

June 18, 1940.

J. A. ADAMS

2,204,644

PULP DENSITY REGULATOR

Filed Sept. 7, 1937

3 Sheets-Sheet 1

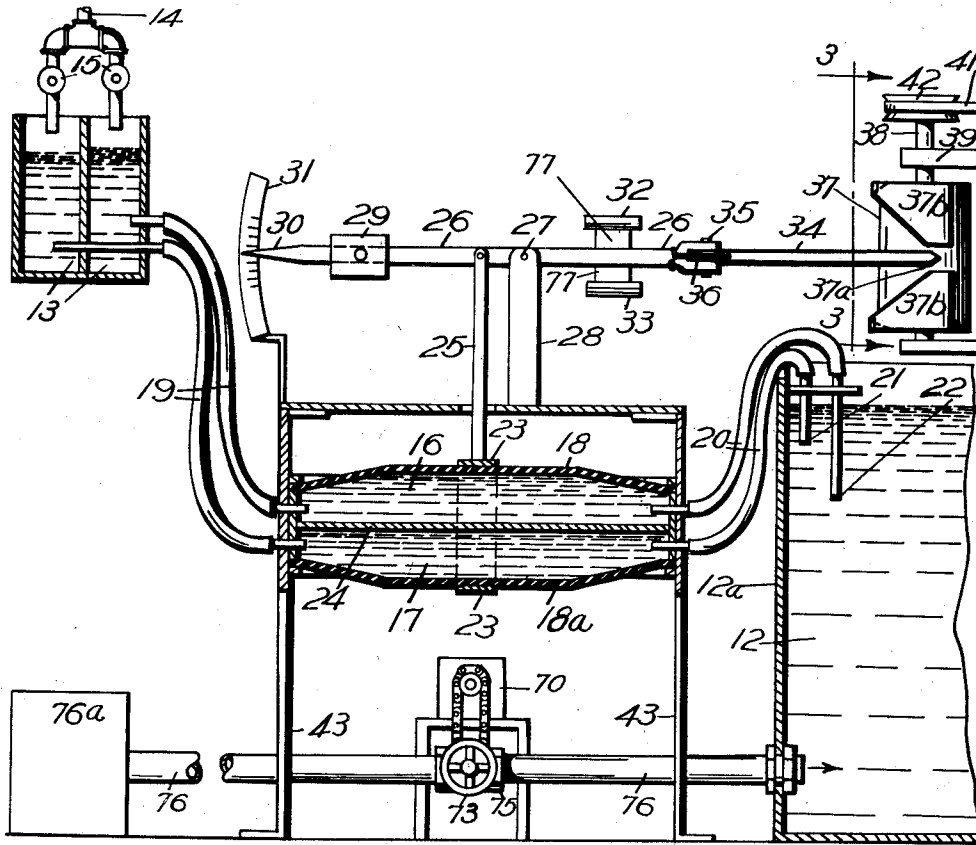


Fig. 1.

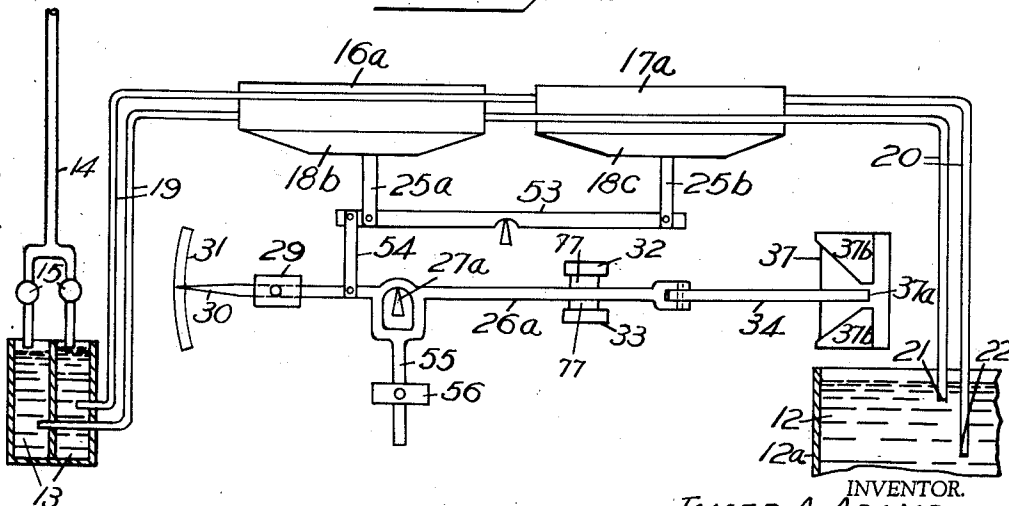


Fig. 2.

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3 Sheets-Sheet 2

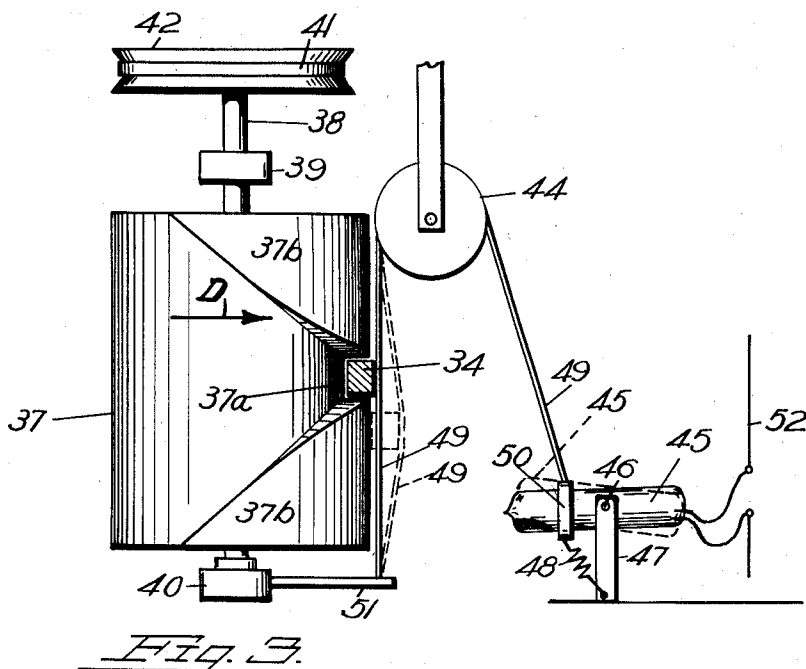
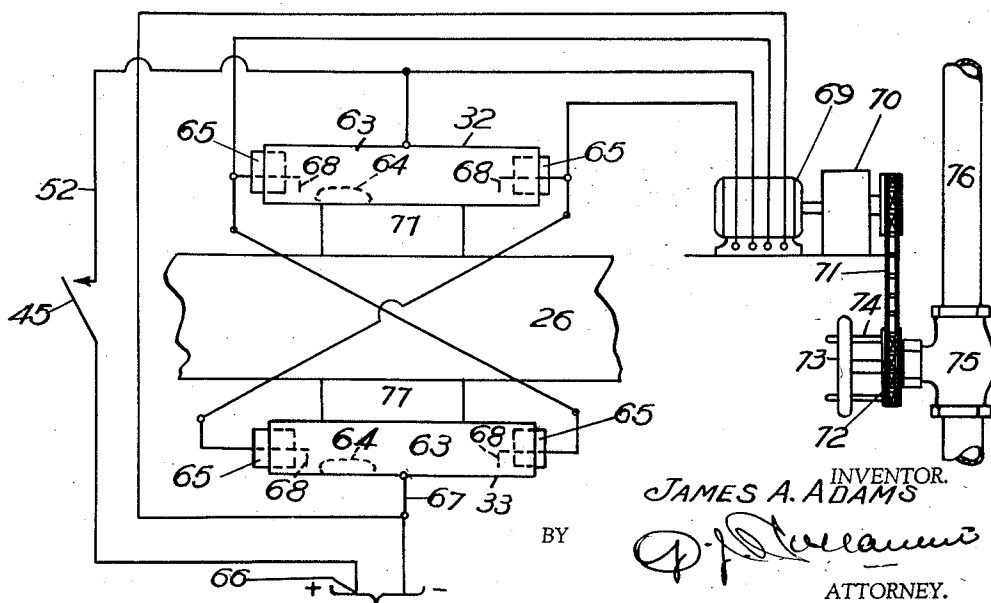


Fig. 4.



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3 Sheets-Sheet 3

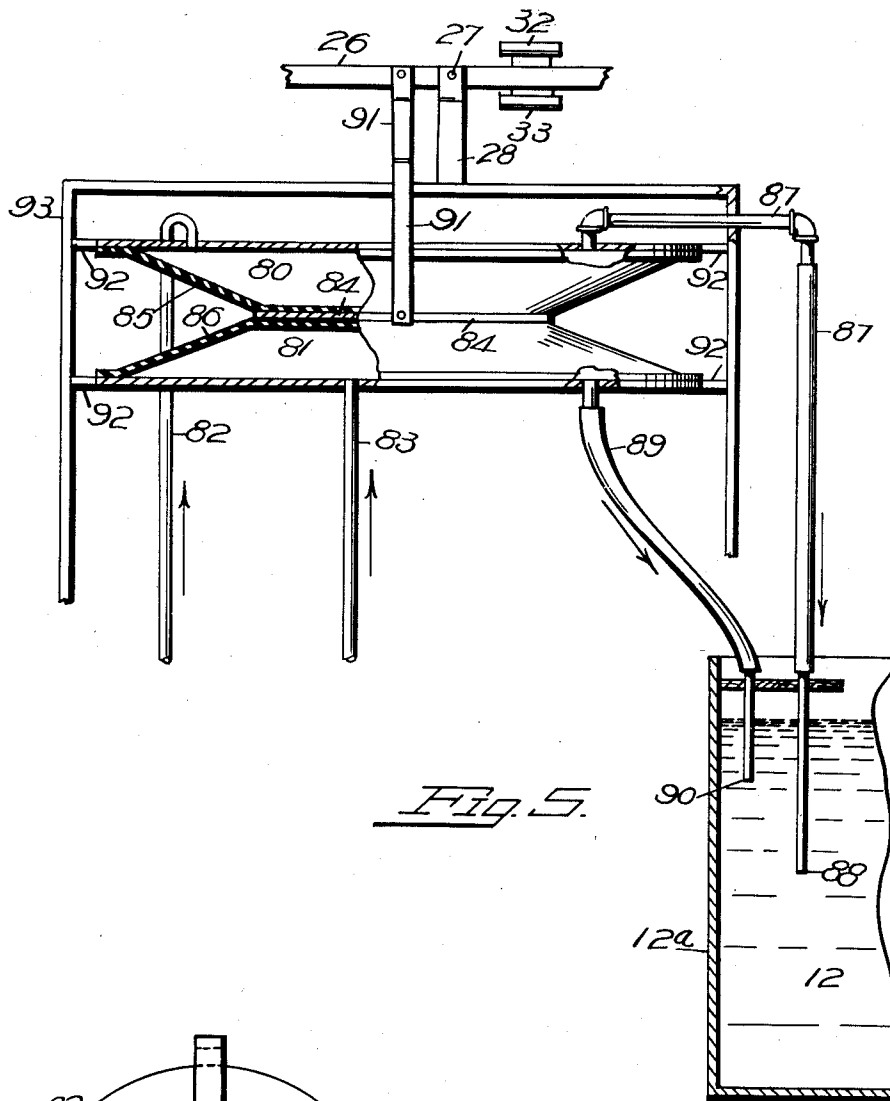


Fig. 5.

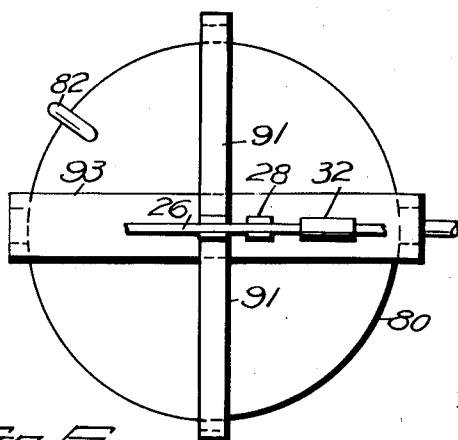


Fig. 6.

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UNITED STATES PATENT OFFICE

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PULP DENSITY REGULATOR

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Application September 7, 1937, Serial No. 162,741

9 Claims. (Cl. 200—83)

This invention relates to improvements in automatic pulp-density regulators.

In certain industrial processes such as, for instance, ore concentrating, paper making, and the like, material being treated is embodied in a "pulp." This pulp usually is composed of the material in a finely divided condition carried in a liquid, usually water, with perhaps other ingredients in addition.

- 10 It is important that this pulp be formed and kept at a constant density so that the next step in the processing will be accomplished at maximum efficiency. Since the pulp usually comprises a plurality of components, care must always be
15 exercised in the mixing to maintain that constant density factor. The mixing of components to form the pulp often is a continuous process and the present invention provides apparatus that is effective for automatically varying a fluid com-
20 ponent of the pulp in response to density variations, to maintain a substantially constant density.

- Therefore it is an object of this invention to provide apparatus that will respond automatically
25 to sustained pulp-density variations and thereby control the flow of a density-affecting component of the pulp to correct variations from the optimum density.

- Another object is to provide such apparatus
30 that will ignore pulp level variations which are not particularly objectionable.

A further object is to provide apparatus that is simple and positive in action.

- A still further object is the provision of appa-
35 ratus of this character that will respond in degree and, optionally, in a convenient position either at, above or below the normal pulp-level.

Still another object is to provide apparatus for this purpose that will respond in degree and time in a manner corresponding to the degree and duration of the density variation to thereby efficiently correct it.

Other objects and advantages will be more fully disclosed in the following description and in the drawings wherein like parts have been similarly designated and in which:

Figure 1 is a vertical sectional view of apparatus built according to this invention;

Figure 2 is a diagrammatic view of a modified arrangement of the apparatus;

• Figure 3 is a fragmentary sectional view on line 3—3 of Figure 1 and drawn on a larger scale and including certain details that were purposely omitted from Figure 1 for purposes of clarity;

Figure 4 is a wiring diagram of electrical cir-

cuits that are well adapted to be used with the apparatus;

Figure 5 is a fragmentary elevation partly in section and illustrates apparatus built according to a further modified form of the invention; and

Figure 6 is a fragmentary plan view, drawn to a smaller scale, of the apparatus shown in Figure 5.

In the drawings reference character 12 denotes a body of pulp. At 13 are shown bodies of fluid, preferably water, the supply of which may be renewed at a selected rate through a conduit 14 and valves 15. Two expansion fluid chambers 16 and 17 are closed respectively by flexible diaphragms 18 and 18a. A pair of flexible conduits 19 are in fluid conductive connection between the bodies of fluid 13 and the fluid chambers 16 and 17 respectively, and flexible discharge conduits 20 connect the respective chambers to points of fluid discharge 21 and 22 respectively, which 20 are located in the body of pulp at different depths below the surface.

A rigid yoke 23 connects the two diaphragms by passing around the outside of the chambers so that, in the form shown in Figure 1, the diaphragms are held in fixed spaced relation to each other.

A partition 24 completely seals the chambers 16 and 17 from each other so that there is no flow of fluid therebetween. The yoke 23 is connected by means of a rod 25 to a beam 26 which is fulcrumed at 27 on a standard 28. On one side of the fulcrum the beam carries a slidable counter-weight 29 and the beam terminates in a point 30 adjacent an arcuate calibrated scale 31. To the right of the fulcrum the beam carries a pair of mercury switches 32 and 33 which, as shown in diagrammatic detail in Figure 4, together serve as a motor-reversing switch. On the extreme right end of the beam is a hinged member 34 which is pivoted to the beam by means of a pin 35 and is normally held in alignment with the beam by a spring element 36.

Adjacent the right extremity of this assembly is a cam element 37 mounted for rotation on a vertical shaft 38 journaled in bearings 39 and 40. The shaft is driven by any convenient source of power, not shown, through an intermediary of a belt 41 over a pulley 42 on the shaft. Adjacent its center the cam element 37 has a symmetrical concentric track 37a above and below which are the eccentric cams 37b.

The two expansion fluid chambers 16 and 17 are supported at their perimeters on a pair of standards 43 in a manner to permit free move-

ment of the diaphragms 18, and it will be understood that the conduit 14 is connected with a source of fluid such as any common water-supply system, which is not shown.

Referring to the details shown in Figure 3, a grooved pulley 44 is mounted adjacent the cam element 37 and a mercury type switch is shown at 45. The switch is pivoted at 46 on a standard 47 and the left end of the switch is urged downwardly by means of a spring element 48. A belt or cord 49 is connected with a band 50 around the switch, and passes over the pulley 44, downwardly in close proximity to the hinged member 34 and is anchored permanently to an arm 51. The mercury switch 45 is used to open and close an electrical conductor 52 which is part of an electrical circuit shown in diagrammatic detail in Figure 4.

In the form, as shown in Figure 1, the two fluid chambers are mounted in superposed relation so that their respective diaphragms are in axial alinement with each other and oppose each other in their movements.

In Figure 2 a modified arrangement is shown wherein the fluid chambers, which are designated as 16a and 17a, are positioned in lateral relation, each with its diaphragm in a downward position as shown at 18b and 18c. The diaphragms are connected by means of rods 25a and 25b respectively, with a fulcrumed beam 53 which in turn is connected by means of a rod 54 to a second fulcrumed beam 26a which corresponds to the beam 26 in Figure 1. The beam 26a is provided with a depending bar 55 adjacent and below its fulcrum, and a compensating weight 56 is adjustably carried on the bar.

In the form shown in Figure 2 it will be noted that the fluid chambers 16a and 17a are located above the surface of the body of pulp, whereas in the preferred form shown in Figure 1, the fluid chambers 16 and 17 are located below the surface of the pulp body 12. It will be understood that the various conduits are intended to be flexible so that the relative altitude of the fluid chambers, with reference to the body of pulp, may be varied, as will be explained hereinbelow.

In Figure 4, a wiring diagram is shown which illustrates certain electrical circuits that are well adapted to be used in connection with either form of the apparatus.

The switches 32 and 33 each comprises a metallic conductive tube 63 containing a body of mercury 64 and plugged at each end with insulating material 65. A source of power, as shown at 66, is conducted along a main conductor 67 to switch 33 and along the main conductor 52 to switch 32. Conductive contactors 68 pass through the respective insulating plugs 65 so that when the tubes 63 are tipped in either direction from the horizontal, the mercury therein will flow to the lowermost end of each tube and thereby close an electrical conductive circuit between each tube and its respective contact point. The four contact points are cross-connected and are also connected with suitable leads to a motor 69 so that when the beam 26 tips in one direction, contacts will be made to operate the motor in one direction and when the beam 26 tips the other direction the motor will be reversed.

The motor is in driving relation with a speed reducer 70, the output of which is transmitted by means of a sprocket-chain 71 to a sprocket 72 that engages a valve hand-wheel 73 by means of prongs 74 to open or close a valve 75 accord-

ing to the direction of rotation of the motor. The valve 75 controls a flow density-affecting fluid from a source, 76a, through a conduit 76 to the body of pulp 12. The electrically-conductive tubes 63 are carried on blocks of insulating material 77 that are attached to the beam element 26.

Operation

In operation a flow of fluid is established from the fluid bodies 13 through the conduits 19, through the respective fluid chambers 16 and 17 and discharged through conduits 20 at different points at different depths below the surface of the pulp body 12. By adjusting the sliding weight 29 on the beam element 26 a condition of stabilization of the beam in a normal horizontal position may be effected. Any change in the pulp level will affect the hydraulic pressure against each diaphragm to a like degree but any change in the pulp density will produce a differential pressure change on the respective diaphragms which will impart a movement to the beam element 26 which will, in turn, actuate the motor-reversing switches 32 and 33 thereon. Movement of the beam element 26 may be observed at its pointed end 30 with reference to the calibrated scale 31.

The hinged element 34 on the right end of the beam element is normally in close proximity to the concentric central part of the cam element 37. This normal position is clearly shown in Figures 1 and 3. When the beam element undergoes angular movement about its pivotal axis or fulcrum 27 the right end thereof will move up or down from its normal position as the cam element permits it to do so when the cams 37b are rotated to the side away from the beam.

On the next revolution of the cam element 37, either one of the cams 37b will engage the hinged portion 34 of the beam element as they rotate in the direction of the arrow D in Figure 3. This will move the hinged end 34 laterally to contact the belt or cord 49, as shown in broken lines in Figure 3. This movement will raise the pivoted mercury switch 45 to its dotted line position to close the electrical conductor 52 which will in turn permit power to flow from the source 66 through the reversing switches 32 and 33 to the motor 69 to drive it in the direction called for by the position of the beam 26. The motor thus actuated will operate the mechanism to control the flow of density-affecting fluid to the body of pulp. The operation of the cam element 37 will introduce a certain desirable factor of delay in the operation of the density-affecting mechanism so that the resultant action will not be too severe.

Obviously and inherently, the cam-element will intermittently move the part 34 of the beam-element, when said beam-element is in position to be contacted by the cam.

It will be seen that due to the angular shape of the cams 37b, the farther from normal that the hinged end 34 of the beam element 26 is moved, the longer period of time the beam will be held in its lateral position and the longer the circuit-breaking switch 45 will remain closed. It will thus be apparent that the greater the variation in the pulp density the greater the automatic response will be to correct that variation and bring the pulp density back to normal.

Obviously the raised portions of the cam 37b can be made of different arcuate lengths to pro-

vide contact periods with the beam-element of varying time duration.

In the arrangement shown in Figure 1 the flow of fluid through the chambers 16 and 17 will normally exert a pressure on the diaphragms 18 and 18a that is above atmospheric pressure. In the arrangement shown in Figure 2 the flow through the chambers 16a and 17a becomes a syphon system so that a pressure below normal atmospheric is usually exerted on the inner surface of the diaphragms 18b and 18c. In this arrangement any differential change in the pressure exerted on the diaphragms will move the fulcrumed beam 53 to actuate the beam element 26a as hereinabove described.

The form of the apparatus as illustrated in Figures 5 and 6 makes use of a source of gas under pressure, that discharges simultaneously into two opposed chambers, 80 and 81 respectively, a conduit 82 leading from the source, not shown, to the upper chamber 80 and a second conduit 83 leading from the source to the lower chamber 81. A rigid plate 84 is positioned between a flexible diaphragm closure 85 of the upper chamber and a similar diaphragm closure 86 of the lower chamber. A discharge conduit 87 leads to a point of gas discharge 88 in a pulp container 12a and another discharge conduit 89 leads to another point of gas discharge 90 at a different depth in the container 12a.

The plate 84 is connected with a yoke 91 which in turn is pivoted to the fulcrumed beam 26 that carries the elements as above defined. The two expansion chambers 80 and 81 are rigidly supported at 92 on a frame 93 and it will be understood that variations in the density of the pulp 12 into which the two discharge conduits are immersed, will differentially affect the pressures in the expansion chambers 80 and 81 which will move the plate 84, the yoke 91 and the fulcrumed beam 26. The beam may govern and be governed as hereinabove described and as illustrated in Figures 1, 3 and 4.

The diaphragms in all forms of the apparatus preferably have an area of many square inches so that even a small differential change per unit of area on the diaphragms will be multiplied to a very considerable total effective force on the mechanism actuated by the diaphragms. It will be understood that the movement of the diaphragms, due to a differential change in the pressure exerted thereon, may be utilized in various ways to actuate density-governing mechanism. The mechanism illustrated and described herein is a typical example. It is to be further understood that the term "pulp" as herein used, means any semi-liquid or solution or mixture of liquid and solid matter.

What I claim and desire to secure by Letters Patent is:

1. In apparatus for automatic pulp-density control, a plurality of expansible chambers, fluid flow means associated with said chambers and discharging into a body of pulp at two different depths therein for expanding and contracting said chambers according to pulp density variations, an element connected with a movable portion of at least one of the chambers for movement thereby, a continuously operating member positioned adjacent said element for reciprocating a portion thereof in directions other than its first said movement, and a motor-operating switch positioned to be actuated by the reciprocating movement of the element.

2. In apparatus for automatic pulp-density

control, a plurality of expansible chambers, fluid flow means associated with said chambers and discharging into a body of pulp at two different depths therein for expanding and contracting said chambers according to pulp density variations, an element connected with a movable portion of at least one of the chambers for movement thereby, means adjacent the element for intermittently moving the same in a direction other than its first said movement, and a motor-operating switch positioned to be actuated by the intermittent movement of the element.

3. In apparatus for automatic pulp-density control, a plurality of expansible chambers, means for discharging flows of fluid at different depths in a body of pulp, said means being also connected with the respective chambers whereby they are expanded and contracted according to pulp-density variations, a beam-element connected with a movable part of at least one of the chambers and fulcrumed for arcuate movement thereby, means adjacent the beam-element for reciprocating a portion thereof laterally of its arcuate path, and a motor-operating switch actuated by such lateral movement according to the arcuate position of said beam-element.

4. In apparatus for automatic pulp-density control, a plurality of expansible chambers, means for discharging flows of fluid at different depths in a body of pulp, said means being also connected with the respective chambers whereby they are expanded and contracted according to pulp-density variations, a beam-element connected with a movable part of at least one of the chambers and fulcrumed for arcuate movement thereby, means adjacent the beam-element for intermittently moving a portion thereof laterally of its arcuate path, and a motor-operating switch actuated by such lateral movement according to the arcuate position of said beam-element.

5. In apparatus for automatic pulp-density control, a plurality of expansible chambers, means for maintaining a flow of fluid simultaneously through the chambers, means for discharging the respective flows of fluid at different depths in a body of pulp, whereby the chambers are expanded or contracted according to pulp-density variations, a beam-element connected with the chambers and fulcrumed for arcuate movement thereby, a motor-reversing switch operated by the arcuate movement of the beam-element, a cam-element positioned adjacent the beam-element for moving a portion thereof laterally of its arcuate path, and a motor-operating switch actuated by said lateral movement.

6. In apparatus for automatic pulp-density control, a plurality of expansible chambers, means for maintaining a flow of fluid simultaneously through the chambers, means for discharging the respective flows of fluid at different depths in a body of pulp, whereby the chambers are expanded or contracted according to pulp-density variations, a beam-element connected with the chambers and fulcrumed for arcuate movement thereby, a motor-reversing switch operated by the arcuate movement of the beam-element, a rotary cam-element positioned adjacent the beam-element for intermittently moving a portion thereof laterally of its arcuate path, and a motor-operating switch actuated by said lateral movement.

7. In apparatus for automatic pulp-density control, a plurality of expansible chambers, means for maintaining a flow of fluid simultaneously through the chambers, means for discharg-

ing the respective flows of fluid at different depths in a body of pulp, whereby the chambers are expanded or contracted according to pulp-density variations, a beam-element connected with the chambers and fulcrumed for arcuate movement thereby, a portion of said beam-element being capable of movement laterally of its arcuate path, a motor-operating switch actuated by such lateral movement, according to the arcuate position of said beam-element, and a cam-element positioned adjacent the beam-element, to effect the said lateral movement.

8. In apparatus for automatic pulp-density control, a plurality of expansible chambers, means for maintaining a flow of fluid simultaneously through the chambers, means for discharging the respective flows of fluid at different depths in a body of pulp, whereby the chambers are expanded or contracted according to pulp-density variations, a beam-element connected with the chambers and fulcrumed for arcuate movement thereby, a rotary cam-element positioned adjacent the beam-element for intermit-

tently moving a portion thereof laterally of its arcuate path, and a motor-operating switch actuated by said lateral movement, according to the arcuate position of said beam-element.

9. In apparatus for automatic pulp-density control, a plurality of expansible chambers, means for maintaining a flow of fluid simultaneously through the chambers, means for discharging the respective flows of fluid at different depths in a body of pulp, whereby the chambers are expanded or contracted according to pulp-density variations, a beam-element connected with the chambers and fulcrumed for arcuate movement thereby, a portion of the beam-element being capable of lateral movement, with reference to its arcuate path, a motor-operating switch actuated by such lateral movement, according to the arcuate position of said beam-element, and a variable cam-element positioned adjacent the beam-element for moving a portion thereof laterally.

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