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APPARATUS FOR REMOVING LIQUID FROM A LIQUID PERVIOUS WEB.

This invention relates to apparatus for causing a liquid medium to flow through a moving, fluid-pervious web. Such a web, when in working use, usually moves, in the direction of its length, continuously or sustainedly; and, again when in working use, it is almost invariably in the form of an endless conveyor belt having a top or working flight which may carry a layer of material to be de-liquified.

Thus, the term "web" as used herein is intended to include such a flight plus a layer of material to be treated carried by that flight, or such a working flight, or an idling or return flight, by itself.

In the former case the liquid medium may be water to be extracted from a carried layer of material or some other liquid to be suctionally induced to leave the material and to proceed to and through the working flight for disposal or re-use when it reaches the underside of that flight.

In the latter case, the web may be an idling flight which is simply to be de-watered by sucking or blowing air through it.

In short, the invention is concerned with apparatus to deal with any situation in which a moving, liquid-pervious web, whether it be a singular entity or such an entity in laminated association with some other layer, is required to have a liquid taken from it or transmitted through it either suctionally or under pressure.

The specific problem to the resolving of which the present invention is mainly directed, ^{advices} ~~arise~~ in the de-watering of a water-pervious conveyor belt or "felt" and

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a film-like layer of fibre-reinforced cementitious material, in the form of an aqueous slurry, carried by a working flight of the belt. Because of this, the invention will be described herein largely, and by way of example, in terms of that specific situation.

10 In the production of asbestos-cement articles the usual practice is to prepare a bath of slurry consisting of the required solids and water. A thin, film-like layer of the slurry is picked up on a rotary sieve and from it transferred to the receiving end of the top or working flight of a felt. The felt transfers the layer to a tread roll by which the layer is wound as a scroll on a mandrel or a size roll. When the scroll is of a radial thickness suited to the articles to be made, it is removed and treated further as required.

When the film-like layer arrives on the felt its major ingredient is water, and a substantial fraction of this water has to be removed before the layer reaches the size roll.

20 Hitherto, the common procedure in de-watering the working flight of a moving felt is to run the felt over one or more suction boxes. These each consist of an open-top box-like structure whereof the width is substantially equal to that of the felt. An exhausting pump leads from the suction box and on operation it induces water in the felt, and that in any layer of material which may be travelling on it, into the suction box.

It will be clear that the larger the suction box and or the greater the vacuous suction applied to it, the more

efficiently will water be removed from the item or items to be de-watered. Obviously, the width of the suction box is more or less settled by the necessity for it to be of substantially the same width as the travelling web. Thus any increase in its size has to be by increasing its length, but there are limitations in doing that, since the bigger the box the more is the web drawn to sag into it, and this results in additional friction on the underside of the felt as it negotiates the box.

10 Examples of existing suction boxes are respectively illustrated in Figs. 1 and 2 of the ^{accompanying} drawings herewith. These figures are more or less schematic and each of them is a cross-section through a common suction box.

Referring to Fig. 1, the suction box 18 has an outlet 19 leading to a vacuum pump. The box has an open-top rimmed by a flange 20. A felt 21, either with or without a layer of material to be treated carried on it, is supported on free-running rollers 22 in an endeavour to lessen the frictional restraint imposed on the motion of the felt by reason of it riding on all of the rim-flanges 20.

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The use of rollers such as 22 prevents undue sagging of the felt but they are objectionable in use because even with them the degree of friction is still considerable and the rollers 22 tend to pick up sludge particles and deposit them on the underside of the felt.

The suction box 23 shown in Fig. 2 is virtually the same as that shown in Fig. 1 except in its provision of stationary bars 24 instead of rollers such as those ^{indicated} ~~marked~~ 22 in Fig. 1. The bars 24 have rounded front edges 25 which

remove both sludge and water without re-deposit of the sludge on the underside of the felt 26. Thus, although, in that respect the suction box of Fig. 2 improves upon that shown in Fig. 1, it does so at the expense of increasing the frictional opposition to free movement of the felt.

Because of the ^{disadvantages} ~~disabilities~~ of existing suction boxes as referred to above, they have generally been used in the nature of a compromise between the desirability of removing as much water as possible from the felt and the practical inhibition against doing so due to frictional loading on the felt while it is travelling. Thus, hitherto, to avoid prohibitive frictional restraint, less than a desired amount of water is extracted from the web during its travel. Some of the remaining water is squeezed out of the web by the tread roll, but even so a good deal more water goes into the formation of the product scroll than the amount just necessary to fulfil the chemical and physical requirements of curing the cementitious ingredient thereof.

According to the present invention there is provided apparatus for causing a liquid to flow from a moving liquid-pervious web, comprising a substantially closed chamber consisting of side walls defined by parallel rotatable rolls, and at least one portion of said web running in contact with said rolls, and end walls defined by a pair of end closure members contoured to extend between said rolls and said portion of the web which close the ends of said chamber; and means for maintaining a pressure difference between the inside of said chamber and that side of said web external to said chamber thereby causing liquid in said web to be removed from it.

Some embodiments of the invention will now be described, by way of examples, with reference to Figures 3 to 17 of the accompanying drawings, in which:-

Figure 3 is a sectional end elevation of one form of apparatus according to the present invention,

Figure 4 is a fragmentary sectional side elevation taken on the line 4-4 indicated in Figure 3, the section line 3-3 shown in Figure 4 being that along which Figure 3 is taken,

Figure 5 is a plan of the apparatus of Figures 3 and 4,

Figure 6 is a perspective detail of a closure member illustrated in Figure 3 to 5,

Figure 7 is a fragmentary perspective view of a preferred embodiment of apparatus according to the present invention,

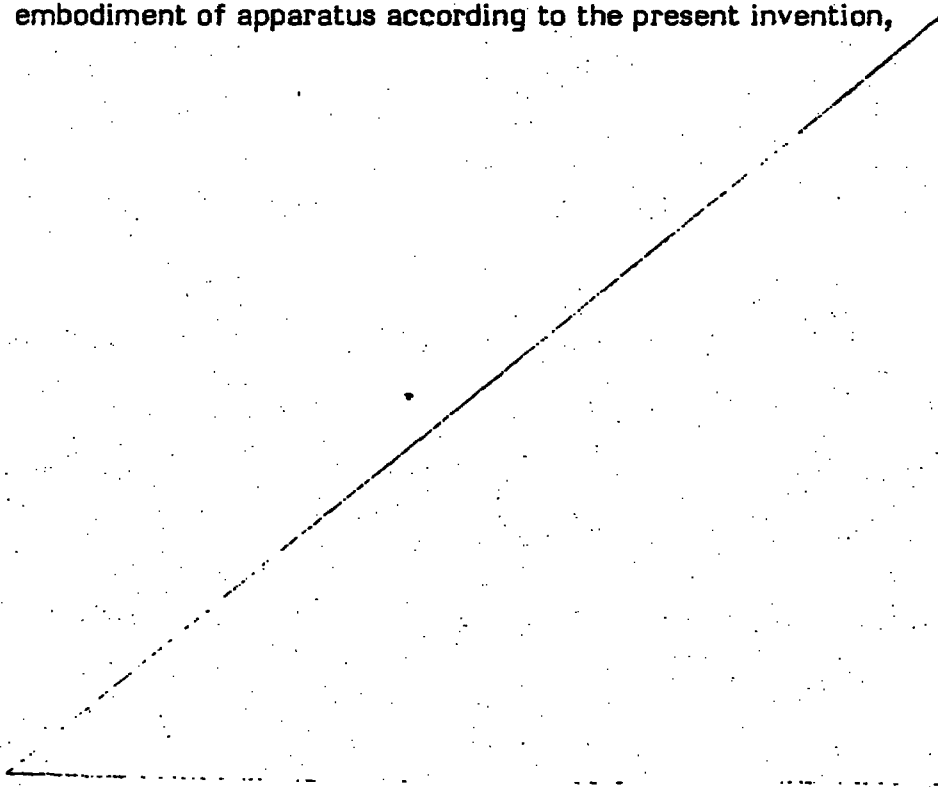


Fig. 8 is an incomplete sectional side elevation taken ^{indicated} on line 8-8 in Fig. 7,

Fig. 9 is an incomplete end elevation taken on line ^{indicated} 9-9 in Fig. 8,

Fig. 10 is a view similar to ^{that of} Fig. 3 showing a modified embodiment of the invention,

Fig. 11 is a sectional detail taken on line ^{indicated} 11-11 in Fig. 10,

10 Figs. 12 and 13 respectively show two further modified embodiments of the invention,

Fig. 14 is a view similar to ^{that of} Fig. 3 showing another modified arrangement,

Fig. 15 is a section taken on line ^{indicated} 15-15 in Fig. 14, and

Figs. 16 and 17 are sectional views respectively showing two further modified embodiments.

20 Referring to Figs. 3 to 6, a liquid-pervious web consisting of a felt 27 which moves either to the right or to the left (as ^{viewed} shown in Fig. 3) and a film-like layer 28 of a material to be de-watered carried by the felt²⁷. This felt²⁷ runs on a pair of parallel carrier rolls 29 and 30 and these run in contact with a bridging roll 31 ^{which is} parallel ^{with} to the other two^{rolls 29, 30}. Each of the three rolls ^{29, 30, 31} may consist (see Fig. 4) of a cylindrical outer shell 32 ^{connected to} ~~mounted on~~ end sleeves 33 ^{mounted on} ~~borne by~~ bearings 34 ^{provided} on a stationary mounting shaft 35. For preference, all of the rolls ^{29, 30, 31} are freely rotatable, however they, or any of them, could be conventionally power rotated provided their peripheral speeds are the same as the lineal speed of the web. To

improve leak-proofedness along the lines of roll contact, rolls 29 and 30 are preferably ^{covered} ~~coated~~ with rubber or the like as indicated at 36.

The rolls 29, 30 and 31, together with the web portion between rolls 30 and 32 fully define the sides of a chamber space 37. The ends of this space ³⁷ are defined and filled by a pair of closure members 38. These two members are virtually the same and either one or both of them has an exhaust (or supply) duct running through it.

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The illustrated closure member ³⁸ consists of a block-like body 39 having a duct 40 extending through it. This duct ⁴⁰ is ~~adapted for~~ ^{adapted} connection to a conventional suction source (not shown) such as a vacuum pump. The longitudinal edge margins ⁵ of the felt 27 run in contact with the top surfaces ⁴¹ of the bodies ³⁹; these ^{is} top surfaces ⁴¹ are laterally arcuate and longitudinally inclined, as indicated in Fig. 6, to accommodate the sag of web 27 when it is under suction. The sides and the bottom of each body ³⁹ are ^{provided} ~~furnished~~ with ribs 42, 43 and 44 which project into grooves 45, 46 and 47 respectively provided in the rolls 29, 30 and 31, so to form labyrinthine seals relative to those rolls. In Figs. 4 and 5 these seals are shown exaggeratedly. In practice, the sides of the ribs of the companion rolls may run in facial contact with those of the closure members, but preferably clearance is provided to give free running operation. This clearance is kept as small as possible compatible with free running. Some suctional loss must occur where free running clearance is

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provided, but experiment has shown that such loss is not detrimental in practice due to the relatively large volume of through-put.

The embodiment shown in Figs. 7 to 9, except for its showing of certain constructional features, is virtually the same as that shown ⁱⁿ ~~by~~ Figs. 3 to 6.

10 In the embodiment of Figs. 7 to 9 a liquid-pervious or felt web (not shown) runs on a pair of parallel carrier rolls 48 and 49 which are rotatably mounted on stationary shafts 50 and 51. These two shafts ^{50 and 51} are rigidly clamped, ^{at} ~~by~~ their ends, on pedestal blocks 52 and caps 53. Blocks 52 are fixed upon or form part of a machine base or frame, not shown.

Rolls 48 and 49 are contacted by a parallel bridging roll 54 freely-rotatably mounted on a non-rotatable shaft 55. This shaft 55 is preferably rubber surfaced and is supported by a pair of U-straps 56 mounted by lugs 57 on bolts 58 secured to pedestal blocks 52. The bridging roll 54 is resiliently urged to bear against the carrier rolls 20 48 and 49 by rubber "springs" 59 sleeved on bolts 58 between the bolt heads 60 and the lugs 57.

Shaft 55 is restrained against rotation by means of one or more upright keys 61 fixed on lugs 57 and slidably intruding into segmental keyways 62 formed ^{the} in/shaft 55.

The felt which runs on rolls 48 and 49 also has its longitudinal edge margins running on runway cantilevers 63 which have their bearing surfaces 64 formed, laterally arcuate and longitudinally inclined, to accommodate the two-dimensional sag of the felt when it is under suction.

The two cantilevers 63 and the three rolls 48, 49 and 54 thus define the longitudinal bounds of the required suction chamber, and the ends of that chamber are closed by closure plates 65 which are formed integrally with the cantilevers 63 and with a take-off duct 66. Both of the closure plates⁶⁵ may have a duct such as 66, or only one of them as may be required.

The closure plates 65 may simply be flat-surfaced in their confrontation of the ends of rolls 48, 49 and 54.

10 The flat closure surfaces of plates 65 may actually touch the ends of the rolls, but for preference they are out of ~~touch~~^{contact} with the rolls by the least amount compatible with the provision of running clearance. This will permit a certain amount of in-leakage to the suction space but experiment has shown that the amount of in-leak is not of consequence in practice.

To enable fine adjustment of the running clearance just mentioned, the rolls 48, 49 and 54 and the closure plates 65 are preferably furnished with means facilitating
20 adjustment of them in the axial direction of the rolls.

To this end the closure plate 65, is mounted, by way of carrier lugs 67^{provided on} duct 66,^{which rest} on support lugs 68^{provided} fixed on the pedestals 52. Retention of^{the closure plates 65 in the} selected^{position of} adjustment is effected by fixing ~~of~~^{screws} bolts ~~threading~~^{ed} into ~~lugs~~^{the} 68 and extending through elongated bolt holes 69^{provided} in lugs 67.

Endwise adjustment of rolls 48, 49 and 54 is provided for by an adjustment plate 70 which is fixedly secured to the related pedestal 52 by bolts or set-screws 71.

Adjustment plate 70 is ^{provided} furnished with three ears 72 which respectively overlies the adjacent end faces of shafts 50 and 51 and 55. Each of these ears ⁷² has a ^{screw} threaded hole in it to receive an adjustment screw 73 which may be selectively brought to bear against the shaft end related to it.

10 The arrangement shown in Figs. 10 and 11 operates in much the same way as already described in relation to the embodiment shown by Figs. 3 to 6 except that it is primarily intended for the de-watering of a return or idler flight of the felt by itself. In this instance the sides of the chamber space are mainly defined by three rolls 74, 75 and 76 about which the felt 77 passes, and a bridging roll 78. The ends of the chamber space are defined by a pair of closure members 79 ^{similar to member 38} ~~the same as that~~ shown in Fig. 6 except for having labyrinthine ribs (or a flat closure surface) on all four of their sides to engage with complementary grooves in all four of the rolls. As a slight variation, rolls 74 and 75 may be furnished with
20 circumferential grooves 80 to act as channels along which water may flow away from the felt vicinity. Instead of grooves, cavities or pockets may be provided in rolls 74 and 75 to enable water to be carried away in "pocketfulls".

In the ^{embodiment} ~~form~~ of the invention as shown in Fig. 12 the arrangement is such as to define two chamber spaces 81 and 82. Each of these has its ends defined by closure members 83 and 84. These (except for being four sided) are substantially the same as those shown in Fig. 6. In this case, the sides of the suction chamber spaces are mainly

defined by carrier rolls 85, 86 and 87 and a bridging roll 88. Suction chamber 81 may be used to de-water a web consisting of felt working flight 89 plus a layer 90 of material to be treated, and suction chamber 82 may be used to de-water the idler flight 91 of the felt.

The embodiment of Fig. 13 is very like that of Figs. 2 to 6; but, to provide for a more capacious chamber space, it is sidewardly defined mainly by two carrier rolls 92 and 93, and three bridging rolls 94, 95 and 96. The end closure members 97 are the same in principle as before, they have a top surface 98 on which the felt 99 rides, and instead of having three sides equipped with labyrinthine ribs they have five such sides to accommodate the five rolls 92, 93, 94, 95 and 96.

The ^{embodiment} ~~form~~ of the invention shown in Figs. 14 and 15 is similar to that shown in Figs. 3 to 6 except in its illustration of the invention as it is applied to a "suction" chamber which is under pressure and therefore blows a fluid medium through the web from the inside of the chamber space. In this case, the main difference (compared with Figs. 3 to 6) is that top surface 100 of the closure member 101 upon which the longitudinal edge margins of the felt 102 ride is convex instead of concave as shown in the earlier figures. This embodiment may be used merely to dry the felt 102 or a product layer carried thereby, in which (latter) case hot air may be sent through the felt. In this embodiment, the felt, instead of riding closely against the top of the closure member, may ride against an arcuate guide-plate 103. Where such a guide-plate¹⁰³ is

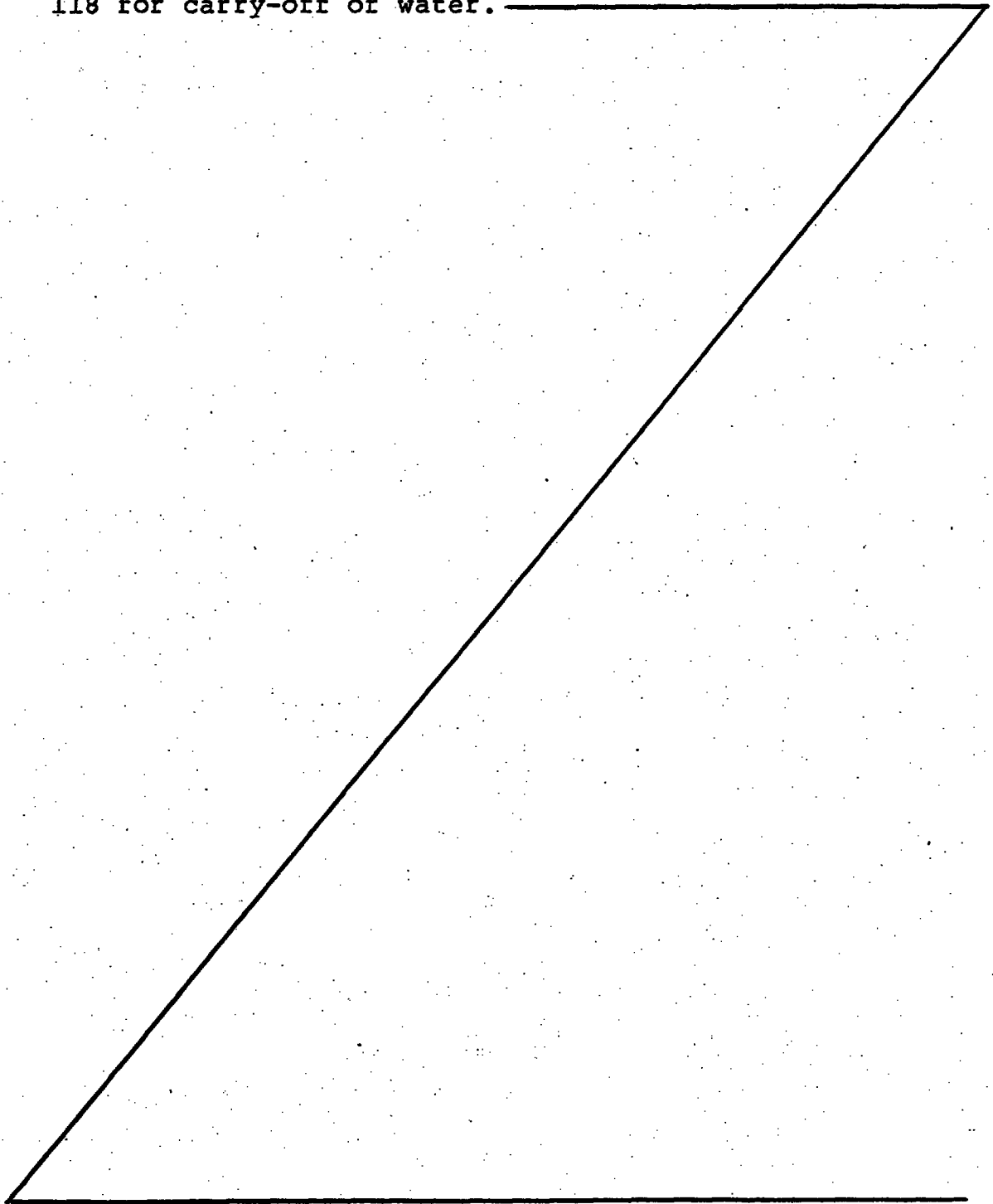
employed, any product layer (104) carried by the felt would have to be of such width as to remain clear of the guide-plate as indicated at 105; moreover, the pressure of the fluid sent through the felt would have to be low enough as not to lift the product layer off the felt.

Fig. 16 shows an ^{embodiment} ~~example~~ of the invention in relation to a rotary sieve (referred to earlier herein). In this figure, a felt 106 travels about two carrier rolls 107 and 108 and a bridging roll 109. Rolls 107 and 108 and a pair of closure members 110 (one having suction outlet 111) form a suction chamber substantially as previously explained. In this case however, the bridging roll 109 is constituted by an ordinary rotary sieve of the kind which, in use, is partly immersed in slurry (112) so as to pick up a film-like layer as indicated at 113.

It will be appreciated that in this embodiment the bridging roll 109 does not form part of the liquid removing chamber. It is simply illustrative of one way by which a web to be de-watered may be fed to that chamber. The sides of the chamber space are fully constituted by the two rolls 107 and 108, those parts of felt 106 which run between them, and the two closure members 110. For example, if roll 109 be regarded as absent from Fig. 16 and the arrows marked 119 reversed, a fully effective de-watering chamber would obtain. Such a chamber could be used to de-water a web as indicated by dotted lines 120. This web would approach the chamber at 121 and depart from it at 122. Thus, at the tops of the two closure members the web plus

the felt would be de-watered, and at the bottoms of those members the felt by itself would be de-watered.

The embodiment shown in Fig. 17 is virtually the same as that shown in Fig. 3 except for the carrier rolls 114 and 115 being uncoated and the bridging roll 116 having a rubber or like coat 117 furnished with grooves or pockets 118 for carry-off of water.





CLAIMS

1. Apparatus for causing a liquid to flow from a moving liquid-pervious web, comprising a substantially closed chamber consisting of side walls defined by parallel rotatable rolls, and at least one portion of said web running in contact with said rolls, and end walls defined by a pair of end closure members contoured to extend between said rolls and said portion of the web which close the ends of said chamber; and means for maintaining a pressure difference between the inside of said chamber and that side of said web external to said chamber thereby causing liquid in said web to be removed from it.

2. Apparatus as claimed in claim 1, wherein each of said end closure members consists of a body having a surface traversed by said web, and at least two other surfaces respectively confronting said rolls and being in closure relationship thereto.

3. Apparatus as claimed in claim 2, wherein the surface traversed by the web is arcuate to correspond with the curvature assumed by said web when in use.

4. Apparatus as claimed in claim 2 or claim 3, wherein each of said surfaces in closure relationship to said rolls has at least one rib on said surface projecting into a circumferential groove on the related roll.

5. Apparatus as claimed in claim 2 or claim 3, wherein each of said surfaces in closure relationship to said rolls is a flat surface which confronts the ends of the said rolls.

6. Apparatus as claimed in any preceding claim, wherein said chamber is a suction chamber and at least one of said closure members has a passage extending through it leading to a vacuum pump.

7. Apparatus as claimed in any one of claims 1 to 5, wherein said chamber is a pressure chamber and at least one of said sealing members has a passage extending through it through which a fluid under pressure is fed into said chamber for expulsion therefrom through said web.



8. Apparatus as claimed in any preceding claim, wherein said parallel rolls comprise a pair of carrier rolls upon which said web rides, and a bridging roll which runs in contact with both of said carrier rolls.

9. Apparatus as claimed in any of claims 1 to 7, wherein said parallel rolls comprise a pair of carrier rolls, about which said web rides, a third carrier roll bridging said pair of rolls and being externally wrapped by said web, and a bridging roll which runs in contact with portions of said web riding said pair of rolls.

10. Apparatus as claimed in any of claims 1 to 7, wherein said parallel rolls comprise three carrier rolls carrying and encompassed by said web, and a single bridging roll running in contact with each of said three rolls thereby defining a pair of fluid medium chambers.

11. Apparatus as claimed in any of claims 1 to 7 wherein said parallel rolls comprise a pair of carrier rolls upon which said web rides and a plurality of bridging rolls serially in contact as a series of which the end rolls respectively ride in contact with said carrier rolls.

12. Apparatus as claimed in any of claims 1 to 7, wherein said chamber space has two opposite sides respectively defined by two carrier rolls and two remaining opposite sides respectively defined by a top flight and a bottom flight of said web.

13. Apparatus as claimed in claim 12 including a bridging roll for said carrier rolls which is applied to said bottom flight and is constituted by a rotary sieve whereby a slurry layer is led on to said bottom flight.

14. Apparatus as claimed in any of claims 1 to 7, which includes at least one pair of rolls in rolling contact and at least one of the pair is coated with resilient material.

15. Apparatus as claimed in any of claims 1 to 7, wherein at least one of said rolls has a cavitied surface providing pockets to conduct liquid away from said web.

16. Apparatus for causing a liquid to flow from a moving liquid-pervious web substantially as hereinbefore described with reference to and as illustrated in Figures 3 to 6, or Figures 7 to 9, or Figures 10 and 11, or Figure 12, or Figure 13, or Figures 14 and 15, or either one of Figures 16 or 17, of the accompanying drawings.

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