Sept. 11, 1973 D. R. KNOKE 3,758,381

SINGLE ENDLESS STRAND MOUNTED IN SELF CENTERING FASHION IN A SERIES OF PARALLEL CONVOLUTIONS AS A FIBROUS WEB SUPPORTING SURFACE IN A PAPERMAKING MACHINE

Filed March 29, 1972 3 Sheets-Sheet 1

Fig. 1

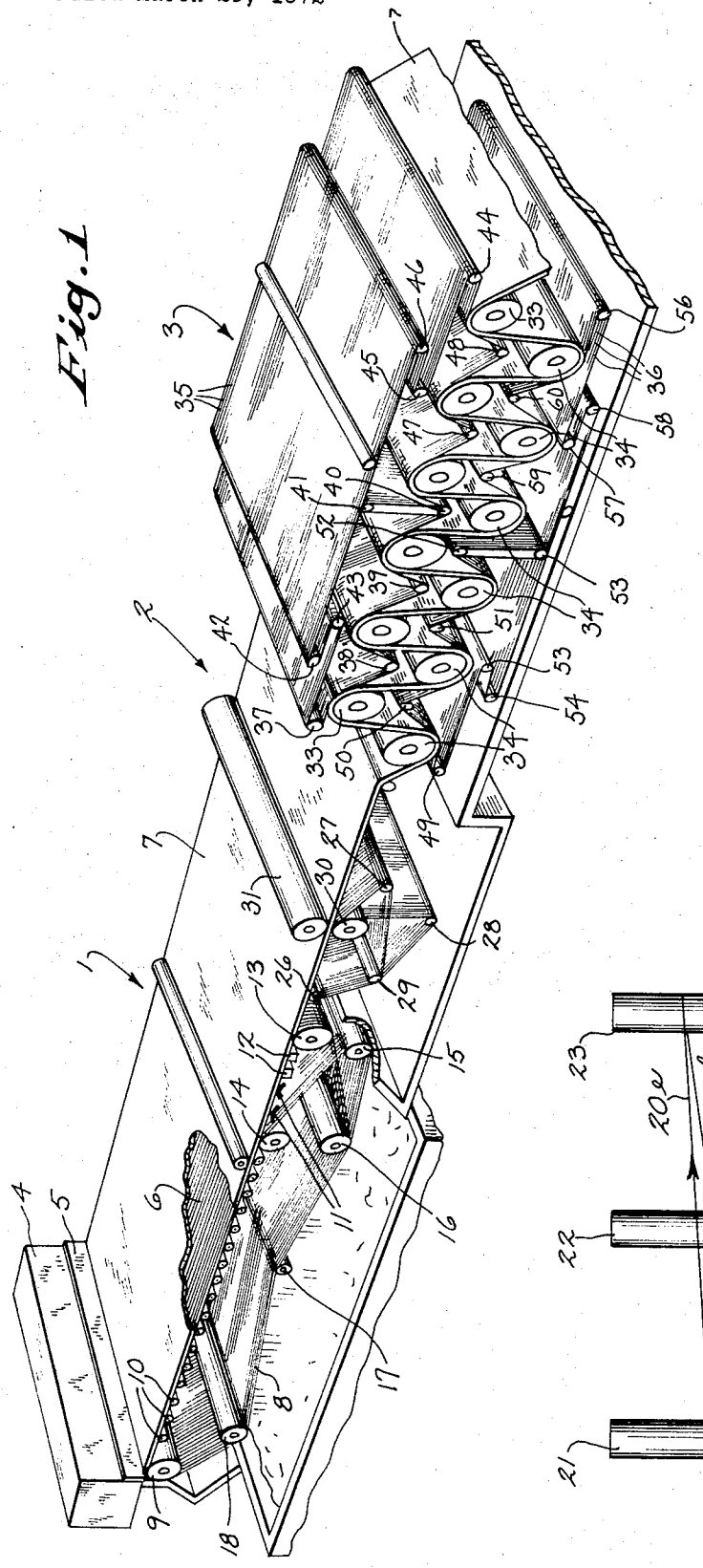
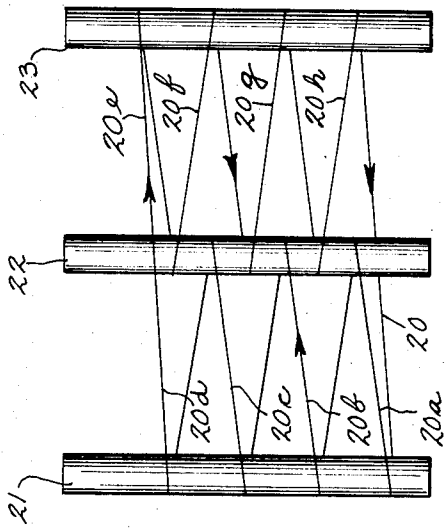


Fig. 2



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Fig. 3

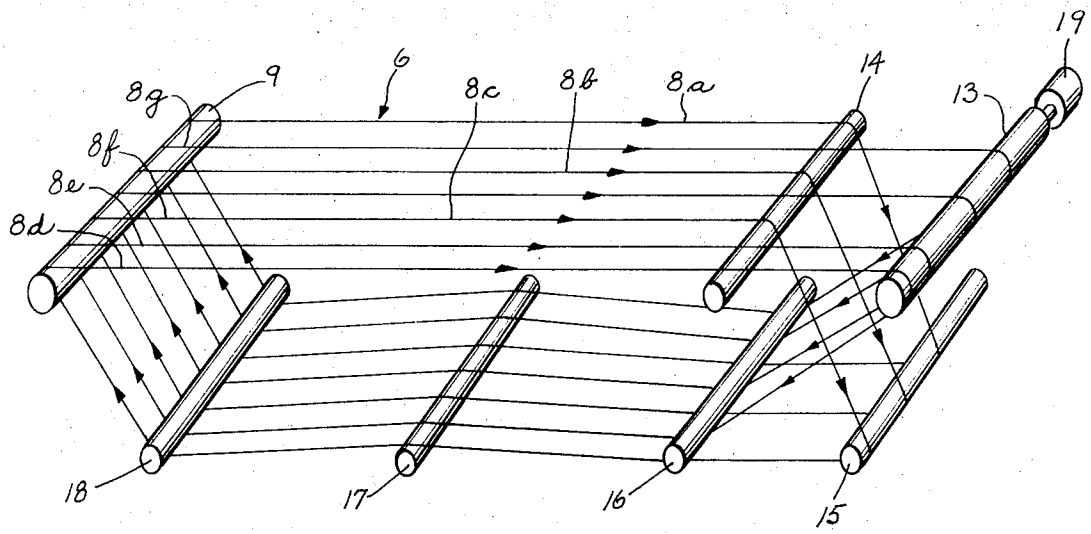
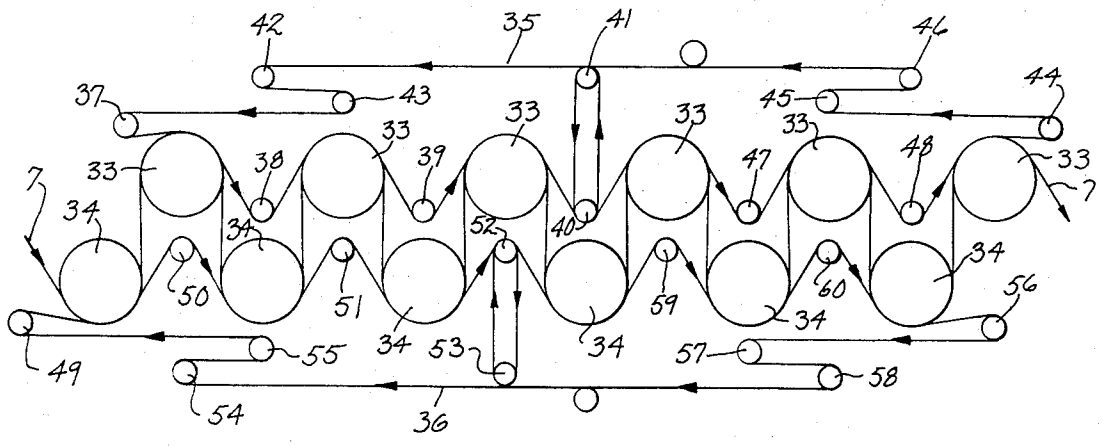


Fig. 6



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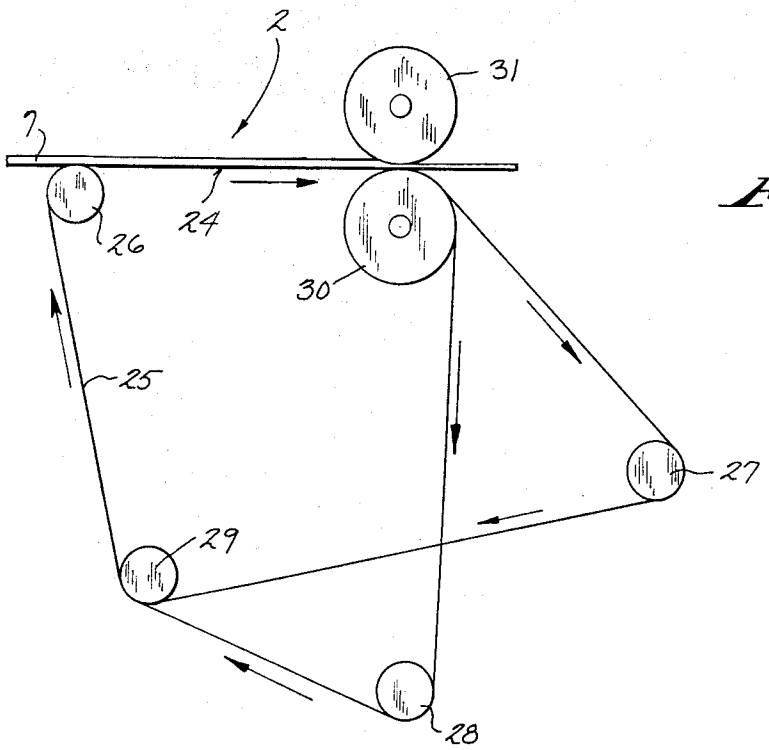


Fig. 4

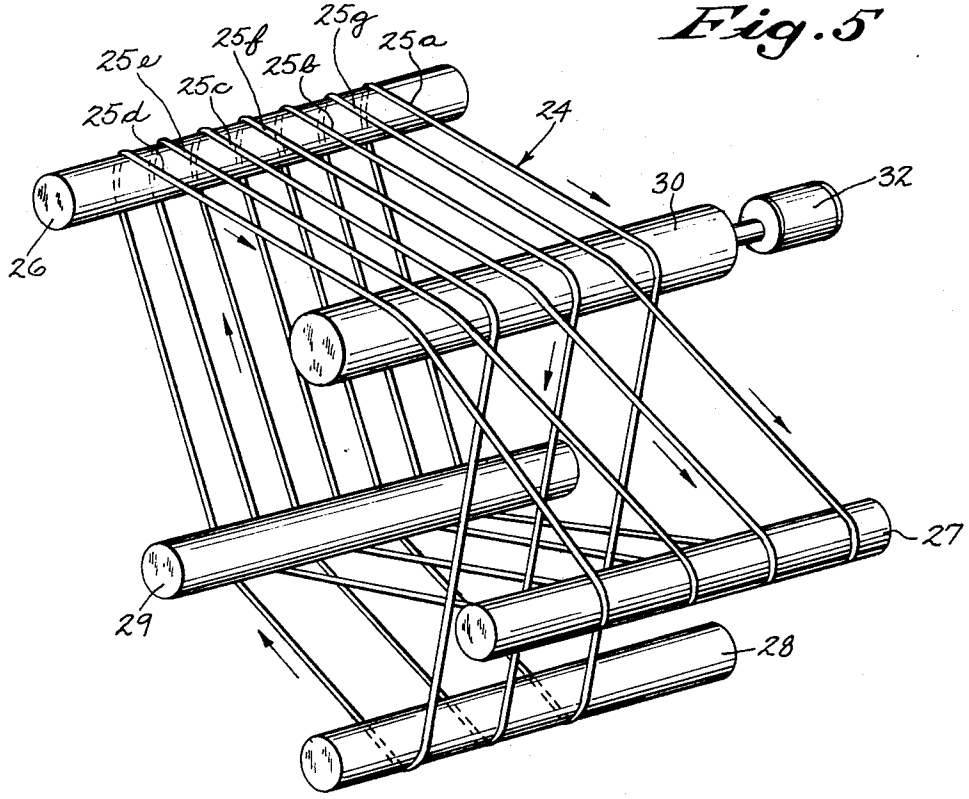


Fig. 5

United States Patent Office 3,758,381 Patented Sept. 11, 1973

3,758,381

SINGLE ENDLESS STRAND MOUNTED IN SELF CENTERING FASHION IN A SERIES OF PARALLEL CONVOLUTIONS AS A FIBROUS WEB SUPPORTING SURFACE IN A PAPERMAKING MACHINE

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U.S. Cl. 162—348 13 Claims

ABSTRACT OF THE DISCLOSURE

A porous, moving, supporting structure for a fluid-impregnated web or sheet, having particular use as a supporting structure for a paper web in a papermaking machine. The web supporting structure is composed of a series of adjacent machine direction convolutions of a single strand mounted to travel in an endless path over a roll assembly. To prevent lateral displacement of the strand in the direction of the roll axes, the strand is wound in both left and right helices on the roll assembly. The counter-displacement tendencies of the merged left and right hand helices prevent the inherent tendency of the strand to drift laterally as it moves through its path of travel.

BACKGROUND OF THE INVENTION

This invention relates to a porous supporting structure for a web or sheet containing a fluid-impregnant, and more particularly to a web supporting structure composed of a series ot adjacent machine direction convolutions of an endless strand which are arranged to travel in a manner to prevent lateral displacement of the strand.

In a papermaking machine diluent water used to prepare cellulose fibers for sheet formation must be removed. The water carried by the formed sheet must be extracted by drainage and pressing, and most of the water remaining in the pressed sheet must be driven out by heat in order to create a paper product. While these water removing operations are taking place, the paper web or sheet must be supported and conveyed by a structure which satisfies both water removal and paper finish requirements. Since gravity, vacuum, pressure, absorption and vaporization are successively used to control the appropriate rate of maximum water removal and also to satisfy the finish or smoothness requirements of the sheet, the structures which support and convey the paper web control the success of the papermaking operation.

The papermaking machine has three sections: forming, pressing, and drying. Each section has distinctive supporting and conveying structures which provide different water removing rates and different paper surface smoothness influences in order to simultaneously provide for the imposed process and product requirements described above. The structures used to support and convey the paper web in each of these sections are generally described, respectively, as forming fabrics, web felts, and dryer fabrics.

It has been recognized that traditional web supporting structures of the papermaking machine, consisting of both machine direction elements or warp yarns and cross direction elements limit their effectiveness in the primary function of water removal. The copending U.S. patent application Ser. No. 10,412 filed Feb. 11, 1970, now abandoned, is directed to a supporting structure for a paper web or sheet in which the cross direction elements are eliminated and a single endless strand is arranged in a series of machine direction loops or convolutions and serves to support the paper web in travel through each of the papermaking sections.

With a web supporting structure of that type there is an inherent tendency for the strand to drift laterally in the direction of the roll axes as it moves through its endless path of travel. More specifically, the strand tends to displace itself laterally one strand width for each revolution through the endless path of travel. This inherent displacement tendency results from the strand being wound in a series of helices and unless compensating measures are taken, the helix literally screws itself off of the supporting rolls. In the past this tendency for lateral displacement has been prevented by using fixed combs or guides which maintain the proper positioning of the convolutions of the strand, or alternatively by skewing the axis of one roll with respect to the other rolls and thereby producing a balancing displacement in an effort to maintain the position of the convolutions on the roll assembly.

SUMMARY OF THE INVENTION

The invention is directed to a porous supporting structure composed of adjacent machine direction convolutions of a strand which is wound on a roll assembly in a manner to prevent lateral displacement of the strand as it moves through its path of travel. In accordance with the invention, lateral displacement of the convolutions, in the direction of the roll axes, is prevented by winding the strand in both left and right hand helices on the roll assembly. The merged left and right hand helices provide a counterbalancing effect which prevents the inherent tendency of the strand to drift laterally as it moves through its endless path of travel. By eliminating the inherent tendency for lateral drift, the invention correspondingly eliminates the need for external devices, such as combs, grooved rolls, skewed rolls, or the like, which have been used in the past to prevent lateral displacement of the strand.

As the strand is wound with both right hand and left hand helices, both sets of strands have a tendency to move laterally in the opposite direction, with the result that adjacent strands are maintained in contiguous relation to provide a more continuous supporting surface without appreciable gaps or spaces between the parallel convolutions.

In a conventional winding pattern utilizing a single, either right or left hand, helix, the strand at one side edge of the pattern must pass through an external loop or guide system and be returned to the opposite side edge of the pattern where it will re-enter the pattern. With the winding pattern of the invention, an external loop or guide system is not required.

Other objects and advantages will appear in the course of the following description.

The drawings illustrate the best mode presently contemplated of carrying out the invention.

In the drawings:

FIG. 1 is a diagrammatic perspective view of a Fourdrinier papermaking machine utilizing the web supporting structure of the invention;

FIG. 2 is a diagrammatic plan view showing the basic winding pattern in which the strand is wound in both right and left hand helices;

FIG. 3 is a diagrammatic perspective view showing the winding pattern in the forming section of the papermaking machine;

FIG. 4 is a side elevation of the press section of the papermaking machine of FIG. 1;

FIG. 5 is a diagrammatic perspective view showing the winding pattern used in the press section; and

FIG. 6 is a side elevation of the dryer section.

FIG. 1 illustrates diagrammatically a papermaking machine including a Fourdrinier or forming section **1**, a press section **2**, and a dryer section **3**. The Fourdrinier section includes a headbox **4** which supplies a slurry of paper pulp through a slice **5** onto a moving web support-

ing surface 6 to form a paper web or sheet 7. The supporting surface 6 is formed by a single endless strand 8 which is wound around a roll assembly so that the adjacent machine direction convolutions of the strand are in closely spaced, parallel relation and define the moving supporting surface.

In forming, a very dilute suspension of fibers is extruded onto the freely draining surface 6 which acts as a filter, collecting the fibers in a wet mat and permitting free passage of water between the machine direction elements or convolutions. Thus, the forming surface must filter fibers from the suspension and drain away excess amounts of water, while at the same time it supports and transports the web of loose fibers which have built up upon its surface. To do this effectively, the supporting surface 6 should be relatively open with uniform spacing between adjacent convolutions of the strand. Preferably, to provide free drainage, the strands are impermeable, and may be formed of metal wire; monofilament plastic, such as nylon polyester or polyacrylic; or plastic impregnated or non-impregnated textile yarn or braid formed of natural or synthetic fibers, or blends of the two.

The roll assembly which supports the strand 8 includes a breast roll 9 located beneath the slice 5, and the slurry which is discharged through the slice onto the supporting surface 6 is carried over a plurality of table rolls 10. As the paper web 7 passes over the table rolls 10, a portion of the water in the web is removed and passes through the spaces between adjacent convolutions of the strand.

As the web is further advanced by the supporting surface 6 of the endless strand 8, it is subjected to the action of a series of dewatering foils 11, followed by a series of suction boxes 12 which also act to remove a portion of the water from the web. A third sequence of water removal may also be provided by having a suction gland extending the length of the driven couch roll 13. Negative pressure applied to the suction gland serves to further extract water from the web.

The roll assembly of the forming section 1 also includes a roll 14 located between breast roll 9 and couch roll 13 and a series of lower rolls 15, 16, 17 and 18 which are located at a level beneath the breast and couch rolls.

The strand 8 can be driven in its endless path by any conventional drive mechanism, and as shown in FIG. 3, the drive comprises a motor and transmission unit 19, which is connected to the shaft of the couch roll 13.

In accordance with the invention, the strand 8 is wound on the roll assembly in a series of both left hand and right hand helices and this winding pattern prevents lateral displacement of the strand in the direction of the roll axes. The basic winding pattern is best illustrated diagrammatically in FIG. 2. As shown in FIG. 2, an endless strand 20, similar to strand 8, is wound on three rolls or guides 21, 22 and 23. In the pattern the strand 20 passes from the roll 21 to the roll 22 in a path 20*a*, then travels beneath the roll 22 and returns to the roll 21. This pattern is repeated with the strand travelling from the roll 21 to the roll 22 in a series of parallel passes or convolutions 20*b*, 20*c* and 20*d*. After travelling from the roll 21 to the roll 22 in the path 20*d*, the strand then passes to the roll 23 in path 20*e* and back to the roll 22. This pattern is repeated with the strand moving from the roll 22 to the roll 23 in a series of parallel passes or convolutions 20*f*, 20*g* and 20*h*. After passing around the roll 23 in path 20*h*, the strand then travels beneath the roll 22 to the roll 21 where the entire pattern is repeated.

As shown in FIG. 2, the passes or convolutions 20*a*–20*d* are wound on the rolls 21 and 22 in the form of a right hand helix, while the passes 20*e*–20*h* are wound on the rolls 23 and 22 in the form of a left hand helix. As the strand is wound in intermingled left and right hand helices on the single roll 22, the lateral displacement tendency of each helix is balanced as the strand travels through its endless path, thereby preventing the inherent tendency of the strand to shift laterally on the rolls or guides.

In order to provide a balanced effect and prevent lateral drifting of the strand, the strand should be wound with approximately the same number of left hand and right hand helices. While FIG. 2 shows the right hand and left hand helices in alternating sequence on roll 22, this pattern is not critical and a series of right hand helices can be positioned on the roll 22 followed by a series of left hand helices, etc. Thus, the left and right hand helices can be arranged in any desired pattern with the object being to provide a balance to prevent the lateral shifting of the strand.

The basic winding pattern illustrated diagrammatically in FIG. 2 is utilized in the forming section 1, press section 2, and dryer section 3. FIG. 3 is a diagrammatic showing of the winding pattern as specifically applied to the forming section 1. As shown in FIG. 3, the strand 8 passes from the breast roll 9 to the roll 14 in a path 8*a*, then travels downwardly around roll 15 beneath roll 16, over roll 17, beneath roll 18, and returns to the roll 9. This pattern is repeated with the strand travelling from the breast roll 9 to the roll 14 in a series of parallel passes or convolutions 8*b*, 8*c* and 8*d*, which constitute a portion of the web supporting surface 6. After travelling from the breast roll 9 to the roll 14 in the path 8*d*, the strand then continues to the couch roll 13, then travel around couch roll 13, beneath roll 16, over roll 17, beneath roll 18, and back to the roll 9. This pattern is repeated with the strand moving from the breast roll 9 to the couch roll 13 in a series of parallel passes or convolutions 8*e*, 8*f*, and 8*g*, all of which, along with pass 8*d*, constitute a portion of the web supporting surface 6. After passing around the roll 13 in path 8*g*, and returning to breast roll 9, the strand moves in the path 8*a* and the entire pattern is repeated.

With the winding pattern shown in FIG. 3, the passes or convolutions 8*a*–8*d* are wound on the roll assembly with a right hand helix, while the passes or convolutions 8*e*–8*g* have the opposite or left hand helix. The intermingled or merged left and right hand helices prevents the tendency of the strand to shift laterally, in the direction of the roll axes, as the strand moves in its path of travel.

With the winding pattern of the invention, it is not necessary to provide an external loop or guide system to transfer the strand from one side edge of the winding pattern to the other in order to provide the endless winding pattern. In the conventional winding pattern in which the strand is wound in either right hand or left hand helices, the strand at one side edge of the pattern must be passed by means of pulleys or guides to the opposite side edge of the pattern where it will re-enter the pattern. With the use of both right hand and left hand helices, as illustrated in FIG. 3, this external loop is not necessary, thereby eliminating the auxiliary guide system which is normally required for the external loop.

FIG. 3 is merely a diagrammatic illustration of the winding pattern that can be utilized in accordance with the invention, and while the convolutions defining the web supporting surface 6, are illustrated as being a considerable distance apart, in practice these convolutions may be in closely spaced or contiguous relation. Similarly, while FIG. 3 illustrates only several convolutions as the web supporting surface, in practice, there may be thousands of machine direction convolutions that define the web supporting surface 6.

In the press section 2, water is extracted from the wet paper web 7 by pressing the web through a set of coacting press rolls. The web supporting surface in the press section serves to (1) support the weak web in the pressure zone, (2) uniformly compress the wet web so as to obtain maximum pressing efficiency and sheet smoothness and to develop a bond between the fibers, (3) receive

water extracted from the web, and (4) transfer the water away from the pressure zone.

As illustrated in FIG. 4, the paper web **7** is transferred from the forming section **1** to the press section **2** and is supported and advanced in the press section by a supporting surface **24** composed of a series of parallel machine direction convolutions of a strand **25** that is wound in an endless pattern around a roll assembly. The roll or guide assembly in the press section comprises a series of rolls **26, 27, 28** and **29**, as well as a pair of cooperating press rolls **30** and **31** which act to express water from the paper web **7** as it is advanced by the supporting surface **24.**

The convolutions of the strand **25** that define the supporting surface **24** should be contiguous or relatively close together so as to provide maximum uniformity of support and pressure application for the web **7.** Furthermore, the strand **25** should be permeable so as to accommodate water expressed from the paper web, compressible so as to respond to the pressure zone and apply uniform pressure, and resilient so as to recover from the pressure zone and continually provide voids for accepting extracted water. It has been found that textile yarns composed of either natural or synthetic fibers of filaments or blends in the form of continuous yarns or braided or twisted structures provide these desired characteristics and are particularly satisfactory for use as the strand **25** in the press section **2.**

The winding pattern of the strand **25** in the press section **2** is best illustrated in FIG. 5. The winding pattern is similar to that described with respect to the forming section and the strand **25** is arranged in both left and right hand helices on the roll **26.**

More specifically, the strand **25** travels in a path or convolution from roll **26** to the nip between the press rolls **30** and **31** in a path **25***a*, then passes downwardly from the press roll **30**, around rolls **28** and **29** to the roll **26** and then returns to the nip zone in a second pass **25***b*. This winding pattern is repeated with the strand moving successively in the passes or convolutions **25***c* and **25***d*, all of which constitute a portion of the web supporting surface **24.** After travelling through the nip zone between rolls **30** and **31** in pass **25***d*, the strand then passes downwardly around the rolls **27** and **29** and returns to the roll **26**, where it travels to the nip zone in a pass **25***e*. This pattern is repeated with the strand moving in a successive series of parallel convolutions or passes **25***f* and **25***g*, which in combination with convolution **25***e*, also constitute a portion of the web supporting surface **24.**

With the winding pattern shown in FIG. 5, the passes or convolution of the strand **25***a*–**25***d* are wound with a right hand helix angle, with the passes **25***e*–**25***g* having the opposite or left hand helix angle. As previously mentioned, the winding of the strand with both right and left hand merged helices on the common roll **26** prevents the tendency of the strand to be displaced laterally, as it moves through its endless path of travel. The winding pattern has an additional advantage when utilized in the press section of the papermaking machine, in that the inherent tendency of the right and left hand helices to be displaced in opposite directions causes the convolutions in the supporting surface **24** to bear against each other and bring the adjacent convolutions into tight contiguous relationship which is preferred for the supporting surface **24** in the press section **2.**

The strand **25** can be driven in its path of travel by a conventional drive mechanism associated with one of the rolls in the roll assembly. As shown in FIG. 5, a motor and transmission unit **32** is connected to the shaft of the lower press roll **30.**

Following the pressing operation, the paper web **7** is transferred to the drying section **3.** The drying operation, as performed in the drying section **3** entails driving off moisture in the wet web or sheet **7** by means of heat and mass transfer. The dryer section includes a series of heated upper dryer rolls **33** and lower dryer rolls **34** and the paper web passes alternately around the rolls **33** and **34.** A single endless strand **35** is wound on a roll assembly in a series of machine direction convolutions which define a web supporting surface and act to apply uniform pressure against the upper drying rolls **33** to increase the heat transfer from the rolls to the paper web **7.** Similarly, a second endless strand **36** travels over a roll assembly in a series of machine direction convolutions which define a web supporting surface and act to force the paper web **7** against the lower drying rolls **34** to aid in heat transfer. The strands **35** and **36** are wound in the manner described with respect to the forming and press sections, in which each strand is wound with a series of both left hand and right hand helices thereby preventing lateral displacement of the strands on the respective roll assemblies.

More specifically, the strand **35** is wound on rolls **37, 38, 39, 40, 41, 42** and **43** in a series of right hand helices and is also wound on rolls **44, 45, 46, 41, 40, 47** and **48** in a series of left hand helices which are merged with the right hand helices on the rolls **40** and **41.** Similarly, the strand **36** which forms the web supporting surface for the series of lower dryer rolls **34**, is wound on rolls **49, 50, 51, 52, 53, 54** and **55** in a series of right hand helices and is also wound on rolls **56, 57, 58, 53, 52, 59** and **60** in a series of left hand helices. The right and left hand helices of strand **36** are intermingled on rolls **52** and **53** to thereby prevent lateral drift of the strand **36** as it moves through its path of travel.

Each strand **35** and **36** is driven in its endless path of travel by a conventional drive mechanism, not shown, associated with one of the rolls in the respective roll assemblies.

While the drawings illustrate the right and left hand helices merged on a common or self centering roll, the use of a common roll is not essential, and the winding pattern can be designed so that the right and left hand helices are wound on separate groups of rolls and are merged or intermingled at locations between rolls.

When using a common or self centering roll, the roll can be located anywhere in the roll assembly, but as the self centering roll carries a full complement of convolutions, it is preferred to locate the self centering roll in a position where it will constitute a portion of the web supporting surface.

While the above description has shown the invention as applied to the papermaking machine, it is contemplated that the invention can be utilized in any application where it is desired to support and convey a fluid impregnated web through use of a single endless strand.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. A porous moving supporting structure comprising, a guide assembly including a plurality of generally parallel guide members, a single endless strand mounted for travel on the guide assembly in a series of convolutions, a first group of said convolutions being disposed on said guide assembly in a series of right hand helices and a second group of said convolutions being disposed on said guide assembly in a series of left hand helices, and drive means for moving said strand in said path of travel, the tendency of the first group of convolutions to shift laterally in one direction with respect to the direction of travel is balanced by the tendency of said second group of convolutions to shift laterally in the opposite direction.

2. The structure of claim **1**, wherein at least one of said groups of convolutions defines a portion of a web supporting surface to support and advance of a fluid impregnated web.

3. The structure of claim 2, wherein the structure is a portion of a papermaking machine and the web is a paper sheet impregnated with water.

4. The apparatus of claim 1, wherein the number of convolutions in said first group is approximately equal to the number of convolutions in said second group.

5. The apparatus of claim 1, wherein the convolutions of said first group are in alternating sequence with the convolutions of the second group.

6. In a papermaking machine, a guide roll assembly including a plurality of guide rolls, a single endless strand mounted for endless travel on the guide roll assembly in a series of machine direction convolutions, a first group of said convolutions being disposed on said guide roll assembly in a series of left hand helices, a second group of said convolutions being disposed on said guide roll assembly in a series of right hand helices, at least one of of said groups of convolutions defining a portion of a web supporting surface to support and advance a wet paper web, means for extracting water from the paper web supported on said supporting surface, and drive means for driving the strand in endless travel on the guide roll assembly, the tendency of the first group of convolutions to shift laterally in one direction with respect to the direction of travel is counterbalanced by the tendency of the second group of convolutions to shift laterally in the opposite direction, thereby preventing lateral displacement of the strand in the direction of the roll axes.

7. The apparatus of claim 6, in which the number of convolutions in said first group is approximately equal to the number of convolutions in said second group and the convolutions of said first group are disposed in alternating sequence with the convolutions of said second group.

8. The apparatus of claim 6, in which the convolutions of the first group are merged with the convolutions of the second group on a common roll of said guide roll assembly.

9. The apparatus of claim 6, wherein said guide roll assembly comprises a portion of the forming section of a papermaking machine and said strand is formed of a substantially water-impervious material.

10. The apparatus of claim 9, and including pressure means for applying pressure to the paper web supported on the supporting surface.

11. The apparatus of claim 6, wherein said guide assembly comprises a portion of the press section of a papermaking machine and said strand is formed of a compressible, resilient water-permeable material.

12. The apparatus of claim 6, wherein said guide assembly comprises a portion of the dryer section of a papermaking machine, said apparatus also including a heated dryer roll, said web supporting surface disposed to force the paper web against the outer surface of said dryer roll.

13. In an apparatus for supporting a web impregnated with a fluid, a guide assembly including three generally parallel guide members with the second guide member being located between the first and third guide members, a single endless strand mounted for travel on the guide assembly in a series of repeating machine direction convolutions, a first group of said convolutions extending from the first guide member to the second guide member and being wound in a left hand helix, a second group of said convolutions extending from the third guide member to the second guide member and being wound in a right hand helix, and drive means for moving said strand in said path of travel, the tendency of the first group of convolutions to shift laterally in one direction with respect to the direction of travel is balanced by the tendency of said second group of convolutions to shift laterally in the opposite direction.

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U.S. Cl. X.R.

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