July 6, 1948. E. A. POIRIER 2,444,668

METHOD OF AND APPARATUS FOR PROVIDING A RESPONSE TO THE CONSISTENCY OF PAPER MAKING STOCKS

Filed March 6, 1943 3 Sheets-Sheet 1

Fig. 3.

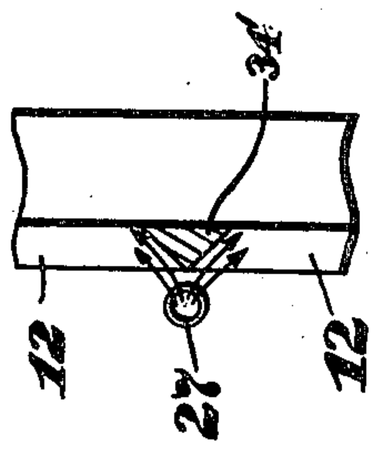

Fig. 1.

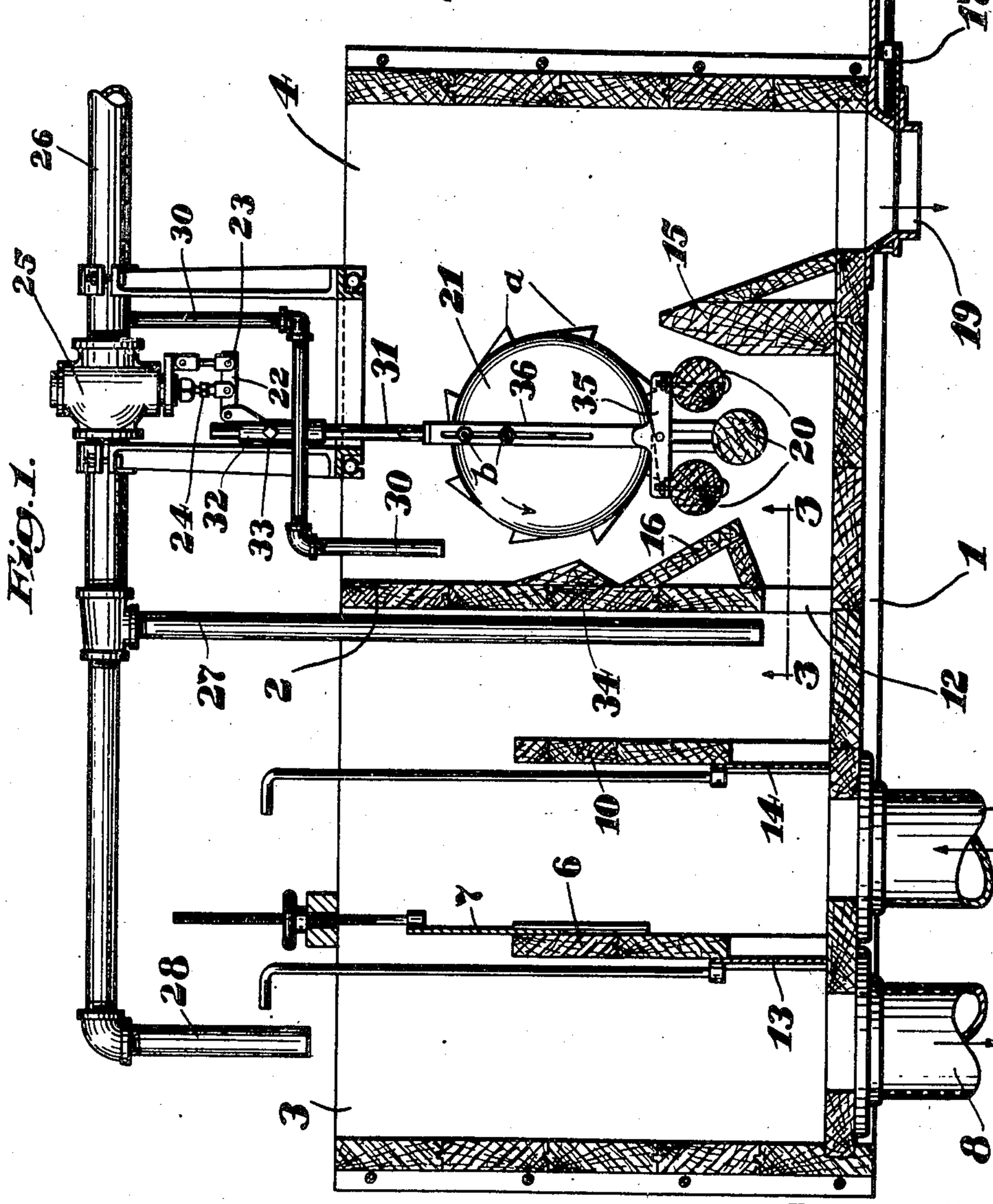

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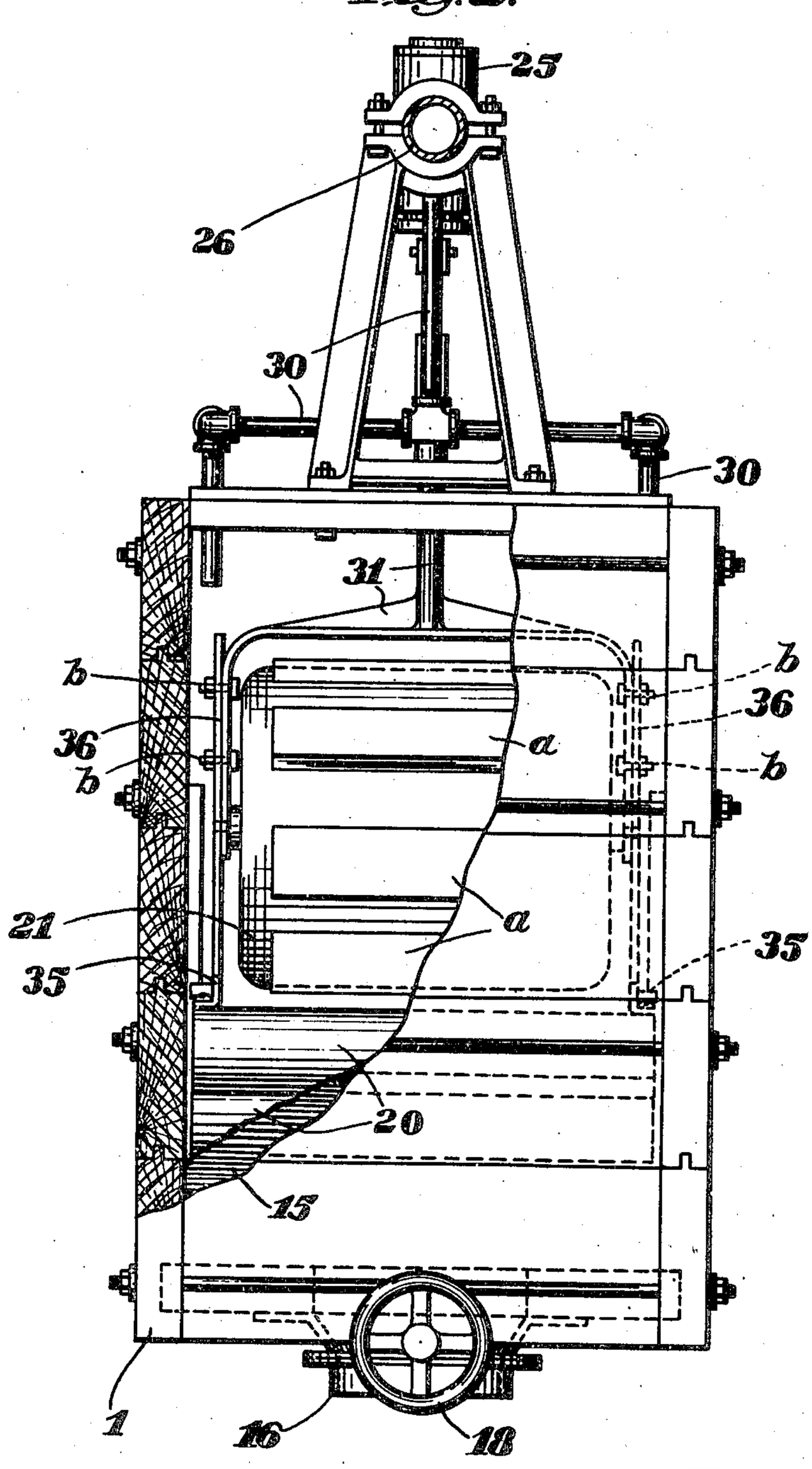
Fig. 2.



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METHOD OF AND APPARATUS FOR PROVIDING A RESPONSE TO THE CONSISTENCY OF PAPER MAKING STOCKS

Filed March 6, 1943 3 Sheets-Sheet 3

Fig. 4.

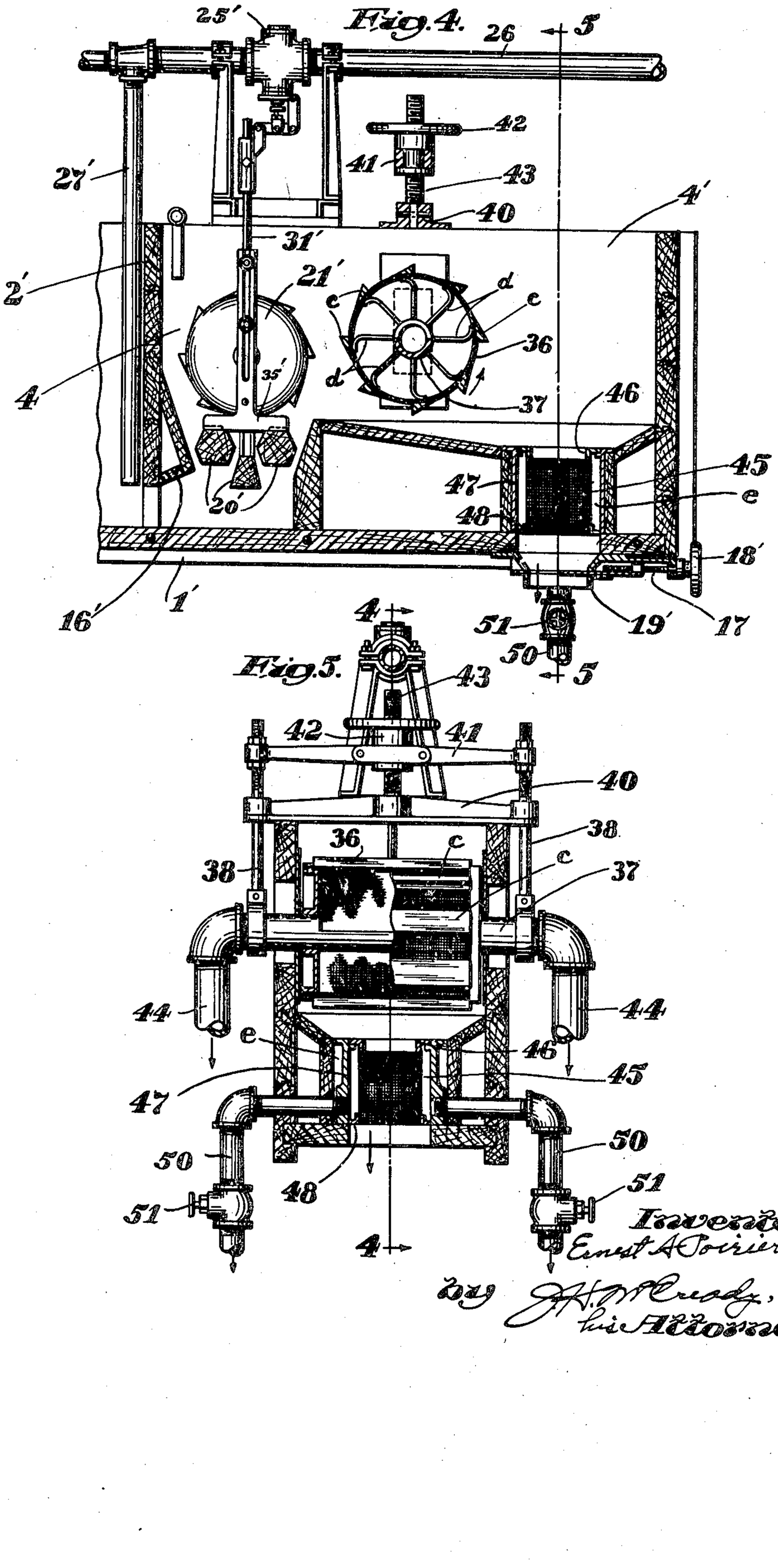

Fig. 5.

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UNITED STATES PATENT OFFICE

2,444,668

METHOD OF AND APPARATUS FOR PROVIDING A RESPONSE TO THE CONSISTENCY OF PAPERMAKING STOCK

Ernest A. Poirier, Waterville, Maine

Application March 6, 1943, Serial No. 478,220

13 Claims. (Cl. 137—78)

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The various processes involved in the manufacture of paper-making stock and its preparation for delivery to the Fourdrinier wire, or other paper-making surface, necessarily introduced variations in the consistency of that material which are highly objectionable, not only when the stock is delivered to the wire, but also in some of the intermediate processes. While this fact has long been recognized, and various consistency regulators have been devised and are in practical use, most of them, at least, are capable of handling only a very narrow range of consistencies. None of the prior art consistency regulators of which I have been able to learn, is capable of compensating for either very low or very high values or for wide variations in consistency.

In a copending application Ser. No. 457,715, filed September 9, 1942, now Patent 2,403,827, dated July 9, 1947, of which the present application is a continuation in part, I have described and claimed an apparatus intended for this purpose. The present invention aims to devise an even better solution for this problem.

The nature of the invention will be readily understood from the following description when read in connection with the accompanying drawings, and the novel features will be particularly pointed out in the appended claims.

In the drawings,

Fig. 1 is a longitudinal, vertical, sectional view of a consistency regulator constructed in accordance with this invention;

Fig. 2 is an elevation, on a somewhat larger scale, of the right-hand end of the apparatus illustrated in Fig. 1 with parts broken away to show certain details of the construction;

Fig. 3 is a horizontal, sectional view on the line 3—3, Fig. 1;

Fig. 4 is a view similar to Fig. 1 illustrating another embodiment of the invention; and

Fig. 5 is a vertical, sectional view taken approximately on the line 5—5 of Fig. 4, but with the control gate omitted.

Referring first to Figs. 1 and 2, the apparatus there shown comprises a trough or container 1 of approximately rectangular form divided by a partition 2 into a head box chamber 3 and a float chamber 4. Stock is pumped into the head box through an intake pipe 5; the surplus overflows the adjustable section 7 of the partition or wier 6 and returns to the stuff chest through a pipe 8, while that portion of the stock which is to have its consistency controlled or modified flows over the wier 10 and through a passage 12 in the partition 2 into the float chamber 4. This arrangement maintains a constant and predetermined head of stock in the head box which produces a flow through the controlling elements of the apparatus. Clean-out gates 13 and 14, respectively, also are provided at the bottom of the respective wiers 6 and 10. So far as the head box structure is concerned, it is much like those in common use.

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The stock delivered to the chamber 4 is diverted upwardly into the main body of that chamber by a wier or baffle 15, and then flows over the upper edge of this wier and downwardly through an outlet 19. Such discharge is controlled by a gate 17 adjustable by means of the hand wheel 18, and this adjustment, together with that of the gate 7 in the head box, determines the volume that will be discharged per unit of time from the apparatus and, consequently, the rate of flow of the stream of stock through the regulator.

Immediately after the stock enters the chamber 4 it flows through a narrow passage between the wier 15 and a baffle 16. Mounted in this passage is a resistance device consisting, in the particular form shown, of three horizontally disposed rods or dowel pins 20, extending longitudinally of the narrow space just referred to from substantially one end thereof to the other, where they serve to break up the stream of stock and produce a great deal of turbulence and eddying in the current. This action has the effect of creating a relatively high degree of internal friction in this part of the stream of stock flowing through the apparatus, such friction being caused partly by the rubbing of particles of stock against each other and partly by the contact of the moving stock with the relatively stationary surfaces of the elements 20.

I have found that this internal friction can be made to exert a far greater degree of resistance to flow in a stock carrying substantial proportions of solid particles than is produced by the customary methods employing external friction only, and that the effects of combining such resistances can be made to vary in accordance with varying degrees of consistency of the stock to produce forces of ample intensity to operate controlling or compensating devices. The illustrated embodiment of the invention is built around this principle.

While the stock tends to rise in the float chamber to approximately the same level as that maintained in the head box, the resistance to its flow imposed chiefly by the presence of the elements 20, plus the fact that stock is being continuously discharged from the float chamber, causes the

head of stock in the latter chamber to vary with changes in consistency of the stock. Such changes in head are utilized to control the introduction of diluting water into the stock when it is too thick or, in other words, when its consistency is too high. For this purpose a float **21** is mounted in the chamber **4** and is pivoted to a lever **22**, fulcrumed at **23**, this lever also being pivotally connected to the valve stem **24** of a valve **25** connected into the supply pipe **26** for the diluting water. Preferably this valve is of the balanced type, so that upon a drop in the float **21** below a predetermined position it will open the valve to varying degrees, depending upon the extent of that drop, and this action will admit diluting water to one or both of the downwardly extending pipes **27** and **28**, respectively. The former conducts water into the stock about to flow into the float chamber, while the latter discharges its water into the surplus stock being returned to the stuff chest. In some cases the latter pipe is omitted.

Preferably the float **21** is made of the revolving type and is equipped with projections or fins *a* which cooperate with the current of stock and with the cleaning water delivered by the spray pipes **30** to revolve it slowly and thus enable it to keep itself clean. This float is supported by a yoke **31** which is forked to straddle the float, as best shown in Fig. 2, and the main stem of this member extends through a sleeve-like bracket **32** which is pivoted to the lever **22** above referred to. A set screw **33** fastens the yoke to the bracket so that it can be adjusted vertically, as desired. The spray discharged by the pipes **30** is intended simply to keep the parts clean and the baffle **34**, Fig. 1, positioned beside the float cooperates with this spray to direct part of it against the driving surfaces of the blades or ribs *a*. Preferably, also, the inlet **12** is provided with a baffle **34'**, Fig. 3, positioned at about the middle thereof, where it serves to split the incoming stream into approximately equal parts and thus assists in properly distributing the flow.

When this apparatus is in operation the resistance to the flow of the stream of stock through the float chamber imposed by the construction of the "throat" portion of the channel or conduit for the stock, plus that caused by the presence of the dowels **20**, produces a change in head of the stock in the float chamber varying inversely with changes in consistency of the stock; that is, the higher the consistency the lower the head, and vice versa. The apparatus preferably is set so that for a normal or desired consistency the float will remain at a predetermined level, but when the consistency rises above that value, the float drops, thus opening the valve **25** to a degree depending upon the extent of such drop and thereby admitting diluting water into the stock at a rate depending upon the change in consistency. When the consistency begins to drop, the float rises to substantially a corresponding degree because the head of stock in the float chamber rises in response to this change in the character of the stock. As this action continues, it results in gradually reducing, and finally shutting off, the flow of diluting water.

While all the operations above described could be performed if the resistance device composed of the members **20** was mounted in a stationary position, I have found that its effectiveness can be varied in such a manner as to promote the accuracy of control of the diluting water by adjusting the position of the resistance device in

response to variations in consistency. For this purpose the device is shown in the drawings mounted upon the float **21** so that it will move in unison with that member. As indicated in Figs. 1 and 2, the opposite ends of the dowels **20** are secured rigidly to the three arms of two small brackets **35**, each formed at the lower end of, or secured to, an upright bar **36** which is slotted to receive bolts *b*, by means of which it is adjustably secured to an arm of the yoke **31**. The float itself is not adjustable relatively to its supporting yoke.

It will be observed that with this arrangement, as the consistency of the stock increases and the float, consequently, moves into a lower position, it will carry the resistance device with it. Such movement, as shown in Fig. 1, will reduce the cross-sectional dimensions of the passages through which the stream must flow and therefore will increase the resistance to that flow. Conversely, if the stock becomes thinner, and the head in the float chamber rises, carrying the float with it, the resistance device also will be raised and thus will increase the cross-sectional dimensions of two of the four paths which the stock must take in flowing through the throat portion of the device. Thus this construction accelerates and increases the variation in the head of stock in the float chamber produced by a change of a given percentage in the solid content of the stock. This, in turn, makes it possible to produce more gradual adjustments of the flow of diluting water.

From the foregoing it will be observed that the rate of supply of stock to the stream flowing through the apparatus, the resistance imposed to such flow, and the rate of discharge of the stock from the regulator can be so coordinated that the head of stock in said float chamber will be maintained at a fixed value so long as the consistency of the stock remains at a fixed value.

The invention is very important from a practical standpoint because it produces much greater changes in hydrostatic head for a given change in consistency than has been possible heretofore by any method or apparatus of which I am aware. This, in turn, results in a finer gradation of adjustment of the diluting water and a greater uniformity in consistency of the stock delivered by the apparatus.

Because the head of stock in the float chamber varies inversely with changes in consistency; i. e., the lower the consistency falls the higher the head rises, and vice versa, this fact of and by itself serves to minimize the variations in the delivery of solid content of stock per minute that otherwise would be produced. In other words, the apparatus tends to deliver a constant weight of paper-making solids per minute, or other unit of time, notwithstanding variations in the proportion of those solids in the stock so delivered. This is an important advantage when the apparatus is used to control the consistency of stock flowing to a paper-making machine, and it can be utilized independently of the addition of diluting water.

One of the limitations inherent in the construction of many prior art consistency regulators is that while they can introduce water into the stock to dilute it, they can do nothing to correct the consistency of a stock that is too thin. That is, they can put water into the stock but they cannot take it out.

The present invention deals with this difficulty, and Figs. 4 and 5 show an apparatus designed for

this purpose. It includes essentially the same mechanism shown in Figs. 1 and 2 and, accordingly, the parts of that apparatus are designated in Figs. 4 and 5 by the same numerals used in Figs. 1 and 2 for corresponding parts, except that the numerals are primed. One difference in the two constructions consists in the fact that the dowels 20' are not of cylindrical form but have flat sides cooperating with each other, and in the case of the two upper dowels with the walls of the throat, to provide parallel-sided passages through which the stock flows into the main body of the float chamber 4'.

In this form of the invention the float chamber is extended lengthwise of the container 1, which forms the conduit or guiding means for the stream of stock, so as to afford additional room for one or both forms of water extracting devices illustrated in Figs. 4 and 5. One of these, and that which is preferred, comprises a cylinder 36 having solid ends and a peripheral surface consisting essentially of wire screening of about the mesh used in a Fourdrinier machine as the paper-making surface. It is also provided with ribs or blades *c* like those on the float 21 to produce a rotation of the screen in the current of stock. Internally it is equipped with a series of blades *d* comprising portions extending radially away from the hub but curved at their outer end portions in the direction of rotation of the device. Supporting this member is a stationary horizontal pipe 37, the upper half of which is cut away inside the screen, as clearly shown in Figs. 4 and 5. At opposite sides of this cut-away portion the pipe 37 supports the screen for rotation, and it is itself supported just outside of these journal areas by two hangers 38—38, Fig. 5, each having a stem which extends upwardly through a guide bracket 40 and is provided above said bracket with a threaded end portion by means of which the two hangers are adjustably secured to the opposite ends of a yoke 41 carried by a large adjusting wheel 42. This wheel forms, in effect, a nut mounted on an upright stationary screw-threaded shaft 43 but having a loose connection with the yoke 41 so that the latter is compelled to follow the vertical movements of the wheel but does not partake of any rotative movement of the latter. Drain pipes 44—44, Fig. 5, are connected with opposite ends of the pipe 37 and carry away any water discharged into the latter.

As above pointed out, the head or level of water in the float chamber rises above the level normally maintained in this part of the apparatus when the stock becomes of a consistency lower than that desired, or for which the apparatus is set. Consequently, by adjusting the height of this water extracting device so that the level of the notch in the pipe 37 is at the level maintained by stock of the desired consistency, the screen 36 then will remove no water from the stock but will simply revolve idly in the stream. If, however, the stock should become too thin, then its level in the float chamber will rise and water will flow through the screen, over the edges of the notch in the pipe 37 and out through that pipe and the drain pipes 44, and the volume of water so delivered will vary with the changes in head of stock in the float chamber. Thus this apparatus comes into operation automatically when needed and stops when the consistency of the stock again becomes normal. The slight amount of stock which adheres to the surface of the screen in any revolution is loosened by the rotation of the screen itself in the body of stock so that cleaning of the screen is necessary only under unusual conditions or at infrequent intervals.

Apparatus of the character shown in the drawings, and operating in accordance with the method above described, has proved in actual practice to afford an exceptionally high degree of regulation over an extraordinary range of consistencies. It handles both extremely low and exceptionally high consistencies with accuracy, corrrecting them to the desired value with a high degree of precision. Much of this superior performance is brought about by the wide change in hydrostatic head of stock produced in response to relatively small changes in consistency by the novel resistance unit and its association with other parts of the apparatus, as shown in the drawings, so that its action is both increased and accelerated for any change in consistency. This, in turn, produces a quicker and more accurate gradation of adjustment of the supply of diluting water, and gives the water extracting device an effectiveness which it otherwise would not have.

Another form of water extracting apparatus is also shown in Figs. 4 and 5 and consists of a stationary cylindrical screen 45 surrounding the channel leading from the main body of the float chamber into the discharge outlet 19'. As here shown, this screen is secured to a bushing 46 which fits loosely into a circular socket formed for it in a fitting 47 mounted permanently in the discharge portion of the apparatus so that the screen can be removed from above when desired. Its lower end is centered loosely in another bushing 48 secured to the fitting 47. This arrangement supports the screen with an annular space *e* between it and the surrounding wall of the part 47, so that as stock flows to the outlet a small fraction of the water constituent will flow through the screen into the space *e*. Two pipes 50—50 conduct such water from this space to any desired point, and these pipes are equipped with valves 51 by means of which this part of the apparatus can be thrown into and out of action when desired. Preferably the floor of the right-hand end portion of the chamber 41 is sloped both laterally and longitudinally, as shown in Figs. 4 and 5, to guide all of the stock through the outlet.

From the foregoing it will be evident that this invention provides a method of consistency control involving the steps of creating a high degree of internal friction in a confined portion of a stream of stock and thereby producing variations in head, and therefore in hydrostatic pressure, in a part of said stream. Such variations are created in response to changes in consistency of the stock. They are utilized to adjust the proportion of water in the stock to approximately a predetermined value either by introducing diluting water into the stock when its consistency is too high, or by taking water out of the stock when its consistency is too low. The invention also involves novel forms of apparatus operating in accordance with this method. It will be evident, however, that the invention may be embodied in other forms and that the method of the invention may be practiced with the aid of other apparatus.

Broad claims covering subject-matter common to this application, and to the disclosure contained in my copending application Serial No. 457,715, are made in the latter case, the claims in the instant application being limited to subject-matter not disclosed in my earlier application.

Having thus described my invention, what I desire to claim as new is:

1. That improvement in methods of controlling the consistency of a stream of paper-making stock, comprising the steps of creating a continuous flow of said stock, restricting a portion of the stream so produced, imposing a resistance to such flow substantially throughout the cross-sectional area of a portion of the length of the restricted section of the stream and thereby producing changes in the head of stock in another part of said stream, which head varies with changes in the consistency of the stock, effecting an increase in the imposed resistance in accordance with decreases in said head and vice versa, and so coordinating the rate of supply of stock to said stream with the rate of discharge of the stock and the resistance imposed on its flow between said supply and discharge that said head of stock will be maintained at a fixed value so long as the consistency of the stock remains at a fixed value.

2. That improvement in methods of controlling the consistency of a stream of paper-making stock, comprising the steps of creating a controlled rate of flow of said stock, restricting a portion of the stream so produced, imposing a resistance to such flow substantially throughout the cross-sectional area of a part, at least, of the length of said restricted section of the stream, which resistance cooperates with said controlled rate of flow to produce changes in the head of stock in a part of said stream varying inversely with changes in the consistency of the stock, effecting an increase in the imposed resistance in accordance with decreases in said head and vice versa, and so coordinating the rate of supply of stock to said stream with the rate of discharge of the stock and the resistance imposed on its flow between said supply and discharge that said head of stock will be maintained at a fixed value so long as the consistency of the stock remains at a fixed value.

3. That improvement in methods of controlling the consistency of a stream of paper-making stock, comprising the steps of creating a controlled rate of flow of said stock, restricting a portion of the stream so produced, imposing a resistance to such flow substantially throughout the cross-sectional area of a part, at least, of the length of said restricted section of the stream, which resistance cooperates with said controlled rate of flow to produce changes in the head of stock in a part of said stream varying inversely with changes in the consistency of the stock, the rate of supply of stock to said stream, the resistance imposed on its flow, and the discharge of said stream being so coordinated that said head of stock remains constant so long as the consistency of the stock remains constant and utilizing said changes in head to extract water automatically from said stock at a fixed level where the rate of extraction varies with said changes in head.

4. The herein described method including the steps of creating a flow of stock along a predetermined path, impeding said flow in a section of the stream so created by producing a high degree of internal friction substantially throughout the cross-sectional area of said section, so limiting the rate of flow away from said section at a point down-stream from it as to produce, in an intermediate part of said stream, changes in the head of stock varying inversely with changes in its consistency, coordinating the flow of stock along said predetermined path with the rate of flow away from said section and the friction imposed on its flow, so that said head of stock will be maintained at a fixed value so long as the consistency of the stock remains at a fixed value and causing the said changes in head to increase the cross-sectional area of said section in which said internal friction is created with an increase in said head and vice versa.

5. The herein described method, comprising the steps of producing a continuous flow of paper-making stock through a predetermined path, creating a high degree of internal friction approximately throughout the cross-sectional area of a restricted section of said path, so controlling the rate of flow away from said section at a point down-stream from it as to produce an hydraulic head in the intermediate portion of said stream between said restricted section and said point, which head will vary inversely with changes in the consistency of the stock, causing said variations in head to adjust said resistance created by said internal friction substantially synchronously with said changes in head and in response thereto to increase said resistance with an increase in consistency and to decrease said resistance with a decrease in said consistency, and so coordinating the rate of supply of stock to said stream with the rate of discharge of the stock and the resistance imposed on its flow between said supply and discharge that said head of stock will be maintained a a fixed value so long as the consistency of the stock remains at a fixed value.

6. That improvement in methods of controlling the consistency of a stream of paper-making stock, comprising the steps of creating a flow of said stock through a restricted path, creating a high degree of internal friction in the stock substantially throughout the cross-sectional area of a portion of said restricted section of said stream, whereby the rate of flow through said restricted path varies inversely with the resistance created by said friction, increasing the degree of said resistance as the consistency increases and decreasing the degree of said resistance as the consistency decreases and thereby accelerating the effect on the rate of flow created by any change in consistency, limiting the rate of flow of said stock away from said restricted section at a point down-stream from it, thereby producing variations in hydrostatic pressure in the intermediate part of said stream in response to changes in the consistency of the stock, and so coordinating the supply of stock to said stream with the rate of flow from said section and the friction imposed on its flow that said hydrostatic pressure will be maintained at a fixed value so long as the consistency of the stock remains at a fixed value.

7. A consistency regulator for paper-making stocks, comprising a conduit for a stream of said stock, resistance means in said conduit for creating a frictional resistance substantially throughout the cross-sectional area of a portion of the stream and thereby impeding the flow of stock through said conduit, whereby an hydraulic head will be created in a part of said stream, which head will vary with changes in the consistency of the stock, means coordinating the rate of supply of stock to said conduit with the discharge of said stock from said conduit and the resistance imposed on its flow between said supply and discharge that said head of stock will be maintained at a fixed value so long as the consistency of said stock remains at a fixed value and means responsive to said changes in head for adjusting automatically the degree of said frictional resistance so that upon an increase in the solid content of the stock the resistance is increased and vice versa.

8. A consistency responsive apparatus for paper making stock comprising a conduit provided with a chamber through which the stock flows, said conduit including a restricted passage adjacent to said chamber, a resistance device positioned in said passage and constructed to reduce the cross-sectional dimensions of said passage and produce a high degree of internal resistance substantially throughout the cross-sectional area of said passage to the flow of the stream therethrough, means coordinating the flow of stock to said conduit with the flow from said chamber and with said resistance device so that for a given consistency of stock a given head of stock will be maintained in said chamber, whereby changes in consistency of the stock will cause the latter to create a head of stock in said chamber varying with changes in the consistency of the stock, a float in said chamber, the position of which varies with the head of stock in the chamber, and connections between said float and said resistance device for causing the float to adjust said device to increase its resistance to the flow of the stock with an increase in consistency of the stock and to decrease such resistance with a decrease in said consistency.

9. A consistency responsive apparatus for paper making stock comprising a conduit for a stream of said stock, a resistance device positioned in said stream and including parts distributed substantially throughout the cross-sectional area of the stream thereby creating a high degree of internal friction in the stock as it flows through said cross-sectional area and thereby producing variations in hydraulic head in another section of said stream, means coordinating the supply of stock to said stream with the rate of flow from said section and the friction imposed on its flow that said hydraulic head will be maintained at a fixed value so long as the consistency of the stock remains at a fixed value, and means responsive to said changes in head to adjust automatically the degree of said frictional resistance so as to increase said resistance simultaneously with an increase in consistency and vice versa.

10. A consistency regulator for paper making stocks comprising parts providing a chamber through which the stock flows, means operable to produce a substantially uniform flow of stock into said chamber, additional means mounted in said chamber for adjustably controlling the discharge of stock from said chamber, a restricted passage through which the stock flows into said chamber, a resistance device positioned in said passage and extending throughout the cross-sectional area thereof where it provides internal frictional resistance to the flow of said stream through said passage and thereby produces variations in the head of said stock in said chamber, which head varies inversely with changes in consistency of the stock, and means responsive to said changes in head to adjust automatically the degree of said frictional resistance so as to increase such resistance simultaneously with an increase in consistency, and vice versa.

11. In a consistency regulator of the type used in connection with paper-making stocks and including a chamber into which the stock flows at a substantially constant rate, means adjustable to control the discharge of the stock from said chamber, a restricted passage through which the stock flows into said chamber, a float in said chamber, the position of which varies with the head of stock in the chamber, that improvement comprising a resistance device positioned in said passage and constructed to reduce the cross-sectional area of said passage and to produce a high degree of internal frictional resistance to the flow of said stream through said passage so that it cooperates with said means for controlling the discharge of stock from said chamber to create a head of stock in the chamber, varying inversely with changes in the consistency of the stock, and connections between said float and said resistance device for causing the float to adjust said device to increase its resistance with an increase in consistency and to decrease such resistance with a decrease in said consistency.

12. A consistency regulator for paper-making stocks, comprising parts providing a chamber through which the stock flows, means operable to produce a substantially uniform flow of stock into said chamber, additional means adjustably controlling the discharge of stock from said chamber, a restricted passage through which the stock flows into said chamber, a resistance device positioned in said passage and extending throughout the cross-sectional area thereof where it provides internal frictional resistance to the flow of said stream through said passage and thereby produces variations in the head of said stock in said chamber, which head varies inversely with changes in consistency of the stock, and means positioned at a substantially fixed level in said chamber and responsive to changes in said head for extracting a portion of the water from said stream when its consistency becomes too low and thereby increasing said consistency.

13. In a consistency regulator of the type used in connection with paper-making stocks and including a chamber into which the stock flows at a controlled rate, means adjustably controlling the discharge of the stock from said chamber and a restricted passage through which the stock flows into said chamber, in combination with a resistance device including means effecting an increase in the imposed resistance in accordance with decreases in the head of stock in said chamber, and vice versa, positioned in said passage and including parts distributed substantially throughout the cross-sectional area thereof where it provides a high degree of internal frictional resistance to the flow of said stock through and around the device and thereby produces, in the head of stock in said chamber, changes in level varying inversely with changes in consistency of the stock.

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