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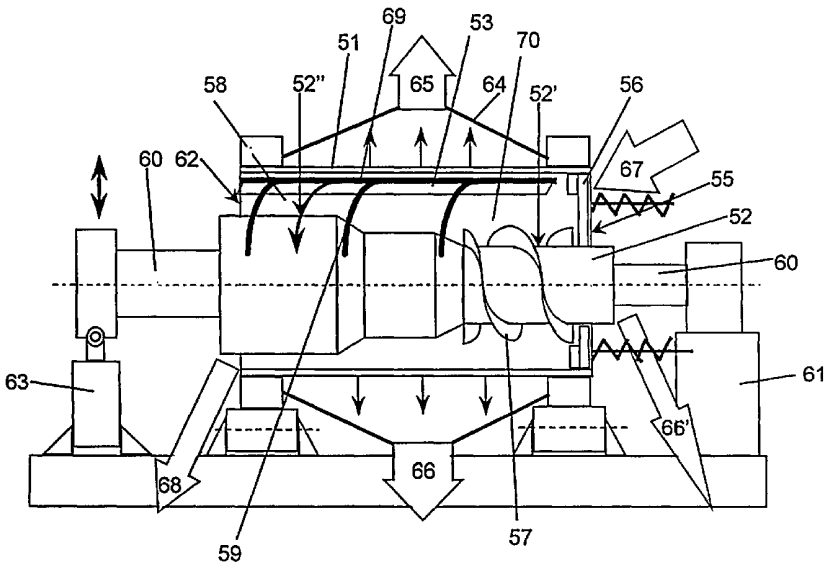
(54) **Title:** APPARATUS FOR TREATING PULP AND ITS USE



(57) **Abstract:** The present invention relates to a novel type of press apparatus for pressing/thickening pulp and the use thereof. A characterizing feature of an apparatus according to the invention is that a roll (52) arranged inside a drum (51) is divided into several parts so that at least two parts of the roll (52) are provided with means for arranging different rotational speeds for the parts, when necessary. According to the invention, the apparatus can also comprise control wings (57) attached to the initial part (52') of the roll to rotate with the roll (52), closure wings (59) arranged in the upper space (58) of the press and a shell (64) arranged outside the drum (51) for discharging vapor (65) and the filtrate (66) removed from the pulp through the drum (51) from the apparatus. The apparatus according to the invention is suitable for use as a press/thickener and washer in the pulp and paper industry.

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APPARATUS FOR TREATING PULP AND ITS USE

The present invention relates to an apparatus for treating pulp and the its use. More closely, the invention relates to a press apparatus. The apparatus according to the invention is particularly suitable for treating various pulping industry fiber suspensions and other such suspensions. According to an advantageous embodiment of the invention, the apparatus can be used for thickening chemical, chemi-mechanical and mechanical pulp as well as recycled fiber pulp and for thickening mixtures thereof mainly by pressing. In some instances it is also possible to use the apparatus according to the invention for washing said pulps.

There are a number of different prior art press apparatuses, in which pulp and paper industry fiber suspension, so-called pulp, can be treated in high consistency or in which the pulps can at least be thickened to high consistency.

At present, most of these apparatuses are dual-roll presses. An example of a prior art dual-roll press is the press apparatus as described in WO 95/10658, shown in fig. 1a. In a dual-roll press according to WO 95/10658 two drums have been arranged side by side, and so-called narrowing slots have been arranged at the lower part of the drums between the surface of the drum and the lower part of the vat, the slots narrowing in the rotational direction of the drum. In such an apparatus, liquid is first pressed from the pulp through the lower part of the vat and/or the drum at the narrowing slot arranged in the lower part of the drum, subsequent to which the pulp is conveyed through the so-called roll nip and more liquid is pressed from the pulp into the drum or drums.

There are, however, some disadvantages with the use of a dual-roll press. A significant disadvantage is that fluctuations in the amount and consistency of the feed flow are reflected in the pulp discharged from the apparatus. Another disadvantage is that the apparatus can only produce a single-stage press at the roll nip. A significant disadvantage of the apparatus is that as the pulp advances in the narrowing slot, its movement in the slot is slowed down due to the friction that increases as the slot decreases. Since the movement of the layer of pulp along the solid surface below the drum slows down due to the increasing friction caused by the decreasing distance between the solid surface and the surface of the drum, and the drum turning on the other side of the layer of pulp still

transports the layer of pulp towards the roll nip, the pulp being transported from the slot towards the roll nip is transported to the roll nip in small pieces as the layer of pulp is torn in the narrowing gap, for example inside the layer of pulp in the direction of the movement, diagonally in relation to the movement of the pulp inside the layer of pulp or transversely in relation to the movement of the pulp. Another significant disadvantage of the dual-roll press is that the filtering wire used on the drum of a dual-roll press is prone to wear since the layer of pulp is removed from the surface of the drum with a scraper. In addition to this, the above-mentioned press type cannot be used for pressing low-consistency pulp, since this kind of pulp does not fasten on the surface of the roll, whereby the pulp will not be transported to the nip between the rolls.

Another previously known apparatus construction is the dual-roll press having an adjustable pressure shoe as shown in figure 1b. This press apparatus is described, for example, in patent publication SU 589315. This type of apparatus operates on the principle that the distance between drum and the pressure shoe arranged within a distance from the drum decreases in the rotational direction of the drum and that the distance between the drum and the pressure shoe can be adjusted, when necessary. The liquid is first removed by pressure in the narrowing space between the shoe and the drum to the inside of the drum and/or through the pressure shoe, and in the case of a dual-roll press, in the roll nip between the drums also inside the drum or drums. In figure 1b the adjustable pressure shoe has been arranged in a dual-roll press, but this kind of pressure shoe can also be installed in a single-drum press.

The press having this kind of adjustable pressure shoe incorporates the same significant disadvantages as the dual-roll press shown in figure 1a.

An example of a third prior art solution is the drum press as shown in patent application FI 864068, also shown in figure 1c, which consists of a perforated drum and a cylindrical roll, arranged eccentrically inside the perforated drum. The drum and roll are arranged to rotate in the same direction. The material to be pressed is fed into the apparatus from one end of the drum in the upper part thereof, above the roll. The material to be pressed rotates several revolution times inside the drum and it is pressed between the roll and the drum in the

lower part of the drum. The liquid is pressed down through the holes in the drum and the pressed material drops down at the lower end of the drum.

A significant disadvantage of this type of apparatus is that in such an apparatus the axial movement of the pulp suspension is totally uncontrollable. In the apparatus, the fluctuation in the amount and consistency of the pulp is "reflected" in the pulp discharged from the apparatus. In addition to this, the amount and consistency of the pulp discharged from the apparatus can greatly fluctuate even if the volume and/or consistency of the feed flow remains constant. The reason for this is that as the axial movement of the pulp inside the apparatus is uncontrolled and uneven, the layer of pulp arriving to the pressing stage is very uneven, whereby the volume and/or consistency of the pulp discharged from the apparatus can easily change, even if the volume and/or consistency of the feed flow remains constant. Further, this type of apparatus cannot be used for treating low-consistency pulp.

The apparatus as described in patent FI 90422 and publication WO 9410373 that has recently been introduced to the market, has brought about some improvements. This apparatus consists of a rotating drum having a rotating press roll arranged eccentrically inside it, as shown in figure 1d. The drum and roll are arranged so as to rotate in the same direction. Preferably both the drum and the roll are perforated. The holes in the drum and roll can be round, oval or slot-like; in practice, almost any shape can be used. The pulp to be treated is fed inside the apparatus in the desired consistency. Experiments have shown that the feed consistency can greatly vary. For example, the feed consistency can vary from 1% to 8%. A roll nip, long in comparison to dual-roll presses, is formed between the drum and the roll, and the consistency in the nip increases to about from 20% to 45%. A fixed control baffle system formed by pieces of screw flights has been arranged between the roll and the drum, above the roll, to direct the movement of the pulp forward. The last control baffle will push the pulp away from the apparatus as well. If needed, the discharge of the pulp can be limited by means of a fixed or adjustable discharge closure plate. Also, the patent publication FI 101607 B discloses a press apparatus having a fixed control wing system, in which the wings are attached to a scraper arranged near the surface of the drum, so that the scraper removes the thickened pulp from the surface of the rotating drum.

Press apparatuses as described in patent publication FI 904222 and FI 101607 B feature a more controlled axial movement of the pulp than the apparatuses shown in figures 1a - 1c. An apparatus as described in WO 9410373 is capable of treating low-consistency pulps and it can even be utilized in displacement washing. The problem with the apparatuses described in the publications is nevertheless that the apparatuses are unable to produce a pulp of constant consistency, if the volume or consistency of the feed flow fluctuates. Another significant disadvantage of the apparatuses is that in the apparatus the pulp flow is broken down to separate floes due to friction between the fixed control baffles and the pulp path and the friction between the end plate and the pulp path.

The patent application FI 954892 and a corresponding Canadian patent application 2187595 disclose the drum press solution shown in figure 1e, in which the diameter of a press roll arranged eccentrically inside a drum increases either continuously or stepwise from the feed end of the apparatus towards the discharge end of the apparatus. The drum and the roll are arranged to rotate in the same direction. As an alternative, the publication also describes a structure using a conical drum or roll for reducing the distance between the drum and the roll from the feed end towards the discharge end. In this solution the distance between the drum and the roll is also adjustable. Further, the distance of the feed end and the discharge end of the roll from the drum can be adjusted independently of each other.

In a solution according to the patent application FI 954892 the layer of material between the roll and the drum at the feed end can be relatively thick in comparison to the layer of material at the discharge end, whereby even a large inlet volume can be pressed to a high solids content. In other words, this solution provides for smoothing the fluctuations of feed flow volume so that the consistency of pulp discharged from the press stays almost constant. The problem in this apparatus, however, is the uncontrolled axial movement of the pulp. Further, the pulp to be thickened is very prone to matting at the feed end of the apparatus, because here the proportion of the roll diameter to the drum diameter is at its smallest and the mobility of the pulp is at its worst.

The press apparatus according to the present invention solves, among others, the problems relating to the axial movement of pulp, the problems with the fluctuations of feed volume and consistency and the problems of matting of the pulp.

The invention is based on the principle that the roll arranged inside the drum is divided to a number of parts so that at least two of the parts of the roll have means for maintaining different rotational speeds for the pieces, when necessary. According to the invention, the front part of the roll can incorporate control wings arranged to rotate with the roll for transporting the pulp to the pressing part of the roll. In addition to this, at least the initial thickening space, advantageously the roll, can be provided with vibrating mechanical/electrical impulse sensors for keeping the pulp in a mobile state. According to the invention, the upper space of the apparatus can be provided with so-called upper space closure wings. The closure wings can advantageously be attached to the frame of the scraper. According to the invention, the apparatus can be provided with an external shell arranged outside drum for removing the vapors and filtrate extracted from the pulp through the drum from the apparatus. The shell can be fastened to the drum so that it rotates with the drum or the shell can be fastened statically to the frame of the apparatus, outside the drum.

The press apparatus according to the invention brings about, among others, the following advantages:

- As the roll is divided into several pieces so that at least two parts have means for arranging different rotational speeds for these parts, for example the end and central parts of the roll can be run with different speeds. This can be used for improving the axial and circumferential movement of the pulp, increasing the mobility of the pulp by turbulence, i.e. reducing the matting of the pulp at the inlet end of the roll, and for eliminating the influence of the fluctuations in the volume and consistency of the pulp inlet flow in the apparatus by, for example, changing the retention time of the pulp.
- If the initial part of the roll is provided with control wings that rotate with the roll, the axial movement of the pulp is more controlled and the mobility of the pulp on the initial part of the roll can be improved.

- In addition to the control wings, impulse sensors can be used for enhancing the mobility of the pulp along the inlet end of the apparatus.
- The upper space closure wings, if any, of the apparatus enable the movement of the layer of pulp to be controlled so that the layer of pulp traverses the whole length of the roll near the surface of the roll, independently of the diameter of the roll and the drum. The closure wings also enable the incoming pulp flow to be directed near the roll at the initial part of the roll and, at later point along the roll, to between the roll and the layer of pulp formed adjacent the roll.
- Controlling the fluctuations in the consistency and volume of the pulp flow is unproblematic and the changes in the consistency and volume of incoming are not reflected in the pulp discharged from the press.
- If there is a shell outside the drum for discharging vapor and filtrate removed from the pulp through the drum, discharging the vapor and filtrate removed from the pulp is controlled.
- The apparatus will also function with low inlet consistencies.
- The apparatus can also be used for washing.
- The apparatus is not prone to clogging, because when the pulp reaches the discharge end of the apparatus - where the pressing force against drum is greatest - it will already be in such a high consistency that the fibers have caught on each other and the pulp will not clog the holes of the drum or roll.

The characterizing features of the present invention will become clear from the appended claims.

In the following, prior art is explained with reference to the following figures 1a - 1e. In the following, the prior art solutions and the apparatus according to the present invention are disclosed in more detail with reference to the appended figures, of which

Figure 1a illustrates a prior art apparatus

Figure 1b illustrates another prior art apparatus

Figure 1c illustrates a third prior art apparatus

Figure 1d illustrates a fourth prior art apparatus

Figure 1e illustrates a fifth prior art apparatus

Figure 2a illustrates an advantageous embodiment of an apparatus according to the invention in side elevation view and

Figure 2b illustrates the apparatus of figure 2a seen from the discharge end of the apparatus.

As shown in figure 1a (patent publication WO 95/10658), a prior art dual-roll press comprises two filtering drums 1 arranged to rotate in opposing directions, a vat 2, inlet conduits 3 for the pulp to be pressed arranged in vat 2 and cleaning scrapers 4 for the drums 1. In a dual-roll press the two drums 1 are arranged side by side so that so-called narrowing slots 6 are formed between the surface of the drum 1 and the lower part 5 of the vessel, the slots narrowing in the rotational direction of the drum so that a roll nip 7 is formed between the drum 1. The pulp to be pressed is introduced in the vat 2 via the inlet conduits 3, subsequent to which the pulp is first transferred through the narrowing slot 6 and then through the roll nip 7 between the drums 1. Thus, liquid is pressed from the pulp first through the drums 1 and/or through the lower part 5 of the vessel, and after this liquid is further pressed from the pulp in the roll nip 7 to the inside of the drum or drums 1. The pulp pressed on the surface of the drums 1 is removed from the surface by means of cleaning scrapers 4 and then discharged from the press.

However, this type of dual-roll press has some significant disadvantages. A significant disadvantage is that fluctuations in the volume/consistency of the feed flow are reflected in the pulp discharged from the apparatus, i.e. the apparatus cannot produce a pulp flow with a constant volume and consistency, if the volume/consistency of the feed flow fluctuates. Another disadvantage of the apparatus is that the apparatus can only produce a single-stage press at the nip. A very significant disadvantage of the apparatus is that as the pulp moves in the narrowing slot, the movement is slowed down due to the friction that increases as the slot decreases. As the movement of the layer of pulp along the solid surface under the drum is slowed down due to increasing friction when the distance between the solid surface and the surface of the drum decreases and the drum rotating on the other side of the layer of pulp still tends to transport the layer of pulp towards the roll nip, the result is that the pulp being transported from the slot to the roll nip is transported there in small pieces, because the layer of pulp breaks, for example, in the direction of the movement of the pulp

inside the layer of pulp, diagonally inside the layer of pulp or transversely in relation to the movement of the pulp. Another significant disadvantage of the dual-roll press is that the filtering wire located above the drum used in dual-roll presses is prone to wear when removing the layer of pulp from the surface of the drum by means of a scraper. Further, the press type described above is not suitable for pressing the low-consistency pulp, because this kind of pulp does not "stick" on the surface of the roll and is thus not transported to the roll nip between the rolls.

Figure 1b (patent publication SU 589315) discloses another prior art apparatus construction, which, in the case of figure 1b, comprises two drums 11, a vessel 12, pulp inlet conduits 13 arranged in the vessel 12, cleaning scrapers 14 for the drums 11, a pressed pulp discharge conduit 15, filtrate discharge conduits 16 and in this case, two adjustable filtering pressure shoes 17 and a pressure shoe 17 adjustment system 18. In the apparatus, both the pressure shoes 17 and the drums can be perforated. The pulp to be pressed is introduced into the apparatus via conduits 13. The rotation of the drums 11 conveys the pulp to between the pressure shoes 17 and the drums 11 and further to the roll nip 19 between the drums 11. The pulp accumulated on the surfaces of the drums 11 is removed therefrom by means of the cleaning scrapers 14 and discharged from the apparatus via conduit 15. Such an apparatus operates on the principle that the distance of the pressure shoe 17, arranged within a distance from the drum 11, decreases in the rotational direction of the drum 11 and that the distance between the pressure shoe 17 and the drum 11 can be adjusted, when necessary. Thus, liquid is first pressed from the pulp in the narrowing slot between the pressure shoe 17 and the drum 11, after which liquid is still pressed in the roll nip 19 between the drums. In the figure 1b used as an example, the pressure shoe 17 is arranged in a dual-roll press, but the pressure shoe can also be arranged in a single-drum press.

However, this kind of dual-roll press and/or single-roll press having an adjustable pressure shoe includes some of the significant disadvantages of the dual-roll press shown in figure 1a.

The drum press shown in figure 1c (patent application FI 864086) comprises a drum 21, a cylindrical roll 22 arranged eccentrically within the drum and an inlet conduit 23 for the incoming material arranged at the end of the drum 21. The drum 21 and roll 22 are arranged to rotate in the same direction. In the apparatus, the material to be pressed is introduced in the apparatus from the upper part of one end of the drum 21, over the roll 22, by means of a screw conveyor 24. The material to be pressed is pressed in the lower portion of the drum, between the drum 21 and the roll 22. The liquid is pressed down through the holes in the drum 21 and the pressed material 25 falls down from the lower end of the drum 21.

A significant disadvantage of such an apparatus is that the axial movement of the pulp is totally uncontrolled. Naturally, any fluctuations in the volume/consistency of the feed flow are "reflected" in the pulp discharged from the apparatus. The volume and/or consistency of the pulp discharged from the apparatus can also vary greatly, even if the volume and/or consistency of the feed flow remains constant. A reason for this is that as the axial movement of the pulp is difficult to control and uneven, the layer of pulp introduced into the pressing stage is very uneven, whereby the volume and/or consistency of the pulp discharged from the apparatus easily changes, even if the volume and/or consistency of the feed flow remains stable. This type of apparatus cannot be used for treating low-consistency pulp, either.

Figure 1d discloses an apparatus according to FI patent 90442 and publication WO 94/10373, which has just been introduced to the market. This apparatus is primarily intended for washing the pulp, but it can be used for pressing pulp as well. As disclosed in figure 1d, the apparatus comprises a rotatingly arranged drum 31, a roll 32 arranged eccentrically inside the drum 31 to rotate in the same direction as the drum, a fixed liquid inlet means 33, a fixed control baffle system 34 formed by pieces of screw flights, a closure plate 35 arranged at one end of the drum 31 and a pulp feed conduit 36 attached thereto. In practice, it is easiest to attach the control baffle system 34 to the liquid inlet means 33, whereby they form one solid unit. Preferably both the drum 31 and the roll 32 are perforated. The holes in the drum 31 and roll 32 can be round, oval or slot-like; in practice, almost any shape can be used. The pulp to be treated is fed into the apparatus at

one end of the drum 31 via conduit 36 in the desired consistency. Experiments have shown that the feed consistency can greatly vary. For example, the feed consistency can vary from 1% to 8%. A roll nip, long in comparison to dual-roll presses, is formed between the drum 31 and the roll 32, and the consistency in the nip increases to about from 20% to 45%. The fixed control baffle system 34 arranged between the roll 32 and the drum 32, above the roll 32, is used for steering the movement of the pulp forward as the pulp rotates with roll 32. The last control baffle 34 will push the pulp away from the apparatus as well. If needed, the discharge of the pulp from the drum 31 can be limited by means of a fixed or adjustable discharge closure plate 37.

In an apparatus according to figure 1d the axial movement of the pulp is more controlled than in the apparatuses according to figures 1a - 1c. The apparatus is suitable for treating low-consistency pulps, and it is also suitable for displacement washing. The main problem of the apparatus is, however, that it cannot be used for producing pulp with a constant consistency, if the volume/consistency of the feed flow fluctuates. Another significant problem with the apparatus is that the pulp path is disintegrated into floes due to the friction between the control baffles and the pulp path and the friction between the end plate and the pulp path.

Figure 1e discloses a drum press solution according to the patent application FI 954892 and its corresponding Canadian patent application 2187595. The main components of this type of drum press are the rotatingly arranged perforated drum 41, a press roll 42 arranged eccentrically inside the drum 41 to rotate in the same direction. The roll 42 can also be perforated. The press roll 42 can be incremental as shown in figure 1e, so that the diameter of the roll increases from the inlet end 43 of the apparatus towards its discharge end 44, or the roll can alternatively be a cone, the diameter of which increases from the inlet end of the apparatus towards its discharge end. In addition to this, the publication also discloses a conical structure of the drum or the roll, which will correspondingly decrease the distance between the drum and the roll from the inlet end to the discharge end. In this solution, the distance between the drum and the roll is adjustable. Further, the distance of the inlet end of the roll from the drum and the discharge end of the roll from the drum can be adjusted independently of each other. The material to be pressed is introduced into the inlet side 43

of the drum, wherefrom it rotates in the drum, being pressed several times between the roll 42 and the drum 41. The pressed pulp is discharged from the discharge end 44 of the press, the filtrate is discharged outside the drum 41 or, if the press roll 42 is perforated as well, filtrate can be removed from the inside of the press roll 42.

In a solution disclosed in figure 1e, the layer of material 45 between the press roll 42 and the drum 41 can be quite thick at the inlet side 43 of the drum compared to the discharge end, whereby even a high feed volume can be pressed to a high solids content. In other words, in this solution the fluctuations in the feed flow can be compensated so that the consistency of the discharged pulp stays almost constant. A problem with this apparatus is, however, the uncontrolled movement of the pulp in axial direction. Also, the pulp to be thickened is very prone to matting at the feed end of the apparatus, because here the proportion of the diameter of the roll to the diameter of the drum is at its smallest and the mobility of the pulp is at its weakest.

Figure 2a is side elevation view of an advantageous embodiment of an apparatus according to the invention, while figure 2b is a view of the apparatus as seen from the discharge end. The main components of an apparatus according to the invention are a rotatingly arranged cylindrical drum 51, a roll 52 arranged eccentrically so as to rotate inside the drum 51, a scraper 53 for removing the layer of pulp 54 accumulated on the surface of the drum 51 and an end plate 56 with its seals arranged at the inlet end 55. According to the invention, the roll 52 is divided into several parts so that at least two parts of the roll 52, for example the initial part 52' and the end part 52", are provided with means for arranging different rotational speeds for the said parts. According to the invention, it is possible to attach control wings 57 to the initial part 52' of the roll so that they rotate together with the roll, and the upper space 58 of the apparatus can be provided with so-called upper-space closure wings 59. The press can have perforations either only on the drum 51 or on both the drum 51 and the roll 52. According to an advantageous embodiment of the invention, the shaft 60 of the roll can be fixedly 61 supported at the inlet end 55, and the discharge end 62 of the roll can be provided with a hydraulic cylinder 63 for adjusting the height of the discharge end 62. According to another advantageous embodiment the apparatus can have an external shell 64 arranged outside the drum 51 for removing vapor 65 and the filtrate 66

removed from the pulp through the drum 51 from the apparatus. The pulp 67 is introduced into a press apparatus according to the invention via the upper part of the end plate 56. From the inlet end 55 the pulp is transported towards the end part 52" of the roll, assisted by the control wings 57. In the roll, most of the water contained by the pulp is removed before the pulp arrives on the final part 52" of the roll. The filtrate 66 removed from the pulp through the drum 51 is discharged from the apparatus via shell 64 and conduits attached thereto. If the roll 52 is perforated as well, filtrate 66 is removed through the roll 52 as well. The pressed layer of pulp 54 accumulated on the inner surface of the drum 51 is removed by means of a fixed scraper 53 so that the scraper 53 dislodges the layer of pulp 54 on the roll 52 and turns the pressed pulp 68 down at the discharge end 62.

According to the invention, the roll 52 in the apparatus shown in figure 2a could as well be one in which the initial part 52' of the roll is a cone extending towards the discharge end 62 and the end part 52" of the roll is cylindrical. In other words, the shapes of the various parts of the roll 52 can vary. The roll 52 could just as well be arranged significantly higher at the inlet end 55 than at the discharge end 62, whereby the roll 52 could be formed by two differently sized cylinders. On the other hand, the apparatus could also be one in which the diameter of the drum 51 is not constant and the diameter of the roll 52 remains constant. In a press as shown in figures 2a and 2b the sizes of the different increments of the roll 52 and also the proportion of the initial part 52' of the roll to the total length 52 and the proportion of the diameter of the end part 52" of the roll to the diameter of the drum 51 depend on the properties of the pulp to be treated.

The control wings 57 attached to the central part 52' of the roll according to the invention can be, e.g., flights of screws, parts of flights of screws, blades or other kinds of control baffles. The control wings 57 can be hollow, and their surface, similarly to the surface on which the control wings 57 are attached (for example, when the control wings 57 are flights of screws, the axis of the screw), can be water-permeable surfaces, i.e. so-called thickening surfaces. The above-mentioned control wings 57 can naturally be used in the roll 52 of the press even if the roll 52 were divided in parts.

In an apparatus according to the invention the upper space 58 can be provided with so-called upper space closure wings 59. The closure wings 59 can advantageously be attached, for example, to the frame 69 of the scraper. The closure wings 59 arranged in the upper space 58 control the movement of the layer 54 of the pulp forming on the surface of the roll 52 so that the layer 54 of pulp moves near the surface of the roll 52 for the whole length of the roll 52 regardless of the diameter of the roll 52 and the diameter of the drum 51. The closure wings 59 can be used for controlling the feed flow of pulp suspension 67 at the initial part of the roll 52 to near the surface of the roll 52, and at a later stage along the roll 52, for directing the pulp to between the layer 54 of pulp formed near the roll 52 and the roll 52. The height of the closure wings 59 must be chosen so that the space between them and the surface of the roll 52 cannot be clogged during operation as a result of, for example, too thick a layer of pulp. The length of the wings 59 must be chosen so that the area formed by the wings 59 does not increase too much in proportion to the total are remaining between the drum 51 and the roll 52.

In an apparatus according to the invention the drum 51 and roll 52 and/or the various parts of the roll 52 can be arranged to rotate in a number of ways. In the apparatus, the drum 51 and the various parts of the roll 52 can have dedicated motors. On the other hand, the apparatus can also be constructed in such a way that it only comprises one motor rotating both the drum 51 and the various parts of the roll 52, whereby the change of rotational speed to suit the drum 51 and the various parts of the roll 52 can be accomplished by means of, for example, transmissions. Naturally, the number of motors in the apparatus can be such that all parts, such as drum 51 and the various parts of the roll 52, do not have their own motor, but the number of motors still is more than one. For example, the drum 51 and the roll 52 can have dedicated motors, whereby the rotational speed to suit the various parts of the roll 52 can be changed by means of a transmission.

An apparatus according to the invention can be provided with, for example, a shell 64 arranged externally of the drum 51 for discharging vapor 65 and filtrate 66 removed from the pulp through the drum 51 from the apparatus. The shell 64 can be attached to the drum 51 so that it rotates with the drum 51 or the shell 64 can be attached statically around the drum 51 to the frame of the apparatus.

In this kind of a press apparatus having a roll 52 divided in several parts so, that at least two parts of the roll 52 have means for arranging different rotational speeds for these parts, the initial 52' and end 52" parts, for example, of the rolls 52 can be run with different rotational speeds. This can be used for, e.g. improving the axial and circumferential movement of the pulp, increase the mobility of the pulp by turbulence, i.e. for reducing the matting problems in the initial part of the apparatus and for eliminating the effects the fluctuations in the volume and consistency of the pulp feed flow have on the pulp discharged from the press by changing the pulp retention time. The rotational speed of the end part 52" of the roll is selected so that its circumferential speed is the same as the circumferential speed of the drum 51. Typically, the drum 51 rotates at 5-50 rpm, advantageously at 8-30 rpm. The proportion of the rotational speeds between the initial part 52' of the roll and the end part 52" typically is between 0.5-2, depending on the pulp so that when increasing the axial movement, the proportion of rotational speeds of the initial part 52' of the roll and the end part 52" of the roll is less than one, and when decreasing the axial movement, the proportion of rotational speeds of the initial part 52' of the roll and the end part 52" of the roll is equal to or larger than one. The initial part 52' of the roll can rotate slower, faster or at the same speed as the drum 51.

If the initial part 52' is provided with control wings 57 arranged to rotate with the roll (52) according to the invention the axial and circumferential movement of the pulp can be controlled even better while increasing the mobility of the pulp at the initial part 52' of the roll. The mobility of the pulp at the inlet end of the apparatus can further be enhanced by adding electrical/mechanical impulse sensors in the initial thickening space 70, advantageously by arranging the sensors on the roll 52 so as to vibrate the roll.

If the apparatus is provided with so-called upper space closure wings 59, the closure wings 59 can be used for controlling the movement of the forming layer of pulp 54 so that the layer of pulp 54 traverses the whole length of the roll 52 near the surface of the roll 52 regardless of the diameter of the roll 52 or the diameter of the drum 51. The closure wings 59 can also be used for controlling the pulp suspension 67 feed flow to near the surface of

the roll in the initial part 52' of the roll, and at a later stage along the roll 52, for directing pulp to between the formed layer 54 of pulp and the roll 52.

Additionally, a tubular shaft can be used in the initial part 52' of the roll. The use of a tubular shaft enables conveying heat (such as steam) to the pulp to be pressed, whereby the viscosity of water is lowered as the pulp is heated, thus enhancing releasing of water from the pulp. The use of a tubular shaft will also enable the insertion of water retention decreasing chemicals to the pulp.

In a press apparatus according to the invention, fluctuations in the volume and consistency of the pulp feed flow 67 are easily controlled due to the structure of the roll 52, and the fluctuations in consistency and/or volume of the inlet flow 67 are not reflected in the discharge flow 68 from the apparatus.

If a shell 64 has been arranged externally of the drum 51 for removing vapor 65 and filtrate 66 removed from the apparatus through the drum 51, the removal of vapor 65 and the filtrate 66 removed from the apparatus through the drum 51 is controlled as well. The press apparatus can also be used with low-consistency pulp feed flows. The feed consistency can be between 0.5-12%, advantageously between 4-8%. The discharge consistency is typically 15-40%, advantageously 30-35%. The apparatus can also be used for washing the pulp. In this case, any washing liquid is introduced at the end part of the roll. A press apparatus according to the invention is not prone to clogging, either, as at the end part of the roll (where the pressing force against the drum is at its largest) the pulp is already thickened to the extent that the fibers are fastened to each other and the pulp does not clog the holes in the drum and/or the roll. In our experiments we have noted that up to 80% of the filtrate removed from the pulp can be removed on the first 60% of the length of the roll. The apparatus can is also suitable for pressurized use, whereby the pressure difference across the filtering surfaces together with the pressing force caused by the roll separates water from the pulp. In pressurized use, the feed end 55 of the apparatus must be completely sealed. The discharge end 62, on the other hand, is sealed by the dense pulp plug between the end part 52" of the roll and the drum 51. In addition to this, we have noted in our experiments that the apparatus according to the invention can be

commissioned faster than presently known presses, and that it also uses less energy than the prior art apparatuses.

Even though the figures 2a and 2b disclose only an apparatus according to the invention, in which the rotatably arranged drum is supported only at the ends of the shaft of the drum, the apparatus can also be one in which the drum has been rotatably suspended by a counter-roll and two auxiliary rolls, as disclosed in patent application FI 821858. In such an apparatus the nip force is transmitted directly from the roll to the counter-roll. As in this case no large forces are exerted on the drum, it can be significantly lighter and less robust than in the apparatus disclosed in figures 2a and 2b. This will in turn essentially reduce the cost of the apparatus.

As has previously been mentioned, the apparatus according to the invention can be used in chemical, chemi-mechanical and mechanical pulp industries for thickening pulps and recycled fiber pulp and their mixtures mainly by means of pressing. In addition to this, the apparatus according to the invention can also be used for washing these pulps.

As has become apparent from the above description, a new type of apparatus has been developed for thickening/pressing/washing pulp, the apparatus eliminating many of the disadvantages and shortcomings of prior art apparatuses. Even though the apparatus has in the above been only described with reference to the advantageous embodiment of figures 2a and 2b, it not intended to limit the protective scope of the invention which is disclosed in the appended claims.

WE CLAIM:

1. An apparatus for pressing/thickening pulp, the apparatus comprising a rotatingly arranged at least partly perforated drum (51), a possibly at least partly perforated roll (52) arranged inside the drum (51) to rotate in the same direction as the drum (51), supports for the rotatingly arranged drum (51), supports (61, 63) for the rotatingly arranged roll (52), an end plate (56) complete with seals at the inlet end (55) of the apparatus, inlet conduits for the pulp feed flow (67), discharge conduits for the pressed pulp (68) and filtrate (66, 66') and operating means for the roll (52) and drum (51), **characterized** that the roll (52) is divided in several parts so that at least two parts of the roll (52) are provided with means for arranging different rotational speeds for the parts, if necessary.

2. An apparatus as claimed in claim 1, **characterized** in that control wings (57) are attached to the initial part (52') of the roll so as to rotate with the roll (52).

3. An apparatus as claimed in claim 1 or 2, **characterized** in that at least the pre-thickening space (70) of the apparatus, preferably the roll (52), is provided with mechanical/electrical impulse sensors.

4. An apparatus as claimed in claim 1, 2 or 3, **characterized** in that the upper space (58) of the apparatus is provided with so-called upper space closure wings (59).

5. An apparatus as claimed in any of the preceding claims, **characterized** in that a scraper (53) is arranged inside the drum (51), in the upper space (58) thereof.

6. An apparatus as claimed in claim 5, **characterized** in that the upper space closure wings (59) are preferably attached to the frame (69) of the scraper.

7. An apparatus as claimed in any of the preceding claims, **characterized** in that at least the shaft (60) of the initial part (52') of the roll is a tubular shaft.

8. An apparatus as claimed in claim 7, **characterized** in that heat is introduced into the pulp via the shaft (60).

9. An apparatus as claimed in claim 7, **characterized** in that chemicals are introduced into the material to be pressed via the shaft (60).

10. An apparatus as claimed in claim 9, **characterized** in that the chemicals introduced into the material to be pressed enhance the separation of water from the material.

11. An apparatus as claimed in any of the preceding claims, **characterized** in that a shell (64) is installed outside the drum (51) for discharging vapor (65) and filtrate (66) removed from the pulp through the drum (51) from the apparatus.

12. An apparatus as claimed in claim 11, **characterized** in that the shell (64) is attached to the drum (51) so that it rotates with the drum (51).

13. An apparatus as claimed in claim 11, **characterized** in that the shell (64) is attached statically to the frame of the apparatus to surround the drum (51).

14. An apparatus as claimed in any of the preceding claims, **characterized** in that the proportion of the diameter of the drum (51) and that of the roll (52) is essentially larger at the inlet end (55) of the apparatus than at the discharge end (57) of the apparatus.

15. An apparatus as claimed in claim 14, **characterized** in that the roll (52) is conical or incremental so that the diameter of the roll (52) essentially increases from the inlet end (55) of the apparatus towards the discharge end (62) of the apparatus and the drum (51) is cylindrical.

16. An apparatus as claimed in claim 14, **characterized** in that the diameter of the drum (51) essentially increases from the discharge end (62) to the inlet end (55).

17. An apparatus as claimed in claim 16, **characterized** in that at the inlet end (55) of the apparatus the diameter of the roll (52) is equal to or essentially smaller than that at the discharge end (62) of the apparatus.

18. An apparatus as claimed in any of the preceding claims, **characterized** in that the circumferential speed of the end part (52") of the roll is essentially similar to the circumferential speed of the drum (51) at the discharge end (62) of the apparatus.

19. An apparatus as claimed in any of the preceding claims, **characterized** in that the rotational speed of the drum (51) is 5-50 rpm, preferably between 8-30 rpm.

20. An apparatus as claimed in any of the preceding claims, **characterized** in that the proportion of the rotational speed of the initial part (52') of the roll to the rotational speed of the end part of the roll (52") is between ½-2, preferably between 1-1.5.

21. An apparatus as claimed in any of the preceding claims, **characterized** in that at the inlet end of the apparatus the shaft (60) of the roll (52) is statically supported (61) while the discharge end (62) comprises an adjustment system (63) for adjusting the height of the roll at the discharge end.

22. An apparatus as claimed in claim 21, **characterized** in that the adjustment system (63) is a hydraulic cylinder.

23. An apparatus as claimed in any of the preceding claims, **characterized** in that the consistency of the pulp feed flow (67) is 0.5-12%, preferably between 4-8%.

24. An apparatus as claimed in any of the preceding claims, **characterized** in that the consistency of the pulp discharge flow (68) is 15-40%, preferably between 30-35%.

25. The use of an apparatus according to any of the preceding claims as a press/thickener for paper industry pulps.

26. The use of an apparatus according to any of the preceding claims as a washer for paper industry pulps.

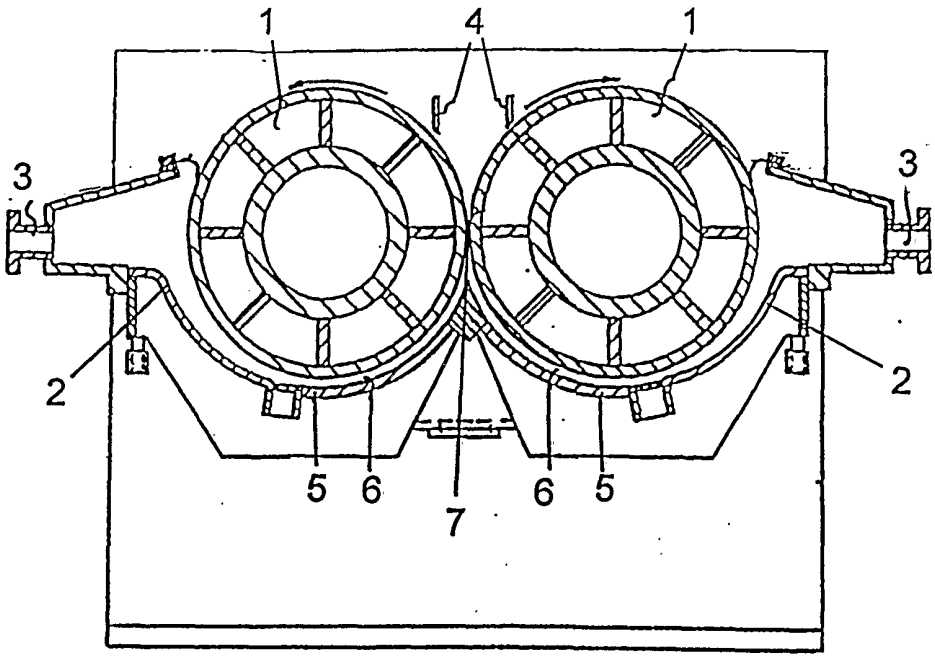

Fig. 1a

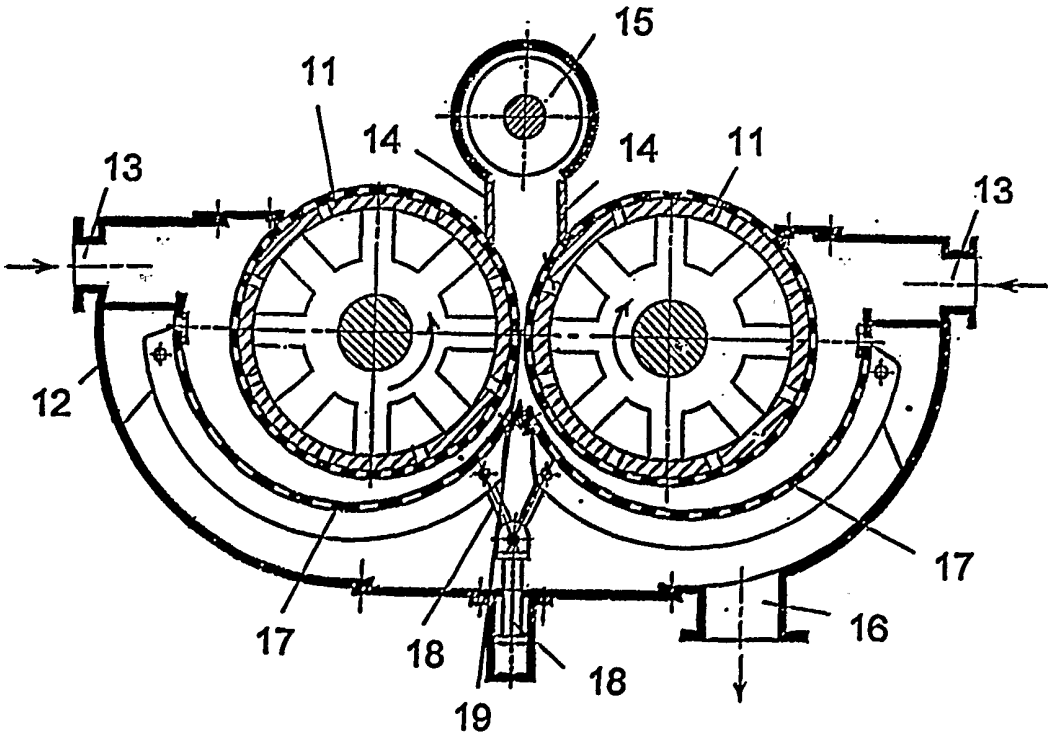

Fig. 1b

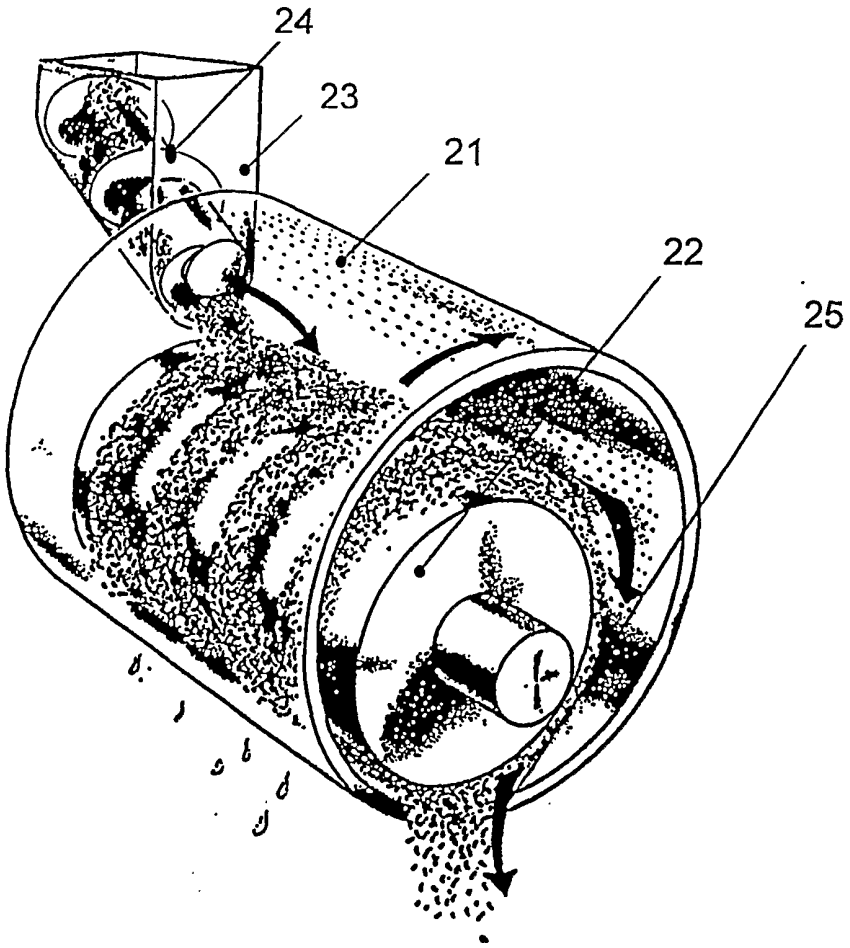

Fig. 1c

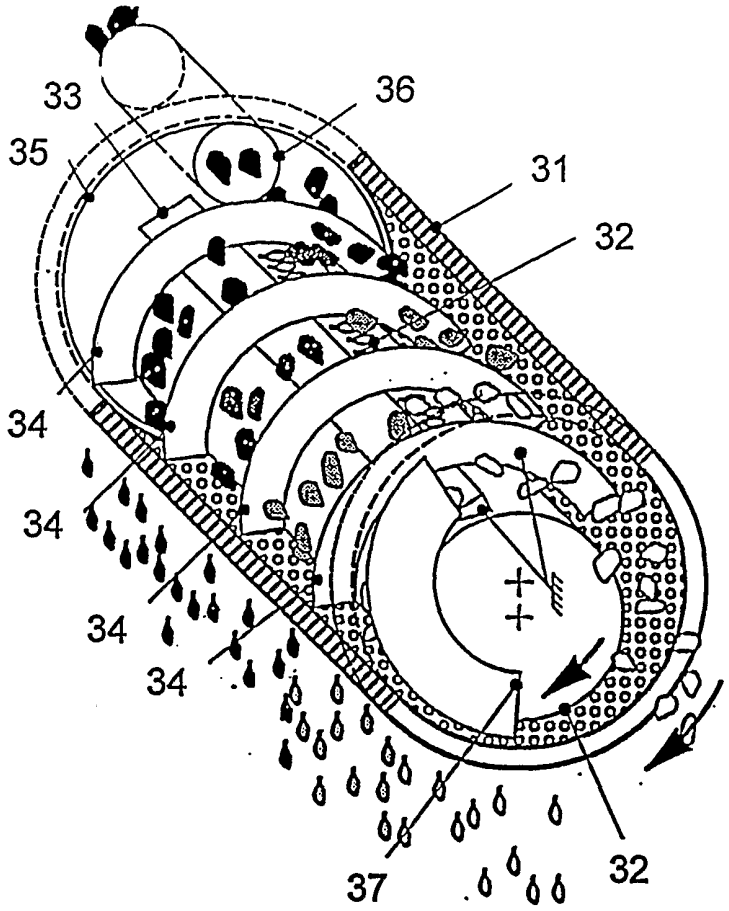

Fig. 1d

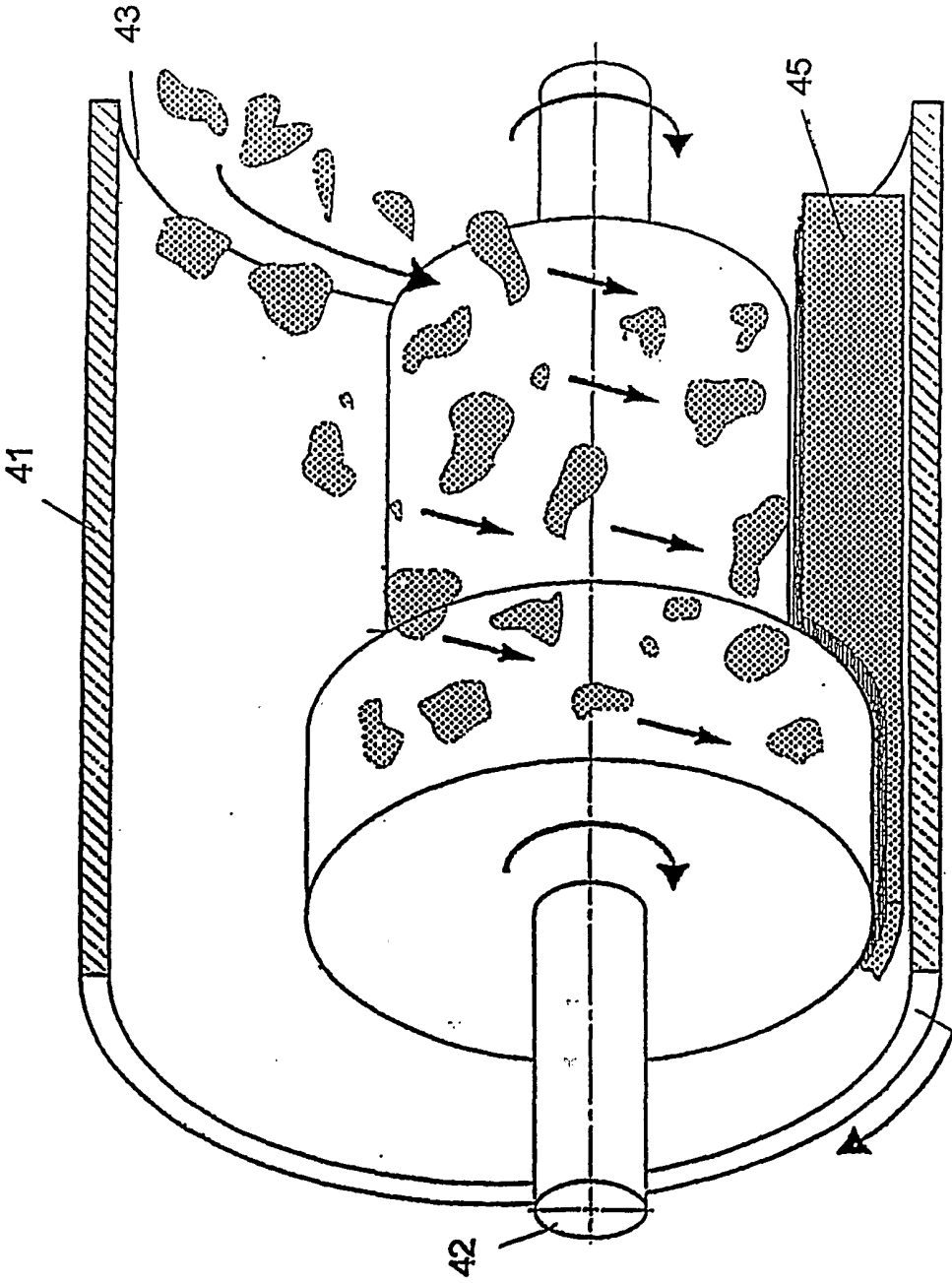

Fig. 1e

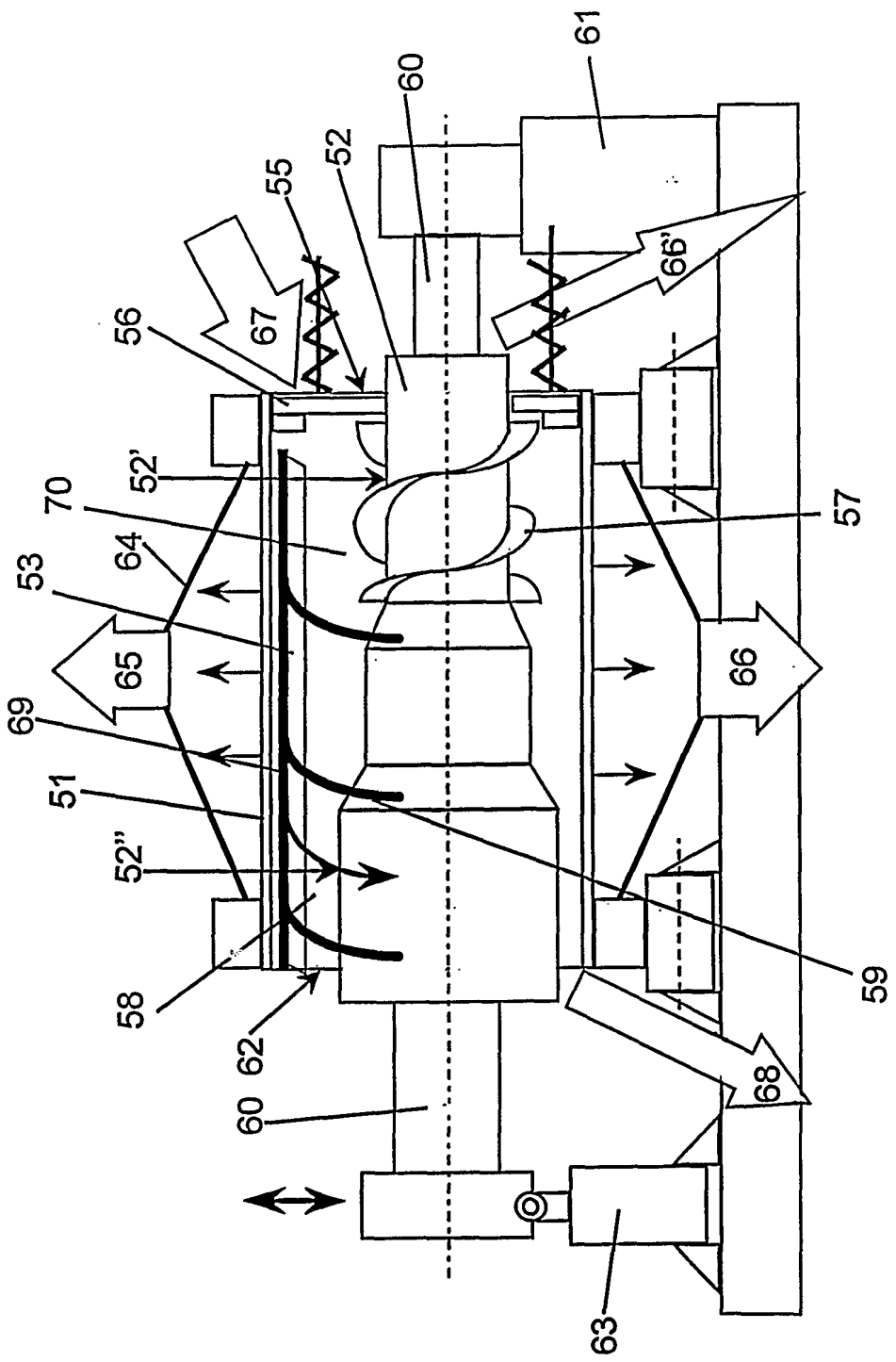

Fig. 2a

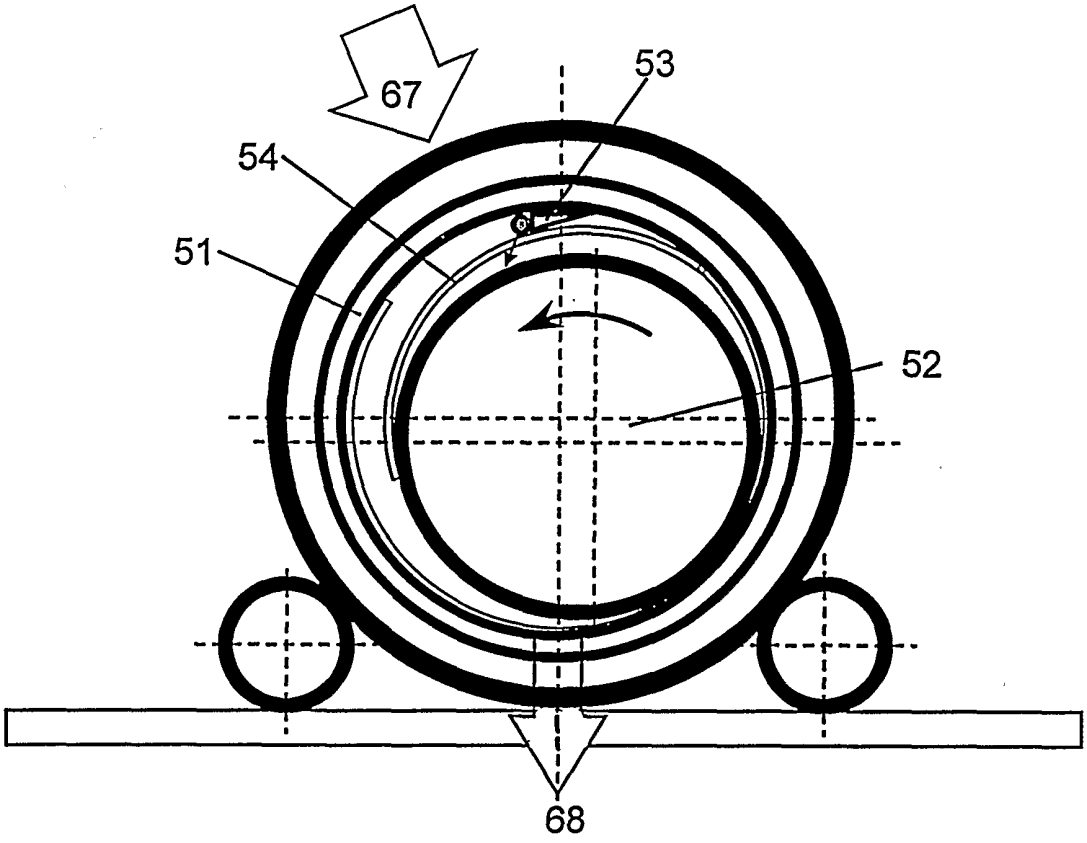

Fig. 2b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/01142

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B30B 9/20, D21C 9/18
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B30B, D21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 8806090 A1 (HEDEMORA AB), 25 August 1988 (25.08.88), page 7, line 4 - page 10, line 31, figure 3 --	1-26
A	WO 9612565 A1 (KVAERNER PULPING TECHNOLOGIES AB), 2 May 1996 (02.05.96), page 4, line 23 - page 9, line 29, figures 1,2 --	1-26
A	WO 9410373 A1 (FINBARK OY), 11 May 1994 (11.05.94), figures 1-3, abstract --	1-26

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"E" earlier application or patent but published on or after the international filing date
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 April 2001	17-04-2001
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Anders Brinkman/MP Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/01142

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SE 9603329-5 A (FINBARK OY ET AL), 14 April 1997 (14.04.97), page 2, line 12 - page 3, line 25, figures 1,2	1-26
A	US 3256808 A (A.J.HUNT), 21 June 1966 (21.06.66), column 4, line 24 - column 5, line 34, figure 3	1-26
A	US 4286512 A (TORSTEN L. BERGGREN), 1 Sept 1981 (01.09.81), figure 1, abstract	1-26
A	US 4368125 A (JAMES D. MURRAY), 11 January 1983 (11.01.83), figures 3,5, abstract	1-26
A	US 5133860 A (LIANG C. TAI ET AL), 28 July 1992 (28.07.92), figure 3, abstract	1-26

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/FI 00/01142

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 8806090 A1	25/08/88	AT 75997 T	15/05/92
		CA 1313472 A	09/02/93
		DE 3871141 A	17/06/92
		EP 0345287 A,B	13/12/89
		FI 93330 B,C	15/12/94
		FI 893856 D	00/00/00
		JP 2502171 T	19/07/90
		JP 2524634 B	14/08/96
		SE 456149 B,C	12/09/88
		SE 8700658 D	00/00/00
		US 4997578 A	05/03/91
WO 9612565 A1	02/05/96	AU 3818695 A	15/05/96
		SE 503504 C	24/06/96
		SE 9403587 A	21/04/96
WO 9410373 A1	11/05/94	AT 164647 T	15/04/98
		AU 5421694 A	24/05/94
		DE 69317794 D,T	30/07/98
		EP 0670927 A,B	13/09/95
		SE 0670927 T3	
		FI 90442 B,C	29/10/93
		FI 924993 D	00/00/00
		NO 306413 B	01/11/99
		NO 951728 A	31/05/95
		RU 2114944 C	10/07/98
		US 5699573 A	23/12/97
SE 9603329-5 A	14/04/97	NONE	
US 3256808 A	21/06/66	NONE	
US 4286512 A	01/09/81	DE 2923646 A	20/12/79
		GB 2027356 A,B	20/02/80
		JP 55005193 A	16/01/80
		SE 421434 B,C	21/12/81
		SE 7806848 A	15/12/79
US 4368125 A	11/01/83	NONE	
US 5133860 A	28/07/92	NONE	