June 25, 1940. J. A. ADAMS 2,205,678

DENSITY CONTROL

Filed Jan. 7, 1937 2 Sheets-Sheet 1

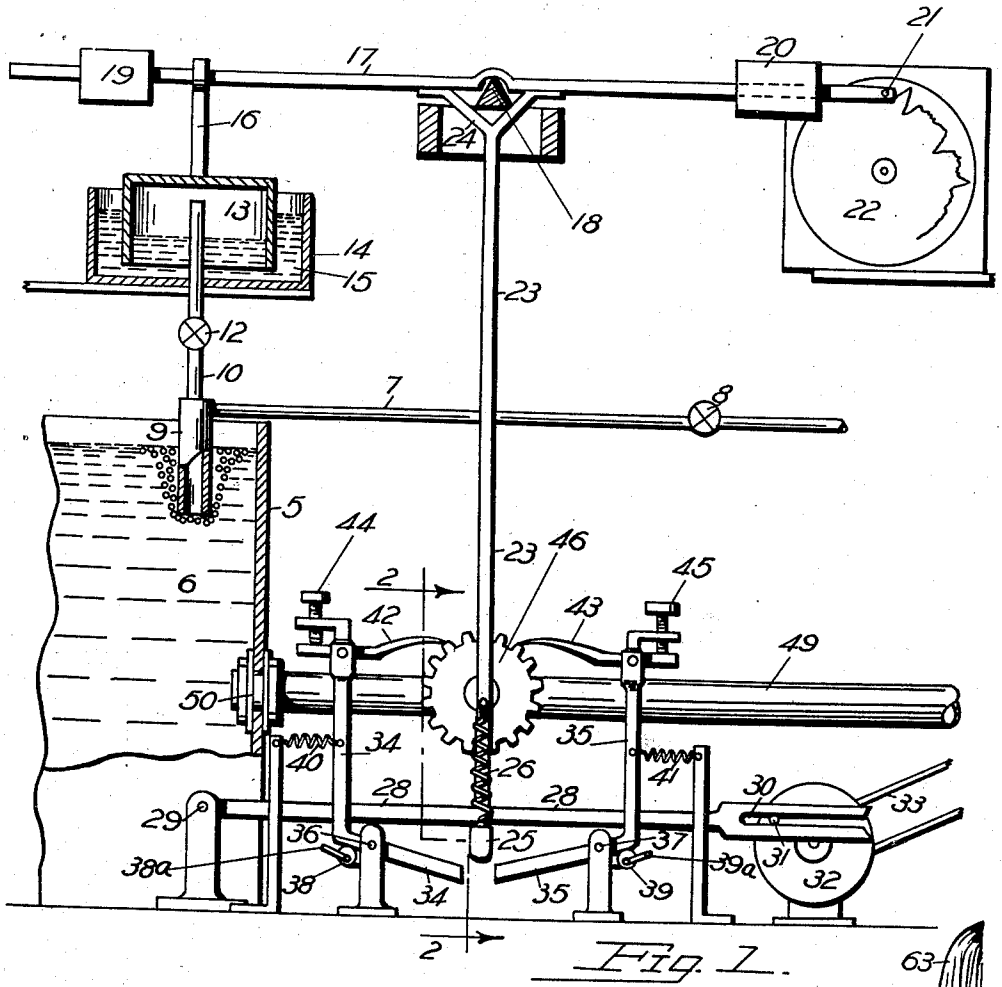


Fig. 1.

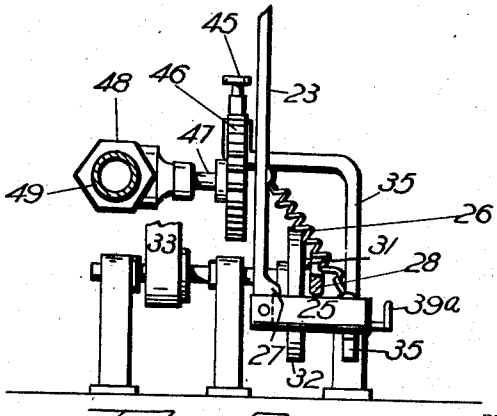


Fig. 2.

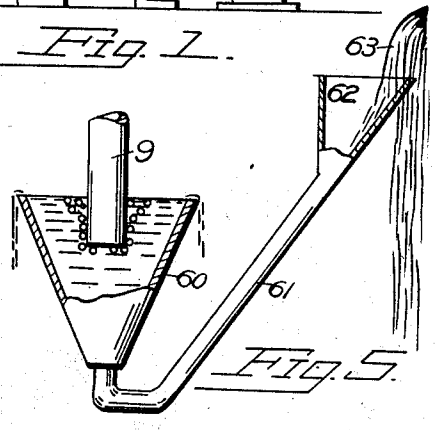


Fig. 5.

INVENTOR.
JAMES A. ADAMS

BY

ATTORNEY.

June 25, 1940. J. A. ADAMS 2,205,678

DENSITY CONTROL

Filed Jan. 7, 1937 2 Sheets-Sheet 2

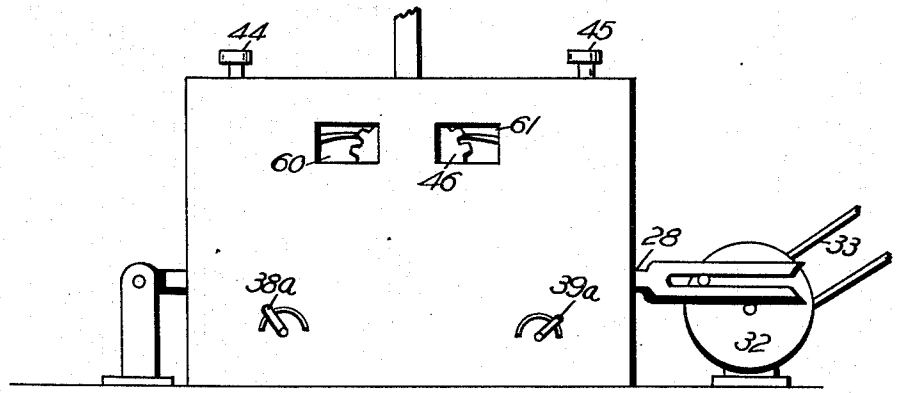


Fig. 3.

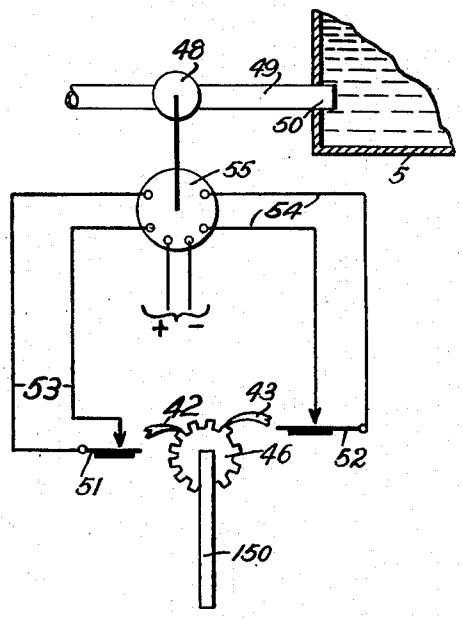
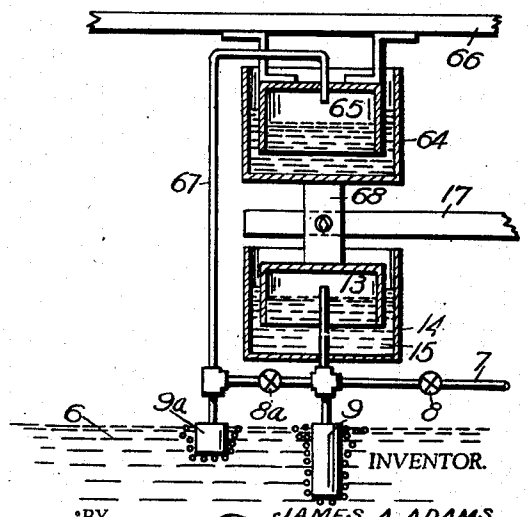


Fig. 4.

Fig. 6.



INVENTOR.
JAMES A. ADAMS
BY
ATTORNEY.

Patented June 25, 1940 2,205,678

UNITED STATES PATENT OFFICE

2,205,678

DENSITY CONTROL

James A. Adams, Carlsbad, N. Mex., assignor to The Mine and Smelter Supply Company, Denver, Colo., a corporation of Colorado

Application January 7, 1937, Serial No. 119,530

7 Claims. (Cl. 137—104)

This invention relates to improvements in pulp-density control apparatus.

In certain industries such as, for instance, mineral recovery or paper making, materials are prepared in "pulp" form as one stage of their processing. This pulp is a fluid usually comprising a mixture of liquids and finely divided solids and since the "pulp" stage of processing is usually preparatory to a subsequent treatment or step in processing, it is very important that the properties of the pulp be kept as near constant as possible, more particularly its density or specific gravity.

Therefore, it is an object of the present invention to provide in apparatus for automatic pulp density control, improved density-operated mechanism that is responsive to variations in the density of the pulp.

A further object is to provide apparatus that will respond to and quickly correct sustained variations in pulp density, irrespective of minor fluctuations in the pulp level.

A still further object is to produce apparatus that will multiply the effect of small sustained pulp density variations so that definite work to correct the variations may be done.

Other objects and advantages will be more fully disclosed in the following description and in the drawings wherein:

Figure 1 is a general elevation partly in section, illustrating apparatus built according to the invention;

Figure 2 is a fragmentary sectional view taken along the line 2—2 of Figure 1;

Figure 3 illustrates a portion of the apparatus in a housing with certain controls on the exterior of the housing;

Figure 4 illustrates, diagrammatically, a modified arrangement of the apparatus:

Figure 5 is a fragmentary view illustrating a modified arrangement of the apparatus; and

Figure 6 is a fragmentary view of a modified form of the apparatus.

Reference character 5 denotes a receptacle containing pulp 6. This receptacle may vary in size and shape in different industries and is here intended to be shown merely as a generic representation for purposes of clarity. The pulp 6 is understood to be of a kind comprising a plurality of components, including liquid and solid matter, that are mixed together, and which may vary in density due to such a cause, for instance, as a variation in the ratio of the solid to the liquid in the mix. It is further understood that the mixing of the pulp is normally a continuous operation and as it is mixed and/or conditioned, it flows on toward the next step in its processing. The term "pulp" is further intended to cover any solution whose density may vary and which it is desired to control.

A low-pressure air line is represented at 7 under control of a valve 8 and connected with open-bottomed tube 9 immersed a few inches in the pulp. A conduit 10 having a restricting valve 12 connects the tube with the interior of an inverted bell-float 13 in a tank 14 that is supported adjacent the pulp-receptacle, the tank containing a liquid such as water 15.

A member 16 extends from the top of the bell-float to engage a beam 17 that is fulcrumed at 18 and has slidable balancing weights 19 and 20. A recording pen 21 is mounted on the beam and records its movements on a rotating record-disk 22.

Below the fulcrum is a depending bar 23 attached to the beam by a Y 24 and at the lower end of the bar is an arm 25 pivoted thereto and urged upwardly by a spring 26 against a stop 27. A rod 28 is pivoted for oscillation at 29 and extends across the arm 25 just above it to contact it on the downward stroke of its movement. Near the end of the rod 28 opposite the pivot the rod is bifurcated as at 30 to engage an eccentric pin 31 on rotating disk 32 that may be driven by any convenient means such as a belt 33, to supply the oscillatory force to the rod.

A pair of angle levers 34 and 35 are fulcrumed at 36 and 37 respectively on either side of the arm 25 and are held against adjustable eccentric stops 38 and 39 respectively by the springs 40 and 41. The lower inwardly extending ends of the levers are normally below the arm 25 and spaced apart to clear the downward stroke of the arm. Eccentrics 38 and 39 are rotatable for adjustment purposes, by means of handles 38*a* and 39*a* respectively.

The upper ends of the levers are provided with pivoted ratchet pawls 42 and 43 respectively, that are adjustable by means of screws 44 and 45 and engage a ratchet wheel 46, that is mounted on or connected with the stem 47 of a valve 48 controlling the flow of a fluid such as water, through a pipe-line 49 which is connected into the pulp receptacle 5 at 50.

In practice, the pipe-line 49 may connect with the pulp receptacle at any other point, the illustration merely being intended as a generic representation of the relation of the elements, for purposes of simple clarity.

In accordance with the invention, the move-

ment of a bell-float actuates mechanism that controls the flow of liquid into a pulp to vary the pulp-density. The mechanism illustrated in Figures 1, 2 and 3 and herein described is disclosed as an example of one that may be used in the apparatus but the invention is not limited to this particular mechanism.

Figure 4 illustrates a modified arrangement of apparatus built according to the invention wherein the ratchet wheel **46** operates a lever arm **150** attached thereto, according to actuating forces imparted through the intermediary of either ratchet pawl **42** or ratchet pawl **43**. Switches **51** and **52** are positioned to be contacted and operated by lever arm **150** as it is moved to the right or to the left by ratchet wheel **46** according to pulp density variations. Switches **51** and **52** control motor-reversing switches **53** and **54** respectively, to operate reversible motor **55** that is connected directly or through a speed reducer with valve **48** in pipeline **49**.

Operation

In operation, air under pressure, for example, about two pounds gauge pressure per square inch, is conducted through pipe **7** into tube **9** and bubbles out through the bottom of the tube and up to the surface of the pulp, the back pressure proportional to the density or specific gravity of the pulp, being conducted through conduit **10** into bell-float **13**. If the specific gravity or density of the pulp increases, more pressure will be required to force the air out through the bottom of the tube **9** and therefore more back pressure will be forced into the bell-float causing it to raise. Minor pulp-level surges of brief duration will not register in the bell-float because of restriction valve **12** but any sustained change of pulp-density, even though very small, will move the float because of the large square area of the top of the bell-float compared to the cross sectional area of the tube **9**.

Disregarding the theoretical factors of friction and compression of the air in the float and conduits, the total cross sectional pressure in the tube **9** will be multiplied in the bell-float in proportion to the cross sectional areas of the tube and the float.

In this form of apparatus it is assumed that the pulp-level is fairly constant except for momentary surges. Such a condition may or may not be present where pulp-density control is desirable. Where there are sustained pulp-level variations, other arrangements and forms of the apparatus may be desirable as will be hereinafter explained.

When the bell-float **13** raises, the beam **17** rotates on its pivot **18** in a clockwise direction to swing the depending bar **23** to the left, bringing arm **25** that is being moved up and down by the oscillating rod **28** and spring **26**, over angle lever **34** so that it is also oscillated about its pivot **36** to actuate pawl **42** to turn ratchet wheel **46** in a clockwise direction. The farther to the left that the bar **23** with arm **25** swings, the greater will be the oscillatory cycle of the angle lever **34** and its pawl **42** and the greater will be the rotating effect on the ratchet wheel **46**. This increase in movement of the angle-lever **34** is due to the fact that its lower portion is inclined with reference to the arc of rotation of the lower end of bar **23** and its arm **25**, and also it is due to the fact that as arm **25** approaches the pivotal axis **36** of the angle lever **34**, the lever ratio will be greatly increased in favor of the upper portion that carries the pawl.

The rotating of wheel **46** turns valve stem **47** to increase the flow of liquid through the pipe **49** and into the receptacle **5** to decrease the pulp-density and restore it to normal, whereupon the apparatus returns to its normal neutral position as illustrated.

It may be noted that in turning the ratchet wheel and valve stem in a clockwise or right-hand direction, a valve **48** of the common type, would be closed or restricted but, of course, this direction of rotation may be made to open the valve, for instance, by the simple expedient of using a left-hand valve or by gearing the ratchet wheel shaft to the valve stem for a right-hand valve.

When the density of the pulp falls below normal, the bell-float will sink to cause the depending bar **23** to swing to the right and actuate the angle-lever **35** and pawl **43** to rotate the ratchet wheel in a counter-clockwise or left-hand direction to cut down the flow of liquid through the pipe **49** to again build up the pulp-density to normal. The movements of the beam **17** may be recorded by means of the pen **21** scribing a graph-curve on the rotating record-disk **22**.

The liquid in pipe **49** is preferably water and it may or may not be the entire liquid or water content supply for the pulp mix. It may be simply a pulp-density balance supply in addition to the main pulp-mix liquid supply.

The eccentric disk **32** rotates constantly and its speed may be varied by any well-known method such as by changing the driving ratio of the pulleys carrying the drive belt **33** or by driving the belt with a variable speed motor. The amplitude of the oscillatory cycle of the rod **28** may be varied by changing the radius of eccentricity of the pin **31**.

If desired the mechanism may be housed as illustrated in Figure 3 in which case the pawl-adjustments **38***a*, **39***a*, **44** and **45** may be placed on the exterior of the housing for convenient access and windows **60** and **61** may be provided for the purpose of observation of the pawls.

The arrangement illustrated in Figure 4 may be used to control automatically density of pulp in any commercial process. As the two-way ratchet wheel **46** is rotated in one direction or the other by actuating pawl **42** or actuating pawl **43**, the lever arm **150** will be moved to close either motor-reversing switch **51** or motor-reversing switch **52**, which are spring opened, to operate the reversible motor **55** in the correct direction of rotation to open or close valve **48** in pipeline **49**, thus to vary the flow of density-modifying liquid through pipeline **49** to the body of pulp in container **5**.

Figure 4 is diagrammatic and while the motor **55** is diagrammatically shown as directly connected with valve **48**, it will be obvious to any skilled mechanic that this connection may be through a train of gears or other speed-reducing power transmission means. Normally, motor **55** will rotate at a speed that preferably should be reduced in driving valve **48**.

The arrangement illustrated in Figure 5 shows the air-discharge tube **9** immersed in a special receptacle **60** which is connected by a conduit **61** to a funnel-like receiver **62**, a lip of which "cuts" the discharge stream **63** of the pulp whose density is to be controlled. By this arrangement the level of the pulp in which the air-discharge tube is immersed, is kept substantially constant,

and at the same time all of the density-changes are registered and corrected by the apparatus.

Figure 6 illustrates a modified form of apparatus whereby sustained pulp-level variations are compensated for so that such changes will not cause the apparatus to act, but density changes will, nevertheless, be registered and corrected. In this form the compressed air tube 7 is connected with two open-bottom discharge tubes 9 and 9a that are immersed in the pulp 6 to different depths. The air-flow in the line 7 may be restricted as desired by means of valves 8 and 8a and by this means and the sliding weights on beam 17, the beam can be balanced between bell-float 13 and a water-tank 64.

An open-bottom chamber 65 is solidly attached to a stationary member 66. An air pipe 67 connects the discharge tube 9a with the interior of the chamber, and water-tank 64 in which chamber 65 is immersed is mounted on cross-arm 68 carried on the beam 17. The other end of the cross-arm is attached to the bell-float 13 that is connected by air-pipe 10 with discharge-tube 9. The apparatus is balanced for a normal pulp-density. When the pulp-density varies, the pressure in the bell-float 13 will vary more than the pressure in the chamber 65, because the discharge-tube 9 is immersed into the pulp to a greater depth than is discharge-tube 9a. The beam 17 will thus be moved to bring the apparatus into corrective-operation as explained hereinbefore. However, a variation in the pulp-level even though sustained, will not unbalance nor move the beam 17 because the results of pulp-level variations will be the same in both the float 13 and the chamber 65.

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

1. In automatic pulp-density control apparatus the combination with actuating means responsive to pulp density variations, of a beam element mounted for bodily arcuate movement by said actuating means, mechanism adapted to reciprocate a portion of the beam-element transversely to its arcuate path of movement, and a pivoted member adjacent the reciprocated portion of the beam-element and positioned to be contacted and moved thereby according to the arcuate position of the beam-element.

2. In automatic pulp-density control apparatus the combination with actuating means responsive to pulp density variations, of a beam-element mounted for bodily arcuate movement from a normal position by said actuating means, mechanism adapted to reciprocate a portion of the beam-element transversely to its arcuate path of movement, and two pivoted members adjacent the reciprocated portion of the beam-element and positioned respectively at opposite sides of the normal position thereof to be contacted and moved thereby according to the arcuate position of the beam-element.

3. In automatic pulp-density control apparatus the combination with actuating means responsive to pulp density variations, of a beam-element mounted for bodily arcuate movement from a normal position by said actuating means, mechanism adapted to reciprocate a portion of the beam-element transversely to its arcuate path of movement, and two pivoted members adjacent the reciprocated portion of the beam-element having oppositely inclined surfaces with reference to each other and positioned respectively at opposite sides of the normal position thereof to be contacted and moved thereby according to the arcuate position of the beam-element.

4. Valve actuating means comprising a float, a fulcrumed beam element connected for movement by the float, an arm mounted for oscillation on the beam element, means for continuously oscillating the arm, a pivoted lever at either side of the arm providing angular inclined surfaces to be individually engaged and oscillated thereby when the arm is moved to one or the other of said surfaces by the fulcrumed beam, a source of fluid flow, a two-way ratchet wheel connected with the valve for controlling the source of fluid flow, and a pawl carried on each lever to rotate the ratchet wheel in opposite directions respectively, whereby the fluid flow is increased or decreased, by operation of the valve.

5. Valve actuating means comprising a float, means for varying the buoyancy of the float, a fulcrumed beam element connected for movement by the float, an arm mounted for oscillation on the beam element, means for continuously oscillating the arm, a pivoted lever at either side of the arm providing angular inclined surfaces to be individually engaged and oscillated thereby when the arm is moved to one or the other of said surfaces by the fulcrumed beam, a source of fluid flow, a two-way ratchet wheel connected with the valve for controlling the source of fluid flow, and a pawl carried on each lever to rotate the ratchet wheel in opposite directions respectively, whereby the fluid flow is increased or decreased.

6. Valve actuating means comprising a float, a fulcrumed beam element connected for angular movement by the float, means for reciprocating part of the beam element transversely to its general angular movement, opposite pivoted members adjacent a reciprocated portion of the beam element positioned to be engaged intermittently thereby and moved according to the angular position of said beam element, means for manually varying the degree of contact between the beam element and the pivoted members, and mechanism controlled by movements of the pivoted members for operating the valve.

7. Valve actuating means comprising a float, a fulcrumed beam element connected for angular movement by the float, means for reciprocating part of the beam element transversely to its general angular movement, opposite pivoted members adjacent a reciprocated portion of the beam element positioned to be engaged intermittently thereby and moved according to the angular position of said beam element, a two-way ratchet wheel engaged and operated by the movements of the respective pivoted members, and mechanism inclusive of an electric valve-operating motor, an electric circuit inclusive of a source of electrical energy connected with the motor, and a switch in the circuit operated by the ratchet wheel, for controlling the motor to operate the valve.

JAMES A. ADAMS.