April 30, 1963 R. M. NEWMAN, JR 3,087,538

APPARATUS FOR EXTRACTING LIQUID FROM A FIBER FORMATION

Filed April 15, 1960 3 Sheets-Sheet 1

Fig. 1.

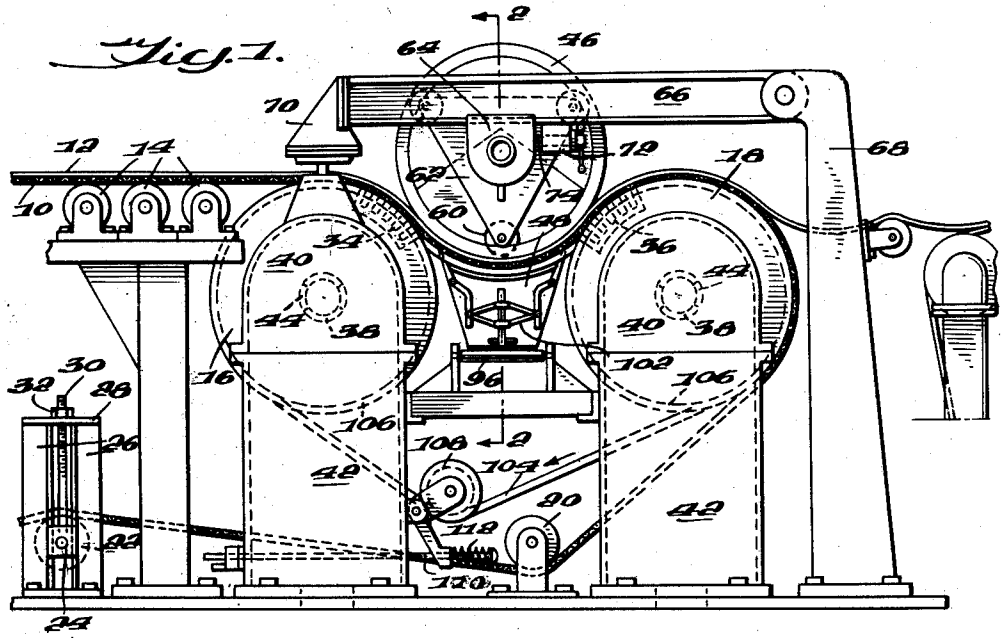


Fig. 2.

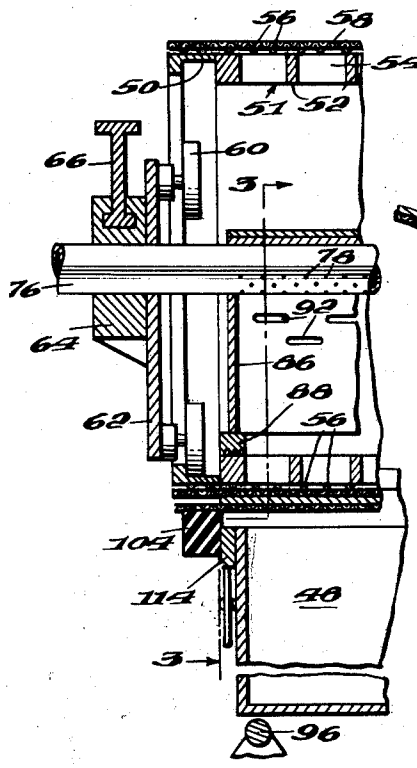
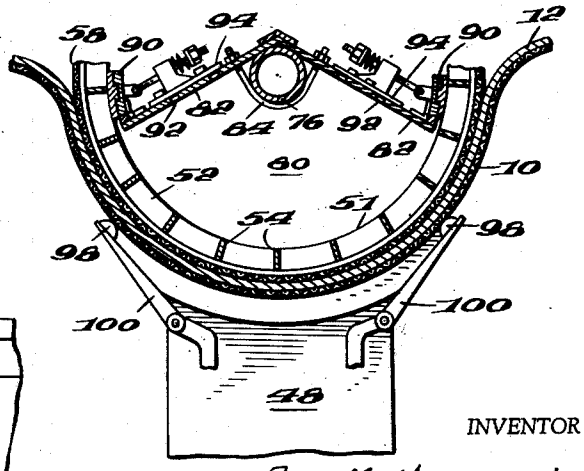


Fig. 3.



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APPARATUS FOR EXTRACTING LIQUID FROM A FIBER FORMATION

Filed April 15, 1960 3 Sheets-Sheet 2

Fig. 5.

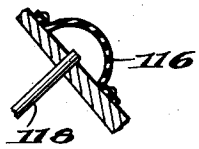


Fig. 4.

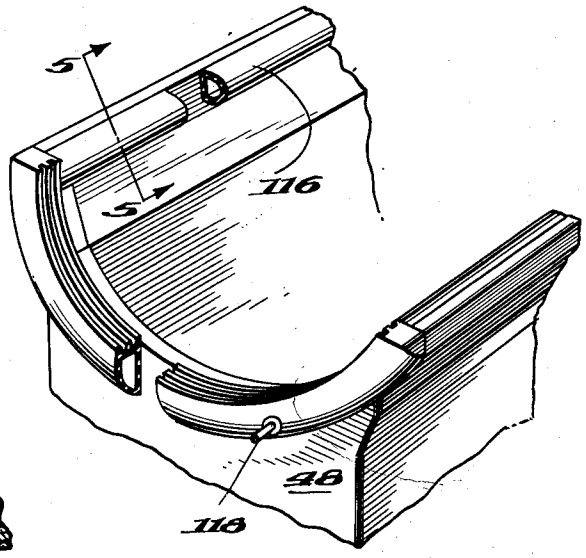


Fig. 6.

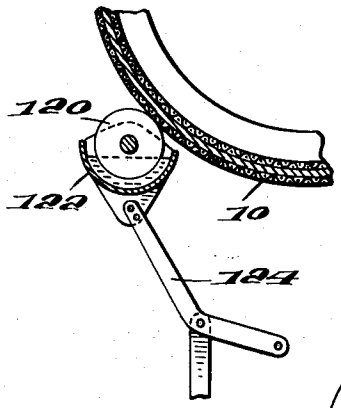
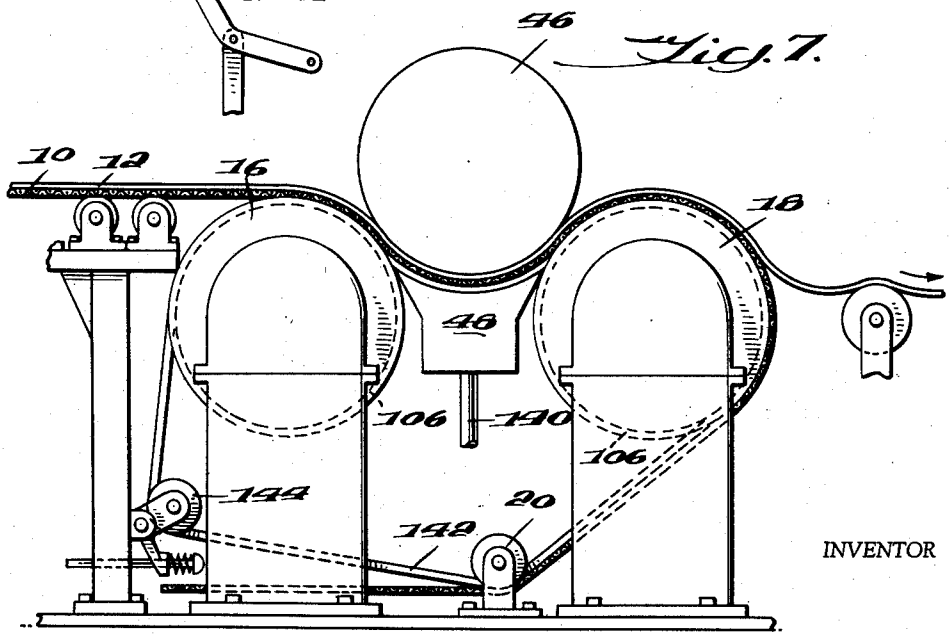


Fig. 7.



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April 30, 1963 R. M. NEWMAN, JR 3,087,538

APPARATUS FOR EXTRACTING LIQUID FROM A FIBER FORMATION

Filed April 15, 1960 3 Sheets-Sheet 3

Fig. 8.

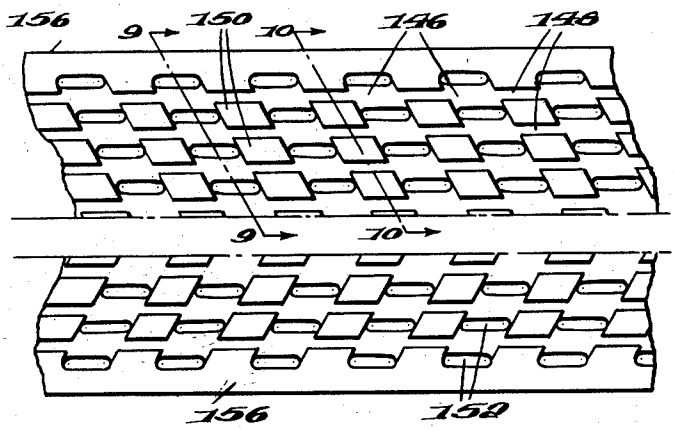


Fig. 9.

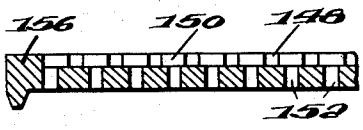


Fig. 10.

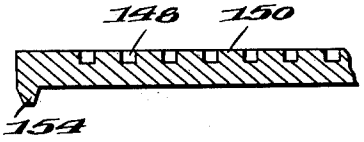


Fig. 11.

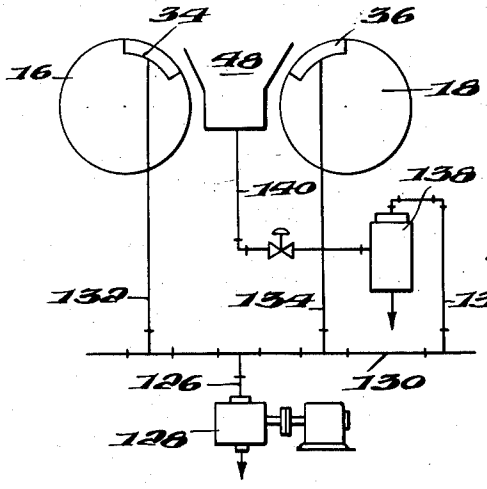
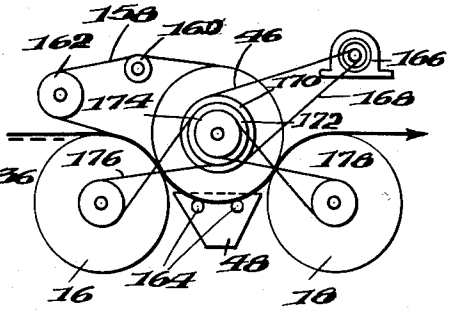


Fig. 12.



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3,087,538
APPARATUS FOR EXTRACTING LIQUID FROM A FIBER FORMATION

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Filed Apr. 15, 1960, Ser. No. 22,454
5 Claims. (Cl. 162—297)

This invention relates to an apparatus for extracting liquid from a newly formed fiber formation. More particularly, it concerns an apparatus for extracting liquid from a newly formed fiber formation on a travelling pervious wire of the type used in Fourdrinier type of paper machinery.

In the manufacture of paper, pressed boards and other products which are formed most expeditiously as a continuous web, Fourdrinier machines have been widely accepted and are commonly used. In a Fourdrinier machine, a fiber slurry is deposited on a fine mesh screen or wire which is supported at a point adjacent a head box by a breast roll and then proceeding in a direction away from the head box, generally horizontally by a plurality of table rolls, over a plurality of suction boxes to a couch roll where the newly formed web is transferred to a press felt for further processing and subsequently to the finishing operation. The purpose of thus providing a generally horizontal flight in the wire is to allow sufficient time for the fibrous material to be properly accreted on the wire and the liquid to be removed therefrom so that the newly formed web may be transferred to the press felt without danger of rupturing.

In conventional Fourdrinier machines the drainage about the head box and the table rolls mostly by gravity accounts for approximately 75 to 80 percent of liquid extraction, the remainder being left to mechanical removal by the suction boxes. While suction boxes have been found generally effective to remove the necessary amount of liquid from the fiber formation, they impose severe stresses on the Fourdrinier wire due to friction developed by suction applied perpendicularly to the direction of wire movement which in turn causes wear, breakage and other deleterous effects resulting in high maintenance costs. Also, to achieve the necessary amount of liquid extraction, it is conventional to employ a plurality of suction boxes in tandem to reduce suction pressures. While this is effective for the purpose intended, it increases the length of the machine and creates not only increased length of wire but also presents a space problem.

Accordingly, a principal object of this invention is to provide an apparatus for extracting liquid from fiber formations on a Fourdrinier wire by which the problems previously incurred are effectively and substantially overcome.

Another object of this invention is the provision of a liquid extraction apparatus of the type referred to which greatly reduces the length of wire run necessary to effect the required amount of liquid extraction from a fiber formation.

A further object of this invention is that of providing an apparatus for extracting liquid from fiber formations on Fourdrinier wires which greatly reduces the frictional drag of the wire and thereby increases the useable life of the wire as well as decreasing the power costs in driving the wire.

Still another object of this invention is the provision of an apparatus of the type referred to which facilitates the combined effects of compaction and differential pressure type liquid extraction from a fiber formation on a Fourdrinier wire without imposing undesirable loading stresses on the wire and thereby reducing the power costs

required by apparatus heretofore available wherein liquid extraction was carried out solely by pressure differential.

Other objects and further scope of applicability of the present invention will be apparent from the detailed description given hereinafter. It should be understood, however, that the detailed description, while indicating preferred embodiments of the invention, is given by way of illustration only since it will be made apparent to those skilled in the art that various changes and modifications can be made without departing in any way from the true spirit and scope of this invention.

In general, the aforementioned objects are accomplished by supporting at least a portion of a tensioned travelling pervious wire such as a Fourdrinier wire on a pair of spaced rolls and providing a pervious pressure roll between the spaced rolls in compacting engagement with the fiber formation on the side of the wire opposite from the spaced rolls to constrain the formation and wire in a generally arcuate path so that the tension in the wire operates to compress the formation against the pressure roll. Means are provided for developing a pressure differential across the formation while it is in contact with the pressure roll which means may be either a positive pressure source within the pressure roll, a negative or suction pressure developed in a catch pan or receptacle positioned beneath the pressure roll and in sealing engagement with the under side of the wire, or by both a positive pressure on the formation side of the wire and a suction pressure on the backside thereof.

A more complete understanding of the new and improved liquid extraction apparatus of this invention and its operation may be had by reference to the accompanying drawings, in which:

FIG. 1 is a fragmentary side elevational view illustrating the liquid extraction apparatus of this invention on one end of a conventional Fourdrinier machine;

FIG. 2 is an enlarged fragmentary cross-sectional view taken along line **2—2** of FIG. 1;

FIG. 3 is an enlarged fragmentary cross-sectional view taken along line **3—3** of FIG. 2;

FIG. 4 is a fragmentary perspective view of the catch pan of this invention equipped with a modified seal structure;

FIG. 5 is a cross-sectional view of the seal taken along line **5—5** of FIG. 4;

FIG. 6 is a fragmentary elevational view illustrating still another form of seal construction adaptable for use with the liquid extraction apparatus of this invention;

FIG. 7 is a fragmentary elevation illustrating a modified form of the liquid extraction apparatus of this invention;

FIG. 8 is a fragmentary plan view of the wire supporting belt incorporated in the embodiment of FIG. 7;

FIG. 9 is a fragmentary cross-sectional view taken along line **9—9** of FIGURE 8;

FIG. 10 is a fragmentary cross-sectional view taken along line **10—10** of FIGURE 8;

FIG. 11 is a schematic showing of a preferred vacuum system adapted for use with the liquid extraction apparatus of this invention; and

FIG. 12 is a schematic view of still another modification of this invention.

Referring now to FIGURE 1 of the drawings, the liquid extraction apparatus of this invention is shown at the delivery end of a Fourdrinier machine which conventionally includes an endless travelling screen or wire **10** on which the fiber formation **12** is accreted and which is supported on a plurality of table rolls **14**. As will be understood by those familiar in this art, while only three table rolls **14** are shown it is common practice to employ as many as 20 or more of these rolls to properly support the wire **10** as it passes from the breast roll, the head box,

and the making board, none of which are shown on the drawing since these items are commonly known and as such, in and of themselves, do not form part of this invention. As shown, after leaving the table rolls **14** the wire **10** is supported on its back side by a receiving couch roll **16**, a delivery couch roll **18** and then begins its lower or return run back to the breast roll (not shown) by passage about guide and tension rolls **20** and **22** respectively. It will be understood further that while only one guide roll **20** and one tension roll **22** is illustrated in the drawings as many of these rolls may be used as necessary to properly support and tension the wire **10**.

In a conventional manner, the roll **22** is supported in end bearing blocks **24** which in turn are received between vertical ways **26** supporting at their upper ends a cap member **28**. A threaded shaft **30** is affixed to the bearing block **24** and associated with a nut **32** positioned above the cap **28** to regulate the vertical positioning of the roll **22** and thus the amount of tension in the wire **10**.

Also, the receiving couch roll **16** and the delivery couch roll **18** per se are conventional and include suction boxes **34** and **36** respectively. Each of the couch rolls is supported on each end by a tubular shaft **38** suitably journaled in housings **40** which in turn are supported on standards **42**. The standards **42**, housings **40**, are hollow and in fluid communication with the suction boxes **34** and **36** by the provision of ports **44** through the tubular shafts **38**. In this manner, the housings and standards **40** and **42** respectively function not only to support properly the couch rolls **16** and **18** but also facilitate the evacuation of the suction boxes **34** and **36** respectively therein by use of a suitable vacuum system which will be described more fully hereinafter.

Having thus allocated the Fourdrinier wire **10** with which the liquid extraction apparatus of this invention may be used, it will be noted that the portion of the wire **10** between the couch rolls **16** and **18** is constrained to take a generally arcuate path by a pressure roll **46** and that a substantial portion of the wire in contact with the roll **46** is covered on its back side by an open top receptacle or catch pan **48**. As will be seen from the description which follows below, the cylindrical or formation engaging surface of the roll **46** is pervious to gas; that the receptacle or catch pan **48** is provided with suitable seal means on its upper edge to make possible a substantial and effective pressure differential across the web or fiber formation **12**; and that this pressure differential, along with the compressive action of the wire **10** on the formation **12** against the pressure roll **46** functions to extract liquid from the formation in a manner much more efficiently than apparatus heretofore available.

In the embodiment illustrated in FIGURES 1, 2, and 3, of the drawings, the pressure roll **46** includes on each end a bearing ring **50** of generally L shaped cross-section which is suitably affixed such as by welding or the like to a cylindrical supporting grill indicated generally by the numeral **51** and formed of a plurality of circumferential members **52** spaced axially from one another by transverse of members **54**. Spirally wrapped about the grill **51** is a supporting wire **56**. As shown, the convolutions of the supporting wire **56** are evenly spaced and support a facing screen **58** having characteristics similar to the screen making up the Fourdrinier wire **10**. To support the pressure roll in position properly between the couch rolls **16** and **18**, a plurality of rolls **60** are received by the bearing rings **50** which bearing rolls are in turn rotatably supported on a trunnion plate **62**. The plate **62** is in turn welded, riveted, or otherwise affixed to a block **64** having an upper under-cut groove to permit its being slidably received on the lower flange of a support beam **66**. In that the organization illustrated in FIGURE 2 will be duplicated on the opposite end of the roll **46**, two supporting beams **66** are provided and each is pivotally supported on one end by a standard **68** and on the other end by a pneumatic, hydraulic or mechanical jack

70 for regulating its pivotal position and thus the vertical position of the pressure roll **46**. To accurately control the horizontal position of the roll **46** on the beam **66**, an internally threaded boss **72** is provided and receives a threaded shaft **74** by which the block **64** may be accurately moved and positioned along the beam **66** and thereby accurately position the roll **46** properly between the couch rolls **16** and **18**.

Extending centrally through the pressure roll **46** is a tubular conduit **76** having a plurality of perforations **78** therein so that a suitable fluid pressure medium such as steam, compressed air or the like may be fed to the interior of the pressure roll **46**. A chamber **80** is provided in the lower interior of the roll **46** for the purpose of rendering more effective the fluid pressure medium supplied thereto, which chamber is established by a pair of generally radially extending plates **82** suitably affixed to the tubular conduit **76** such as by U-bolts **84**. End walls **86** of the chamber terminate at their lower ends in chime seals **88** which frictionally engage the outermost ring **52** of the roll **46**. To seal the ends of the plates **82** against the interior of the pressure roll grill **51**, seal members **90** are provided, and further, the plates **82** are formed having a plurality of venting apertures or slots **92** which may be adjusted between opened and closed positions as desired by plates **94**.

The receptacle or catch pan **48** is supported upwardly against that position of the wire **10** backed up by the roll **46** by suitable means not shown and may be removed by lowering on to rollers **96** and movement axially of the couch rolls **16** and **18**. To effectively seal the upper portion of the receptacle against the wire, in one form of this invention the axially extending or side walls thereof terminate at their upper ends in wire contacting members **98** mounted on pivotal arms **100** and connected to a toggle linkage mechanism **102** so that the pressure exerted by the seal members **98** against the wire may be properly regulated. To seal the ends of the receptacle effectively against the wire **10**, a pair of belts **104** are trained about pulley grooves **106** on each end of the couch rolls **16** and **18** and maintained under proper tension by a sheave **108** pivotally affixed to the receiving couch roll standard **42** and biased to tension the belt by a headed rod **110** and spring **112**. In this manner, the belts **104** are urged upwardly against the wire **10** and the pressure roll **46** to establish a travelling frictionless seal therewith. As shown in FIGURE 2, the belt makes frictional contact with a rub plate **114** on the end of the receptacle or catch pan **48**.

Alternative forms of seal arrangements for the upper portion of the receptacle **48**, are illustrated in FIGURES 4, 5, and 6, of the drawings. In the embodiment illustrated in FIGURES 4 and 5, the upper portion of the catch pan **48** supports a plurality of tubular resilient seal strips **116** which may be inflated through nipples **118**. With this arrangement, the belts **104** need not be used.

Another embodiment of the seal structure satisfactory to effectively seal the upper portion of the receptacle **48** against the wire **10** is illustrated in FIGURE 6. In this instance, it is contemplated that the belts **104** will be used to seal the ends of the receptacle in a manner similar to the embodiment illustrated in FIGURES 1 to 3. To seal the sides of the receptacle, however, a roller **120** is provided suitably journaled in a trough **122** which in turn is flexibly mounted to the upper edge of the receptacle. The trough is adapted to contain a suitable liquid so that no gas may pass between it and the roller and further, the roller and trough is supported on a lever arm **124** by which the sealing pressure of the roll against the wire **10** may be regulated.

A pumping system for developing necessary suctions or negative pressures in each of the suction boxes **34** and **36** in the couch rolls **16** and **18** respectively as well as in the catch pan or receptacle **48**, is shown schematically in FIGURE 11. As shown, the intake **126** of a motor driven pump **128** is connected to a header **130** fed by

branch lines **132**, **134**, and **136**. The branch lines **132** and **134** go directly to the couch roll suction boxes **34** and **36** respectively while the branch line **136** is connected to a chamber **138** which in turn is connected to the receptacle **48** through line **140**. As will be understood by those familiar in the art, liquid removed by the suction boxes **34** and **36** or collected in the catch pan **48** may be fed from the chamber **138** or pump **128** to drain or to recovery apparatus.

In operation, the apparatus above described is particularly suitable to the Fourdrinier technique of accreting fiber formations wherein a fiber slurry is deposited on the travelling wire **10** as it passes beneath the head box (not shown). Almost immediately, a substantial percentage of the liquid from the slurry passes through the wire leaving the fiber formation accreted thereon by gravity for the most part and by the time the formation reaches the last table roll **14**, approximately 75 to 80 percent of the liquid has been extracted in most operations. Thus before the formation or web may be transferred to the press felt for subsequent processing and finishing, a substantial portion of the remaining 20 to 25 percent of the liquid in the formation must be removed. In the apparatus of this invention this liquid extraction is greatly expedited by the compressive action exerted on the formation by the tensioned wire **10** against the pressure roll **46**. The facing screen **58** on the roll **46** moves at the same speed as the wire **10** in most operations so that the formation is not in any way upset or harmed, though it may be desirable to deliberately bulk or stretch the formation to achieve various surface effects by adjusting the speed of the roll to a value different from that of the wire **10**. Further, since the compressive force exerted on the formation is the result of tension in the wire **10**, it is evenly compacted over the area thereof in contact with the roll **46**.

While the compressive forces developed by the roll **46** and the wire **10** on the fiber formation **12** greatly assists in removal of liquid, the amount of extraction is considerably increased by a pressure differential which may be created across the formation by either the introduction of steam or other compressed fluid into the chamber **80**, by creating suction pressures in the catch pan or receptacle **48**, or by combining the effects of pressure in the chamber **80** and vacuum or suction in the receptacle **48**. If the steam chamber **80** is used alone or in combination with suction pressures in the receptacle **48**, the vents **92** are covered by the plates **94** to permit the development of sufficient pressures in the chamber. If on the other hand, it is desired to use only the suction pressures developed by the receptacle or catch pan **48**, without complementing the suction pressures with positive pressures in the chamber **80** then the vents **92** are opened to prevent negative pressures from developing in the chamber **80**. Also, the vents **92** may be opened if it is desirable to provide a steam shower over the formation without subjecting it to positive pressures, again relying only on suction pressures in the catch pan **48**.

To illustrate further modifications of apparatus by which the desirable results of this invention may be realized, reference may be had to FIGURES 7 to 10 and 12 of the drawings. In the embodiment shown in FIGURE 7, the arrangement of the principal components, i.e., the wire **10**, couch rolls **16** and **18**, the pressure roll **46** and the catch pan **48** is the same as the apparatus shown in FIGURE 1 except that in this instance the wire is backed up with a perforate endless belt **142** underlying the wire **10** as it passes over the couch roll **16**, under the pressure roll **46**, over the couch roll **18** and under the guide roll **20**. The belt **142** extends across the width of the wire **10** and is adjustably tensioned by a tension roll **144** of conventional construction. In this manner, the compressive stresses necessary to compact the formation **12** against the roll **46** may be developed largely by the belt thereby alleviating to some extent the tensile forces necessary in the wire **10**.

The structural configuration of the belt **142** is shown in FIGURES 8, 9 and 10 and is such that free passage of fluids through the wire **10** and the fiber formation **12** is permitted. To effect this characteristic, the upper portion of the belt is formed having a plurality of channels **146** situated angularly with respect to the direction of belt travel and inter-connected by a plurality of grooves **148** leaving parallelogram-shaped raised portions **150** for supporting the back of the wire **10**. The lower portion of the belt is formed having a plurality of slots **152** opening at the bottom of the channels **146**. Further, the lower edge of the belt is equipped with a depending projection **154** which complements the shape of the pulley grooves **106** in the couch rolls **16** and **18** thereby to guide the belt as it passes over the rolls. Also, it will be noted that the belt terminates at its edges in a continuous portion **156** so that the perforated portion thereof is isolated to enhance the seal between the receptable **48** and the pressure chamber **80** across the wire **10** and formation **12**.

As will be understood by those familiar in the art, belt **142** may be formed of any of several suitable materials such as textile reinforced rubber, various plastic materials or other materials which are sufficiently flexible to enable the belt to be trained about the rolls **16**, **46**, **18**, **20**, and **144**.

As indicated, the operation of the embodiment illustrated in FIGURE 7 is identical to that of the arrangement illustrated in FIGURE 1 except that the compressive forces against the fiber formation **12** are augmented by the belt **142**. This feature is desirable in that it relieves the wire **10** of much of the tensile stresses necessary therein to produce the desired compressive effect on the formation **12** and against the pressure roll **46**.

A still further modification of this invention is illustrated schematically in FIGURE 12. In this embodiment, the facing screen **58** on the pressure roll **46** is replaced by a travelling wire cloth **158**. The wire cloth **158** is similar to the Fourdrinier wire **10** and is trained about guiding and take up rolls **160** and **162** to maintain the desired tension and alignment thereof. An advantage of this arrangement is that additional working area insofar as liquid extraction is concerned may be developed by the co-action of the wire mesh **158** against the formation as backed up by the receiving couch roll **16** thereby resisting centrifugal throw-off of the formation as it passes over this couch roll and further, the departure of the mesh **158** from the roll **46** may be advantageously used to direct the cloth screen **158** past appropriate cleaning and reconditioning devices.

In addition, the embodiment illustrated in FIGURE 12 contemplates at least two pressure rolls **164** positioned in the receptacle **48** under the pressure roll **46** to augment the liquid extraction. This is brought about by the pumping effect of the rolls in contact with the wet wire **10** in a manner similar to the pumping effect of table rolls as will be understood by those familiar with this art. Further a suitable drive mechanism is illustrated in FIGURE 12 for rotating the couch rolls **16** and **18** synchronously with the pressure roll **46** by power developed in a motor **166**. The drive system may be adapted to the other embodiments of the invention mentioned above and contemplates a drive belt **168** trained about a pulley **170** on the pressure roll **46**. Pulleys **172** and **174** positioned concentrically with the pulley **170** are arranged to drive the couch rolls **16** and **18** through crossed belts **176** and **178** respectively. Other drive arrangements could be used, however, and may be more desirable, particularly where it may be desirable to drive the rolls at different speeds.

Thus, it will be seen by those familiar with this art that the above mentioned objectives may be fully realized by this invention. The arrangement of the tensioned wire **10**, couch rolls **16** and **18**, pressure roll **46** and receptacle **48** is such that a substantial and yet exceptionally uniform pressure may be exerted on the formation **12** to effectively express residual liquid therefrom without danger of upset-

ting the formation. While this compaction, by itself, is highly desirable, considerably more liquid extracting capacity is provided by the foraminous or pervious facing on the pressure roll **46** and the differential pressure generated across this facing and the formation by pressure chamber **80**, suction by the receptacle **48**, or both, thereby requiring much less wire run alloted to liquid extraction than an apparatus heretofore available. Yet, very little frictional drag and the deleterious effects thereof are imposed on the wire **10** since surfaces which exert the most pressure thereon rotate and accordingly, move with the wire.

Moreover, as demonstrated by the foregoing description, the new and unique results of this invention can be achieved by several different structural embodiments, the basic apparatus being represented by the embodiments of FIGS. 1, 7 and 12 while variations in effective catch pan seal arrangements are shown in FIGS. 4, 5, and 6. Although these embodiments represent preferred forms, it is contemplated that still other forms might be used without departing from the true spirit and scope of this invention. For example, the wire could be fed about the pair of spaced couch rolls and the pressure roll in such a manner that it engages substantially the entire periphery of the pressure roll, thereby increasing the area of pressure extraction. Also it will be appreciated that by using various sizes of rolls as well as various combinations of wire tension, and pressure differentials, a host of different liquid extraction characteristics can be effected.

In view of the many possible variations which can be made in the apparatus of this invention, it is to be distinctly understood that the foregoing description is illustrative only and not limiting. Correspondingly, the true scope and spirit of this invention is to be determined by the appended claims.

I claim:

1. Apparatus for extracting liquid from a fiber formation on a Fourdrinier wire comprising a pair of spaced rolls; an endless, porous, flexible belt extending across the width of the wire and supporting the wire from one side thereof, said belt being trained about said rolls; means for tensioning said belt; a pervious pressure roll intermediate said spaced rolls engaging the formation on the other side of the wire; and means for developing a pressure differential across the formation.

2. The apparatus recited in claim 1 in which said pressure differential developing means comprises: means defining a pressure chamber in said pressure roll for developing a positive pressure against the formation; and a receptacle positioned between said spaced rolls and opening to said belt and the wire from said one side thereof opposite said pressure roll, and means cooperating with said belt to form seal means between the wire and said receptacle.

3. The apparatus recited in claim 2 in which said seal means includes: an inflatable member mounted on the opened edges of said receptacle, said member being in continuous contact with said belt.

4. The apparatus recited in claim 2 in which said seal means includes a pair of wire contacting members flexibly connected to upper wall portions of said receptacle, and means for moving said members into transverse engagement with the belt and said pressure roll said last-mentioned means including lever arms supporting each end of said members.

5. The apparatus recited in claim 4 in which said contacting members include rollers in combination with a liquid trough for effecting a seal between said rollers and said receptacle.

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