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Prechtel

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[54] **FIBROUS WEB FORMING MACHINE WITH WHITE WATER RECIRCULATING ARRANGEMENT**

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[58] **Field of Search** 162/264, 216, 380, 337, 162/348, 317, 214, 217, 259, 190, 189, 380, 252; 55/36, 55, 165, 169, 189

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[57] **ABSTRACT**

A fibrous web forming system wherein white water is recirculated from the suction boxes to the stock inlet. The closed conduit system includes a closed vessel wherein the velocity of the stock is reduced, and from the top of which excess water and entrained gas is drawn off to a degassing chamber from which the water and gas are separately withdrawn. A pump downstream from the closed vessel withdraws water therefrom and supplies it to the stock inlet, while fresh pulp is supplied to the recirculating water at the point in the conduit system between the closed vessel and the suction side of the pump.

5 Claims, 3 Drawing Figures

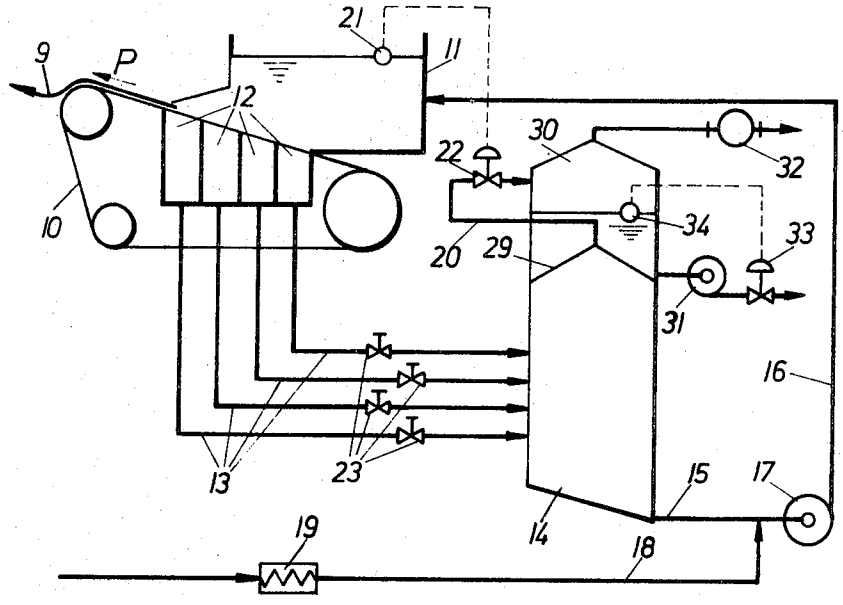


Fig. 1

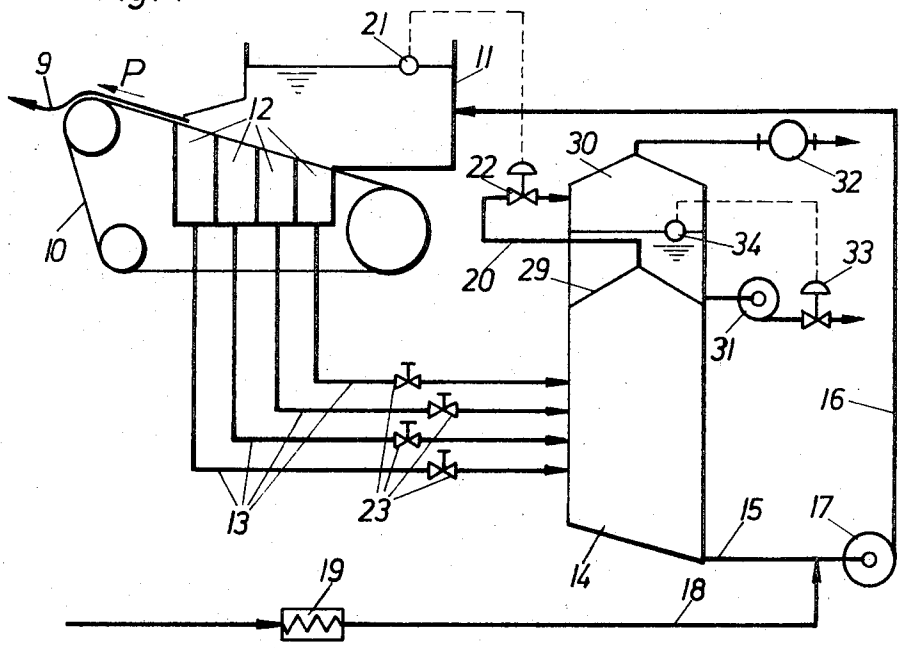


Fig. 2

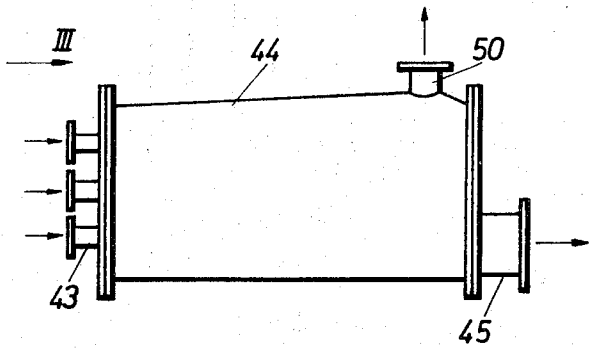
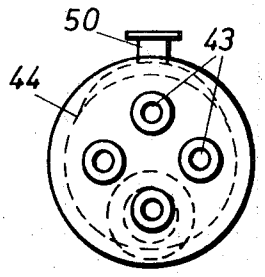


Fig. 3



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FIBROUS WEB FORMING MACHINE WITH WHITE WATER RECIRCULATING ARRANGEMENT

The present invention relates to a web forming machine, such as a papermaking machine, and especially to the wet end thereof. More particularly still, the present invention relates to a web forming machine in which a fibrous suspension is supplied to a foraminous member and a web formed on the foraminous member by draining liquid from the suspension therethrough and with the liquid being returned via a closed conduit for recirculation through the machine.

Web forming machines of the nature referred to comprise a foraminous member in the form of a cylinder or a circulating wire, a stock inlet which supplies the fibrous suspension to the foraminous member, suction boxes applied to the foraminous member on the side thereof opposite the side to which a suspension is supplied and adapted for extracting liquid from the suspension, and closed conduit means extending from the suction boxes through a pump back to the stock inlet and provided with a connection for the supply of additional fibrous pulp thereto and a connection for discharging excess liquid which accumulates in the system.

In a web forming machine of the nature referred to the liquid, which is principally water, and which is referred to as water herein, is conveyed in closed circuit from the suction boxes back to the stock inlet by a circulating pump which produces the required suction in the suction boxes and further supplies the head to the liquid necessary to return it to the stock inlet. During the travel of the liquid from the suction boxes back to the stock inlet, fresh fibrous pulp is added to the liquid via a suitable pulp supply duct. Since the incoming fresh fibrous pulp is provided with a watery vehicle, it will be apparent that all of the water coming from the suction boxes is not utilized for reducing the pulp to the proper consistency so that a certain quantity of excess water must be removed from the circulatory system continuously.

It is known in such a system to provide a connection for the discharge of excess water downstream from the circulating pump in the conduit through which the water flows from the suction boxes back to the stock inlet. A regulating valve incorporated in the excess water duct controls the excess water flow therethrough so that the liquid level in the stock inlet box remains at a substantially constant level. The pulp duct which supplies fresh pulp to the water, in this case, extends into the recirculating conduit downstream from the aforementioned connection through which excess water is removed from the system.

The above referred to known system is quite simple but has the disadvantage that gases remain entrained in the circulating water. When the conduit system is filled in the course of putting the system into operation, part of the air contained in the pipe line is dispersed in the liquid therein in the form of bubbles or is dissolved in the liquid. Furthermore, the incoming fresh fibrous pulp always introduces a relatively large quantity of gas, also in bubble form, into the circulating water. It is possible, of course, for a small amount of the gas bubbles to escape from the stock inlet box if the stock inlet box is constructed so as to be open to the atmosphere but the amount of gas separated out in this manner is usually less than the amount of gas constantly being supplied to the system.

Accordingly, with such an arrangement, the gas content in the circulating water is gradually increased during operation to such a point as to interfere with the proper formation of the web on the foraminous member and/or to prevent the circulating pump in the system from delivering the recirculated water uniformly.

In a system in which an open vessel is provided to which the lines leading from the suction boxes extend, it is possible for the recirculated liquid to be at least partially degassed. However, in such an open system, the circulating pump functions only for supplying the water to the stock inlet box and cannot produce the desired negative pressure in the suction boxes. Because of this, it is necessary for an additional suction pump to be disposed downstream of the suction boxes and upstream of the aforementioned open vessel which results in higher installation and operating costs for the system.

Alternatively, the reduced pressure in the suction boxes can be produced by drop tubes extending downwardly therefrom into the submerged location in the aforementioned open vessel. However, to obtain the drop height necessary to develop the desired suction, it is necessary to provide a room for the open vessel well below the level of the suction boxes. In such an open circuit, the excess liquid is discharged via an overflow weir disposed in the open vessel. Thus, in contrast to the closed system, it is not possible with such an open system to regulate the liquid level in the stock inlet box by controlling the amount of excess water returned thereto. Rather, the amount of return water which flows to the stock inlet box must be varied and this requires the use of complex control devices.

With a closed system the aforementioned difficulties do not occur but, as mentioned above, the disadvantage does exist of inadequate gas separation and the closed circulatory system has, therefore, not been widely accepted in practice.

With the foregoing in mind, a primary objective of the present invention is the provision of a closed liquid returning system in a web forming arrangement of the nature referred to in which the water is subjected to an improved degassing step before being returned to the stock inlet box.

In dealing with the problem of degassing the water, a zone is established through which the water flows and wherein the flow velocity thereof is substantially less than that obtaining in the remainder of the system, and with the water flowing at the reduced velocity in substantially a horizontal direction. The reduced velocity flow zone is disposed between the suction boxes of the machine and the circulating pump and the discharge conduit by means of which excess liquid is withdrawn is disposed in the upper region of the reduced velocity zone. Furthermore, suction means is associated with the aforementioned discharge duct.

Due to the low velocity with which the water passes through the aforementioned zone, it is possible for the bubbles of gas contained therein to rise upwardly to reach the connection for the excess water discharge duct. A part of the water flow is constantly diverted through the aforementioned duct and gas bubbles are thereby reliably entrained therein and carried away by the excess water discharged. The combined discharge

of excess water and gases results in a particularly effective separation of the gases from the recirculating water so that improved conditions are established for the formation of the web on the foraminous member.

The common discharge of the excess water and the gases also permits relatively simple regulation of the liquid level in the stock inlet box by the use of one regulating valve only. It is conceivable that excess water and the gases can also be discharged separately with the gases being collected above the level of the water moving along the aforementioned low velocity zone where the water moves at a reduced velocity. In such a case, however, the liquid level in the stock inlet box would have to be regulated by controlling the amount of gas discharged and two level regulating systems would, thus, be required which would introduce interaction and could incur the danger of oscillation of liquid levels, with subsequent damage to the uniform conditions desired in the web formation region of the machine.

It will be appreciated that the low velocity zone, or settling section, referred to above is disposed on the suction side of the circulating pump so that gas separation from the water is particularly effective due to the reduced pressure standing on the water. A further advantage obtained by the use of the system of the nature referred to is that the water from the settling region enters the circulating pump substantially free of gas bubbles and this insures a uniform delivery rate of the circulating pump.

The system described also avoids the larger gas bubbles becoming finely divided in passing through the circulating pump which would make them much more difficult to separate from the water, and prevents any part of the gases becoming dissolved in the water due to an increase in pressure on the water and which would also make separation of the gases from the water difficult.

The present invention, in practice, has made it possible to employ known closed system techniques and to utilize the advantages thereof without encountering the disadvantages referred to in respect of gases entrained or entrapped in the water. The advantages referred to include the fact that no room at a low level is required to accommodate drop tubes and vessels, while no additional suction pump is required to develop suction on the suction boxes. Furthermore, the advantage exists that the entire process can be controlled quite simply.

In a web forming process of the nature referred to, the forming of the web can be substantially influenced by a number of different factors among which is the adjustment of the negative pressure in the individual suction boxes under the foraminous member on which the web is formed by means of valve elements incorporated in the suction lines leading from the boxes. The open liquid return circuit has the drawback that the entire amount of liquid drawn off and, therefore, the liquid level in the stock inlet box is varied so that the level control system responds substantially immediately and varies the amount of incoming water. This variation in the amount of incoming water, however, will also alter the density of the suspension in the stock inlet box and in an undesirable manner. Accordingly, with an open system of the nature referred to, it is extremely difficult to establish stable operation conditions.

By contrast, and particularly if the negative pressure is individually adjusted in the individual suction boxes, no appreciable changes of liquid level and of the density of the suspension of the stock inlet box are produced in the enclosed type liquid return circuit. This comes about because of the difference between the amount of water flowing toward the stock inlet box and that leaving the suction boxes is substantially constant at all times. Thus, if the amount of water drawn off from one of the suction boxes is reduced, the amount drawn off from the other suction boxes will be correspondingly increased.

The suction means for conveying excess water together with the gas bubbles therein overcomes the pressure difference between the suction in the suction boxes and the atmosphere, and any conventional commercial delivery means may be employed so long as it is suitable for handling liquids containing gas. The amount of excess water to be discharge amounts to from only about 1 to about 5 percent of the total amount of liquid in the system and it, therefore, follows that the cost of the means for conveying the excess water and gas away from the system will be quite low.

A further advantage of the closed system according to the present invention comes about because the duct through which fresh pulp is supplied to the recirculating water is connected into the system on the suction side of the circulating pump so that the circulating pump will function as a highly effective instrumentality for mixing the freshly supplied pulp with the recirculating water. This feature, in particular, is not to be found in any known apparatus because the duct delivering fresh pulp must always be located downstream from the excess water discharge duct and when this duct is disposed on the delivery side of the circulating pump, the newly supplied pulp does not pass through the pump and cannot be mixed into the water thereby.

In the practice of the present invention it has been found of advantage to construct the settling, or low velocity section for the circulating water as a vessel extending substantially vertically. With such a vessel it is very advantageous for the inlet for the recirculating water, together with the outlet therefor, to be disposed in the lower zone of the vessel at the greatest possible axial distance from each other, while the connection for the duct which conveys away the excess water is advantageously disposed at the upper end of the vessel.

In a still further embodiment of the present invention, a separate water withdrawl conduit is associated in a known manner with each suction box and the conduit leading from each suction box extends separately into the settling section. Such an arrangement avoids any pressure surges which could occur in any one of the suction conduits from being propagated into the other suction conduits and thereby effecting the formation of the web in the machine.

According to the present invention, it is also advantageous for the excess water conduit to extend into a degassing vessel or chamber, the lower region of which is connected to a first suction means for the excess water and the upper region of which is connected to a second suction means for the gases separated from the excess water. By means of such a degassing vessel, or chamber, it is possible for the gas bubbles to escape from the excess water, whereupon the escape gases and the excess water can be conveyed away separately and brought to atmospheric pressure by individual suction means. Such an arrangement requires additional suction means as opposed to the provision of a single suc-

tion means, as described, but offers the special advantage that the delivery or withdrawing of excess water is always uniform. Where only one suction means is provided for removing both gas and excess water, it is possible for sudden fluctuations to occur, especially if the quantity of gas being removed varies rather suddenly.

It is important in the practice of the present invention to insure that the excess water transferred, together with gases from the settling or low velocity region, into the aforementioned degassing vessel, or chamber, is at a pressure less than that prevailing in the settling or low velocity section. It is, however, necessary for this lower pressure to be regulated to a specific value and a regulating valve is incorporated in a known manner in the excess water duct and is under the control of the liquid level in the stock inlet. Such a valve is advantageously disposed between the low velocity settling section of the water return system and the degassing vessel or chamber. With such an arrangement, the quantity of excess water withdrawn from circulation is completely independant of the instantaneous pressure difference between the low velocity settling section and the degassing vessel, or chamber, but depends, rather, merely upon the level of the suspension in the stock inlet box.

The exact nature of the present invention will be more fully comprehended upon reference to the following detailed specification taken in connection with the accompanying drawings wherein:

FIG. 1 schematically illustrates the wet end of a web forming machine embodying the present invention;

FIG. 2 is a side elevational view of a vessel adapted for functioning as a settling section in the water recirculating system of the machine of FIG. 1; and

FIG. 3 is a view looking in at the left end of FIG. 2 as designated by the arrow 3 on FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings somewhat more in detail, the apparatus illustrated therein, and in connection with which the present invention is employed, comprises a foraminous member in the form of a wire **10** guided in endless path by a plurality of rollers. The wire **10** runs in a direction indicated by the arrow P and above the upper reach of the belt is a stock inlet **11** opening against the wire and beneath the wire to which the suspension is supplied is a plurality of suction boxes **12.** Suction lines **13** lead from the suction boxes to a vessel **14** which functions as a settling zone or low velocity section and within which the suspension slows down until its flows out of vessel **14** via conduit **15.** Conduit **15** leads to the suction side of a circulating pump **17** which discharges into a conduit **16** leading to stock inlet **11.**

Fresh pulp is supplied to conduit **15** on the upstream side of pump **17** via a conduit **18** having embodied therein a pumping means **19.**

The aforementioned stock inlet **11** to which the suspension is supplied, and from which the suspension flows to the wire **10,** covers the entire web forming zone of wire **10,** but it is also possible to employ a stock inlet in which the suspension flows from a horizontal slit-like opening and is supplied to the wire in the manner conventionally employed for the manufacture of paper webs.

The suction boxes draw water through the wire during the formation of the web and cover substantially the entire web formation zone of the wire on the underside thereof. In general, the suction boxes are constantly filled with water extracted from the suspension on the wire. The fibers remaining on the wire form a web **9** which, when it is removed from the wire as illustrated, is completely formed but is still moist and is passed to a conventional drying apparatus not illustrated in the drawings.

The negative pressure required in the suction boxes **12** is produced by the aforementioned circulating pump **17** because the pump is continuously drawing water from closed vessel **14** and therethrough from conduits **13** leading to the suction boxes **12.** It is advantageous to be able to control the individual negative pressures in the several suction boxes and, to this end, an individual suction conduit leads from each suction box and each said conduit has therein a restrictor valve **23.**

It will be appreciated that the fresh fibrous pulp introduced into conduit **15** from conduit **18** passes together with the recirculating water through pump **17** and is thoroughly admixed with the water in the pump.

The pump **19** which supplies the pulp is a metering type pump so that the amount of pulp supplied to the recirculating liquid can be accurately determined.

In respect of the removing of gas from the recirculated water, vessel **14** may comprise a conical or dome-like top and from the extreme upper end thereof a conduit **20** leads through a regulating valve **22** into another chamber or vessel **30** which may advantageously be combined with vessel **14** as a unitary structure. Vessel, or chamber, **30** is a degassing vessel and gases separated from the water collect in the top of vessel **30,** while the water supplied to vessel **30** via conduit **20** collects in the lower part thereof. A suction means, such as a pump **31,** or a drop tube, is connected to a lower portion of vessel **30** and draws water therefrom through a regulating valve **33.** Similarly, a suction means, as represented by reference numeral **32,** is connected to an upper portion of vessel **30** and draws gas therefrom.

The aforementioned regulating valve **22,** which is incorporated in duct **20** leading off from the top of vessel **14,** is under the control of a liquid level measuring means **21** disposed in stock inlet **11** and is operable to maintain the liquid level in stock inlet **11** at a substantially constant value by controlling the rate of flow in duct **20.**

The other regulating valve **33** incorporated in the discharge conduit leading from pump **31** is associated with a liquid level measuring means **34** in vessel **30** and is operable to maintain the liquid level in degassing vessel **30** at a substantially constant value.

In the FIG. **1** embodiment, the vessel **14,** which is combined with the degassing vessel **30** is arranged in a vertical manner with a conical or dome-like separating partition **29** between the respective parts of the vessel. It will be evident, however, that the two vessels, **14** and **30,** could be constructed as independant units and disposed separate from each other.

FIGS. **2** and **3** show a vessel **44** disposed in a horizontal fashion and adapted to perform the same function as vessel **14** of the FIG. **1** modification. In FIGS. **2** and **3,** the connections indicated at **43** receive the discharge ends of the conduits **13** leading from the suction boxes, while the connection **45** connects to duct **15** leading to the inlet side of circulating pump **17.** The connection

50 in the top of the vessel is provided for being connected to conduit 20 for discharging excess water and gases from the chamber 44. It will be noted that the upper portion of chamber 44 inclines upwardly in the direction of flow through the chamber and that connection 50 is disposed at the uppermost portion thereof.

In respect of either of the vessels 14, 44, the internal cross-sectional area at right angles to the direction of flow therethrough, is sufficiently large to reduce the flow velocity of the water passing therethrough to a value sufficiently low to permit the gas bubbles in the water to rise therefrom so that the gas can be extracted via conduit 20. It has been determined that a suitable flow velocity within the vessel may be on the order of from about 0.1 to 0.4 meters per second.

While FIG. 1 illustrates a machine in which a wire is passed about a plurality of supporting rollers, it will be understood that the invention is applicable to a cylinder type machine in which a foraminous cylindrical or drum member is provided on which the web to be made is formed. In the case of a cylinder or drum member being provided, the wire is tensioned about the drum member or cylinder and the interior of the drum member or cylinder is provided with suction boxes to which water drains during the formation of the web.

While the term "water" has been employed throughout the foregoing description, it will be understood that any liquid vehicle is intended and that, even when the vehicle is principally water, it will contain dissolved and suspended materials and is not clear water.

It will be understood that modifications may be made within the purview of the appended claims.

What is claimed is:

1. In a machine for forming a fibrous web and having a foraminous member to one side of which a fibrous suspension is supplied from a stock inlet box, suction boxes on the other side of said foraminous member to withdraw liquid from the suspension through the foraminous member, and a closed conduit system leading from said suction boxes to said stock inlet box and including a circulating pump, closed chamber means in said system forming a zone upstream of said pump and of substantially greater cross sectional area at right angles to the direction of liquid flow therethrough than the cross sectional area of said conduit system whereby the velocity of liquid flow in said conduit system is substantially reduced upon entering said chamber means and is oriented in a substantially horizontal direction, means for supplying fresh pulp to said conduit system between said chamber means and the inlet of said circulating pump, a discharge conduit for the discharge of excess liquid connected to an upper portion of said chambers means, a degassing chamber to which said discharge conduit leads, a pump connected to a lower portion of said degassing chamber to remove liquid therefrom, and suction means connected to an upper portion of said degassing chamber to remove gas therefrom.

2. A web forming machine according to claim 1 which includes a first flow control valve in said discharge conduit between said chamber means and said degassing chamber.

3. A web forming machine according to claim 2 which includes means sensitive to the liquid level in said stock inlet box and connected in controlling relation to said first flow control valve for maintaining the liquid level in said stock inlet box substantially constant.

4. A web forming machine according to claim 2 which includes a second flow control valve through which liquid withdrawn from said degassing chamber by said suction means passes.

5. A web forming machine according to claim 4 which includes means sensitive to the liquid level in said degassing chamber and connected in controlling relation to said second flow control valve for maintaining the liquid level in said degassing chamber substantially constant.

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