March 14, 1967 K. V. KRAKE 3,309,265

FABRIC BELT FOR PAPERMAKING MACHINE

Filed Sept. 27, 1963 2 Sheets-Sheet 1

Fig. 1

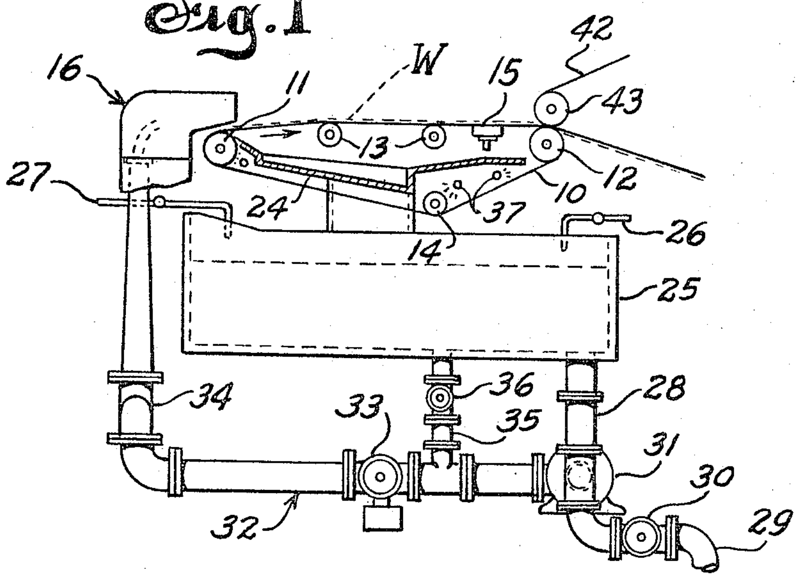
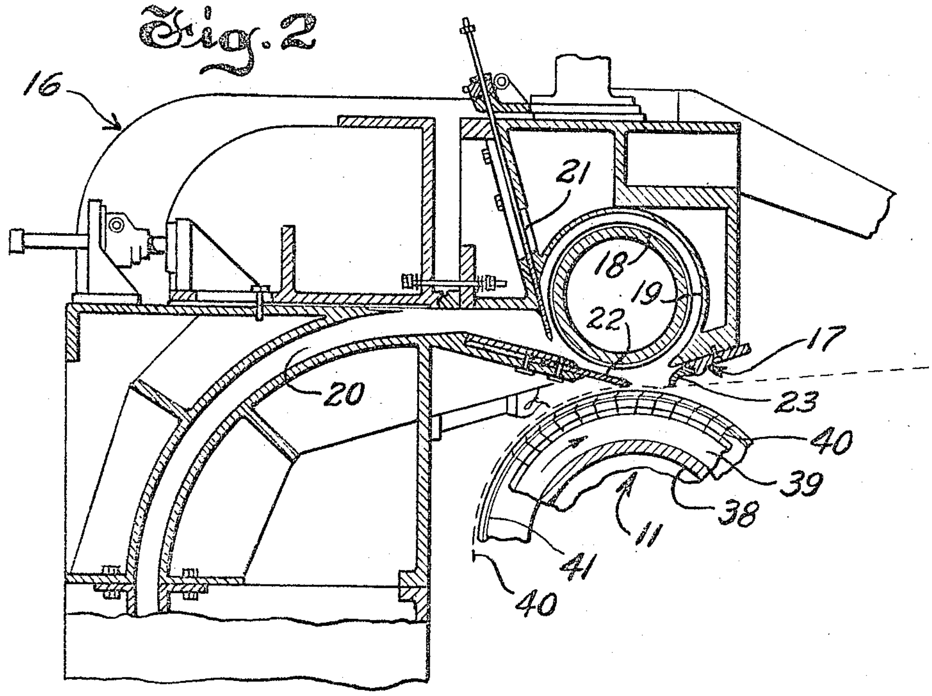


Fig. 2



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FABRIC BELT FOR PAPERMAKING MACHINE

Filed Sept. 27, 1963 2 Sheets-Sheet 2

Fig. 3

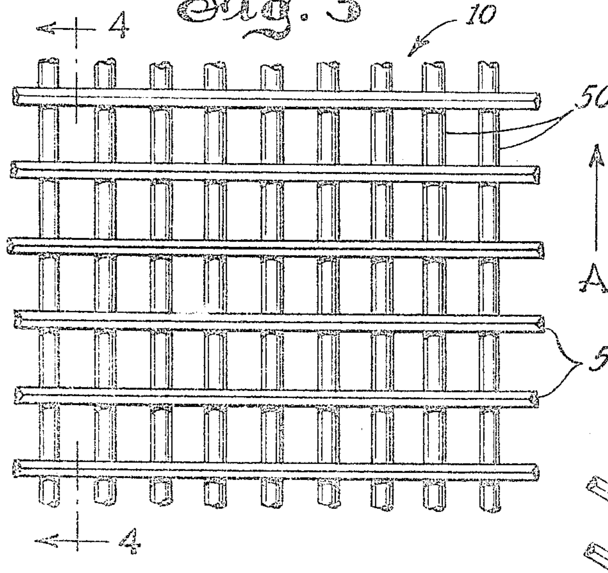


Fig. 9

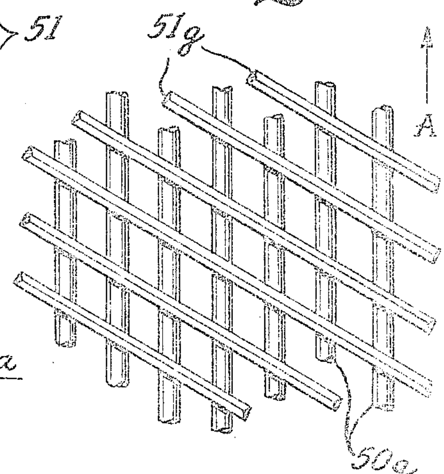


Fig. 4

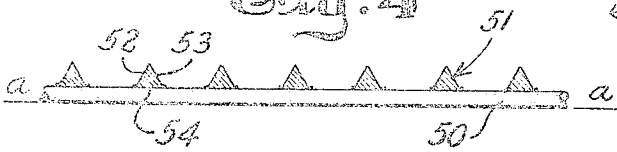


Fig. 5

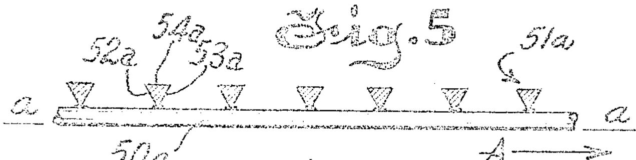


Fig. 6

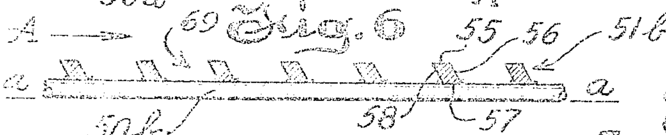


Fig. 8

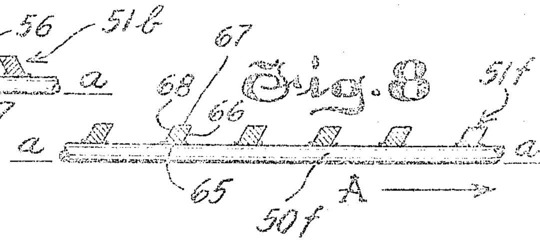
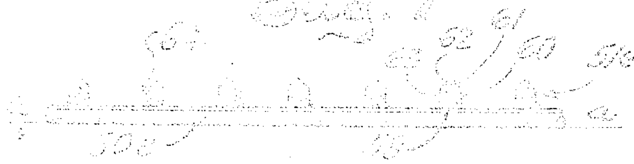


Fig. 7



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FABRIC BELT FOR PAPERMAKING MACHINE

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7 Claims. (Cl. 162—348)

My invention relates to papermaking machines, particularly of the Fourdrinier type, and, more particularly, to improved Fourdrinier fabrics for use in such machines.

Fourdrinier fabrics for forming paper webs by drainage of water from paper stock applied onto the fabrics commonly comprise warp strands extending in the machine direction (that is, in the direction in which the Fourdrinier fabric is moved as stock is applied onto the fabric) interwoven with shute strands extending in the cross machine direction.

The weaving process is necessarily quite time consuming and expensive due to the fact that each of the shute strands must pass between various ones of the warp strands and each shute strand must be put into place individually.

It has been proposed in a prior application of Winterton U. Day, Ser. No. 97,492, filed Mar. 22, 1961, now Pat. No. 3,164,514, that such Fourdrinier fabrics be made of cross laid wires, that is, a set of parallel, spaced warp wires extending in the machine direction and a plurality of parallel, spaced shute wires extending in the cross machine direction and simply laid onto one side of the series of warp wires, with the shute and warp wires being welded together. This constituted a substantial improvement on the prior interwoven fabrics, being much simpler in construction and, therefore, considerably cheaper to manufacture.

It is an object of the present invention to provide cross laid welded fabrics which are of the basic type illustrated in the Winterton U. Day prior application and which constitute improvements by each being made up of a set of filaments or wires of nonround cross section having surfaces extending other than at 90 degrees with respect to the plane formed by the other set of filaments or wires for the purpose of changing the drainage of white water from the paper stock applied onto the fabric and thereby changing the characteristic of the resulting paper web.

The invention consists of the novel constructions, arrangements, and devices to be hereinafter described and claimed for carrying out the above stated objects and such other objects as will be apparent from the following description of preferred forms of the invention, illustrated with reference to the accompanying drawings, wherein:

FIG. 1 is a fragmentary, schematic, side view of a Fourdrinier web forming machine including a Fourdrinier forming fabric movably trained in the form of a loop about a plurality of supporting rolls and also including a stock inlet for applying stock onto the fabric;

FIG. 2 is a longitudinal sectional view on an enlarged scale of the stock inlet;

FIG. 3 is a fragmentary plan view of the forming fabric used in the machine illustrated in FIGS. 1 and 2;

FIG. 4 is a sectional view of the forming fabric taken on line 4—4 of FIG. 3;

FIGS. 5, 6, 7 and 8 are views similar to FIG 4 of modified forms of forming fabric constructed according to the principles of the invention; and

FIG. 9 is a plan view of another modified form of forming fabric constructed according to the principles of the invention.

Referring now to the drawings, and in particular to FIGS. 1 and 2, the illustrated papermaking machine may be seen to comprise an endless fabric belt 10 positioned about a breast roll 11, a couch roll 12, table rolls 13 and a guide roll 14. A vacuum box 15 is positioned beneath the belt 10 and in contact with it.

A headbox 16 having a slice 17 is positioned above the belt 10. The headbox 16 may be of any suitable type, but is preferably one that is particularly suitable for pressure forming. As shown, the headbox comprises a turbulizing driven roll 18 disposed in a cylindrical cavity 19. A stock inlet conduit 20 is connected to the cavity 19, and a throttle plate 21 is adjustably positioned adjacent the roll 18 within the conduit. The inlet is provided with an apron plate 22 and the slice 17 has an end lip 23 which terminates adjacent the breast roll 11. The belt 10 extends around the breast roll 11 and in contact with the lip 23, as shown particularly in FIG. 2.

A tray 24, which is adapted to collect the white water, i.e., the liquid which drains through the fabric 10 during the web forming operation, is disposed between the upper and lower runs of the fabric 10, as illustrated. This tray is arranged to discharge into a mixing tank 25 normally maintained about three-fourths filled with paper stock, which is a fluent mass of fibers and water. Fresh water for makeup purposes may be added through the pipe 26; and additional stock, as is necessary to maintain the proper consistency or fiber concentration of the fluid suspension of stock delivered to the web forming region in the inlet 16, is added through a second inlet pipe 27.

The bottom of the mixing tank 25 is inclined, as shown, and a main flow line 28 connects to the tank at the lower end thereof. The main flow line 28 includes a branch extension 29 having a valve 30 therein for use in draining the mixing tank, and the main flow line 28 also connects with the inflow side of a stock or fan pump 31, which is the principal means relied upon to deliver stock to the web forming region of the machine.

The outlet of the fan pump 31 is connected to the conduit 20 in the headbox 16 by suitable piping indicated generally at 32. Included in this piping is an automatically operable pressure regulating valve 33 and a transition section 34 which converts the circular cross sectional stream delivered by the fan pump 31 and piping 32 to a stream of rectangular outline. The piping 32 also includes a bypass line 35 which connects the outlet side of the fan pump 31, upstream of the pressure regulator valve 33, with the mixing tank 25. A shutoff valve 36 is provided in the bypass line 35. Suitable showers or sprays, indicated generally at 37, are provided for effecting continuous cleaning of the rolls and fabric, in accordance with usual papermaking practices.

The particular breast roll 11 that is illustrated is of the open surface type and comprises a cylindrical shell 38 having a plurality of outwardly projecting rings 39 fixed thereon. The rings 39 support a plurality of vanes 40, and the open surface of the roll 11 is formed by a ribbon 41 that is countersunk endwise into the vanes 40. The fabric 10 is driven by means of any suitable prime mover connected to any of the rolls supporting the fabric 10, and the turbulizing driven roll 18 is also preferably driven by any suitable prime mover (not shown) so as to promote turbulence in the stock passing onto the fabric 10.

A conventional felt section is disposed behind the Fourdrinier section just described, and the felt section may comprise a felt 42 in the form of a loop that extends around a plurality of rolls including the roll 43 which has a nip with the couch roll 12.

In operation, the fan pump 31 draws stock from the mixing tank 25 and discharges it under pressure from the piping 32 into the conduit 20. A part of the stock that passes through the conduit 20 is propeled around within the cylindrical cavity 19 by the driven roll 18, and turbulence and dynamic energy are thus added to the stock prior to its passage onto the fabric 10. A part of the stock from the conduit 20 discharges onto the fabric 10 and breast roll 11 in a web forming region between the apron 22 and lip 23, and white water drains from the stock through the fabric and into the breast roll. The vanes 40 of the breast roll are preferably forwardly bent, as shown, so that they retain a part of the water draining from the stock, so that this water is thrown out of the breast roll 11 between the upper and lower passes of the fabric 10 for helping to dewater the stock to form a web W. White water continues to drain through the fabric 10 as the fabric moves over the table rolls 13 and suction box 15 to the couch roll 12; and the table rolls 13 and suction box 15 all have a vacuum effect for helping to dewater the paper web W. The paper web W is transferred from the fabric 10 onto the felt 42, and the felt section of the machine functions as do conventional felt sections for additionally dewatering the web W and for transferring the web to a conventional drier section (not shown).

Referring to FIG. 3, the fabric 10 may be made up of a plurality of warp strands or filaments 50 which extend in the machine direction, that is, in the direction of movement of the fabric 10 which is indicated by the arrow A in FIG. 3, and a plurality of shute strands or filaments 51 which extend in the cross machine direction. The strands 50 are equally spaced from each other, and the strands 51 are likewise equally spaced from each other, although it will be understood that the strands 50 may be spaced from each other at different distances than the strands 51. The strands 51 in the illustrated form of fabric extend at right angles to the strands 50 and overlie all of the strands 50 so that the strands 51 are on the papermaking side of the cloth 10, that is, the upper side of the run of the fabric 10 between the rolls 11 and 12 which comes into contract with the lip 23 as the fabric 10 moves.

The strands 50 are round metal wires, such as of brass or bronze. The wires 51 may be made of the same metal and are triangular in cross section as illustrated in FIG. 4, each of the wires 51 having plane faces 52, 53, and 54. The face 54 of each of the wires 51 is in contact with the warp wires 50, and the wires 51 are suitably welded to the wires 50 on the edges of the faces 54. The faces 52 and 53 extend at acute angles with respect to the plane *a—a* of the fabric through corresponding points of either of the sets of wires, and the faces 52 and 53 meet at apices that are remote from the wires 50.

The modified form of fabric illustrated in FIG. 5 comprises shute wires 51*a* that are also triangular in cross section and have plane surfaces 52*a*, 53*a*, and 54*a*. The apex of the triangle of each of the wires in cross section formed by the sides 52*a* and 53*a* is in contact with the warp wires 50*a*, and each of the wires 51*a* is welded to each of the wires 50*a* along the apex formed by the surfaces 52*a* and 53*a*. The faces 52*a* and 53*a* extend at acute angles to the plane *a—a* of the fabric as shown.

The modified form of fabric illustrated in FIG. 6 comprises the warp wires 50*b* and shute wires 51*b*. The shute wires 51*b* each have a cross section in the form of a parallelogram and have plane sides 55, 56, 57, and 58. The plane sides 57 are in contact with the warp wires 50*b*, and the wires 51*b* are welded at the edges of the plane sides 57 to the wires 50*b*. The sides 56 and 58 of the wires 51*b* are at acute and obtuse angles with respect to the plane *a—a* of the fabric, so that the wires 51*b* lag or extend backwardly from the direction A of movement of the fabric.

The modified form of fabric illustrated in FIG. 7 comprises the warp wires 50*e* and shute wires 51*e*. The shute wires 51*e* in cross section form five plane sided figures with plane surfaces 59, 60, 61, 62, and 63. The plane surfaces 59 are in contact with the wires 50*e*, and the wires 51*e* are welded to the wires 50*e* at the edges of the surfaces 59. The surfaces 60 and 63 extend at right angles to the plane *a—a* of the fabric; and the plane surfaces 61 and 62 extend at acute angles to the plane *a—a* and form an apex 64 which projects upwardly on the papermaking side of the fabric.

The modified form of fabric illustrated in FIG. 8 comprises the warp wires 50*f* and shute wires 51*f*. The shute wires 51*f* in cross section form parallelograms having plane sides 65, 66, 67, and 68. The plane surfaces 65 are in contact with the warp wires 50*f*, and the wires 51*f* are welded to the wires 50*f* at the sides of the plane surfaces 65. The surfaces 67 extend parallel with the plane *a—a* of the fabric, and the surfaces 66 and 68 are at acute and obtuse angles with respect to the plane *a—a* so that the wires 51*f* lean in the direction of movement A of the fabric.

The advantage of making the shute wires in the various forms of fabric non-round in cross section is to be able to better control the flow of white water between the shute wires and thus to control better the lay of fibers in the finished web and to prevent stapling or fixing of the fibers with respect to the shute wires. The advantage, in particular, of the inverted triangular shape of shute wires, as illustrated in FIG. 5, is to provide the least amount of stapling while yet providing good white water drainage. The paper fibers have a certain stiffness, and due to this stiffness, they are not able to bend around the triangular shute wires 51*a* to fix themselves with respect to the shute wires. It will be observed that the drainage openings between the triangular shute wires 51*a* opens downwardly or inwardly with respect to the fabric so that the drainage openings increase in width inwardly of the wire. While the openings are not strictly in the form of a vena contracta, nevertheless they do open inwardly or downwardly of the wire and provide little impedient to the flow of the water through the fabric which helps in paper formation. The advantage of the form of fabric illustrated in FIG. 4 having the base surfaces 54 of the triangular shapes in contact with the warp wires 50 is to give the maximum amount of white water drainage. The advantages of the forms of fabric shown in FIGS. 6 and 8 are to provide horizontal lines in the paper web and to control cross directional stiffness and strength of the finished web. With respect to the fabric shown in FIG. 6, in which the shute strands 51*b* lag in the direction A of movement of the fabric, this configuration of shute strands allows the white water to more easily flow and be drained between the shute strands 51*b*, the flow being in the direction indicated by the arrow 69.

The forms of fabric having plane surfaces of the shute wires in contact with the warp wires are generally the types most easily welded; since, if electric resistance welding, for example, is utilized, there are greater surfaces of the warp wires and shute wires in contact that may be bonded together. Such forms of fabric are illustrated in FIGS. 4, 6, 7 and 8.

Although I have specifically mentioned electric resistance welding for welding the various wires of the fabrics together, other metal joining methods may also be used, such as brazing, thyratron welding, or even soldering. Since better weld joints are provided with certain types of welding if larger area surfaces are in contact, it may be desirable to make each of the warp wires of the various embodiments in the form of a ribbon of rectangular cross section. Also, although I have referred to the warp and shute filaments as being of metal, it will be apparent that these filaments can instead be made of synthetic or organic material; and, in this case, the strands can be fastened together by means of a suitable adhesive, such as an epoxy resin.

One noteworthy fact with respect to the disclosed fabrics is that the transversely extending strands 51, 51*a*, etc. are elevated with respect to the strands 50, 50*a*, etc. extending in the machine direction; and, therefore, the stock fibers applied onto the fabrics in the forming region between the lip **23** and the apron **22** tend to turn parallel with the transversely extending strands **51**, **51***a*, etc. The resulting web, therefore, is one that has an increased strength transversely as compared to webs that are formed on conventional woven wires that have both the warp and shute strands substantially in the same plane. The elevated transversely extending strands **51**, **51***a*, etc. have another advantageous function, namely, of providing a scraping action on the end of the lip **23**, so as to assure that there is no undue accumulation of fibers behind the lip **23** with resulting poor and uneven sheet formation.

Although it will be obvious that the dimensions of the filaments **50**, **51**, etc. may vary; if it is desired to make a lightweight tissue, the warp wires and the shute wires may, for example, have thicknesses of about .00775 inch and .0095 inch, respectively. In this case there may be about 70 warp wires and 52 shute wires to the inch. The size of the openings looking directly down on the fabric may vary accordingly with the spacing and sizes of the filaments, but may, for example, be about .0065 inch x .0097 inch for tissue. Shute wires **51**, **51***a*, etc. would thus be spaced about .0065 inch in the machine direction; while in the cross direction, the distance between adjacent warp wires would be about .0097 inch.

The forms of fabric previously described include strands that extend at right angles to each other. It will be obvious that the strands instead may be made to extend at acute angles with respect to each other, such as the strands **50***g* and **51***g* making up the fabric illustrated in FIG. 9. The strands **50***g* may be either round or of rectangular cross section similar to the other warp strands, and the shute strands **51***g* may have any of the cross sections previously described for the shute strands.

I wish it to be understood that the invention is not to be limited to the specific constructions and arrangements shown and described, except only insofar as the claims may be so limited, as it will be apparent to those skilled in the art that changes may be made without departing from the principles of the invention.

What is claimed is:

1. An endless fabric belt for Fourdrinier type paper-making machines which is adapted to be supported by and to travel in a certain direction over a plurality of spaced rotatable rolls and to receive and drain a fluent mass of fibers and water to form a paper web on the belt, said belt comprising a first set of filaments extending parallel to each other and longitudinally of the belt and a second set of filaments all disposed on the same side of the belt and extending parallel to each other and crosswise of the belt in contact with and all at a certain angle to the filaments of said first set, the filaments of each of said sets being solid in cross section and being equal in transverse dimension and being equally spaced and the filaments of said two sets being bonded together at intersections of

the filaments, the filaments of said second set being non-round in cross section and having substantially plane surfaces which lie at acute angles with respect to the plane of the belt.

2. An endless fabric belt for Fourdrinier type paper-making machines as set forth in claim **1**, each of said second set of filaments having a cross section in the form of a triangle with the base of the triangle being disposed in contact with said first set of filaments.

3. An endless fabric belt for Fourdrinier type paper-making machines as set forth in claim **1**, each of said second set of filaments having a cross section in the form of a triangle with the apex of the triangle being in contact with said first set of filaments.

4. An endless fabric belt for Fourdrinier type paper-making machines as set forth in claim **1**, said second set of filaments each having a cross section in the form of a parallelogram, opposite sides of which have acute and obtuse included angles with the plane of the belt, another side of the parallelogram being in contact with said first set of filaments.

5. An endless fabric belt for Fourdrinier type paper-making machines as set forth in claim **1** in which said second set of filaments each has a cross section with two plane sides extending substantially at right angles to the plane of the belt and another plane side in contact with said first set of filaments and two more plane sides that meet at an apex opposite said plane side in contact with said first set of filaments.

6. An endless fabric belt for Fourdrinier type paper-making machines as set forth in claim **1** in which said second set of filaments each has a cross section in the form of a parallelogram with two opposite sides of the parallelogram leaning in the direction of movement of said belt.

7. An endless fabric belt for Fourdrinier type paper-making machines as set forth in claim **1** in which said second set of filaments each has a cross section in the form of a parallelogram with two opposite sides of the parallelogram leaning opposite to the direction of movement of said belt.

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