Jan. 27, 1953 L. D. McGLOTHLIN 2,626,786

AUTOMATIC CONSISTENCY CONTROL MEANS

Filed May 5, 1947 2 SHEETS—SHEET 1

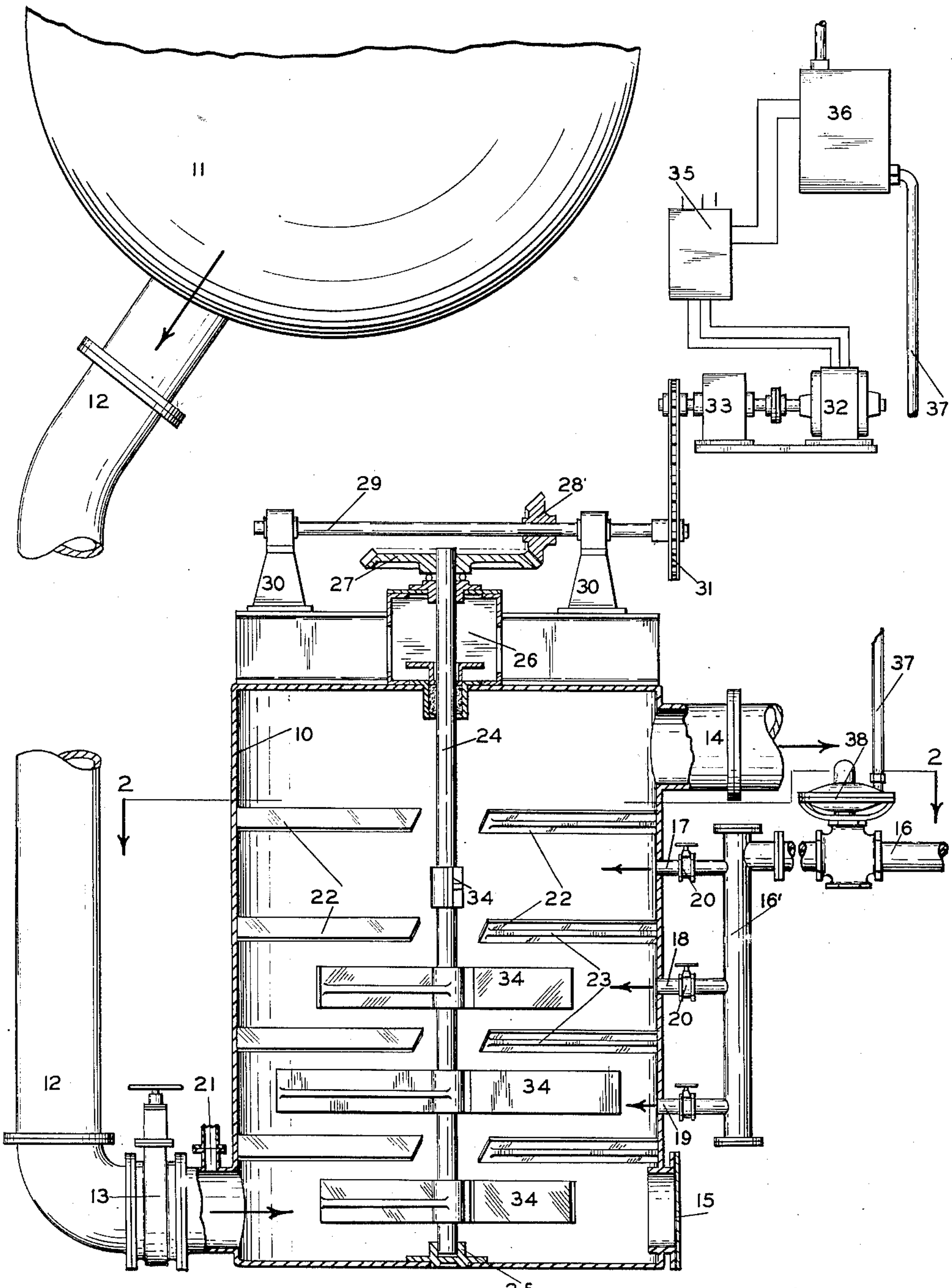

Fig 1

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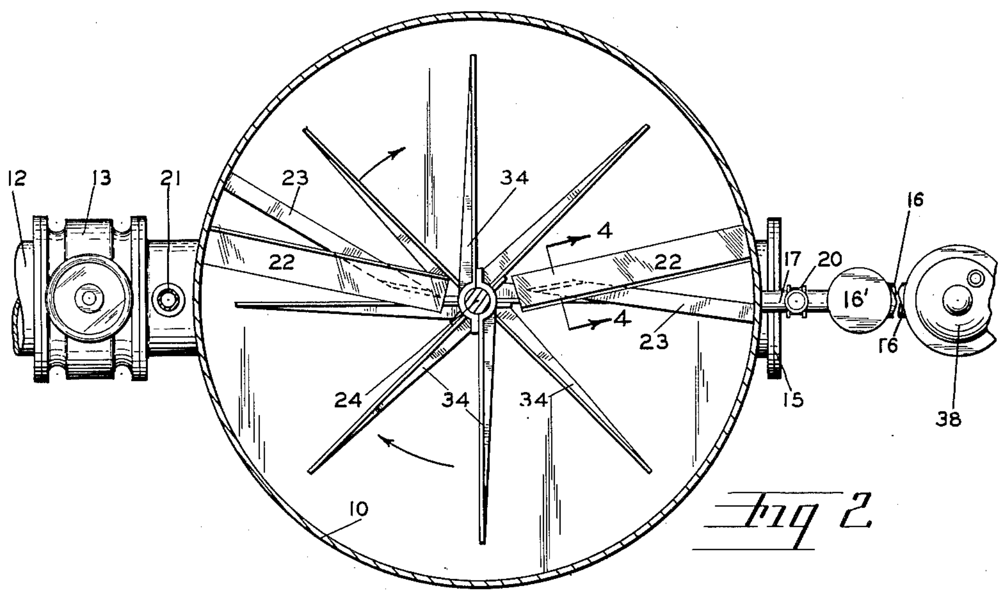

Fig 2

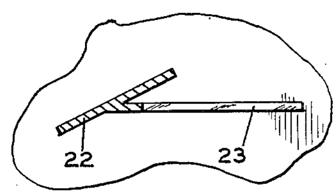

Fig 4

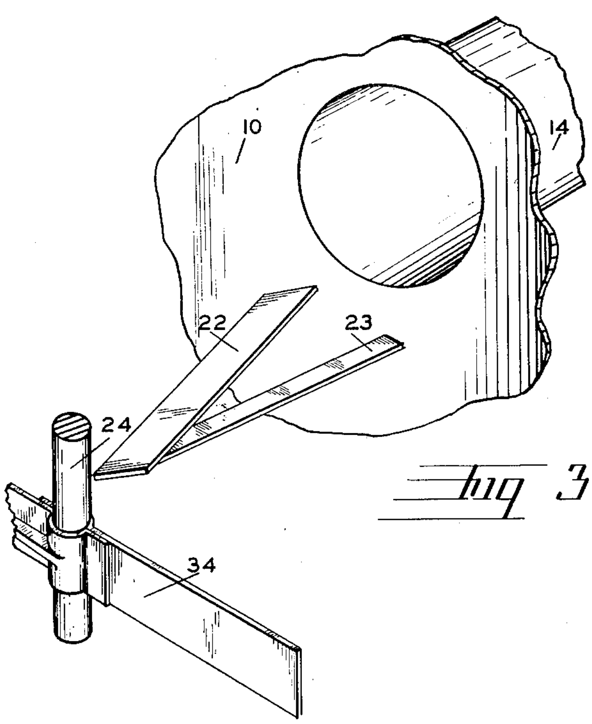

Fig 3

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Patented Jan. 27, 1953 2,626,786

UNITED STATES PATENT OFFICE

2,626,786

AUTOMATIC CONSISTENCY CONTROL MEANS

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Application May 5, 1947, Serial No. 745,893

4 Claims. (Cl. 259—8)

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This invention relates in general to means employed for regulating the consistency of a fluid suspension by automatically controlling the addition of liquid to the suspension.

In particular, this invention relates to the regulation and control of the consistency of pulp stock, such as that used in the manufacture of paper, especially to stock which has been subjected to "cooking" in a digester, as, for example, kraft paper stock.

After the "cooking" in the digester the stock is delivered or "blown" into a tank, commonly referred to as a "blow tank," from whence the stock is pumped to the washers in order that the liquor in which the stock has been "cooked" may be separated from the pulp.

The stock coming from the digester generally has a consistency of about 15%. It is customary to add enough weak liquor to the stock at this stage to reduce the consistency to about 7%, or 6%, so that the stock can be properly handled by the pumps and delivered to the washers. However, as is well known, it is also essential to control the consistency of the stock so that it will be of fairly uniform consistency when delivered to the washers.

An object of the present invention is to provide an improved device for reducing the consistency of the stock, as desired, before the stock is delivered to the washers.

Another object of this invention is to provide an improved control means which will operate automatically and efficiently to maintain a uniform predetermined consistency in the stock preparatory to its being pumped to the washers.

A further object is to provide an automatic consistency control means which will be highly sensitive to changes in the consistency of the stock and thus able to maintain a more accurate control of the consistency.

An additional object is to provide a consistency control for stock in which "black liquor" is utilized but in which no excessive foaming of the "black liquor" will be developed by the control means employed.

The manner in which these objects and other advantages are obtained with my improved consistency control means will be understood from the following description of the construction and operation of the same, in which description reference is made to the accompanying drawings.

In the drawings:

Fig. 1 is a sectional elevation of the main portion of my device with the associated elements of the entire control means indicated more or less diagrammatically;

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Fig. 2 is a plan section taken on line 2—2 of Fig. 1;

Fig. 3 is a fragmentary view, in perspective, taken from the interior of the main tank of Figs. 1 and 2, showing a portion of the upper rotating paddle and upper baffle in the tank and the outlet from the tank; and

Fig. 4 is a transverse vertical section through one of the baffles corresponding to line 4—4 of Fig. 2.

Referring first to Figs. 1 and 2, the device includes a main consistency control tank 10, which is preferably cylindrical in shape as indicated. The stock from the digester, after being delivered to the usual "blow tank," which is indicated at 11 in Fig. 1, passes through pipeline 12 into the bottom of the consistency control tank 10. A suitable valve 13, such as a gate valve, is provided in pipeline 12 to control the rate of flow of the stock into tank 10 or to shut off the flow entirely when desired.

The tank 10 is closed at the top and a stock outlet pipe 14 is connected near the top of tank 10 through which the stock is drawn by pumping means (not shown), and caused to pass to the washers previously referred to. A clean-out 15 is provided in the bottom of tank 10.

It is customary, in reducing the consistency of stock delivered from the digester, to add weak "black liquor" to the stock rather than ordinary water. The chief reason for this is that the addition of fresh water for the purpose of reducing consistency will dilute the "black liquor" in the stock and such dilution then hampers the final recovery of the chemicals from the "black liquor" when the latter has been separated from the pulp as a result of the washing process. Thus, since the consistency of the stock can be reduced by the addition of any liquid, the same general "black liquor" is used for the purpose.

The weak "black liquor" which, as mentioned above, is thus used for reducing the consistency of stock in the tank 10, is delivered to the tank 10 by the pipeline 16 through the intermediary of a vertical pipe section 16′ which in turn connects with the tank 10 through a plurality of inlet branch pipes indicated at 17, 18 and 19 in Fig. 1. These branch inlet pipes connect with the tank 10 at different levels and each inlet pipe is controlled by a separate hand valve 20. Thus, as apparent from Fig. 1, the incoming diluting liquor can be distributed in equal amounts simultaneously at different levels, as desired, or the comparative rate of distribution at different levels in the tank can be modified. A supplementary inlet port for the liquor is provided at the entrance end of the pipeline 12 between the valve 13 and the tank, this inlet port being shown at 21 in Fig. 1. A branch pipeline (not shown) for the "black liquor" is connected to this inlet and is also controlled by a suitable hand valve so that the "black liquor" can be delivered into the bottom of tank 10 as well as at the other levels, should this be desired. "Black liquor" delivered into the bottom of tank 10, when the stock inlet valve 13 is closed, can also be used for flushing out the bottom of the tank 10.

A plurality of baffles 22 extend horizontally within the tank 10. These baffles are arranged in pairs at different horizontal levels, as shown in Fig. 1, and the corresponding baffles of each pair are arranged in vertical alinement. Thus, as apparent from Fig. 2, these baffles form two vertical rows. However, these two vertical rows are preferably not diametrically opposite each other. While the baffles extend in horizontal direction, the upper faces of the baffles are inclined so as to form dihedral angles with the horizontal planes in which the lower edges of the baffles lie. The inner end of each baffle 22 is supported by a horizontal brace 23 arranged as shown in Figs. 2, 3 and 4, the inner ends of the braces 23 being connected to the under side of the baffles respectively and the outer ends of the braces being secured to the tank wall a short distance behind the points where the outer ends of the baffles are secured to the wall.

A vertical shaft 24, centrally located within the tank 10, extends upwardly through the tank and through the top of the tank. The bottom end of the shaft 24 is rotatably supported in a suitable bearing 25 located in the bottom of the tank. The shaft 24 extends through a packing box 26 placed on the top of tank 10, and this packing box contains packing gland elements and permits convenient access to the packing gland elements. A gear 27 is secured to the top of the shaft 24 and a suitable thrust bearing is provided between the gear 27 and the top of the packing box 26. A pinion 28, keyed to a horizontal shaft 29, meshes with gear 27. The horizontal shaft 29 is rotatably mounted in a pair of supporting standards 30 which in turn are supported on channel beams extending over the top of the tank 10. A sprocket wheel 31 is keyed to the end of the shaft 29 and is driven from a motor 32 through the intermediary of a reducing unit 33 and sprocket chain connection.

At spaced intervals on the shaft 24, within the tank 10, paddle blades 34 are mounted. These paddle blades are secured to brackets which in turn are rigidly mounted in place on the shaft 24. The paddle blades are arranged in pairs, the forward faces of each pair of blades being substantially diametrically opposite each other as shown in Fig. 2. All the blades are of the same size and shape, each blade preferably having a front face constituting a vertical plane surface and a horizontal reinforcing rib on the rear face. The blades are all arranged so that their front faces will face in the direction of rotation of the entire assembly, thus clock-wise as viewed in Fig. 2.

Unlike the baffles 22, the respective blades 34 of the pairs are not in vertical alinement but are in staggered vertical sequence. Each pair of blades 34 is placed a short distance below a pair of baffles 22, as shown in Fig. 1. The upper faces of the baffles 22 are so arranged that they will engage the stock when rotary motion is imparted to it in one direction by the blades 34 (thus when the stock is rotated clock-wise as viewed in Fig. 2). Thus the entire arrangement of paddles and baffles is such that as each pair of paddles encounters the stock the paddles will produce a mixing and rotary motion and as the rotating stock encounters each pair of baffles the stock will receive an upward thrust. Consequently the stock will not only be mixed and rotated but will also be moved upwardly from the bottom of the tank until it reaches the outlet pipe 14 through which it is drawn by pump suction. During this mixing and lifting of the stock in the tank 10 additional liquor is admitted to the stock at various levels and in various amounts in order to lower the consistency of the stock as desired.

The electric power for operating the motor 32, which is used to rotate the paddles 34 in the tank 10, is delivered through a thermocouple watt meter, diagrammatically indicated at 35 in Fig. 1, which serves to convert wattage to milli-voltage, and which in turn actuates an automatically balancing potentiometer or similar controller, diagrammatically illustrated at 36 in Fig. 1, and this in turn operates a pilot air valve (not shown) controlling the passage of compressed air through the compressed air line 37 to a diaphragm-operated control valve 38 in the pipeline 16. The thermocouple 35, balancing potentiometer and pilot valve 36, and diaphragm valve 38 are all well known and of standard construction and need not be further described. The thermocouple 35 and the balancing potentiometer 36, together with the diaphragm valve 38, are so arranged that any load on the motor 32 which exceeds a given minimum will cause the thermocouple watt meter, acting upon the balancing potentiometer which operates the pilot valve in the compressed air line, to permit compressed air to pass to one side of the diaphragm in the diaphragm control valve 38 so as to open the valve 38 against the force of the spring, which spring normally holds the valve closed. This opening of valve 38 permits liquor to pass into the tank 10 through the inlet branch pipes 17, 18 and 19, as previously mentioned. It will be apparent that the higher the consistency of the stock in the tank 10 the greater will be the load on the motor 32, and, similarly, that the lowering of the consistency of the stock in the tank 10 by the addition of liquor delivered through the inlets 17, 18 and 19, will reduce the motor load.

The general idea of controlling the dilution or consistency of stock by the amount of power required to rotate a paddle within the stock, is known to be old in the art. However, it will be found that the particular arrangement of paddles, baffles and diluting-liquor inlets which I have provided in my device will greatly facilitate the maintenance of uniformity in the reduced stock consistency. By having a plurality of paddles at different levels, arranged in staggered angular relationship, in combination with the fixed baffles, a slower rate of rotation of the paddles is sufficient for maintaining the consistency control. This is important inasmuch as "black liquor" has a tendency to foam when agitated too rapidly and the foaming of the liquor gives rise to other subsequent difficulties.

Due to the fact that the stock enters the tank 10 at the bottom and leaves through pipe 14 at the top of the tank, and to the fact that the stock is given only relatively slow agitation while passing through the tank, any foreign objects, such as bits of metal which may inadvertently have become mixed with the stock, will have a tendency to collect at the bottom of the tank, from which point they can easily be removed through the cleanout plug **15**. This is another incidental advantage of my device.

From Fig. 2 it will be observed that, due to the fact that the baffles **22** of each pair are not diametrically opposite each other, and due to the staggered angular relationship of the different sets of paddle blades **34**, no two paddle blades come into vertical alinement with any of the baffles simultaneously. The result of this arrangement is that the resistance to the rotation of the shaft **24** is more evenly distributed throughout each complete revolution of the shaft and paddles. In addition to this feature there is the advantage obtained by introducing the diluting liquor simultaneously at different levels into the tank **10**. This not only enables a more thorough mixing of the added liquor and stock to take place but also reduces the amount of fluctuation in the resistance to the rotation of the shaft and paddles. Consequently the dilution of the stock as it passes through tank **10**, the dilution resulting from the addition of extra "black liquor" required to bring the stock down to the desired predetermined lower consistency, takes place without resulting in any wide range of fluctuation in the load on the motor **32**. Excessive fluctuation in the motor load has heretofore been encountered with consistency control devices which similarly regulate the dilution by the motor load. Since the range of fluctuation of the motor load is thus reduced the entire means becomes more sensitive and this greater sensitivity in turn makes possible a closer control and greater uniformity in the consistency of the stock with my invention.

Several modifications in the means which I have described and illustrated would be possible without departing from the main principles of my invention. Thus other arrangements of the plurality of paddles and baffles within the tank **10** could be worked out to produce substantially the same results. Consequently it is not my intention to restrict myself to means constructed exactly as illustrated or to limit my invention otherwise than as set forth in the claims. However, the particular means illustrated I regard as a preferred means for carrying out my invention and this same means is proving satisfactory in actual practice.

Although I have described my invention as employed for the purpose of controlling the consistency of certain types of paper stock at a particular stage, and this I consider to be the main field of use for my invention, nevertheless I do not wish to limit my invention to any particular use since the invention could be employed to control the addition of a modifying medium to other fluid suspensions.

I claim:

1. In a consistency control device of the character described, a receptacle for a fluid suspension, an element rotated on a substantially vertical axis in said receptacle, means for delivering a diluting liquid to said receptacle, means for delivering the fluid suspension into the lower portion of said receptacle, means for withdrawing the fluid suspension from the upper portion of said receptacle, a series of paddle blades secured to said rotated element and spaced at different heights on said element, the forward faces of said blades in the direction of rotation of said element being substantially vertical, whereby said blades will produce rotation of the fluid suspension as an entire body in said receptacle with minimum agitation of the suspension, and a series of stationary baffles located within said receptacle, said baffles being spaced at different heights in said receptacle and extending into the spaces between said series of spaced blades, said baffles having faces sloping obliquely upward with respect to the direction of rotation of said element to promote upward movement of the rotating suspension in said receptacle.

2. In a consistency control device of the character described, a receptacle for a fluid suspension, an element rotated on a substantially vertical axis in said receptacle, means for delivering a diluting liquid to said receptacle, means for delivering the fluid suspension into the lower portion of said receptacle, means for withdrawing the fluid suspension from the upper portion of said receptacle, a series of paddle blades secured to said rotated element, said blades arranged in pairs, the blades in each pair being at the same horizontal level and extending in substantially diametrically opposite directions, said pairs of blades being spaced at different heights on said element, the forward faces of said blades in the direction of rotation of said element being substantially vertical, whereby said blades will produce rotation of the fluid suspension as an entire body in said receptacle with minimum agitation of the suspension, the corresponding blades at different heights being arranged in staggered relative position, and a series of stationary baffles located within said receptacle, said baffles arranged in pairs, the baffles in each pair being at the same horizontal level but not arranged diametrically opposite each other, said pairs of baffles being spaced at different heights in said receptacle and extending into the spaces between said series of spaced pairs of blades, the corresponding baffles at different heights being in substantially vertical alignment, the arrangement of said blades and baffles being such as to avoid several blades being in vertical alignment with adjacent baffles at the same instant, thereby reducing fluctuations in the power required for rotating said element, said baffles having faces sloping obliquely upward with respect to the direction of rotation of said element to promote upward movement of the rotating suspension in said receptacle.

3. In a consistency control device of the character described, a receptacle for a fluid suspension, an element rotated on a substantially vertical axis in said receptacle, means for delivering a diluting liquid to said receptacle, means for delivering the fluid suspension into the bottom of said receptacle, means for withdrawing the fluid suspension from the top of said receptacle, a series of paddle blades secured to said rotated element and spaced at different heights on said element, the forward faces of said blades in the direction of rotation of said element being substantially vertical, whereby said blades will produce rotation of the fluid suspension as an entire body in said receptacle with minimum agitation of the suspension, a series of stationary baffles located within said receptacle, said baffles being spaced at different heights in said receptacle and extending into the spaces between said series of spaced blades, said baffles having faces sloping obliquely upward with respect to the direction of rotation of said element to promote upward movement of the rotating suspension in said receptacle, inlet ports for said diluting liq-

uid spaced at different heights in said receptacle, and means for controlling the passage of diluting liquid through each port into said receptacle.

4. In a consistency control device of the character described, a receptacle for a fluid suspension, an element rotated on a substantially vertical axis in said receptacle, means for delivering a diluting liquid to said receptacle, means for delivering the fluid suspension into the bottom of said receptacle, means for withdrawing the fluid suspension from the top of said receptacle, a series of paddle blades secured to said rotated element, said blades arranged in pairs, the blades in each pair being at the same horizontal level and extending in substantially diametrically opposite directions, said pairs of blades being spaced at different heights on said element, the forward faces of said blades in the direction of rotation of said element being substantially vertical, whereby said blades will produce rotation of the fluid suspension as an entire body in said receptacle with minimum agitation of the suspension, a series of stationary baffles located within said receptacle, said baffles arranged in pairs, the baffles in each pair being at the same horizontal level, said pairs of baffles being spaced at different heights in said receptacle and extending into the spaces between said series of spaced pairs of blades, said baffles having faces sloping obliquely upward with respect to the direction of rotation of said element to promote upward movement of the rotating suspension in said receptacle, inlet ports for said diluting liquid spaced at different heights in said receptacle, and means for relatively controlling the passage of diluting liquid through each port into said receptacle.

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