

May 8, 1934.

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1,957,941

DENSITY CONTROLLING APPARATUS

Filed Nov. 16, 1932

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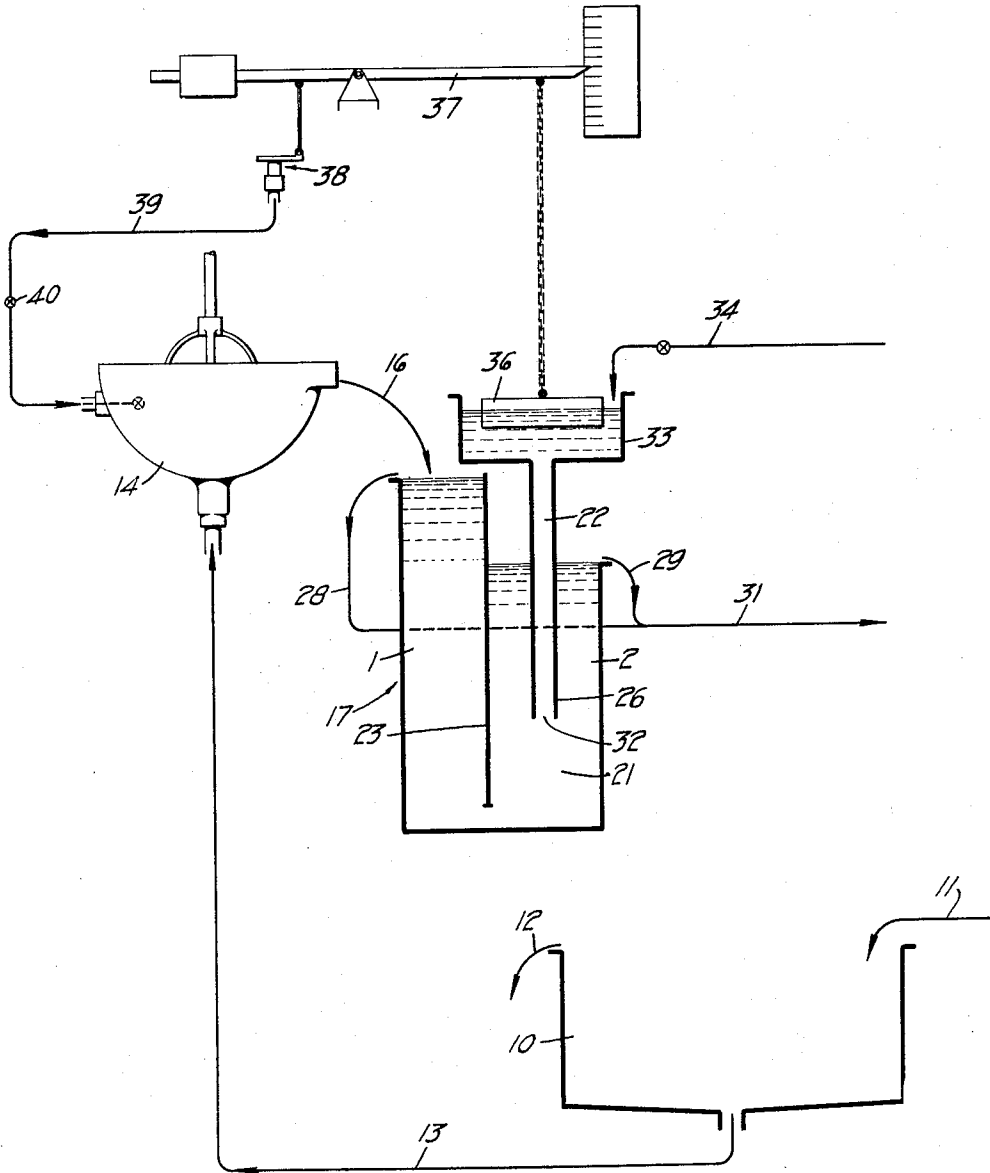


FIG-1-

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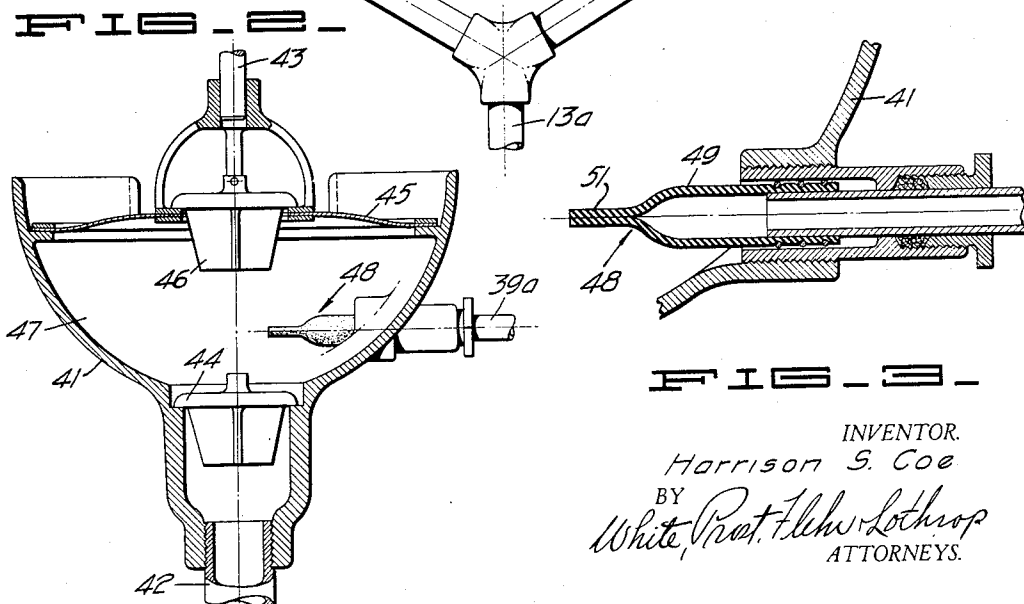
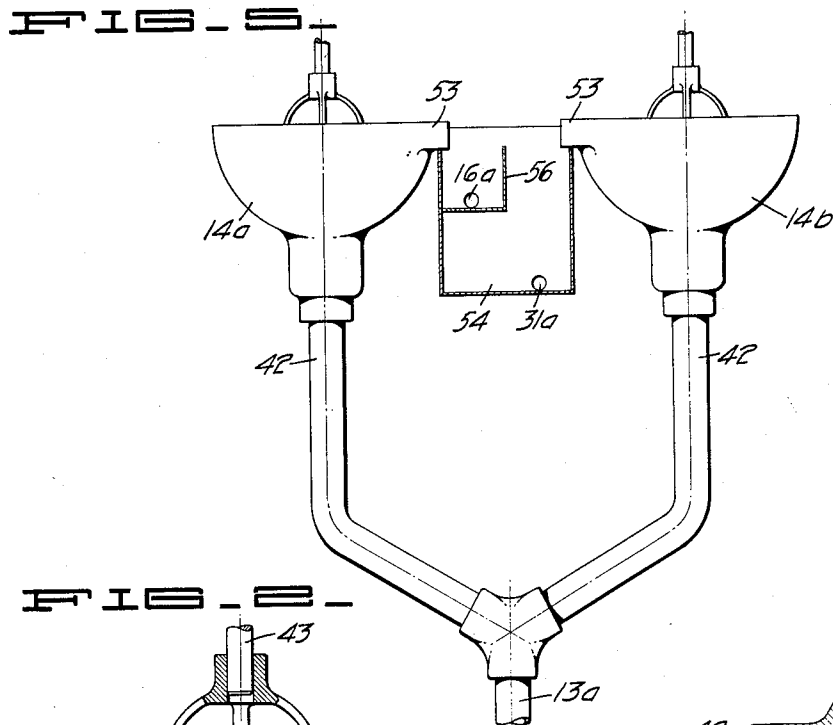
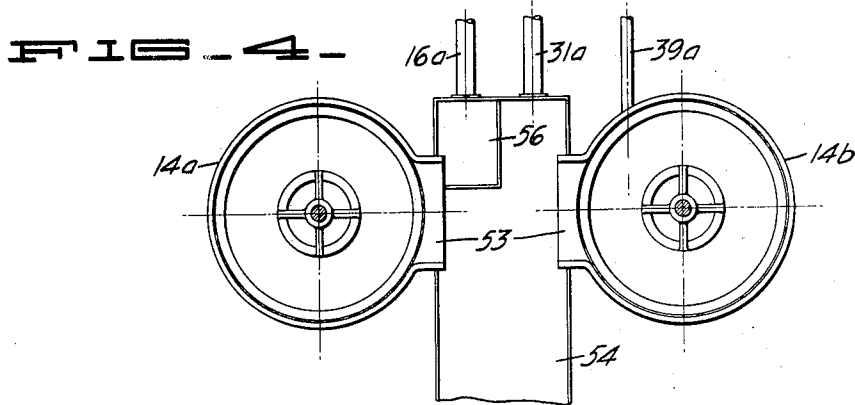
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4 Sheets-Sheet 2



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4 Sheets-Sheet 3

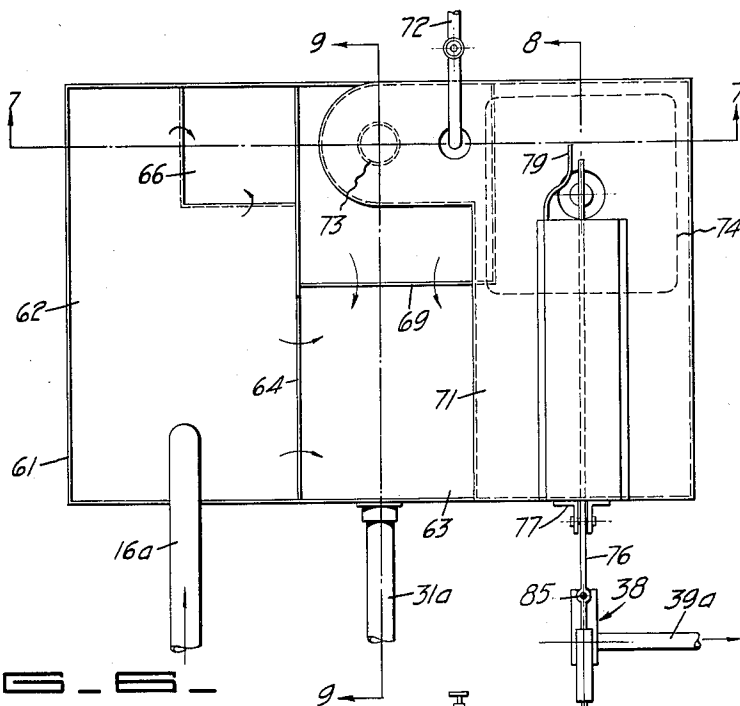


FIG. 6.

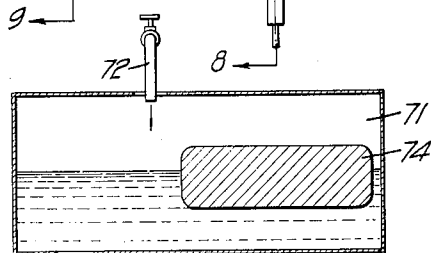
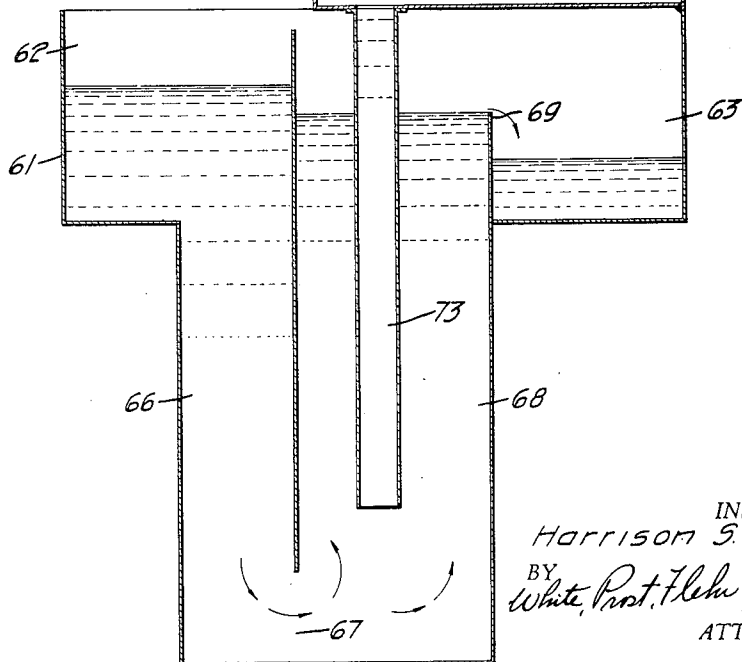


FIG. 7.



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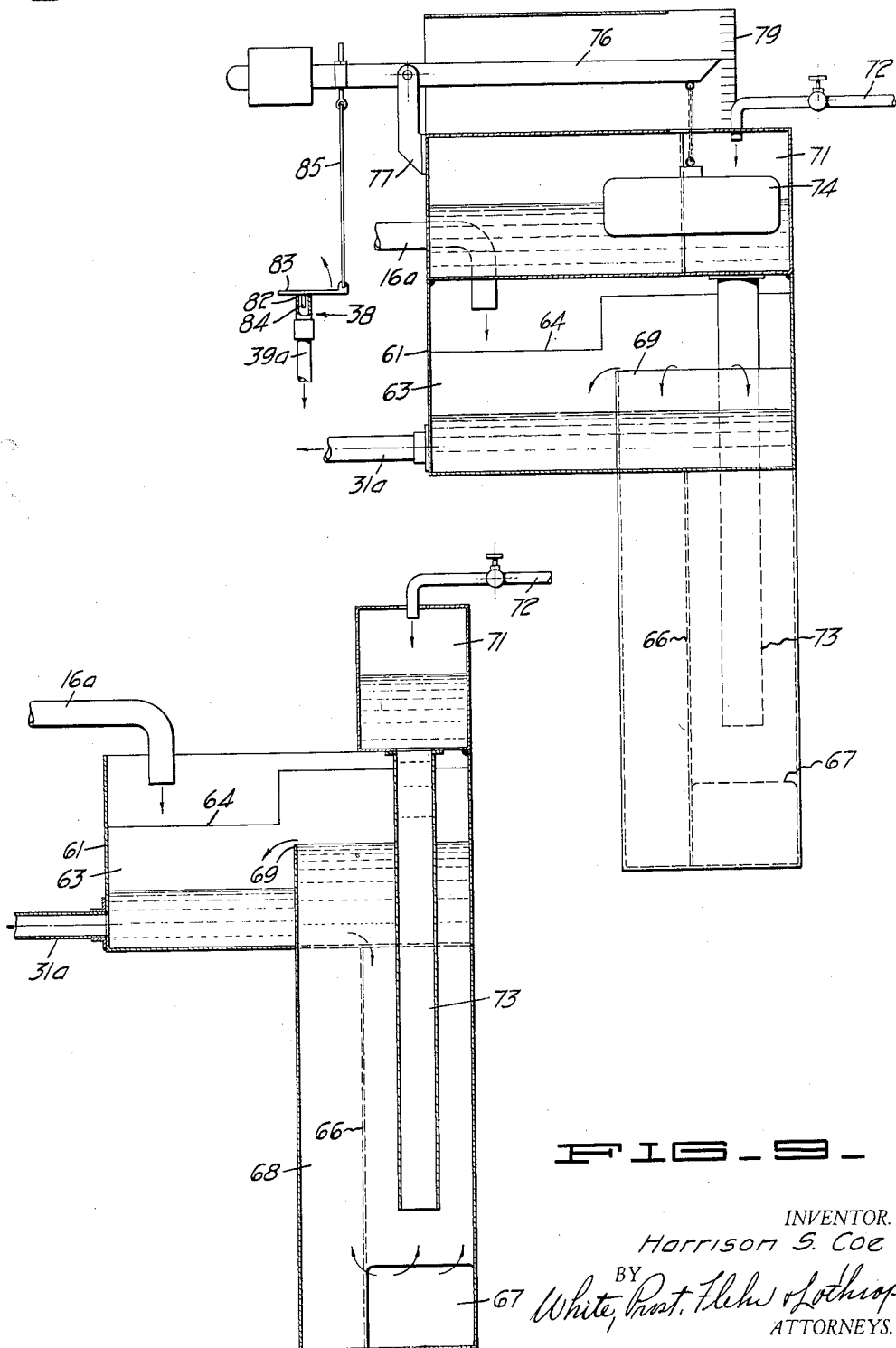
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DENSITY CONTROLLING APPARATUS

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4 Sheets-Sheet 4

FIG. 8-



UNITED STATES PATENT OFFICE

1,957,941

DENSITY CONTROLLING APPARATUS

Harrison S. Coe, Palo Alto, Calif.

Application November 16, 1932, Serial No. 642,903

1 Claim. (Cl. 103—39)

This invention relates generally to methods and apparatus for handling various fluid materials. More specifically it relates to methods and apparatus for controlling the quantity of material being introduced into or removed from, a process or apparatus in which fluid material is used, as for example thickening or classifying apparatus, or grinding mills.

It is a general object of the invention to provide a method and apparatus of the above character which will be characterized by mechanical simplicity, and which will operate upon a continuous flow of fluid material.

It is a further object of the invention to provide a method and apparatus of the above character which will be particularly applicable where it is desirable to employ one or more pumps of the suction displacement type, as for example what is commonly known as a diaphragm pump, for handling fluid material.

Another object of the invention is to provide an improved method and apparatus whereby the characteristics, as for example density of a fluid material, is used to control or regulate a process or apparatus with which the invention cooperates. For example, in one application of the invention a thickening process is controlled or regulated to secure a final discharge of substantially constant specific gravity.

It is a further object of the invention to provide a method and apparatus of the above character which will not tend to clog or be detrimentally effected by sedimentary or coarse granular material, and which will afford a high degree of sensitivity.

Further objects will appear from the following description in which the preferred embodiments of the invention have been set forth in detail in conjunction with the accompanying drawings.

Referring to the drawings:

Figure 1 is a diagrammatic view, illustrating my method and apparatus applied in conjunction with a thickener of the gravity type.

Fig. 2 is a cross sectional detail, in side elevation, showing a diaphragm pump such as can be utilized in my method and apparatus.

Fig. 3 is a cross sectional detail, illustrating the preferred form of check valve which I utilize for admitting air into the suction chamber of the pump.

Fig. 4 is a plan view illustrating a duplex arrangement of diaphragm pumps.

Fig. 5 is a side elevational view of a duplex pump arrangement, such as illustrated in Fig. 4.

Fig. 6 is a plan view, illustrating a specific

gravity testing device in conjunction with mechanism actuated by this device, for controlling admission of air to the suction chamber of a diaphragm pump.

Fig. 7 is a cross sectional view, taken along the line 7—7 of Fig. 6.

Fig. 8 is a cross sectional view taken along the line 8—8 of Fig. 6.

Fig. 9 is a cross sectional view taken along the line 9—9 of Fig. 6.

The method of the invention can be best understood by first referring to Fig. 1 of the drawings, which diagrammatically illustrates an installation in conjunction with a thickener 10 of the gravity type. Introduction of fluid feed material into the thickener 10 is indicated at 11, the overflow from the thickener indicated at 12, and the discharge of thickened fluid material by line 13. Line 13 is connected to the suction side of a diaphragm pump 14, the discharge of which, indicated at 16, leads to a specific gravity testing apparatus indicated generally at 17.

The specific gravity testing apparatus 17 is similar to that disclosed and claimed in my said copending application Ser. No. 587,700. Aside from the fact that apparatus 17 effects a response in accordance with variations in the gravity of the thickened fluid material, it is characterized by the fact that it utilizes a hydrostatic balance between two fluid bodies, these bodies being designated 21 and 22. Body 21 is formed of fluid material discharged by the diaphragm pump 14, while body 22 is formed of a liquid of known constant gravity, such as water.

The arrangement of walls for defining and retaining fluid bodies 21 and 22 will not be described in detail with reference to Fig. 1. However, as diagrammatically illustrated, wall 23 serves to divide the container into two spaces, which are designated by numerals 1 and 2. Body 22 is shown confined by a conduit or pipe 26, having a lower open end communicating with space 2. Body 21 is formed within space 2.

Removal of fluid material from body 21 introduced from the pump 14 is indicated by lines 28 and 29, which lead to a common discharge line 31. This removal by way of lines 28 and 29 preferably occurs over weirs so that the levels of material in spaces 1 and 2 remain substantially constant. Adjacent the bottom of pipe 26, at a point or localized region indicated at 32, a hydrostatic balance is established between the fluid materials forming bodies 21 and 22. To maintain such a balance water is continuously supplied to the body 22. Thus the upper end of pipe 26 is shown

communicating with a receptacle 53 into which water is continuously introduced by way of line 34.

It may be explained at this point that when the thickened fluid material forming body 21 is of a given specific gravity, water within receptacle 33 will assume a corresponding definite level, sufficient to maintain a hydrostatic balance between bodies 21 and 22, at the localized region 32. If the material forming body 21 increases in gravity, the level of water in receptacle 33 will rise to reestablish the hydrostatic balance. Likewise if the gravity of the material forming body 21 decreases, the level of water in receptacle 33 falls to a point sufficient to reestablish the balance. I utilize such changes in the level of water within receptacle 33, to effect an automatic compensating control of the pumping capacity of diaphragm pump 14. As representative of suitable mechanism for effecting this result, in Fig. 1 there is shown a float 36 which is connected to one end of a fulcrumed beam 37. The other end of beam 37 is connected to a flap valve 38, preferably of a type to be presently explained, which serves to control admission of air into the pipe line 39. Pipe line 39 connects to the suction chamber of diaphragm pump 14, preferably thru a suitable check valve disposed within or adjacent to the suction chamber, to prevent back flow of fluid material being pumped. A flow orifice, such as afforded by a valve 40, is also interposed in line 39.

The discharge of thickened material from a gravity thickener, as such apparatus is commonly utilized in the art, tends to vary its gravity in accordance with varying conditions within the thickener and in accordance with variations of the feed. Many other types of apparatus for separating a fluid feed into lighter and heavier components, have somewhat similar characteristics. Such variations are generally objectionable, not only because a fairly uniform gravity is frequently desired, but likewise because the capacity of the thickener is impaired. Under optimum conditions the specific gravity of the thickened material discharged should vary only between relatively close limits, irrespective of variations in the rate of introduction of characteristics of the feed material. The apparatus just described with reference to Fig. 1 automatically varies the rate of removal of the thickened material from the thickener 10, in accordance with variations in its gravity, whereby in practice such variations are maintained between relatively close limits.

Before explaining the manner in which the apparatus illustrated in Fig. 1 serves to automatically maintain the gravity of the thickened material between relatively close limits it should be pointed out that the reciprocating member of diaphragm pump 14 is reciprocated at a constant rate with a fixed stroke, and that the capacity of this pump is somewhat in excess of that required to handle the discharge from the thickener 10. In other words if pump 14 were operated continuously and at maximum capacity, the gravity of the thickened material would tend to gradually decrease. Assuming now that pump 14 is operated continuously and at its maximum pumping capacity, a decrease in the gravity of the thickened material handled causes a lowering of the water level in receptacle 33, with the result that the weight of float 36 causes a tilting of beam 37, to effect a tilting and partial opening of valve member 38. A certain amount of air from the

ber of pump 14, during each suction stroke, which results in a material lowering of its pumping capacity. In this connection note that valve 40 is so adjusted that even when valve 38 is fully open, pump 14 will still function at a reduced minimum capacity. Due to the reduced rate of removal, the gravity of the thickened discharge material now gradually increases, to reduce the amount of opening of valve 38, until the capacity of the pump is just sufficient to maintain the gravity of the thickened material at a desired optimum value. When the gravity of material is being maintained at about its desired value, valve 38 is sucked closed shortly after the beginning of each suction stroke, thereby causing a controlled slug of air to be admitted into the suction chamber to reduce the pumping capacity to the correct value. Thus the capacity of diaphragm pump 14 is automatically regulated, so as to maintain the gravity of the thickened material between desired limits.

The apparatus and method described above will give a practical degree of regulation in connection with commercial installations of thickeners or like apparatus, particularly where the thickener is handling metallurgical pulp. Aside from the effectiveness of the regulation secured and the simplicity of the apparatus, no clogging will result where the fluid material being handled contains coarse granular material such as sand.

Figs. 2 and 3 illustrate in greater detail a conventional type of diaphragm pump, with a novel type of check valve for controlling admission of air into the suction chamber. The pump in this instance consists of a hollow body 41, provided with a suction pipe connection 42. The flexible diaphragm 45, carried by the body, is connected to a reciprocable actuating rod 43. The lower portion of body 41 carries the check valve 44, and another check valve 46 is carried by diaphragm 43. The air pipe 39a extends into the suction chamber 47 of the body 41, and its inner end is connected to the check valve 48 illustrated in detail in Fig. 3. This check valve simply consists of a hose 49 formed of rubber or other resilient material, having its inner end portion 51 flattened to cause the same to be normally closed. During a suction stroke if air is admitted to pipe 39a, the flattened end portion 51 will open a certain amount to permit admission of this air into the suction chamber. If admission of air is discontinued during the latter part of the stroke, which is the preferred mode of operation, then the check likewise closes before the suction stroke is completed. During a discharge stroke, that is a downward movement of the actuator rod 43, the flattened end portion 51 is closed under the pressure within the fluid chamber, to prevent admission of the fluid material being pumped into pipe 39a. A check of this character, while simple and inexpensive, is effective and reliable. Likewise the positioning of this check within the suction chamber avoids formation of a cushioning column of air which would make operation upon high suction heads difficult, and prevent operation of the pump at maximum capacity.

In Figs. 4 and 5 I have shown an arrangement of duplex diaphragm pumps for handling the fluid material. In this case the two diaphragm pumps, 14a and 14b, have their individual suction lines 42, connected to a common suction pipe 13a. The discharge spouts 53 from the two pumps, discharge the fluid material into a launder 54. A portion of the discharge from pump 14a is delivered into a receptacle 56, which in turn is in

communication with pipe 16a leading to the specific gravity testing apparatus. Pipe 31a serves to return the fluid material from the specific gravity testing apparatus, back to launder 54.

5 The suction chamber of pump 14b is connected to air line 39a, for admitting controlled quantities of air.

With the arrangement of duplex pumps described above, it is evident that only the pumping capacity of pump 14b is automatically controlled by regulated admissions of air by way of pipe 39a. Likewise only a part of the discharge from the pump 14a, is diverted to the specific gravity testing apparatus. However such an arrangement will give a measure of control sufficient for commercial purposes.

In Figs. 6 to 10 inclusive I have illustrated a suitable embodiment for the specific testing device, in conjunction with the mechanism for effecting opening and closing of the valve connected to air pipe 39a. The device as illustrated consists of a structure 61, formed of a plurality of walls to afford separate compartments and flow paths for the fluid material. Thus one compartment 62, serves to receive the fluid material delivered from pipe 16a. Receiver 63 is arranged to redeliver the fluid material to pipe 31a, and an overflow wier 64 between compartment 62 and receiver 63, may be provided to assist in maintaining the level of the fluid material in the compartment at a substantially constant level. Communicating with the lower portion of compartment 62, there is a depending passage 66. An opening 67 serves to connect the lower portion of passage 66, with the lower portion of an adjacent upstanding space 68. From space 68 fluid material may flow over wier 69, to the receiver 63, whereby the level of fluid material in this space is maintained fairly constant.

Arranged near the upper portion of the structure there is a receptacle 71 adapted to receive a continuous small stream of water from pipe 72. A conduit 73 extends downwardly from receptacle 71, thru space 68. The lower end of this conduit 73 is open, to establish a hydrostatic balance, as has been previously explained with respect to Fig. 1. Positioned within receptacle 71, there is a float 74 which is connected to one end of a beam 76. This beam is provided with a pivotal support 77, and has its outer end connected to a valve 38. Valve 38 is arranged to control admission of air into the pipe 39a. Arranged adjacent one end of beam 76, there is a graduated scale 79, so that one can visually determine at any time, the gravity of the fluid material being handled.

Operation of the apparatus illustrated in Figs. 6 to 10 inclusive will be evidenced from the previous description with respect to Fig. 1. A constant level of fluid material is maintained in compartment 62, because of the continual flow of a

portion of this fluid material over wier 64 into the receiver 63. A continual down flow of fluid material occurs thru passage 66, a continual up-flow occurs thru space 68, and a constant level is maintained in space 68 because of the continuous flow over wier 69 to receiver 63. A hydrostatic balance is maintained at the lower end of conduit 73, and thus the position of float 74 controls opening and closing of valve 38.

A suitable detailed construction for valve 38 is shown in Fig. 8. A relatively small annular seat 82 is provided, and disposed upon this seat there is a valve member 83. A pin 84 depending from the valve member serves to loosely retain the same upon the seat. One end of the valve member is connected to a link 85, which in turn is connected to beam 76. Upward movement of link 85 causes a tilting of valve member 83, thus permitting a controlled amount of air to be admitted to pipe 39a. If the amount of opening movement is sufficient the valve member will remain open during the entire suction stroke. However when open only a slight amount, corresponding to a normal condition of operation when the gravity is at or near the desired value, the valve member is sucked closed shortly after the beginning of the suction stroke of the diaphragm pump, and is therefore continuously teetered upon its seat.

I have found that a valve such as just described will give a close degree of regulations, and will render the apparatus highly sensitive to gravity variations. When the pump is operating upon a high suction head, such as is common in the metallurgical industry, it is impractical if not impossible to secure proper control by permitting introduction of air throughout the suction stroke, when the gravity is at or near the desired value. Furthermore introduction of a slug of air during only the initial part of the suction stroke permits more efficient opening and closing of a check valve of the type shown in Fig. 3.

I claim:

In apparatus of the character described for the handling of fluid pulp of varying gravity, a pump of the diaphragm type for handling said fluid pulp, means for establishing a body of said fluid pulp from the discharge side of said pump, means for establishing another body of liquid of constant gravity arranged to be in contact with the material of said first body at a localized region within the first body, means for continuously supplying liquid to said second body, an air pipe leading to the suction chamber of the diaphragm pump, a valve for controlling admission of air into said pipe, and means for effecting opening and closing of said valve in accordance with variations in the level of liquid forming said second body.

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