Nov. 17, 1942. R. D. KEHOE ET AL 2,302,327

AUTOMATIC CONSISTENCY CONTROL MEANS

Original Filed Nov. 28, 1940 4 Sheets-Sheet 1

FIG. 4.

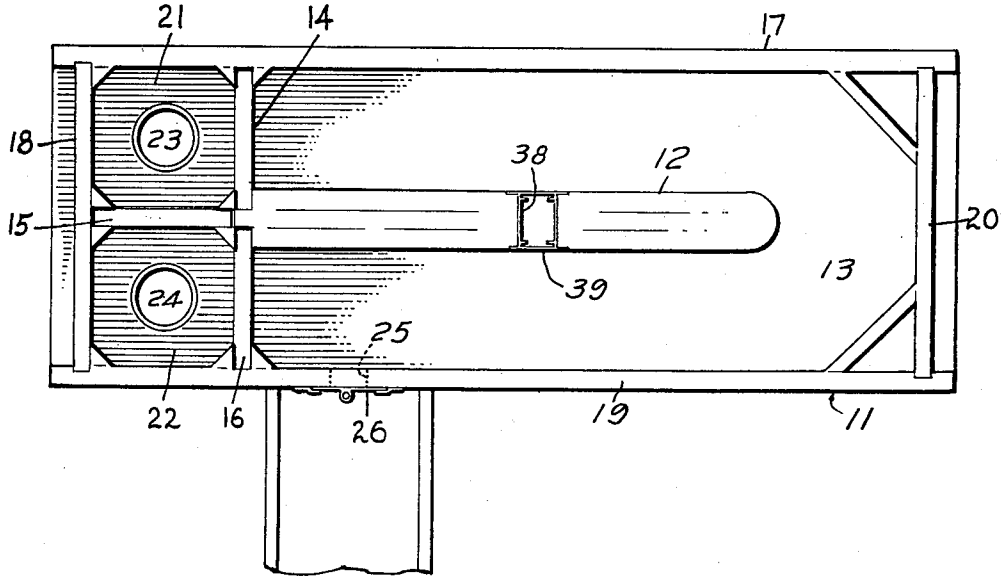
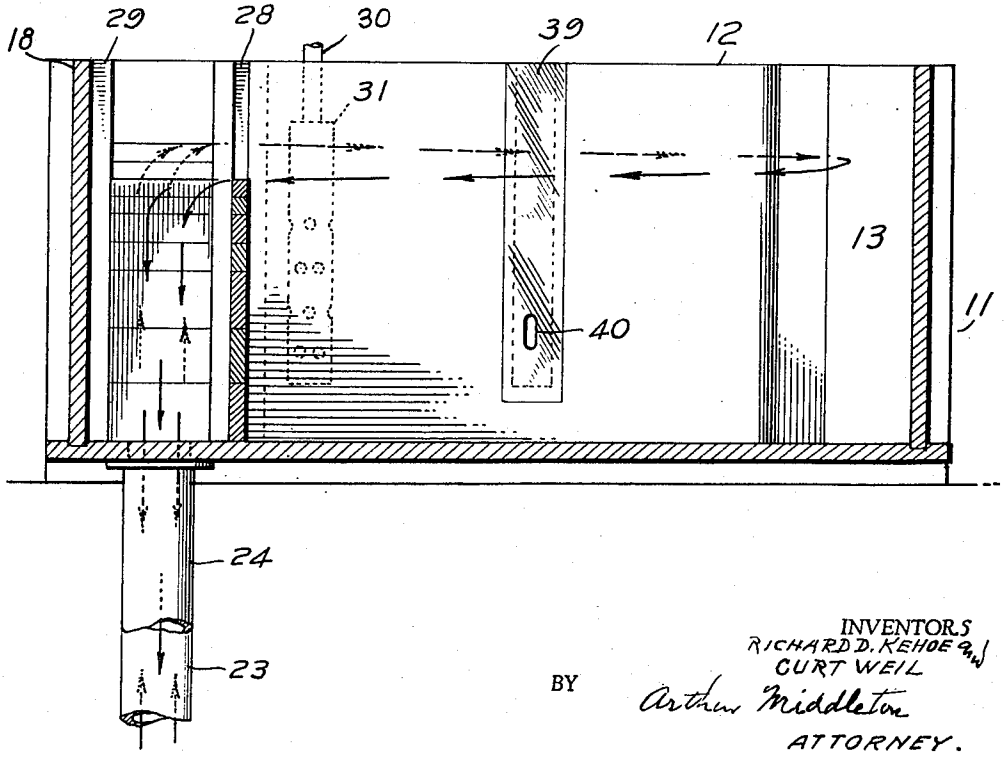


FIG. 1.



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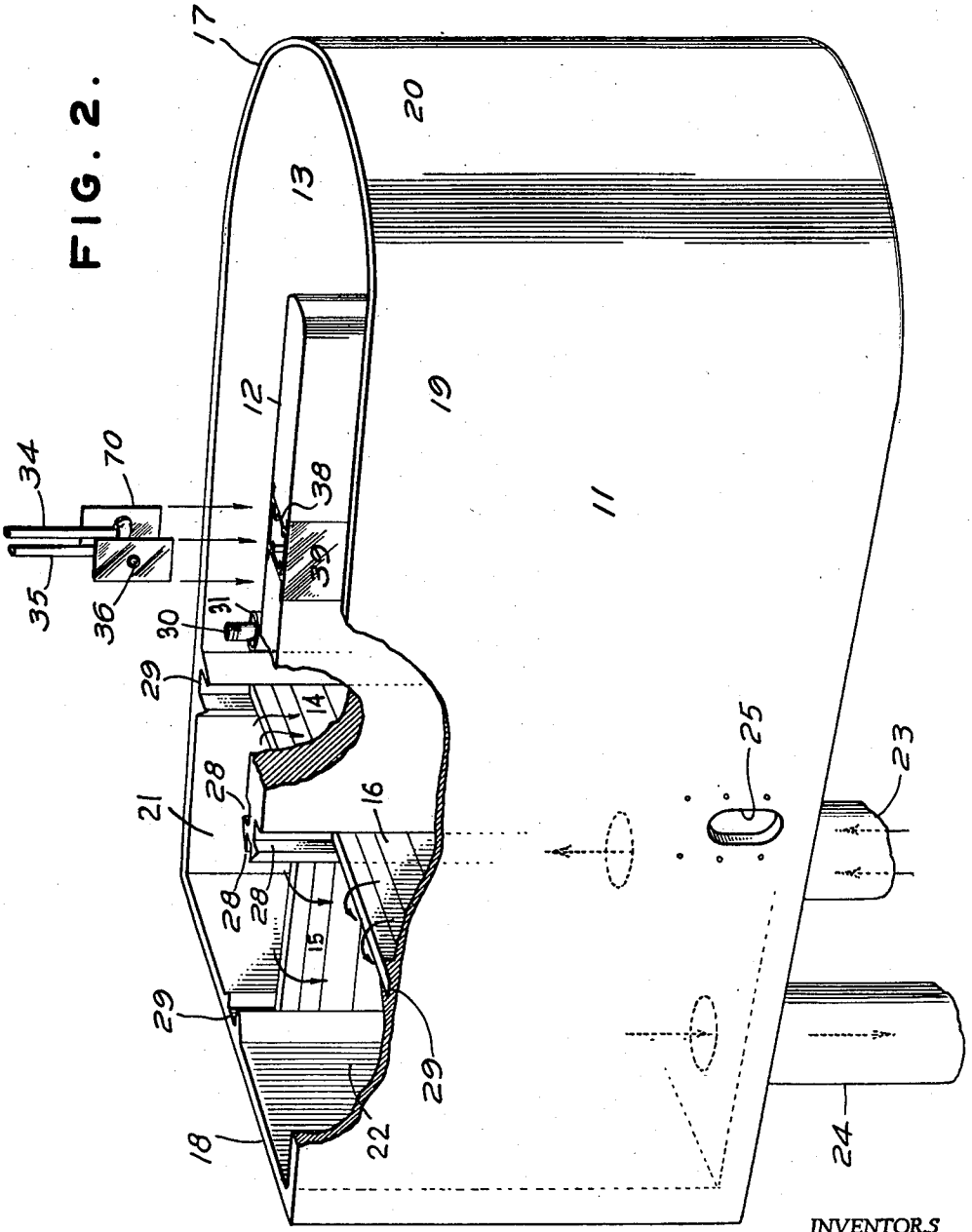
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AUTOMATIC CONSISTENCY CONTROL MEANS

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FIG. 2.



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AUTOMATIC CONSISTENCY CONTROL MEANS

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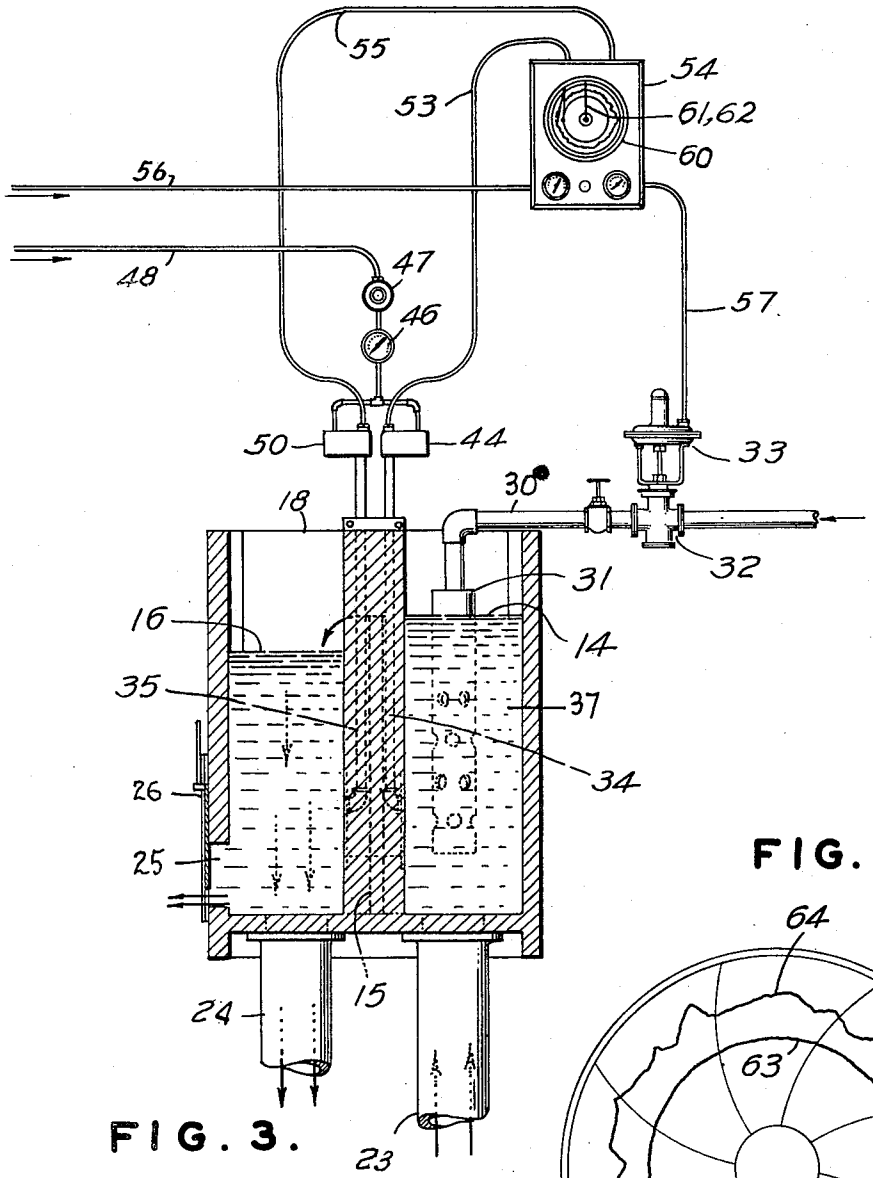
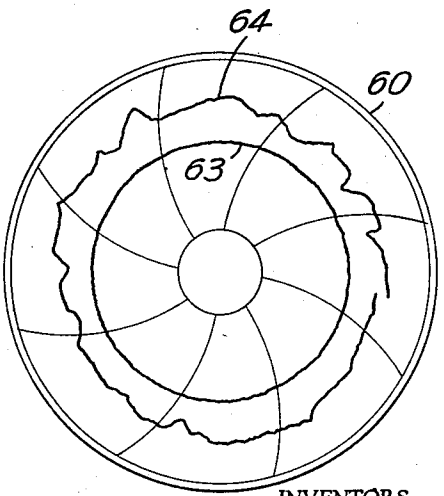


FIG. 3.

FIG. 8.



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AUTOMATIC CONSISTENCY CONTROL MEANS

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FIG. 6.

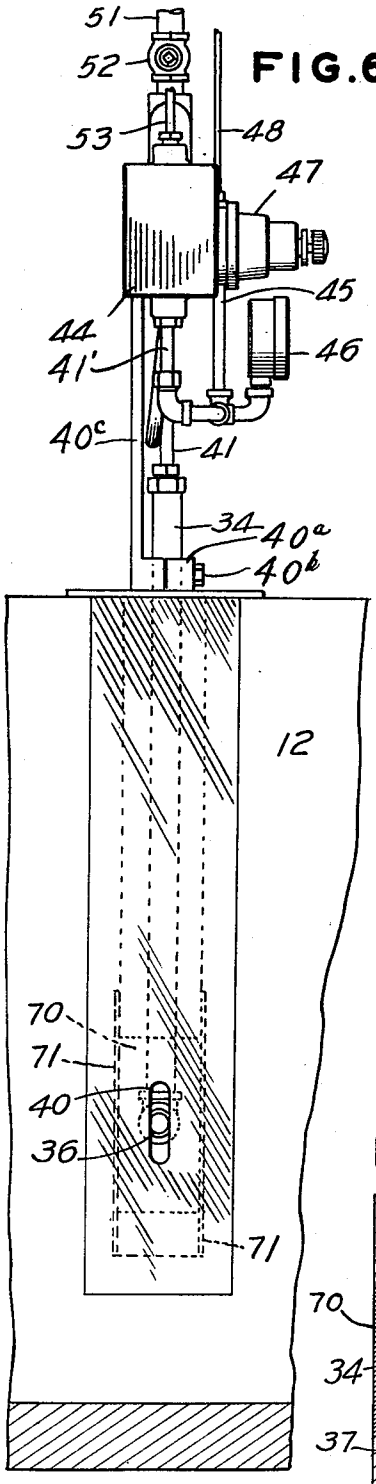


FIG. 5.

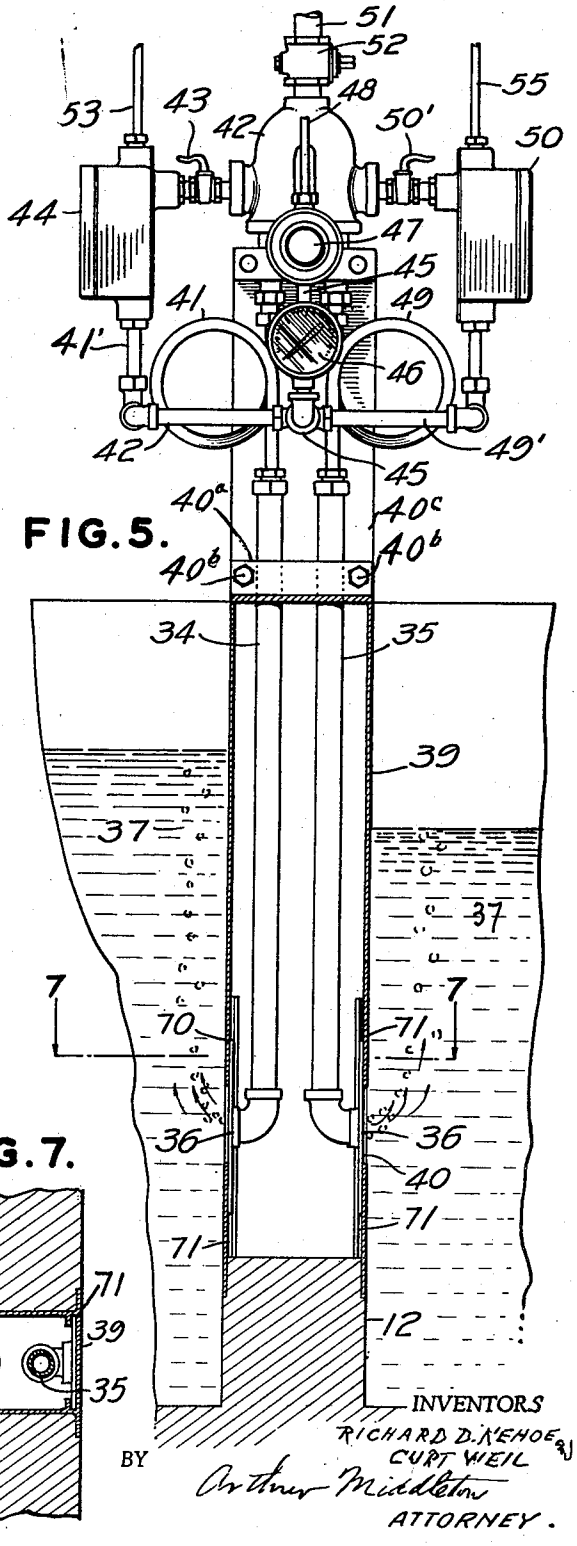
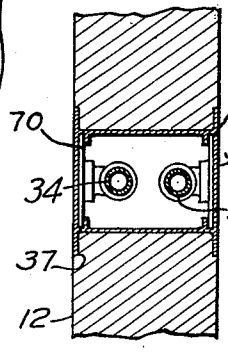


FIG. 7.



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Patented Nov. 17, 1942 2,302,327

UNITED STATES PATENT OFFICE

2,302,327

AUTOMATIC CONSISTENCY CONTROL MEANS

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Original application November 28, 1940, Serial No. 367,530. Divided and this application July 25, 1942, Serial No. 452,330

6 Claims. (Cl. 265—11)

This is a division of our parent application Serial No. 367,530, filed November 28, 1940, disclosing a pulp density control station comprising a flow box provided with a round-the-end flow baffle whereby the stock is caused to flow through the box or station in a U-shaped path. It is from this U-shaped flow that the control impulse for the density control of the stock by means of diluting water is derived.

The aforementioned parent application covers the feature that in this control station the regulation of the pulp density with diluting water is effected automatically with the aid of a pressure differential responsive device that is structurally embodied in and unitary with the round-the-end flow baffle.

The present divisional application covers a feature also embodied in the round-the-end flow baffle type of flow box or control station, whereby excess undiluted or unregulated stock is caused to discharge over a by-pass weir at the entrance of the U-shaped flow path of the stock from which the control impulse proper is derived. By co-ordinating the adjustable height of this excess by-pass overflow weir with the respective adjustable heights of an inlet and an outlet weir of the aforementioned U-shaped flow path, desired flow conditions may be obtained and maintained therein along that path so that a desired density control can be derived therefrom.

Therefore, the following specification and drawings in the present divisional application are identical with those of the aforementioned parent application.

This invention relates to apparatus for controlling the stock consistency of a pulp such as is used for paper making, or of rag stock used in the manufacture of dry felts, or of free sulphite stocks.

Variations in stock consistency cause trouble whenever and wherever they occur. It is impossible to attempt manual control of consistency because no operator can judge stock consistency accurately. Manual control, aided by consistency testing is also impractical, because no operator can make consistency tests with sufficient speed and accuracy and adjust the amount of diluting water quickly enough to prevent consistency variations. Many devices, based on various principles, have been used to control diluting water automatically in an attempt to prevent irregularities in operation that result from consistency variations.

The operation of this invention is based on the following principle:

Stock flowing through a trough or channel assumes a natural slope. The angle of slope depends on the consistency of the stock. The higher the consistency the steeper the slope. A slope is formed because a certain amount of energy is needed to move the stock through the trough to overcome internal and wall friction. This energy is expressed in the form of a pressure head. The potential head energy is converted into velocity energy and as the stock moves along, less energy is required. The velocity is accelerated and as the stock quantity remains the same, and the velocity is increased, it follows that the cross-section of the stock must decrease to allow the same amount of stock to pass through the cross-section in the time unit. As the width of the trough remains the same the height of the stock must decrease, thus forming a slope.

This phenomenon—the difference in head pressure between two spaced points in a trough—is used to actuate a valve, controlling the admission of diluting water to the stock. Inasmuch as the pressure is taken at two points in the same trough, it follows that variation in the static head, caused by reasons other than consistency changes, is the same at the two points and will not affect the functioning of the regulator.

Thus automatic viscosity controlled devices of the character herein contemplated, convert a pulp or stock of fluctuating and excessive viscosity into one of substantially constant viscosity of desired dilution by automatically varying the rate of feed of water or other diluent to the stock, in keeping with the demand of the fluctuations. That is to say, a rise in viscosity of the pulp will cause a corresponding increase in the water fed to the stock, while a drop in viscosity causes a decrease in the amount of water supplied.

Where such a device operates due to a sloping stock level, it has been found that in a stock beating engine, for instance, the slope of the liquid level is subject to uncontrollable variations, that are characteristic of the operation of the beater and result from the changing resistance which the stock solids offer to the beater roll, and from the flow disturbances caused by coarse lumps or aggregations of solids or the like.

It is one of the objects of this invention to establish suitable stock flow conditions as a basis for the proper functioning of the viscosity control device. Another object is to improve and simplify the construction of the control device.

To attain some of these objects, a special viscosity control station or tank is provided and disposed at a point past the beater and made in-

dependent of the disturbing influences thereof and of pumps. This control station is designed to provide an undisturbed, even, and constant-volume stock flow as a basis for the viscosity indications and responses from which the impulses for viscosity control are to be derived. Since the function of the control station is to supply to the stock more or less water, the stock acted upon in the control station must have at least a maximum viscosity and a minimum dilution ultimately required of it.

Features relating to the control station comprise the arrangement of a flow passage or channel for stock whose viscosity is to be regulated at a favorable point in the stock flow path. The flow through this passage or channel is kept substantially free from undue fluctuations or disturbances by the provision of a specially arranged feed and outlet means.

This control station is designed with an inlet or feed section so arranged that unregulated or undiluted stock excessively fed thereto beyond the amount that can have its viscosity regulated overflows and is returned to a point in the flowpath ahead of the control station. This acts somewhat as a safety valve and excess flow absorber so that to the viscosity-controlling section of the station there is admitted a substantially constant volume of stock into the flow passage for viscosity regulation. The slope of the liquid level between inlet and outlet of the control station is the basis for the operation of the viscosity control. A controllable discharge opening at the outlet section of the control channel permits the withdrawal of the quantity of stock of regulated dilution needed for the current production.

Other features have to do with the construction of the viscosity control device per se, and with the manner of its mounting in the control station.

The mechanical design of the control of this invention consists of two presssure pipes submerged in the stock at two spaced points supplied with compressed air. The back pressure in the two pipes varies according to the angle of the slope of the stock. This difference in pressure actuates an impulse amplifying instrument and controller, which in turn operates the motor of the diluting water valve. The instrument is designed so that the air pressure regulates the diluting water valve to keep the differential back pressure in the two pressure pipes the same. In other words, the angle of the stock slope is kept the same by admitting the proper amount of diluting water as the consistency changes.

Other features include a flushing water connection for the bubble pipes, and for vertical adjustability of the bubble pipes relative to one another.

In one embodiment the flow passage that is part of the control station is established in a tank by way of a longitudinally extending vertically disposed round-the-end-flow baffle so that inlet and outlet are disposed substantially at the same end of the tank, the bubble pipes of the control device straddling the baffle.

In a more specific case the bubble pipes are incorporated directly in the baffle wall in such a way as to offer no obstruction to the stock flow and to avoid flow disturbance.

In an embodiment comprising the application to the treating of paper pulp, the control station or box is disposed at a point in the flowpath, which lies between the beater engine and the refiner, or more specifically between the stuff chest following the beater and the refiner or Jordan. This is by way of example, since the control station can be disposed at other suitable points in the flowsheet. However, this embodiment may be modified by placing the control station at other points of the flowpath, for instance, more nearly ahead of the screen that feeds the paper machine, so long as it is independent of disturbing influences normally present in the stock flowpath.

Another feature of this invention resides in the use of a controller operated by the differential pressure derived from the bubble pipes, which controller operates a diaphragm type of motor operated valve for supplying more or less diluting water to the stock. This invention also proposes to use a pneumatic recorder that records or registers on one disc or tape: (1) the consistency of the stock in the viscosity control station, and (2) the consistency of the stock at some point in the flowpath prior thereto. It is common to have such discs marked not only by days, for say, six days at a time, but by hours of each day. Thus, a supervisor can, from an inspection of such a recorder disc, observe the record of action of the viscosity control station but also compare the performance of that station with performance of a prior station in the flowpath. If the performance of the viscosity station is indicated as having become uneven at some time, and at the same time, uneven operation is shown of the prior station, then the inspector is thus informed that the trouble was at a station ahead of the viscosity control instead of in the control itself.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description. In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit. In the accompanying drawings there has been illustrated the best embodiment of the invention known to us, but such embodiment is to be regarded as typical only of many possible embodiments, and the invention is not to be limited thereto.

The novel features considered characteristic of our invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawings in which:

Figure 1 shows a longitudinal sectional view of the viscosity or consistency control tank.

Figure 2 is a perspective view thereof with parts broken away.

Figure 3 is a vertical transverse sectional view thereof with a diagrammatic showing of the mechanisms associated with the control tank.

Figure 4 is a plan view of the tank.

Figure 5 is an elevational view of the bubble-pipe assembly shown in its position in the midfeather of the control tank.

Figure 6 is a side view of the apparatus of Figure 5.

Figure 7 is a sectional plan view taken along the line 7—7 in Fig. 5.

Figure 8 is a somewhat diagrammatic view of

a recorder chart or disc but with actual operating graphs shown thereon.

Taking up for description first, the viscosity or consistency control station and its details, 11 indicates the control basin or tank that provides a flow-through channel or trough, and has a vertical, longitudinally-extending partial partition or mid-feather 12 that leaves a free round-the-end passage 13 at one end but at the other end there are provided three adjustable height dams 14, 15 and 16 extending between the midfeather and the tank walls 17, 18 and 19 respectively. 20 indicates the other wall of the tank which may be rounded or bevelled. These dams form a feed inlet compartment 21 and an overflow compartment 22. A stock inlet pipe 23 communicates with inlet compartment 21 and a stock outflow pipe 24 communicates with overflow compartment 22. 25 indicates an outlet for the regulated and diluted stock, outflow from which is controlled by suitable valve mechanism indicated generally by 26. Each of the adjustable height dams is preferably formed of removable boards or sections 27 that slide vertically in appropriate aligned grooves 28 and 29 respectively on the midfeather and the tank wall.

A water inlet pipe or conduit 30 has a perforated and enlarged terminus section 31 disposed in the stock flowpath just after the stock spills or cascades over the dam 14 from the inlet compartment 21. This pipe 30 has a valve 32 between its terminus 31 and a source of diluting water. The valve is controlled, in my preferred embodiment, by a diaphragm motor mechanism 33 that is air operated. Disposed adjacent to the midfeather 12 on the high stock-slope side of the midfeather is a high head bubble pipe 34 and on the other side of the midfeather, a lower head bubble pipe 35, each having a free outlet or nipple 36 from which air bubbles are emitted into the stock 37. The bubble pipes must be spaced from one another in the direction of stock flow. Thus these pipes may straddle the midfeather 12, although my preferred disposition of these pipes is to embed them out of stock flow obstructing position within the contour of the midfeather 12 in a recess 38 therein into which fits a box-like construction or casing 39. A certain amount of vertical slidable adjustment is provided between the bubble pipe outlets or nipples 36 and the air outlet slots 40 in the casing 39, since the bubble pipes 34 and 35 are adjustably mounted as by means of a clamping member 40*a* and bolts 40*b* upon a common frame or base construction 40*c*.

High head bubble pipe 34 is connected to a bent or flexible pipe 41 that provides a conduit that passes upwardly to connect with a U-shaped casing 42, then outwardly through valve 43 into a pressure leveling casing or throttling device 44, out from the bottom thereof by pipe 41' leading into a manifold pipe 45 associated with which is a pressure gauge 46. Manifold pipe 45 passes into a knob-operated pressure-reducing valve 47 which in turn is connected with a source of air-pressure through pipe 48. Lower head bubble pipe 35 similarly is connected to a bent or flexible pipe 49 that provides a conduit that passes upwardly to connect with the U-shaped casing 42, then outwardly through valve 50' into a pressure leveling casing or throttling device 50, then out from the bottom thereof by pipe 49' leading into the manifold pipe 45, through the pressure reducing valve 47 to air-supply pipe 48. The U-shaped casing 42 is connected at its top with a water pipe 51 that has a valve 52 controlling it. It will be noted that the throttling or resistance devices 44 and 50, as well as the reduction valve 47, and the U-shaped casing 42 are also mounted upon the common frame 40*c*, making this control device inclusive of the bubble pipes, the throttling devices and the reduction valve a substantially self-contained unit.

Referring to Figure 3, from pressure leveling casing 44 there extends a branch pipe 53 from the high head pressure line that leads to and is connected with a control or regulator instrument 54. Similarly, from the pressure leveling casing 50 there extends a branch pipe 55 from the lower head pressure line that leads also to the control instrument 54. Also connected to the control instrument 54 is an air-pressure line 56, the air in which is controlled by the regulator instrument 54 and then passes through pipe 57 to the diaphragm motor valve operating mechanism 33. The control instrument 54 is of the type obtainable in the open market and operates when differential pressure passes a danger point. That is, when the high head back pressure from bubble pipe 34 is dangerously higher than the pressure in the lower head back pressure from bubble pipe 35, the regulator instrument permits air pressure from line 56 to pass to and operate the motor controlled valve 32 that provides diluting water. For example, the trade name of a satisfactory instrument of this type is Stabilog made by The Foxboro Company, of Foxboro, Massachusetts.

Such an instrument has a recording or registering attachment including a recording chart 60 that usually has a capacity for a one day record, and the record is divided into hours and minutes. In our preferred embodiment, we use an instrument that has two recording pens or styluses 61 and 62. One stylus makes a graph 63 on the chart 60 that is a record of the consistency of the regulated stock leaving the control station or tank 11, while the other stylus makes a graph 64 on the same chart 60 (and usually more or less concentric therewith) that is a record of the consistency of the unregulated or undiluted stock entering the viscosity control station 11.

The viscosity or consistency control station 11 and its associated parts is located in a place in a paper-making flowpath where it is substantially free from pulsations or other variations. In one preferred form, it is located between the stuff-chest and the refiner, That is, in the complete flowsheet, there would first come the beating engine, then the stuff-chest, from which the stock is usually pumped to the control station 11. Following the control station is the refiner or Jordan. Excess unregulated and undiluted stock spills from the entrance end of the control station and flows back to the stuff-chest, whereas regulated and diluted stock flows from the control station to the refiner, although any excess of this can also be recycled back to the stuff-chest along with the excess unregulated stock that is going back there. In another arrangement, the control station 11 and its associated parts, are located between the refiner or Jordan station and the screen that is ahead of the paper machine.

In the operation of the control station 11 and its associated parts, stock enters the tank 11 through the inlet pipe 24 upflowing into the inlet compartment 21. The liquid level in this compartment is controlled by the adjusted height of the top plank or weir of dam 14 over which the

stock spills or cascades into the control area of the tank 11. The top plank or weir of dam 15 is so adjusted that any unregulated and undiluted stock in inlet compartment 21 that is in excess of that desired to enter the main control area of the tank 11, is spilled or cascaded over the dam 15 into overflow compartment 22 from whence it is conducted by outlet pipe 24 back to the stuff-chest or other point ahead of the control station. Stock that has spilled over dam 14 flows in a U-shaped path around the midfeather 12 through space 13 and ultimately to dam 16 over which the stock spills or cascades into overflow compartment 22. Thus excess regulated and diluted stock mixes with the excess unregulated and undiluted stock in the overflow compartment 22 and passes in admixture therewith out through pipe 24 to the stuff-chest. Regulated and diluted stock is drawn off from the control station through take-off opening 25 that is controlled by valve 26. This regulated stock then goes to a refining station or to whatever the subsequent treatment of it is to be.

Stock in spilling over dam 14 encounters the perforated section 31 of the water diluting pipe 30 where and by which the stock is diluted as required, due to the control thereof initiated by the differential back pressure set up in the bubble pipes 34 (higher pressure) and 35 (lower pressure). The difference in back pressures set up in the air-emitting bubble pipes is due to the slope of the fluid level assumed by the stock as it flows from the feed end at dam 14 to the outlet end at dam 16. This slope in level is to be seen in Figures 1 and 3.

The bubble pipe assembly operates as follows: Air under pressure comes into pipe 48 and is controlled by reducing control valve 47 to a pressure as indicated on gauge 46. Air pressure then flows from the manifold 45 through pipe 41' upwardly through casing 44 in which there is a known or usual pressure leveling apparatus. From this casing, the air-pressure passes through valve 43, casing 42 and downwardly through coiled pipe 41 into the bubble pipe 34, from which air is emitted through elbow and nipple 36 into the high level stock. From manifold 45, air pressure also flows through horizontal pipe 49' through casing 50, that is equivalent to casing 44, through valve 50' to and through U-shaped casing 42, down coiled pipe 49 into bubble pipe 35, from which air is emitted through elbow and nipple 36 into the lower level stock. The same degree of air pressure is thus supplied to both bubble pipes 34 and 35, but since pipe 34 has a higher back pressure in it, than pipe 35, the pressure pipes 53 leading from casing 44 and 55 leading from casing 50 have differential pressures in them. This differential pressure between the pipes causes the instrument 54 to act when their relative difference becomes too great, or passes a danger factor, whereupon the instrument permits air pressure to flow through line 57 to the diluting water valve control 33. This valve remains open until the relative differential pressures between pipes 53 and 55 decrease to within the allowance permitted, whereupon the diluting water valve is operated to reduce the volume of diluting water being added, or perhaps is completely closed. Thus undue fluctuations in relative back pressure differential exerted on the bubble-pipes 34 and 35 due to change in the slope of the fluid level of the stock flowing in the control station, bring about more or less diluting water to be added to the stock through the water pipe 31.

The horizontal zone of emission of air by the nipples 36 of the bubble pipes permit of adjustment relatively. That is, they can be in the same horizontal plane as shown in Fig. 7, or one can be adjusted to be higher than the other, as some peculiar or unusual stock conditions might require. The coils in the pipes 41 and 49 allow for vertical adjustment of the bubble pipes without interfering with the airlines connected to them. This can be accomplished by having the nipples 36 pass through a plate 70 that is fastened to the nipple and arranged to slide vertically in grooved flanges 71 provided on the inner faces of the casing sides 39, whereby there is established a face-to-face relationship between the plate 70 and the inner face of a respective side wall portion of the casing 39.

Occasionally the bubble pipes 34 and 35 may become clogged or encrusted, so a water flushing arrangement has been provided for them which is operable by shutting off valves 43 and 50' followed by turning on valve 52 which permits water from the pipe-line 51 to flow downwardly through the casing 42 and then downwardly through pipes 41 and 49 to and through bubbles pipes 34 and 35 respectively, to flush from them any accumulations therein.

A control tank that has proven satisfactory had as inside measurements an overall length of 6'—2¾", a width of 27¾", and a depth of 36". The inlet and overflow compartments were about 13" square, while the midfeather was 4'—0" long.

Among the advantages realizable from the practice of this invention are: Manually initiated changes of consistency can be easily made by turning the knob on the control or regulator instrument 54 which changes the relative position of the valve opening, admitting more or less water to the stock stream and reducing or increasing consistency. As the measuring system is not required to do any of the mechanical work of controlling the valve, light parts can be used in the control, eliminating inertia. Hunting of the valve is eliminated as it responds instantly to the slightest change in consistency. The recording of consistency before and after regulation, on a twenty-four hour or more chart, is a distinct advantage, especially for checking irregularities in stock consistency during preparation or handling from beaters to stuff-chest, for if the consistency of the stock in the chest is beyond the range of the control, it shows on the chart and the reason for the unsatisfactory operation can be investigated. This control apparatus has proved that it can maintain consistency within plus or minus 1/10 of 1% provided the stock is delivered to the control station at consistencies between 2 and 7%.

We claim:

1. A control station for regulating the consistency of a supply of fluid stock by regulating the dilution thereof, comprising a flow channel for the stock, said flow channel having a vertical wall portion both sides of which are adapted to be exposed to the flow of the stock being regulated, as the stock flows first past one and then past the other side, said vertical wall portion having a recess, a consistency control device adapted to be disposed in said recess, and comprising a base construction mounted on said vertical wall portion, a pair of air pressure bubble pipes mounted on said base construction and ex-

tending in said recess, said bubble pipes having lower end air releasing openings disposed so that the plane of each opening substantially registers with a respective side face of said wall portion, an air pressure supply connection, a branch connection between said air pressure supply connection and each bubble pipe, and a pressure throttling device interposed in each branch connection.

2. A control station according to claim 1, with the addition of means for blanking off said recess, to substantially restore the respective exposed surfaces of said wall portion, that are interrupted by said recess.

3. A control station according to claim 1, with addition of means for blanking off said recess, to substantially restore the respective exposed surfaces of said wall portion, that are interrupted by said recess, said blanking off means comprising a box-like construction mounted in said recess and adapted to house said bubble pipes, and provided with side wall openings substantially registering with the openings of said bubble pipes.

4. A control station according to claim 1, with the addition of means for blanking off said recess, to substantially restore the respective exposed surfaces of said wall portion, that are interrupted by said recess, said blanking off means comprising a box-like construction mounted in said recess and provided with openings larger than those of the lower end openings of said bubble pipes, and a vertical plate member fixed on each bubble pipe and constituting the lower terminal portion thereof, each plate member having face-to-face relationship with the inner face of a corresponding side wall portion of said box-like construction, said plate members being effective to blank off the differential of area between the lower end opening of the associated bubble pipe and the corresponding larger opening in the box-like construction.

5. A control station according to claim 1, with the addition of means for blanking off said recess, to substantially restore the respective exposed surfaces of said wall portion, that are interrupted by said recess, said blanking off means comprising a box-like construction mounted in said recess with openings larger than those of the lower end openings of said bubble pipes, and a vertical plate member fixed on each bubble pipe and constituting the lower terminal portion thereof, each plate member having face-to-face relationship with the inner face of a corresponding side wall portion of said box-like construction, said plate members being effective to blank-off the differential of area between the lower end opening of the associated bubble pipe and the corresponding larger opening in the box-like construction, and means for vertically adjusting the position of each bubble pipe while said plate members maintain the closure of said differentials of area.

6. A control station according to claim 1, with the addition that the pressure throttling devices are also mounted upon said base construction and unitary therewith.

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