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METHOD AND APPARATUS FOR MAKING PAPER

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2 Sheets-Sheet 2

FIG. 3

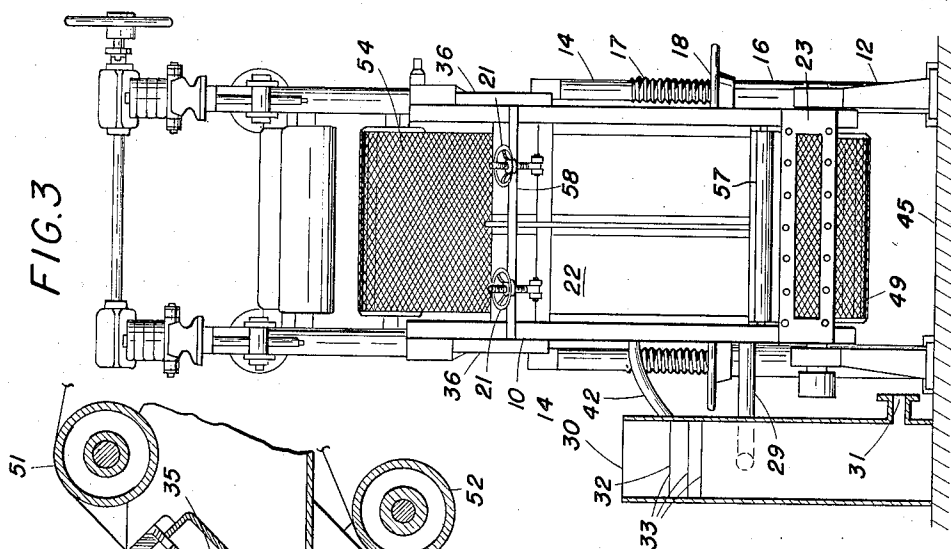
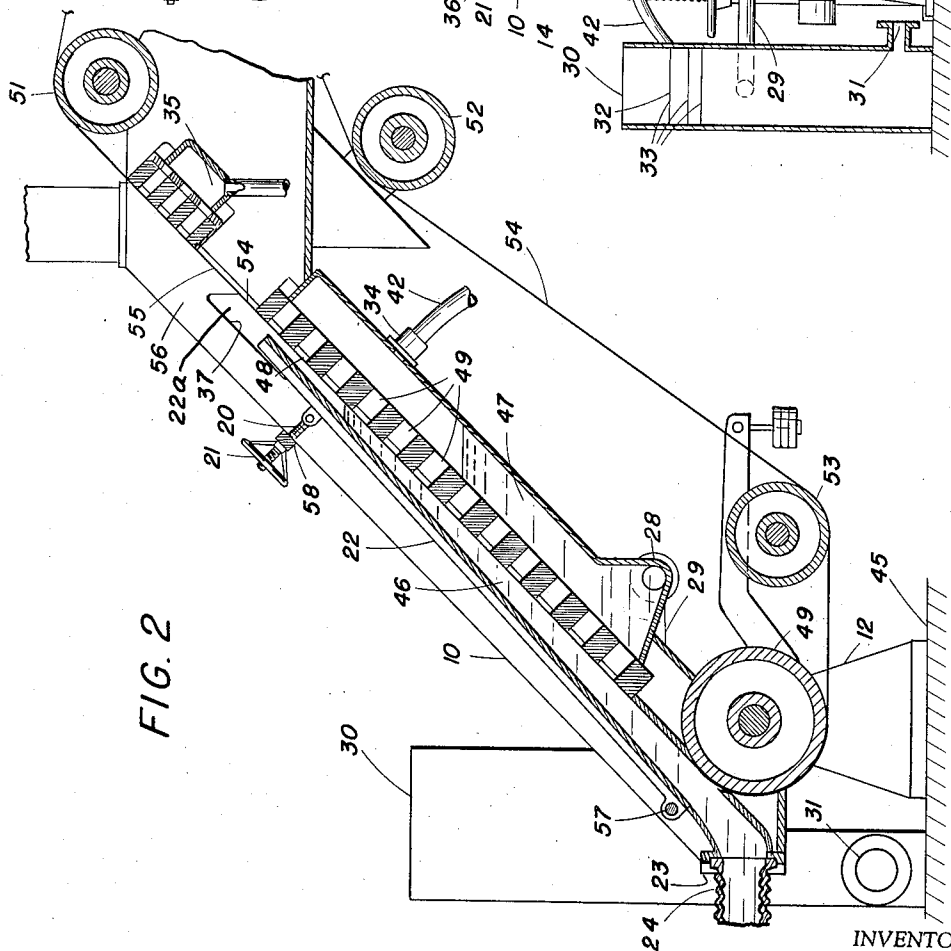


FIG. 2



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METHOD AND APPARATUS FOR MAKING PAPER

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13 Claims. (Cl. 162—211)

This application is a continuation-in-part of my patent application Serial Number 191,345, filed October 21, 1950, now abandoned.

My invention relates to improvements in apparatus for making paper and, more particularly, for forming a continuous sheet of paper, cardboard and similar fibrous material.

A continuous sheet (or endless track) of paper, cardboard, or other fibrous material is formed by feeding a suspension of the fibrous material onto a moving, finely meshed wire netting, or screen.

The fibers being deposited on the upper side of the screen, form the sheet while the excess of water passes through the meshes of the screen. The two main types of screen used in papermaking machines are the long or Fourdrinier screen and the screen cylinder. It is a well known fact that the formation of the sheet on a cylinder machine differs from that effected on a Fourdrinier wire. Therefore, a sheet formed on the cover of a cylinder screen has characteristics different from those of a Fourdrinier sheet. In a horizontally arranged Fourdrinier machine a pond of stock is formed by floating the fibrous suspension onto the wire from above through a slot-shaped opening or the like, while the water is drained freely and relatively fast therethrough.

In a cylinder machine, however, a screen cylinder is revolved in a vat containing the diluted fibrous material as pulp. When the sheet is formed the water is drained through the meshes of the cylindrical screen into the interior of the latter while the fibers are deposited on the screen to form the paper stock. The resistance to draining of the water is increased as more fibers are deposited on the screen. Thereby a difference between the height of the water level inside the cylinder and the suspension level outside the same is brought about which also causes a difference between the internal pressure of both liquids which shall henceforth be called the "hydrostatic pressure difference."

In a cylinder screen the first stage of draining the pulp and/or the formation of the sheet is due to this hydrostatic pressure difference. The fibers are relatively slowly deposited so that they are intimately felted.

Whereas any desired quantity of fibrous material in any desired concentration and thickness may be deposited upon a Fourdrinier wire per time unit, the possibilities for doing so in a cylinder machine are far more limited and can hardly be increased without encountering considerable difficulties. Thus, it is one important disadvantage of cylinder machines that the continuous paper sheet must be lifted from the rotating cylinder immediately at the end of the sheet forming zone. This is particularly difficult to achieve in a satisfactory manner if the sheet to be lifted is relatively thick and, therefore, its moisture content relatively high. In order to overcome the aforesaid limitations and to manufacture paper, cardboard or cardbox having the properties of a cylinder-made product, it was necessary heretofore to employ

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a plurality of cylinder molds in series. This method, however, has the drawback that the fibers of the individual layers are not as intimately felted as is possible with a one-layer mat; aside from the fact that such a multiple-mold cylinder requires a considerable quantity of material and structural elements thus becoming more complicated, expensive and rather unintelligible.

It has also been proposed to arrange an endless screen as used in a Fourdrinier machine travelling upwardly at an angle during its passage through a part or the entire paper-forming zone of a papermaking machine. In a machine of this kind the pulp is floated onto the screen from above, for instance through a flow box, and the water is drained through the screen either freely, or draining is accelerated by providing suction boxes below the aforesaid flow box under the inclined screen. However, this causes the fibers in the suction zone above the suction box to be deposited very rapidly onto the screen which causes a less satisfactory felting of the fibers with one another than is obtained in a cylinder machine.

It is an object of the present invention to provide an improved papermaking machine having an inclined wire screen which will make it possible to obtain the various advantages in paper making heretofore obtainable only with cylinder machines.

It is another object of this invention to provide a paper-making machine which will avoid the above-mentioned drawbacks.

It is a further object of this invention to provide a method of and device for making paper, cardboard and similar fibrous material which will combine the advantages of the Fourdrinier and the cylinder machines, while imparting upon the paper, cardboard and the like material the advantageous features inherent in such material when made on cylinder machines.

According to my invention the formation of a screen or track of paper, cardboard and the like fibrous material is carried out on an improved machine comprising a box and an inclined screen wire traversing the aforesaid box at an angle in an upwardly slanted direction, thereby subdividing the box into an upper and a lower chamber. The upper chamber is provided with feeding means for the pulp and the lower chamber is provided with discharge means for the drainage water. The suspension of fibrous material (the pulp) is fed to the upper chamber under a certain pressure, which, in conjunction with a specific arrangement of the water discharge outlet of the lower chamber causes the liquid suspension in the upper chamber to assume a higher level than the drainage water in the lower chamber. The screen is passed through the liquid in the upper and the lower chamber, thus forming the dividing plane between both chambers, and the formation of the sheet takes place on the upper side of the screen. On the part of the screen passing between the chambers below a level corresponding to that of the drainage water in the lower chamber, sheet formation takes place as in a cylinder machine, i.e. exclusively through the difference in hydrostatic pressures between the liquids in the upper and lower chambers. This makes it possible to obtain a paper made on a long wire as used in Fourdrinier machines which fully corresponds in quality to cylinder-made paper. Since the arrangement of the screen permits the same to be made of any desired length, while the opposite is the case with cylindrical screens, provision can be made for an exceptionally long zone of sheet formation, which greatly increases the performance of the machine.

Another advantage of the improved papermaking machine according to my invention over the known cylinder machines resides in the fact that the screen travels in a straight line for a considerable length of time after having

left the zone of sheet formation, whereby it becomes possible to make paper or cardboard of great thickness on one single machine. Furthermore, the screen may be made to continue in a straight travel, and the sheet may be left on the screen until the material has dried sufficiently to permit its being lifted from the screen in unobjectionable condition.

Yet another advantage of the machine according to my invention lies in the fact that the screen may be driven at relatively high speed, since there is no danger of the outer layers of the sheet slipping off the screen. The latter drawback often happens with cylinder machines due to the occurring centrifugal forces.

In a machine according to my invention the discharge outlet for the lower chamber may be provided at the height of the liquid level to be attained in said chamber. It is, however, of special advantage to arrange the discharge at the lower end of this chamber so as to avoid the formation of a deposit of fibrous material therein. In the latter arrangement the desired liquid level is attained by providing in the discharge conduit following the chamber a control means such as, for instance, a throttle valve or a weir tank for raising the water level in the same to a desired height, which tank has an overflow weir at the same height as the level to be attained in the lower chamber the latter line thereby being held under a pressure substantially equal to that of the surrounding atmosphere. The fibrous suspension or pulp is fed to the screen in the upper chamber, preferably at the lower end of the latter. It is necessary that the pulp is fed under a pressure sufficient to overcome the hydrostatic pressure which depends on the liquid level in the upper chamber. The height of the liquid levels in both chambers may be adjusted by the control valve arranged in the discharge conduit for the drainage water on the one hand and by varying the feeding pressure of the pulp being fed into the upper chamber on the other hand. By adjusting the liquid level in both chambers to a desired ratio in the length of the zone of sheet formation may be determined and adapted to a great extent to the properties of the material. A change in the length of the sheet forming zone may also be attained by altering the angle of inclination of the upwardly slanted part of the screen inside the box, or the box and the screen therein may be tilted jointly together. A decrease of the inclination of the screen also counteracts the drawback that part of the deposited fibers would otherwise be washed off the screen where the latter emerges from the pulp.

A particularly advantageous arrangement according to the invention provides for an overflow at the level of the surface of the fibrous suspension in the upper chamber. At this level the paper sheet or track on the screen emerging from the liquid in the upper chamber is washed off to a varying degree, which leads to an increase in the concentration of the liquid in the surface area around the emerging sheet. An increase in the concentration of the liquid, however, leads to an increased washing off effect. This drawback is avoided by removing continuously a certain quantity of the liquid by way of the aforesaid overflow, thereby removing immediately any liquid layer of increased concentration. Means may be provided for adjusting the overflow level, for instance in the form of level-adjusting boards, so as to control the quantity of fibrous suspension removed by way of the overflow.

According to yet another advantageous feature of my invention, the upwardly slanted or cover wall of the upper chamber is pivotally mounted at its lower end and may be swung with its upper end about the hinge thus formed toward or away from the inclined screen. It is thus possible to reduce or increase the cross section of the upper chamber continuously in the direction of travel of the ascending part of the screen so as to adapt the cross section and together therewith the admitted quantity of pulp over the whole length of the screen in contact with

the liquid in the upper chamber in accordance with the properties of the suspended fibrous material.

In order to accelerate and to improve the drainage of the part of the sheet above the level of the drainage water in the chamber, the part of the latter which is not filled with drainage water may be subjected to a slightly decreased pressure, for instance, a pressure which is 10 to 20 mm. water column less than normal. Of course, when atmospheric pressure prevails above the drainage water in the chamber, the drainage of excess water from the sheet above the drainage water level takes place due to gravity alone.

As yet another feature of the invention the drying of the sheet after leaving the paper forming box may be intensified, for instance, by arranging a number of known suction boxes under the screen.

Other objects and advantages of the invention apart from the ones described above will appear more clearly from the following specification in connection with the accompanying drawings wherein:

Figure 1 represents a schematic lateral view of a paper-making machine having an upwardly slanted screen;

Figure 2 shows the same machine as represented in Figure 1, but in a longitudinal section;

Figure 3 is a cross section along line 3—3 of Figure 1; and

Figure 4 shows the overflow device shown in Figures 1 and 2 in greater detail and in perspective view.

Referring now to the drawings in detail, and particularly to Figure 1, reference numeral 10 designates an upwardly slanted box which is pivotally mounted at the lower part of its bottom end onto brackets 12. The top end 11 of the box 10 is supported by two rods 14 articulatedly connected with the bottom of the top end 11 by means of an articulated juncture 13. Each of the rods 14 is housed in a supporting tube or sleeve 16 which is in turn rotatably mounted on a pivot means 19. The pivot means 19 are in turn pivotally mounted on a supporting articulated juncture 15, the supporting member of which is rigidly attached to the foundation plate 45 on which the machine is standing. Each of the rods 14 is provided with a thread 17 which engages an internal thread in the sleeve 16. The latter may be rotated with aid of a hand wheel 18 or any other suitable device, thereby threading the rod 14 downwardly into or upwardly out of the sleeve 16, so as to increase or decrease the distance of the top end 11 of box 10 from the foundation plate 45, and together therewith vary the inclination of the slanting box 10. Reference numerals 11', 13', 14', 16' and 18' indicate the position of the corresponding parts when the top end 11 has been lowered to the position indicated at 11' and the angle of inclination of box 10 has been correspondingly decreased.

As shown in Figures 2 and 3, a breast roll 49, a couch roll 50 (shown in Figure 1 only) and deflection rollers and/or idlers 51, 52, and 53 are so arranged on or supported by the box 10 that the rotating endless screen 54 traverses with its ascending reach 55 the upwardly slanted part of box 10, subdividing the same into an upper chamber 46 above, and a lower chamber 47 below the ascending reach 55. This ascending reach 55 of screen 54 is guided along its two sides in guide means 48 mounted on the inside of the side walls 56 of the slanted box 10. The ascending reach 55 of screen 54 is further guided by traverses 49 extending across the whole width of box 10. The upper chamber 46 is limited as to its cross section by a roof or cover plate 22 which is pivotally mounted on hinge means 57 provided at its lower end and is in free communication with the surrounding atmosphere at 22a; and at 26 in weir tank 25 described hereinafter. The distance from the upper end of the roof plate 22 to the ascending reach 55 of screen 54 is narrowed or widened by adjusting the threaded bolts 20 which are rotatably mounted in threaded bores in the upside wall 58 of box

10 and provided with hand wheels 21 for rotating the same.

The adjustable roof plate 22 serves to control the passage of liquid through the screen and to provide for an even quantity of the same to pass therethrough per unit of time and area, thereby guaranteeing a deposit of even thickness on the screen. Normally, if there is no adjustment of the roof plate and the cross section of the upper chamber remains the same throughout, the largest quantity of water per unit of time and area will naturally pass through the screen where that passage is not or only lightly obstructed by the formation of the fiber layer on the screen. The least obstruction is found in the region near the bottom of the lower chamber. From this region upwardly the quantity of water passing through the screen per unit of time and area is evenly or unevenly decreasing until reaching the upper level of liquid in the upper chamber, said quantity depending upon the amount of fibers deposited at each height and the kind of fabric to be manufactured. In order to counteract this irregular effect the lower region of the screen must be fed with a larger quantity of the suspension while less is fed in ascending direction which reduction in quantity of suspension fed is achieved by gradually reducing the cross section of the upper chamber in ascending direction. In the upper region of the upper chamber less liquid will pass through the screen and therefore less suspension per area and time unit is required. The decrease in diameter of the upper chamber is achieved in the simplest manner by altering the distance of the roof part 22 from the screen through turning the roof part around the hinge provided at its lower end.

The lower transverse front wall 23 of box 10 possesses an inlet opening connected by means of a flexible tube 24 to a weir tank 25 wherein the fibrous suspension or pulp is dammed up to a desired level 26. Of course, the level 26 in the tank 25 also determines the level of the fibrous suspension in chamber 46 above the ascending reach 55 of screen 54. This level 26 may be adjusted manually or mechanically to any desired height by level changing means such as, for instance, weir-adjusting sills or boards 27 provided in the tank 25. The fibrous suspension is pumped into tank 25 to the desired level 26 by means of a pressure pump or compressor 59 connected to tank 25 through the inlet opening 60 provided therein.

The lower chamber 47 is provided at its lowermost part with an outlet 28 for discharging the drainage water which outlet 28 is connected through a flexible tube or conduit 29 (shown in Figure 3) with a second weir tank 30 for raising the level of the drainage water therein which level is thus held under substantially the same pressure as that exerted by the surrounding atmosphere on the liquid level in tank 30. This weir tank 30 has an outlet 31 for the final discharge of the drainage water. The liquid level 32 in the tank 30 determines the drainage water level in the lower chamber 47. This weir tank 30 is equally provided with manual or mechanical adjusting means such as, for instance, exchangeable weir-adjusting boards or sills 33 for changing the drainage water level 32 to any desired height. At its upper portion the lower chamber 47 is provided with a further outlet through a joining socket 34 which is connected through a flexible pipe 42 to a suction pump 43, which in turn may serve to evacuate air from the upper portion of the lower chamber 47, thereby creating a moderate vacuum in that portion above the surface level of the drainage water in the lower chamber 47. Following the zone of sheet formation which ends approximately where the ascending reach 55 of screen 54 emerges from the liquid level 26, one or several flat suction boxes 35 may be arranged below the screen for facilitating the drying process of the formed sheet. On the outside of both side walls 56 of the box 10, overflow means, for instance, in the form of troughs 36, are arranged at the level 26 in the upper chamber 46 for lead-

ing off the excess of fibrous suspension overflowing into the troughs 36 at that level.

As is shown in Figure 4, each of these troughs 36 is connected to the upper chamber 46 through an opening 37 provided above the ascending reach 55 of screen 54. The overflow level together with the quantity of fibrous suspension overflowing into trough 36 may be controlled by manually or mechanically adjustable overflow control means for instance in the form of level adjusting boards or sills 38 guided in a groove 39. At its bottom the trough 36 has a discharge pipe 40 for discharging the overflowing excess of fibrous suspension.

The sheet is formed by depositing the fibers contained in the suspension fed into the upper chamber 46 onto the ascending reach 55 of screen 54.

The first stage of sheet formation below the drainage water level 32 is due entirely to the difference between the hydrostatic pressures of the suspension above, and the drainage water below the ascending reach 55 of the screen 54, i.e., the upper end and the under side of the upper reach of wire 54 are simultaneously in contact with the liquids in the upper and the lower chamber, respectively, over an extended zone of the wire. After an eventual further dehydration of the sheet with the aid of a moderate vacuum corresponding to approximately 10 to 20 mm. water column, which depression is generated in the portion of the lower chamber 47 above the drainage water level 32 by means of the aforesaid suction pump 43, and after still further drying by the action of the flat suction box 35, the sheet is lifted from the screen with the aid of the upper felt 44. It is, of course, understood that the present invention is by no means limited to the particular structure and particular method described above but also comprises any modifications within the scope of the appended claims.

I claim:

1. A method for making paper by forming a continuous sheet of fibrous material in a paper forming zone, comprising the steps of (a) feeding a suspension of fibrous material onto the upper side of a straight, inclined upwardly travelling depositing surface under sufficient pressure so as to maintain a determined level of said suspension thereon, (b) maintaining a drainage water level below the said surface at a height lower than the aforesaid determined suspension level, said drainage water being in contact with the under side of said surface throughout approximately the first half of said paper forming zone, (c) maintaining both said determined suspension levels above the travelling surface and said drainage water below the surface under substantially the pressure of the surrounding atmosphere, the drainage water being maintained free from suctioning, thereby depositing fibrous material from the suspension to continuously form a sheet exclusively under the hydrostatic pressure difference existing between the suspension above and the drainage water below the surface, in said first half of said paper forming zone which extends up to the same height as the drainage water level, and thereby also draining the excess water in the remainder of said paper forming zone, which remainder extends above the drainage water level, exclusively under the influence of the hydrostatic pressure of said suspension, and (d) carrying the sheet at an angle upwardly from said paper forming zone.

2. An apparatus for making an endless sheet of fibrous material comprising a sheet-forming box, an endless screen having an upper reach, said upper reach traversing said box straight, at an angle in upward direction, an upper and a lower chamber formed in said box by said traversing screen, inlet means provided at said upper chamber for feeding a fibrous material suspension on to said upper reach, outlet means provided at said lower chamber for discharging the drainage water therefrom, control means in connection with said inlet and said outlet means for so adjusting the feeding of fibrous material suspension to said upper chamber and the discharge of

drainage water from said lower chamber, that the level of said fibrous material in contact with said screen in said upper chamber is maintained constantly higher than the level of said drainage water in contact with said screen in said lower chamber, said level of drainage water being higher than the level of said inlet means, and an adjustable overflow device provided in one lateral wall of said upper chamber so as to control the surface level of said fibrous material suspension in said upper chamber.

3. An apparatus according to claim 2, wherein said adjustable overflow means comprise exchangeable weir boards of different height.

4. An apparatus for making an endless sheet of fibrous material comprising a sheet-forming box, an endless screen having a straight elongated upper reach, said upper reach traversing said box straight at an angle in upward direction, an upper and a lower chamber formed in said box by said traversing screen, inlet means in communication with said upper chamber for feeding a fibrous material suspension onto said upper reach, outlet means provided at said lower chamber for discharging the drainage water therefrom, control means in connection with said inlet and said outlet means for so adjusting the feeding of fibrous material suspension to said upper chamber and the discharge of drainage water from said lower chamber that the level of said fibrous material in contact with said screen in said upper chamber is maintained constantly higher than the level of said drainage water in contact with said screen in said lower chamber, said drainage water being in contact with the underside of said screen throughout approximately the first half of the length of said sheet-forming box, thereby causing fibrous material from said suspension to be deposited, throughout said first half of said sheet-forming box, exclusively under the hydrostatic pressure difference between the suspension above and the drainage water below, and means for maintaining both the suspension above and the drainage water below under a pressure substantially the same as atmospheric pressure so that in the remainder of said sheet-forming box excess water is drained exclusively under the influence of the hydrostatic pressure of the suspension.

5. An apparatus according to claim 4, wherein angle adjusting means are provided for tilting said sheet-forming box, and together altering therewith said angle of inclination of said upper reach of said endless screen.

6. An apparatus according to claim 4, wherein a connecting socket is provided at said lower chamber above the drainage water level, and a suction pump attached to said connecting socket for creating a moderate vacuum within said lower chamber.

7. An apparatus according to claim 4, wherein suction boxes are provided below said upper reach of said

endless screen after leaving the zone wherein the sheet of fibrous material is being formed, traversed by said screen.

8. An apparatus according to claim 4, wherein a roof wall is provided in said upper chamber above said upper reach of said endless screen, said roof wall being so inclined with regard to said upper reach that the distance between both decreases in the direction of ascending movement of said screen.

9. An apparatus according to claim 4, wherein there are provided a roof wall in said upper chamber above said upper reach of said endless screen, hinge means provided at the lower end of said upper chamber above the entrance of said endless screen into the latter, said roof wall being pivotally mounted at its lower edge on said hinge means, and roof adjusting means provided at the upper end of said upper chamber for rotating said roof wall about said hinge means, thereby varying the distance of the upper end of said roof wall from said upper reach of said endless screen.

10. An apparatus according to claim 4, wherein said inlet means are provided at the lower portion of said upper chamber, and wherein said control means comprise a weir tank for controlling the level of the suspension in said upper chamber.

11. An apparatus according to claim 10, wherein said control means comprise level adjusting means mounted inside said weir tank for changing the height of the suspension level therein.

12. An apparatus according to claim 4, wherein said outlet means are provided at the lower portion of said lower chamber, and wherein said control means comprise an adjusting means for regulating the drainage water level inside said lower chamber.

13. An apparatus according to claim 12, wherein said adjusting means is a weir tank with exchangeable weir boards of different height.

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