mercury in said U-tube and the water in said conduits acting as an arc quenching dielectric.

CHARLES ERB WUENSCH.

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