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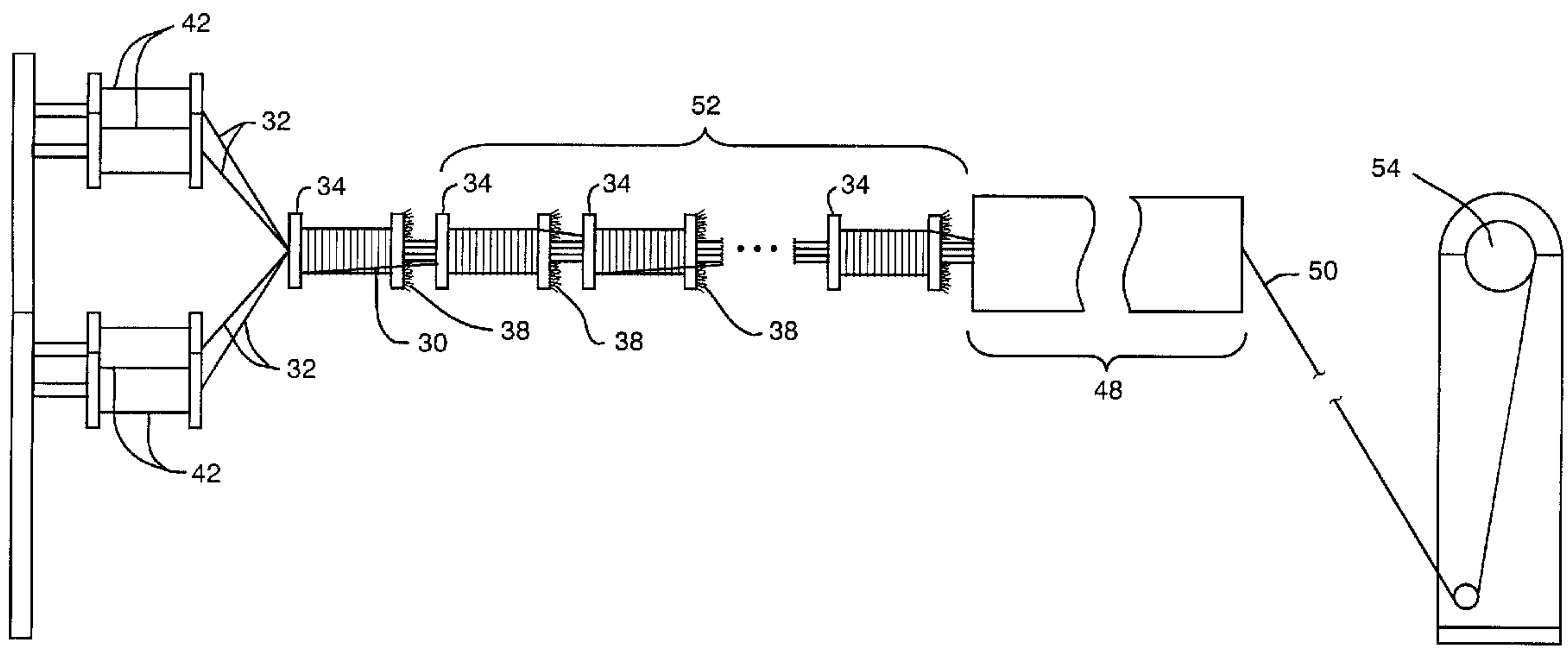
(54) Titre : FIL POUR MACHINE DE FABRICATION DE PAPIER
(54) Title: PAPERMAKER'S YARN



(57) Abrégé/Abstract:
A yarn has a central core of untwisted filaments (32) overwrapped with alternating helically wound twisting filaments (30), wherein the helically wound filaments (30) alternate from right to left and from left to right to form a distinct layer of filaments wrapped in a clockwise direction, and a distinct layer of filaments wrapped in a counterclockwise direction.

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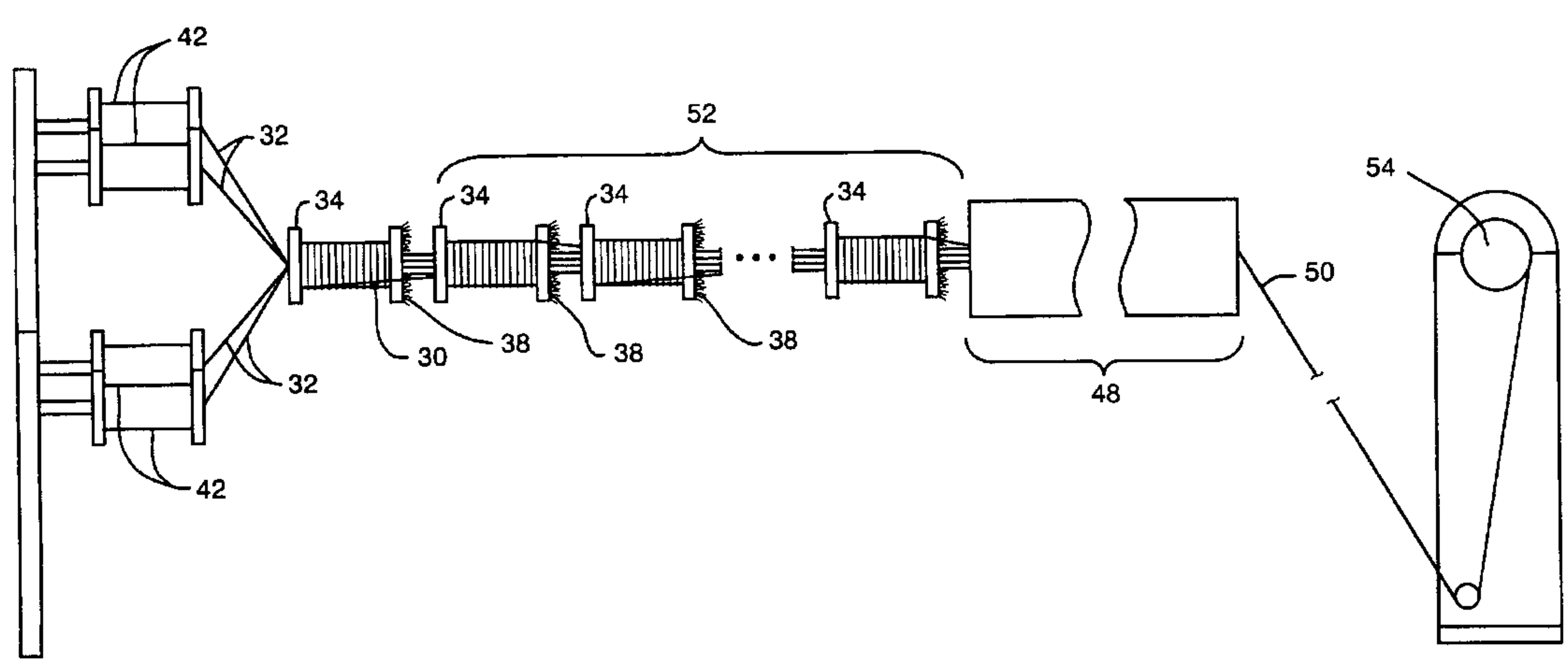
(54) Title: PAPERMAKER'S YARN



(57) Abstract: A yarn has a central core of untwisted filaments (32) overwrapped with alternating helically wound twisting filaments (30), wherein the helically wound filaments (30) alternate from right to left and from left to right to form a distinct layer of filaments wrapped in a clockwise direction, and a distinct layer of filaments wrapped in a counterclockwise direction.

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PAPERMAKER'S YARN

Cross-Reference to Related Applications

A claim of benefit is made to U.S. Provisional Application Serial No. 60/125,283 filed March 19, 1999, the contents of which are incorporated herein by reference. This is a continuation-in-part application of the Provisional Application filed March 19, 1999, the contents of which are incorporated herein by reference.

Background of the Invention

(1) Field of the Invention

This invention relates to yarns for use in papermaking fabrics, and more specifically to stuffer yarns used in papermakers' fabrics.

(2) Description of Prior Art

In the early days of papermaking, a slurry of paper-forming particles was deposited on a wire screen. Eventually, that wire screen evolved into a woven fabric woven from yarns. Indeed, because the screens are woven, such products that are used on papermaking machines have become known as papermachine clothing. As one can imagine, the properties of the yarns used in weaving papermachine clothing are important, and contribute to, the final characteristics of the papermachine itself.

The usual papermaking machine has three primary sections: a forming section, a press section, and a drying section. In the forming section, a water slurry or suspension of cellulose fibers, known as the paper stock or pulp, is fed onto the top of the upper run of a travelling endless forming belt. The forming belt provides a papermaking surface and operates as a filter to separate the cellulosic fibers from the aqueous medium to form a wet paper web. In forming the paper web, the forming belt serves as a filter element to separate the aqueous medium from the cellulosic fibers by providing for the drainage of the aqueous medium through its mesh openings, also known as drainage holes, by vacuum means or the like located on the drainage side of the fabric.

From the forming section, the somewhat self-supporting paper web is transferred to the press section of the machine and onto a press felt, where still more of its water content is removed by passing it through a series of pressure nips formed by cooperating press rolls, these press rolls serving to compact the web as well. A press felt generally includes a woven fabric to which a batt material is applied, usually by one or more needling operations, as is known in the art. As will be described herein, the stuffer yarns of the present invention may be used to enhance batt anchorage in a press felt.

After leaving the press section, the paper web is transferred to a dryer section where it is passed about and held in heat transfer relation with a series of heated, generally cylindrical dryer rolls to remove still further amounts of water therefrom. One or more dryer fabrics may be employed to press the moist web uniformly and successively against the dryer cylinders to dry the web.
As used herein and in the claims, the term "papermaking machine" is to be considered in a broad or generic sense, that is, the machine producing a paper or paper-like material such as pulp, board, asbestos sheet or other similar structures.

In the dryer section, the dryer cylinders are internally heated by steam or the like. The cylinders usually have imperforate surfaces for contacting the paper web. Other rolls, such as pocket rolls, may have surfaces which are perforated or slotted to permit the passage of heated air therethrough to increase the drying action on the web.

Ideally, dryer fabrics should have at least the following properties. First, they should have a top surface that is fine enough to minimize marking of the sheet of paper being produced. Second, they should have a resilient bottom layer to provide long life while enduring the stress the fabric is subjected to while in contact with the machine over a long period of time. Third, the dryer fabric weave should be open enough to allow heat to pass through without significant impedance. Fourth, the fabric should be designed in such a way that the permeability of the fabric, and thus the heat transfer from the dryer cylinders to the web, may be controlled.

In multilayer dryer fabrics, it is known in the art that a certain degree of control may be exhibited over the permeability of the woven dryer fabric by inserting additional cross machine direction yarns, called stuffer picks, or stuffer yarns, into the weave at selected positions across the fabric. These yarns serve to fill the air pockets or voids created in the weave between the machine direction and cross machine direction yarns. These stuffer yarns can also serve the supplemental purpose of joining the top and bottom layers of the fabric and lending an increased cohesiveness and durability to a fabric that would otherwise be overly porous and vulnerable to wear.

Problems Associated with Prior Art Stuffer Yarns

In the past, several varieties of stuffer yarns have been employed for the purposes noted above. The most common yarns utilized have been cabled monofilament yarns, hollow monofilament, and thermoplastic coated (or deformable) cross- machine-direction yarns. Each of these yarns brings limitations to the dryer fabric application. Specifically, a daunting problem is that none of the three prior art stuffer yarns provide the desired degree of permeability control in the dryer fabric in which a stuffer yarn is used.

Prior Art Cabled Yarns

In addition, a number of problems specific to the use of cabled yarns as stuffer yarns in a dryer fabric are well known in the art. For example, a major problem is that they are bound tightly and are not able to efficiently fill the interstices of the woven fabric to impede the flow of air, as desired. Furthermore, the cabled monofilament stuffer yarn does not weave efficiently. Undesirable torque builds up during the weaving process which results in pigtails or kinks being pulled into the fabric.

In addition, the diameter and shape of the fibers used in the manufacture of the cabled yarn should be identical. When fibers of varying diameters are twisted into a cabled yarn, the resulting yarn becomes buckled and kinked. The difficulties of incorporating such a yarn into a weave are obvious. Even if it were possible to weave such a yarn into a fabric, the resulting fabric would be uneven and cause marking and non-uniform drying to the paper web. Thus, cabled yarns are limited to fiber bundles of uniform cross section and diameter. The result of this limitation is that cabled yarns have a somewhat uniform radius, and will not fill fabric voids. The result of having fabric voids in papermakers' fabric made with cabled yarns of the prior art is loss of control over the permeability of the fabric.

Prior Art Monofilament Hollow Yarns

Monofilament hollow yarns have also used been used as cross machine direction stuffer picks in dryer fabrics. Further, while hollow monofilaments will distort to fill the fabric voids they will not provide the same effect as the intertwisted yarns' ability to allow individual monofilaments to disperse in the fabric voids. The major disadvantage of using hollow yarns as stuffer yarns is that such yarns are more difficult to produce than conventional monofilament yarns and, as a result, are significantly more expensive than cabled monofilament or intertwisted monofilament yarns.

Thermoplastic Coated Deformable Cross-Machine-Direction Yarns

Cross-machine direction yarns which are deformable have been used as stuffer yarns, but, like hollow yarns, they are very costly to manufacture. Further, they require special post-treatment to allow the coating to deform to fill the fabric voids.

For the foregoing reasons, there is a need for an improved stuffer yarn for use in papermakers' fabrics, and for an improved method of making such a yarn that is fast and economical.

Summary of the Invention

The present invention satisfies these needs with an improved assembled multifilament stuffer yarn for use in papermakers' dryer fabrics and press felts, utilizing monofilament filaments that are helically wrapped or twisted clockwise and counterclockwise around a core by pulling the wrapping or twisting filament with the core.
Additionally a stuffer yarn may include core yarn or monofilament or a parallel bundle of core yarns or monofilaments fed from a supply reel, fed through the hollow centers of the supply spools from which the intertwisting filaments payoff.

The yarn is made by passing a filament or a yarn or a plurality of filaments or a mixture of filaments and yarns or a mixture of a core filament and a yarn or a mixture of a core filament and a core yarn, hereinafter referred to in the specification and in the claims as the "core," from static-positioned spools through the hollow center of twisting filament-loaded supply spools positioned sequentially in a linear pattern.

As the core is passed through the hollow center of each of the twisting filament-loaded supply spools, the core is helically wrapped by a twisting filament that is pulled off of the supply spool along with the moving core. The supply spools are oriented in positions such that the twisting filament that is pulled off some of the supply spools wraps the core in a clockwise direction, and some of the twisting filaments wrap the core in a counterclockwise direction.

Accordingly, an object of the invention is invention to provide an improved assembled monofilament yarn for use in a papermaking fabric that will efficiently control the flow of air through the fabric.

A further object of the present invention is to provide an improved assembled monofilament yarn for use in a press felt that provides improved anchorage for needling batt fibers.

Yet another object of the present invention is to provide an improved dryer fabric for the dryer section of a papermaking or similar machine utilizing the intertwisted monofilament yarns of the present invention as stuffer yarn.

Another object of the present invention is to provide an improved press felt for the press section of a papermaking or similar machine utilizing the multifilament yarns of the present invention for scrim structure substrate.

Yet another object of the invention is to provide a dryer fabric that may be employed to press the moist web uniformly and successively against the dryer cylinders to dry the web.

A further object of the invention is to provide yarns that can be utilized as stuffer picks in a dryer fabric, filling in fabric voids, thereby allowing for improved control of permeability.

Another object of the invention is to provide a yarn that can be utilized in a papermakers' fabric and which provides improved control of heat transfer.

Another object of the invention is to provide a yarn which will impart greater wear resistance and compaction resistance to a press felt made therefrom.

Another object of the invention is to provide a multifilament yarn that can be woven efficiently, without undesirable torque build-up which results in kinks being pulled into the fabric.

A further object of the invention is to provide an improved papermakers' yarn that is less expensive to make than monofilament hollow yarns and cross-machine-direction yarns.

Features, aspects, and advantages of the present invention are better understood with regard to the following description, appended claims, and accompanying drawings.

<u>Brief Description of the Drawing</u>

Fig. 1 is a diagrammatic representation of papermaking machine.
Fig. 2 shows a top plan view of a typical prior art hollow monofilament yarn.
Fig. 3 is a cross-sectional view in the cross-machine direction of a prior art fabric utilizing the hollow monofilament yarn of Fig. 2 as cross-machine direction stuffer picks.
Fig. 4 is a cross-sectional view of one embodiment of the yarn of the present invention.
Fig. 5 is a cross-sectional view of a prior art dryer fabric.
Fig. 6 is a cross-sectional view in the cross-machine direction of a dryer fabric of the present invention.

Fig. 7 is a fragmentary side schematic showing the spindle assembly used to make the yarn of the present invention.

Fig. 8 is a perspective view of the spindle assembly used to make the yarn of the present invention.

Fig. 9 is a view of the first supply spool in the spindle assembly.

Fig. 10 is a view of two supply spools in the spindle assembly.

Fig. 11 is a view of one of the last two supply spools, which are motor-driven.

Description of the Preferred Embodiments

At the outset, the invention is described in its broadest overall aspects with a more detailed description following. The present invention is a multifilament stuffer yarn for use in papermakers' fabrics, and a method of making the stuffer yarn. The improved yarn has applications for use in the dryer, forming and press sections of a papermaking machine.

Fibers selected for use in the yarn and fabrics of the present invention may be those commonly used in papermakers' fabrics. The fibers could be cotton, wool, polypropylenes, polyesters, aramids or nylon. One skilled in the relevant art will select yarn materials according to the particular application of the final fabric.

The Structure of the Yarn in Relation to its Function in Papermakers' Fabrics

Turning now to the specific forms and aspects of the invention selected for illustration in the drawing, which is intended for illustrative purposes and which is not intended to limit the scope of the appended claims, Fig. 1 shows a diagrammatic representation of a papermaking machine, on which fabrics constructed partially of yarn made in accordance with the present invention may be used.

The exemplary papermaking machine is shown for the purposes of illustration of the application of the yarn of the present invention to papermakers' dryer fabrics. As shown in Fig. 1, the machine includes a forming section 60 (having a forming fabric 61), a press section 62 (having a press felt 63), and a dryer section 64 (having a dryer fabric 65).

Fig. 5 illustrates a prior art dryer fabric 80 having cross- machine-direction yarns 82, machine direction yarns 84, and cabled monofilament stuffer yarns 86. Fig. 6 illustrates a cross sectional view in the cross machine direction, having machine direction yarns 82, cross- machine-direction yarns 84, and the wound stuffer yarns of the present invention 88.

From Fig. 6, the advantages of the dryer fabric utilizing the wound yarn of the present invention over the prior art dryer fabric of Fig. 3 or Fig. 5 become apparent. Compared to the single, fixed-diameter hollow monofilament yarns 28 of Fig. 3 and the cabled stuffer yarn 86 of Fig. 5, the embodiment of Fig. 6 illustrates the advantages of the wrapped yarn 88 of the present invention in creating a dryer fabric which allows the papermaker increased control of permeability in the dryer section of the papermaking machine. As seen in the cross-sectional view in Fig. 4 of one embodiment of the yarn of the invention and in Fig. 6, the separation of filaments comprising the yarn of the invention causes the yarn to fill the interstices of the fabric, which controllably inhibits the air flow through the fabric, and results in the formation of a superior sheet of paper.

In yet another embodiment of the invention, the wound yarns of the present invention may be used as stuffer picks in the cross machine direction of a press fabric. As has previously been described, press fabrics are used in papermaking machines to support the moist, freshly formed paper web as it encounters a variety of rolls to extract water from the moist paper web. A press felt is formed through a needling process, whereby a batt material is applied to a base fabric and driven into interengagement with the fabric. As is known in the art, there is significant stress placed upon the press felt in the press section of the papermaker's machine.

In the present embodiment, the wound yarns of the present invention are inserted as stuffer picks in the press fabric, in much the same manner as has been previously described with respect to a dryer fabric. The fabric is subsequently needled with batt material. In the present embodiment, improved anchorage of the batting material in the base fabric is effected by the interengagement of the batt fibers with the additional wound stuffer picks of the present invention during needling. Specifically, the multifilament stuffer picks of the present invention engage the batting material more tightly during needling as a result of the increased contact area. Additionally, because the cross machine-direction yarns are wound multifilament, the degree to which batt fibers become enmeshed and intertwined with these yarns is greater than that in prior art felts. This increased entwinement results in higher frictional forces between the batt fibers and the wound stuffer picks, thus producing a higher degree of restricted lateral movement of batt fibers once needled. This embodiment provides an advantageous felt construction, offering improved felt durability and wear characteristics.

In yet another embodiment, the wound yarns of the present invention may also be used as stuffer yarns in forming fabrics of a papermaking machine.

Thus it will be readily apparent to those skilled in the art that the use of the bound yarns of the present invention, and specifically the use of the bound yarns of the present invention as stuffer picks in the dryer and press fabrics of a papermaking machine affords the papermaker enhanced control over the papermaking process such as the control of heat transfer and permeability in the dryer section and improved batt retention and wear qualities in the press section.

The preceding detailed descriptions of embodiments of the present invention are intended to provide examples of how bound cross machine-direction stuffer picks may be used in accordance with the present invention, but they are not intended to limit the use to the applications described. Further embodiments may also be designed in accordance with the present invention. It is to be understood that numerous combinations of yarn types, yarn diameters, winding geometries and arrangements of yarns may be used with equal facility and effectiveness. It is also to be understood that many other variations and modifications of this fabric construction, all within the scope of this invention, will readily occur to those skilled in the art. While the embodiments, as described above, have been illustrated in the form of dryer and press fabrics made up in simple duplex weaves, it will be understood that any appropriate multi-layer weave can be used which will enable the introduction of stuffer picks. By varying the geometry of the stuffer picks, a large variety of dryer and press fabrics of different characteristics can be achieved. Accordingly, the foregoing is intended to be descriptive only of the principles of the invention and is not to be considered limitative thereof.

Making the Papermakers' Yarn

The yarn is made by pulling the core yarn or core filament from static-positioned core yarn spools mounted on hollow spindles and then through the hollow center of each of several twisting filament-loaded supply spools positioned sequentially in a linear pattern.

As shown in Fig. 8, the core yarns 32 are pulled from core yarn spools 42 held on a core yarn spool holding array 44.

As shown in Fig. 7 and Fig. 8, the core is advanced through a series of spindles 36 in a spindle assembly 52. Each spindle 36 in the assembly 52 serves as an axle for a twisting filament-loaded supply spool 34. In one embodiment twenty (20) core yarns pass through eight (8) spindles 36, with each spindle 36 serving as the axle of yet another twisting filament-loaded supply spool 34. The supply spool 34 is held stationary, and the twisting filament 30 is pulled off the twisting filament-loaded supply spool 34 at 90 degrees from the tangential direction, and then is fed into the spindle 36.
If the core yarns 32 were merely pulled through the spindles 36, they would remain essentially parallel to one another, and in the formation of the array, with no twisting. However, when a twisting filament 30 is pulled from a twisting filament-loaded supply spool 34 on the axle of the spindle 36, the mere act of pulling the bundle of core yarns 32 through the spindle 36 causes the twisting filament 30 to rotate off the top of the twisting filament supply spool 34 and twist around the core yarn to form a bundle.

The twisting filament 30 forms a layer because each successive twisting filament joins the bundle at some distance away in the spindle assembly. The characteristics of the twist can be varied by changing the spacing of the twisting filament-loaded supply spools. The spacing of the spools may be uniform or nonuniform, depending on the desired twisting characteristics.

Since a twisting filament 30 is added to the bundle at every spindle 36 in the assembly, the character of the bundle changes accordingly. For example, if there are twenty filaments in the bundle of core filaments 32, there will be 21 filaments in the bundle after the yarns pass through the first spindle 36 (20 core filaments 32 and 1 twisting filament);

and 22 filaments (20 core filaments and 2 twisting filaments 30) in the bundle after they pass through the second spindle 36, etc. In one embodiment there are eight spindles 36, and eight twisting filaments 30, so the core is advanced consecutively through a series of eight spindles 36. (The number of spindles 36 will correspond to the number of twisting filaments 30).

The length of the twist is determined by the amount of twisting filament 30 on the twisting filament-loaded supply spool 34 (i.e. by the circumference of twisting filament-loaded supply spool 34). As used herein the length of the twist refers to the distance it takes for a yarn to start at the top of the bundle and go around the bundle and end up at the top again. The smaller the circumference of the filament on the twisting filament-loaded supply spool 34, the greater the length of the twist, and the larger the circumference of the spool 34, the shorter the resulting length of twisting. Of course as the twisting filament 30 is pulled from the twisting filament-loaded supply spool 34, the circumference of the spool 34 will get smaller. Starting with the second twisting yarn spool 34 in the spindle assembly, it is possible to rotate the twisting filament-loaded supply spool 34 to compensate for twist that is applied as a result of a decreasing diameter of the spool.

At the end of the spindle assembly the diameter of the bundle is significantly larger than the diameter of the bundle when it passed through the first spindle 36. This change in diameter will also effect the length of the twist.

Controlling Tension of Twisting Filaments As They Payoff the Twisting Filament-Loaded Supply Spools

As shown in Fig. 7, and Figs 9-11, one end of each twisting filament-loaded supply spool is provided with an annular array of monofilament whiskers 38. The whiskers used in one embodiment of the invention are available as a brush from Wyrepak-Watkins. The whiskers are part of a patented device, described in U.S. Patent No. 4,508,290. As the twisting filaments payoff the twisting filament-loaded supply spools, the tension of the twisting filaments is controlled by pulling them through the monofilament whiskers.

Controlling the Number of Times a Twisting Filament is Wrapped Around the Core

The number of times a twisting filament is wrapped around the core is increased by driving at least one twisting filament-loaded supply spool with a motor-driven pulley to increase the number of revolutions per minute of the twisting filament-loaded supply spool. By controlling both the speed of the pulley driving at least one twisting filament-loaded supply spool, and by controlling the speed of the takeup reel 54 (Figs. 7 and 8), the number of wraps of the twisting filament around the core can be controlled. In a preferred embodiment, the core is wrapped with twisting filament at a rate of between 2 and 100 wraps per linear inch of core passing through a twisting filament-loaded supply spool.

The Temporary Glue or Adhesive Applied to Hold the Filaments Together

Post- treating of the wrapped/intertwisted bundle may be used to further bind the assembly of filaments. This can include heat treating, resin coating, impregnation or the use of low melting temperature filaments or filaments coated with a low melting polymer within the assembly of filaments.

For example, after the combined bundle of core yarns and twisting yarns leaves at least the last spindle in the spindle assembly, it is joined together with a temporary glue. The glue is strong enough to enable the yarn to be woven into a fabric, but weak enough to allow the filaments in the yarn to separate slightly during the weaving process, as desired. This separation of filaments or breakdown causes the yarn to fill the interstices of the fabric, which controllably inhibits the air flow through the fabric, and results in the formation of a superior sheet of paper.

After the bundle is passed through at least the last spindle 36 in the spindle assembly, a temporary glue or adhesive is applied to at least one filament. The purpose of applying a temporary glue is to hold the filaments together for weaving the yarn into the fabric. The glue might, for example be a urethane that is either heat or ultarviolet cured. The temporary nature of the glue allows the filaments in the bundle to become unwound or to separate after the yarn is woven into a fabric. As described previously, this is desirable in the dryer fabric because the unwound yarn does a better job of filling the interstices of the fabric than the prior art stuffer yarns. It provides increased interference in air flow through the fabric which results in the formation of a superior sheet of paper. While the intertwisted structure will contain the bundle of filaments as a group, the individual monofilaments may migrate somewhat independently within a finite length of the stuffer pick. This will allow filaments to fill towards the warp yarn apex of the open void or shed.

In addition to urethane, the glue that is applied may be selected from a member of the group consisting of ethylene vinyl acetate adhesive, polyamide adhesive, nylon adhesive, thermoset epoxyresin, thermoset vinyl ester resin, and thermoset polyester resin, and hot melt adhesives.

As an alternative to temporary glue, adhesive coated filaments or yarns may be provided to join the core yarns and the twisting filaments. The adhesive coated yarns may be in addition to the core yarns 32 and twisting filaments 30, or they may be selected from the core and/or twisting filaments 32, 30. The adhesive coated yarns may be parallel to the core yarns 32 or they may be twisting filaments 30 or active yarns.

The adhesive coating may be activated by a heat zone, shown schematically in Fig. 7 and Fig. 8 as an oven 50 and subsequently cooled prior to winding. The yarn is heated in oven 50 to a temperature of about between 140°F and 500°F, with the actual temperature to be determined by the nature of the glue or adhesive selected. The temperature should be high enough to produce a bond between the glue or hot melt adhesive and the twisting filaments which is strong enough to hold together during weaving, but weak enough to allow the filaments to separate after the yarn is woven into a fabric.

A die, set of rolls or other methods of compressing or squeezing the monofilaments and adhesives together to enhance the adhesive distribution may be used. Fig. 7 and Fig. 8 show that the yarn is taken up by a take-up reel 54, the turning of which pulls the core filaments 32 from the core yarn spools 42 and through the spindles 36.

In another embodiment, the adhesive coated yarns may be wound on small diameter packages and fed into the system over end to provide a greater degree of intertwisting.

Various Constructions of Yarn

Although the yarn of one embodiment is comprised of 20 core yarns and eight (8) twisting filaments 30, it is understood that any combination of twisting and core yarns may be used, with a minimum of two filaments (one twisting filament and one core filament 32) to a maximum of about 100 total yarns.

The following table shows the results achieved with various constructions of the present invention (where sample 2 represents a control, and the other samples represent constructions according to the invention).

TABLE

Sample	Weft	Construction	Picks (in)	Tension Kg/m	Woven CFM	Final CFM
1	x3674	8 core/ 8 twisting	50	850	138	90
2 (control)	16 ply	4 X 4	50	850	145	93
3	x3677	12 core/ 4 twisting	50	850	160	113
4	x3673	16 core/ 8 twisting	42	850	129	112
5	x3673	16 core/ 8 twisting	40	850	145	127
6	x3678	20 core/ 4 twisting	40	850	155	125
7	x3678	20 core/ 4 twisting	40	1000	140	115
8	x3675	4 core/ 8 twisting	50	1000	139	94
9	x3676	8 core/ 4 twisting	50	1000	143	96
10	x3674	8 core/ 8 twisting	50	1000	120	76

In addition, the twisting filaments and core yarns may be of any shape, and are not limited to yarns having a circular cross section. For example, the yarns may have a rectangular, trapezoidal, square, oval shape, or other shape. In addition, the twisting and core yarns need not be of uniform size.

To modify the intertwist level and resulting compaction of the filament bundle one or more of the spools may be rotated by driving the hollow spindles while the fibers paying off the preceding bobbins pass through the hollow spindle holding the rotating spool or spools. For example, 12 spools of twisting filament, a monofilament, are mounted on hollow spindles in a linear relationship. Each spool is alternated so the twisting filament pays off over the head of the twisting filament-loaded supply spool in clockwise or anti clockwise direction causing the twisting filament to twist off in a "s" or "z" direction. Each end of twisting filament is fed into the next hollow spindle. If the twisting filament-loaded supply spools are numbered in a linear sequence as spool number 1, 2, 3, 4,...12, then one possible format is that the twisting filament from twisting filament-loaded supply spool 1 is rotating clockwise off the static spool, wraps the moving core which is passing through the center of supply spool 1 in a clockwise direction, and is fed along with the core into the hollow spindle holding twisting filament-loaded supply spool 2. The twisting filament from spool 2 pays off counterclockwise and rotates about the twisting filament from spool 1 and the moving core. The moving core, now wrapped with two intertwisted twisting filaments is then fed through the hollow spindle holding twisting filament-loaded supply spool 3 while the twisting filament from spool 3 pays off in clockwise direction and wraps the bundle comprising the core and helically-wound twisting filaments from the two preceding twisting filament-loaded supply spools. This arrangement continues until at twisting filament-loaded supply spool 12 there are eleven intertwisted twisting filaments and the core being wrapped by the twisting filament paying off twisting filament-loaded supply spool 12. The result is an intertwisted bundle of twelve filaments and a core bound successively by the known twisting action of taking a twisting filament over the end of the spool or package. The resultant twist per inch is 1/ ¶d where 1 is the number of twists inserted divided by the length of yarn in the circumference of the package core d. multiplied by the constant, pi, of 3.1416.

In the above example all spools are static and only the action of the yarn provides the twisting or wrapping action about the filament(s) passing through the hollow spindle. The twisting or wrapping action is fixed in direction "s" or "z" by the direction of pay off the twisting filament-loaded supply spool and the twisting or wrapping rate is limited by the diameter of the wound filament on the twisting filament-loaded supply spool from which the filament is "peeled". Accordingly the intertwisting or wrapping density or spacing remains constant and independent of the throughput speed of the passing filament(s).

Controlling the Rate of Wrap

Another configuration of the invention would be to rotate one or more twisting filament-loaded supply spools by driving at least one of the hollow spindles with a motor driven belt 40 as shown in Fig. 11. Modifying the above example, if spool 12 is driven at a rate of 300 RPM, then twisting filament 12 will twist and wrap about the bundle of filaments passing through the hollow spindle at 50 IPM linear speed of "L" with a relationship of (1 x RPM) / L or (1 x 300) ÷ 50 = 6 wraps per inch about the bundle.

Another configuration would be to feed a core yarn or yarns into the first hollow spindle, 1. This would provide opportunity for a multitude of yarns of filaments to become an untwisted core to the final structure.

One embodiment of a yarn asssembly method

An embodiment of the method of making a yarn of the invention is performed as follows.

As shown in Fig. 7 and Fig 8, the core filaments or yarns or cores 32 are fed from a series of core yarn spools 42. Each core spool 42 is allowed to rotate, and the core is pulled off the side of the core spool 42 at an angle of 90 degrees from the direction of spool rotation.

Example:

Twelve active ends of 0.008 inch polyester monofilaments (HC;Type 900C) were processed with alternating "S" and "Z" pay-off from the spools.

Yarn position	1	2	3	4	5	6	7	8	9	10	11	12
Direction	S	Z	S	Z	S	Z	S	Z	S	Z	S	Z

Positions 11 and 12 had the 0.008 inch monofilament, but each was previously coated with 31% (wt.) EVA hot melt resin.

The twisting filament-loaded supply spool at position 12 was driven at a rotation of 746 RPM as the intertwisted filaments (eleven) comprising the core passed through the hollow spindle 12 at a linear speed of 125 FPM (feet per minute). As explained previously, the speed of the core is determined by the speed of the takeup reel. It is important to note that the rotation rate should be varied depending on the type of twisting filament being used. In a preferred embodiment, the core is wrapped with twisting filament at a rate of between 2 and 100 wraps per linear inch of core passing through a twisting filament-loaded supply spool.

The completed assembly of twelve monofilaments was then heated in a series of radiant heat tubes totaling 14 feet in length at a temperature of 415° F. After passing in an ambient air cooling zone the yarn was precision wound to a 3 ¼ inch x 11 inch tube.

The yarn was woven directly from the above noted tube as a stuffer pick in a two-layer, all monofilament dryer fabric. The fabric was heat set and air permeability was tested and compared to a section of fabric woven using the standard 4 x 3 cabled 0.008 inch monofilament stuffer at the same picks per inch.
The comparison showed the intertwisted monofilament structure which is the object of this invention provided a CFM of 70 compared to 100 for the standard cabled monofilament.

Example of Making A Dryer Fabric

First, a yarn is made using an embodiment of the method described above, wherein the first twisting filament is pulled off the end of the first twisting filament-loaded supply spool to wrap in a clockwise direction around the core, and the second twisting filament is pulled off the second twisting filament-loaded supply spool to wrap in a counterclockwise direction around the core. The core is passed through twelve twisting filament-loaded supply spools, as the twisting filament from each supply spool paysoff in alternate directions, clockwise and counterclockwise. The core may be comprised of two or more parallel filaments. The core filaments and the twisting filaments may be either nylon or polyester. The number of revolutions per minute of at least one of the twisting filament-loaded supply spools is controlled by a motor-driven pulley. The core is wrapped at a rate of between 2 and 100 wraps per linear inch of core passing through a twisting filament-loaded supply spool. A temporary glue is applied to at least the last twisting filament being wrapped around the core. The yarn is passed through an oven to form a temporary bond between the glue and the twisting filaments. The yarn is cooled and coiled on a takeup reel. The yarn is then inserted as stuffer picks in making a dryer fabric.

Example of Making A Press Felt

First a yarn is made according to any one of the above embodiments of the invention. Then the yarn is woven into a base fabric. Batt fibers are then needled into the base fabric, which provides improved anchorage for the batt fibers.

While the present invention has been described in connection with preferred embodiments thereof, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from the true spirit and scope of the present invention. Accordingly, it is intended by the appended claims to cover all such changes and modifications as come within the true spirit and scope of the invention.

AMENDED CLAIMS

[received by the International Bureau on 22 January 2001 (22.01.01); original claims 1-24 replaced by new claims 1-26 (7 pages)]

1. A yarn made by the steps comprising:

passing at least one core filament through a first twisting filament-loaded supply spool having a hollow center and an end;

pulling a first twisting filament off said end of said first twisting filament-loaded supply spool wherein said first twisting filament is wrapped around said filament to form a first bundle;

passing said first bundle through at least one second twisting filament-loaded supply spool having a hollow center and an end;

pulling a second twisting filament off the end of said second twisting filament-loaded supply spool to wrap around said first bundle forming said yarn wherein said yarn has a greater amount of said twisting filaments than said core filaments.

2. The yarn made by the steps according to claim 1 further comprising the additional steps of:

rotating said twisting filament-loaded supply spools with a motor to control said wrap of said twisting filaments.

3. The yarn made by the steps according to claim 1 further comprising the additional steps of:

tensioning said twisting filament to control wrap of said twisting filament.

4. The yarn made by the steps according to claim 1 wherein said filament-loaded supply spools have whiskers on said ends to control said twisting filament tension.

5. The yarn made by the steps according to claim 1 wherein said core filament is a plurality of parallel filaments.

6. The yarn made by the steps according to claim 2 wherein said first twisting filament is pulled off said end of said first twisting filament-loaded supply spool to wrap in a clockwise direction around the core, and said second twisting filament is pulled off said second twisting filament-loaded supply spool to wrap in a counterclockwise direction around the core.

7. The yarn made by the steps according to claim 1 wherein said twisting filaments which wrap around said core filaments are joined together by a glue which is strong enough to hold together during weaving, and which is weak enough to allow said filaments to separate after the yarn is woven into a fabric.

8. A yarn comprising:

at least one first twisting filament having at least one first rotation pay-off orientation; and,

at least one additional subsequent twisting filament having a rotation pay-off opposing said first twisting filament's rotation wherein at least one said additional subsequent twisting filament is wrapped around at least one said first twisting filament.

9. The yarn according to claim 8 wherein said first twisting filament comprises a plurality of parallel individual twisting filaments. wherein said filaments are individually and parallel to another.

10. The yarn according to claim 9 wherein said plurality of parallel twisting filaments are a plurality of matched pairs of a first individual twisting filament having an S rotation pay-off and a second individual twisting filament having a Z rotation pay-off.

11. The yarn according to claim 9 wherein said yarn further comprises a glue wherein said glue is applied to said subsequent twisting filaments wherein said glue is strong enough to hold together during weaving. and which is weak enough to allow said filaments to separate after said yarn is woven into a fabric.

12. The yarn according to claim 11 wherein said glue is a hot melt adhesive having a melting range between 140° F and 500°F.

13. The yarn according to claim 11 wherein said glue is selected from the group consisting of ethylene vinyl acetate adhesive. polyamide adhesive. nylon adhesive. ultraviolet curable epoxy resin. ultraviolet curable vinyl ester resin. ultraviolet curable polyester resin. thermoset epoxy resin. thermoset vinyl ester resin. and thermoset polyester resin.

14. A method of making a dryer fabric having a stuffer yarn comprising the steps of:

pulling at least one twisting core filament from an end of a static-positioned core yarn spool wherein said twisting core filament is under tension;

passing at least one said twisting core filament through a first twisting filament-loaded supply spool having a hollow center and an end;

pulling a first twisting filament which is under tension off said end of said first twisting filament-loaded supply spool to wrap around said twisting core filament to form a first bundle;

passing said first bundle through at least one second twisting filament-loaded supply spool having a hollow center and an end;

pulling a second twisting filament off of said end of said second twisting filament-loaded supply spool to wrap around said twisting core filament to form said stuffer yarn; and,

weaving said yarn into said dryer fabric.

15. The method of making a dryer fabric having a stuffer yarn according to claim 14 further comprising the steps of:

rotating said twisting filament-loaded supply spool with a motor to control the wrapping of said twisting filaments onto said yarn.

16. A method of making a press felt comprising the steps of:

pulling at least one twisting core filament from a static-positioned core yarn spool having whiskers;

passing at least one said twisting core filament through a first twisting filament-loaded spool having a hollow center and an end;

pulling a first twisting filament off said end of said first twisting filament-loaded spool under tension to wrap around said twisting core filament to form a first bundle:

passing said first bundle through at least one second twisting filament-loaded spool having a hollow center and an end:

pulling a second twisting filament of the off said end of said second twisting filament-loaded spool under tension to wrap around said twisting core filament to form said stuffer yarn:

weaving said yarn into a fabric: and.

needling said fabric with fibers to form said press felt.

17. The method of making a dryer fabric having a press felt according to claim 16 further comprising the steps of:

rotating said twisting filament-loaded supply spool with a motor to control wrap of said twisting filaments onto said yarn.

18. A dryer fabric comprising:

a yarn comprising

a) at least one first twisting filament having at least one first rotation pay-off orientation: and.

b) at least one additional subsequent twisting filament having a rotation pay-off opposing said first twisting filament's rotation wherein at least one said additional subsequent twisting filament is wrapped around at least one said first twisting filament.

wherein said yarn is weaved to form said dryer fabric.

19. The fabric according to claim 18 wherein said first twisting filament has a plurality of parallel individual twisting filaments.

20. The fabric according to claim 19 wherein said plurality of parallel twisting filaments are a plurality of matched pairs of a first individual twisting filament having an S rotation pay-off and a second individual twisting filament having a Z rotation pay-off.

21. The fabric according to claim 19 wherein said yarn further comprises a glue wherein said glue is applied to said subsequent twisting filaments wherein said glue is strong enough to hold together during weaving, and which is weak enough to allow said filaments to separate after said yarn is woven into said fabric.

22. The fabric according to claim 21 wherein said glue is selected from the group consisting of ethylene vinyl acetate adhesive. polyamide adhesive. nylon adhesive. ultraviolet curable epoxy resin. ultraviolet curable vinyl ester resin. ultraviolet curable polyester resin. thermoset epoxy resin. thermoset vinyl ester resin. and thermoset polyester resin.

23. A press felt comprising:

a yarn comprising

a) at least one first twisting filament having at least one first rotation pay-off orientation; and.

b) at least one additional subsequent twisting filament having a rotation pay-off opposing said first twisting filament's rotation wherein at least one said additional subsequent twisting filament is wrapped around at least one said first twisting filament.

wherein said yarn is weaved to form a fabric; and.

a fiber that is needled into said fabric.

24. The press felt according to claim 23 wherein said first twisting filament comprises a plurality of parallel individual twisting filaments.

25. The press felt according to claim 24 wherein said plurality of parallel twisting filaments are a plurality of matched pairs of a first individual twisting filament having an S rotation pay-off and a second individual twisting filament having a Z rotation pay-off.

26. The press felt according to claim 23 wherein said yarn further comprises a glue wherein said glue is applied to said subsequent twisting filaments wherein said glue is strong enough to hold together during weaving, and which is weak enough to allow said filaments to separate after said yarn is woven into said fabric.

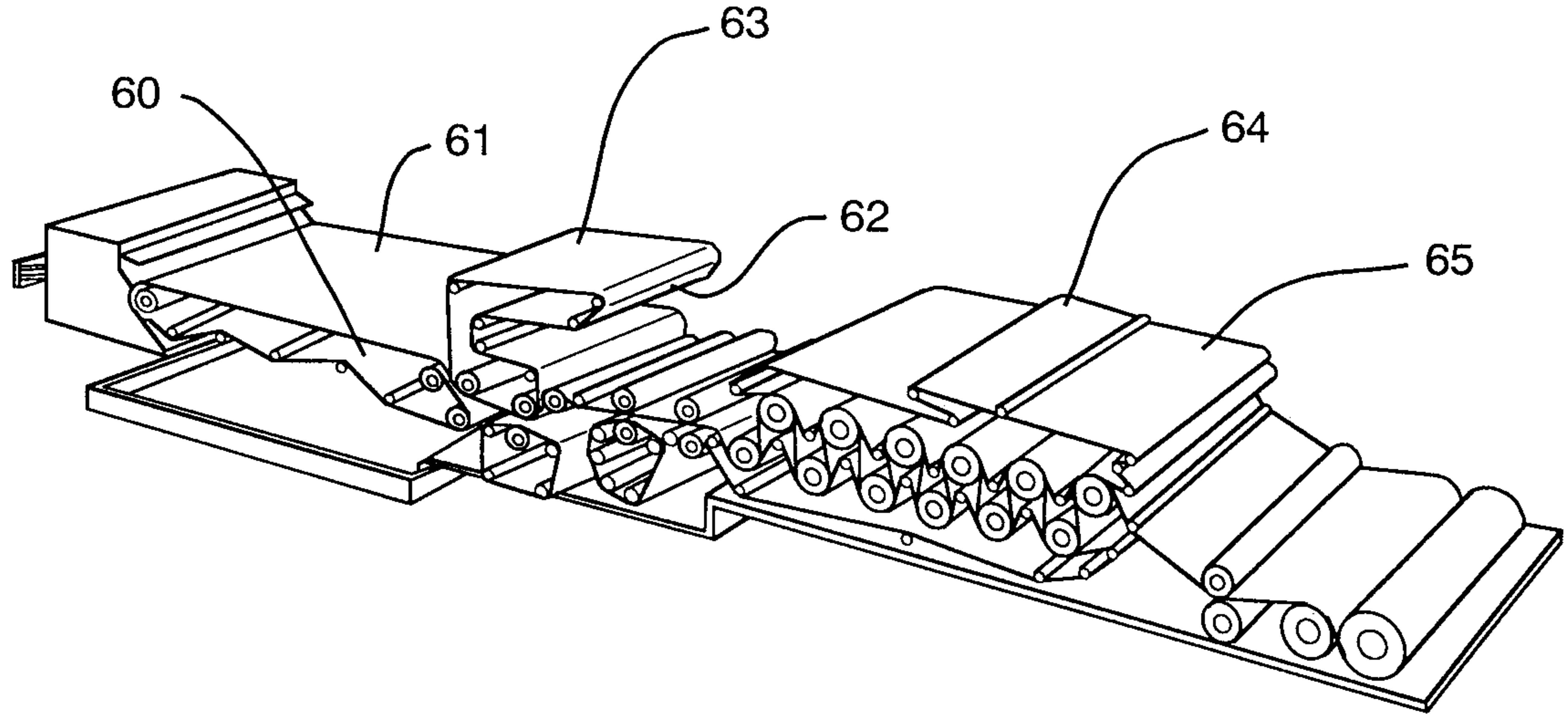

FIG. 1

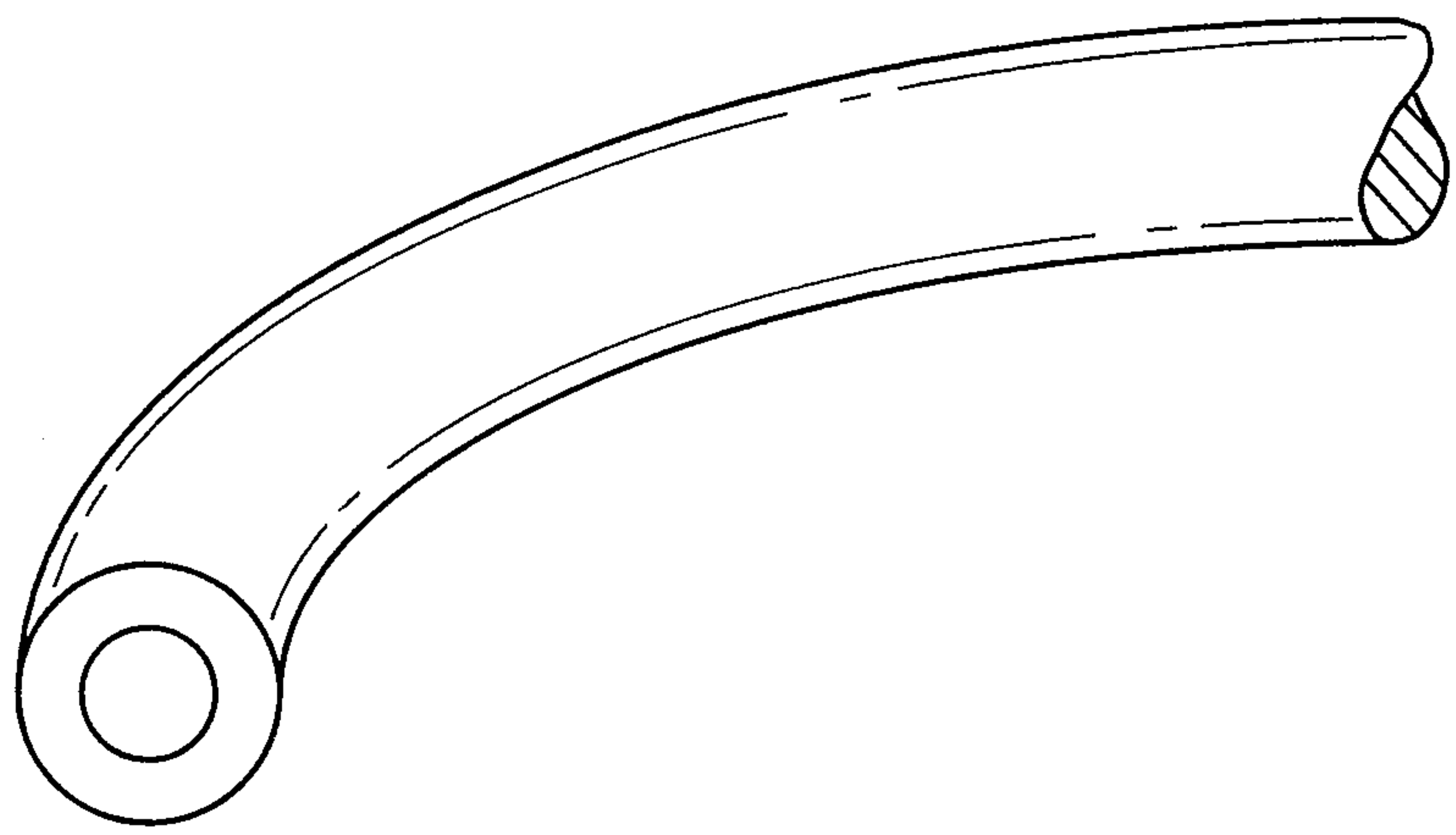

FIG. 2 Prior Art

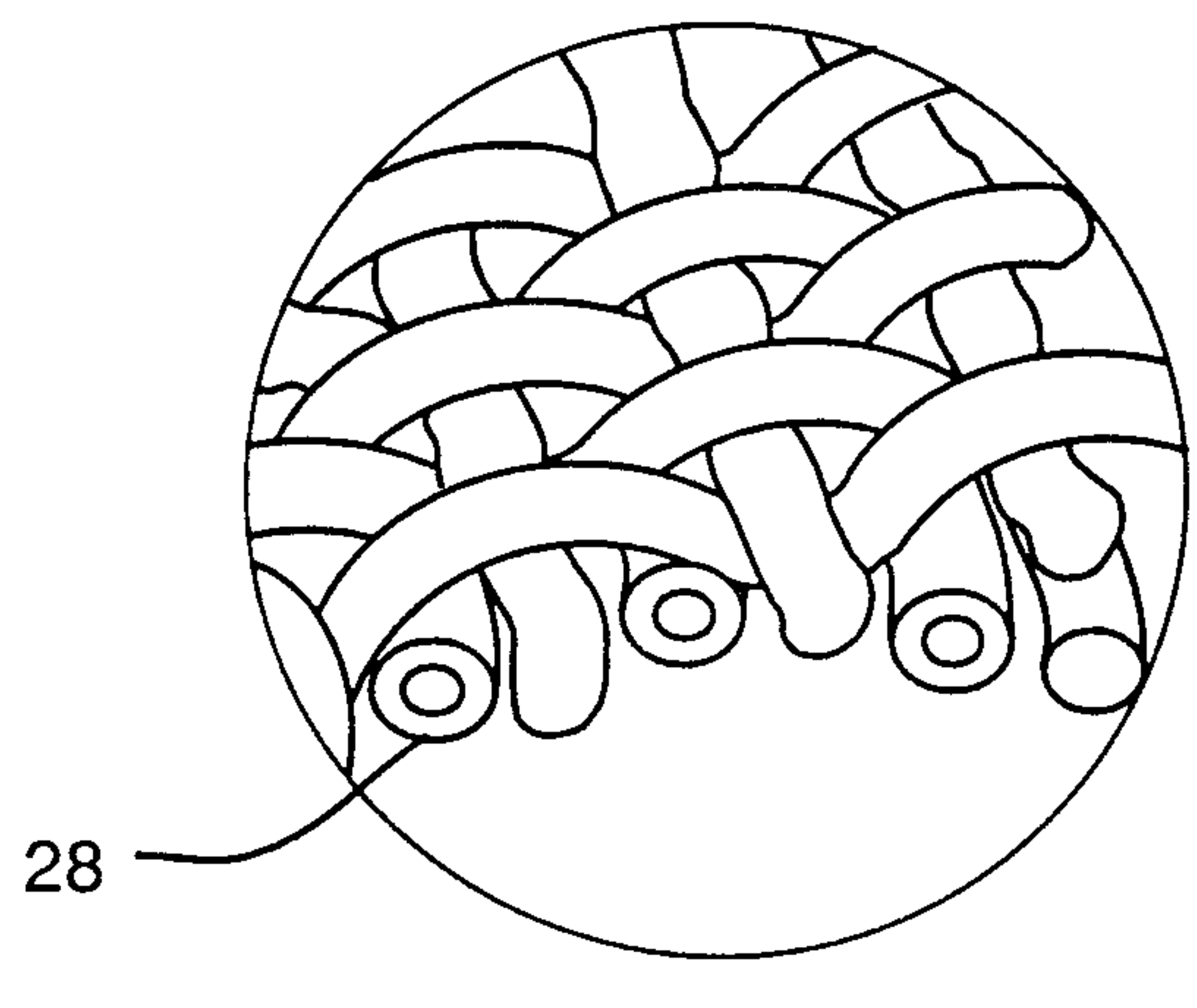

FIG. 3 Prior Art

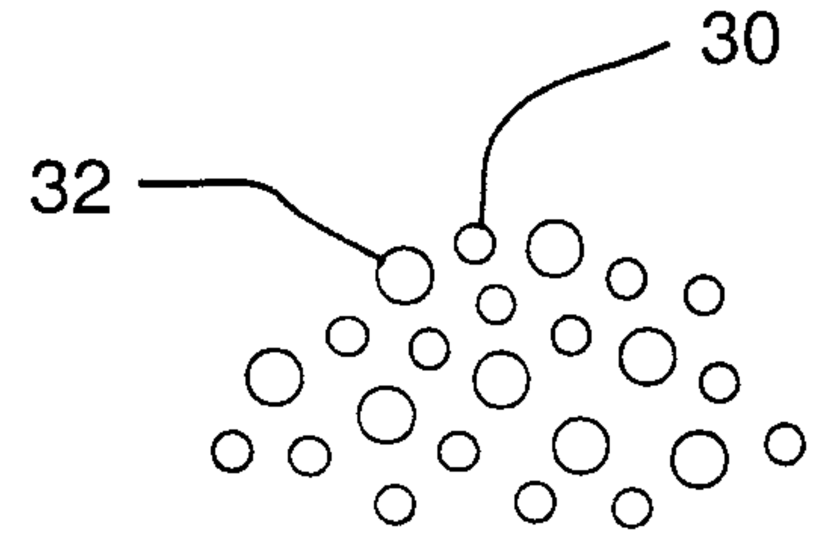

FIG. 4

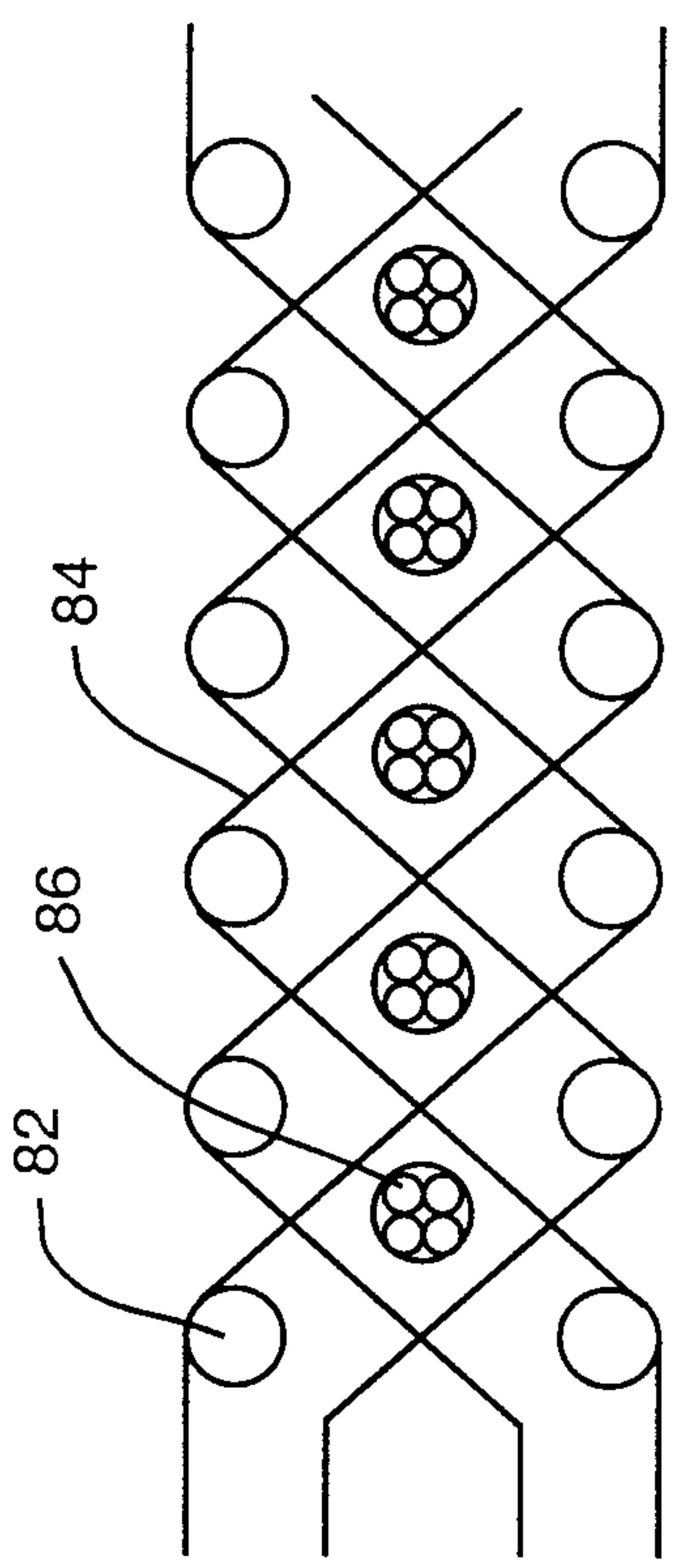

FIG. 5 Prior Art

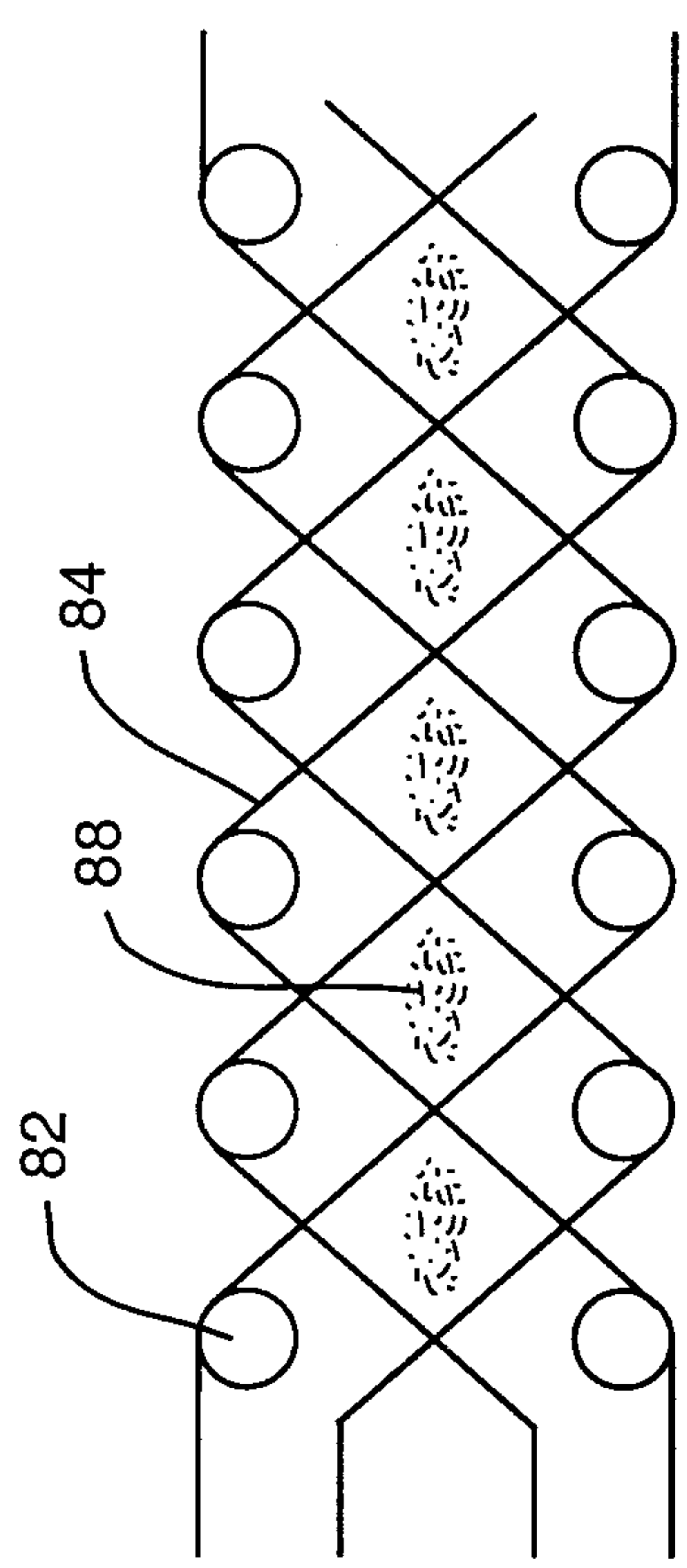

FIG. 6

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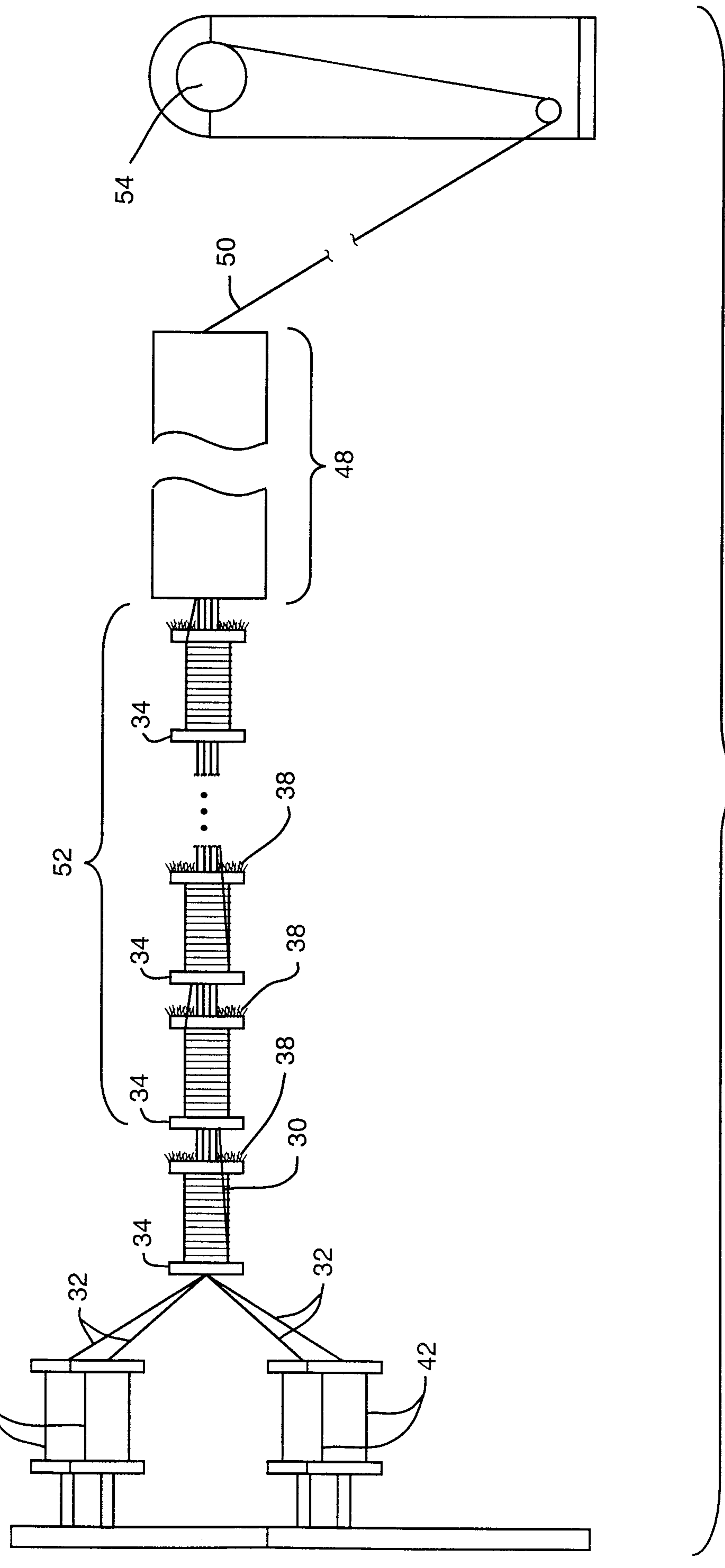


FIG. 7

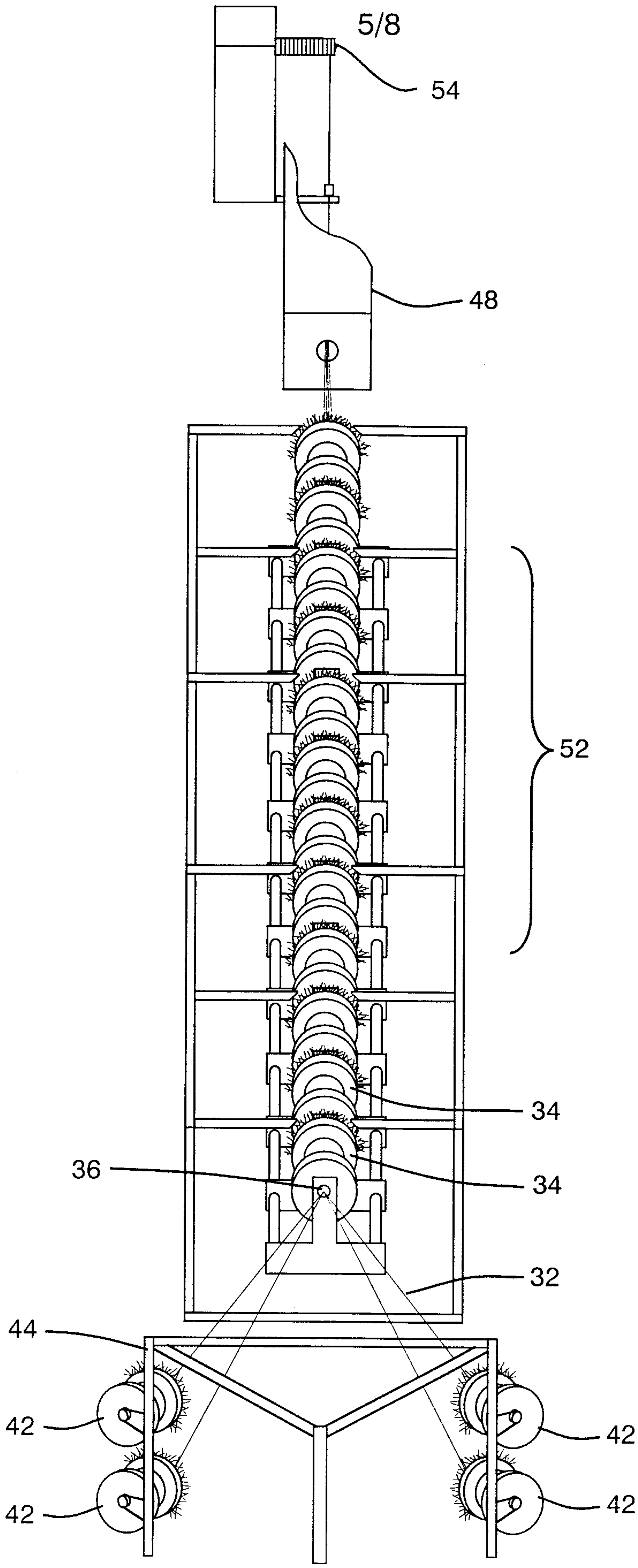


FIG. 8

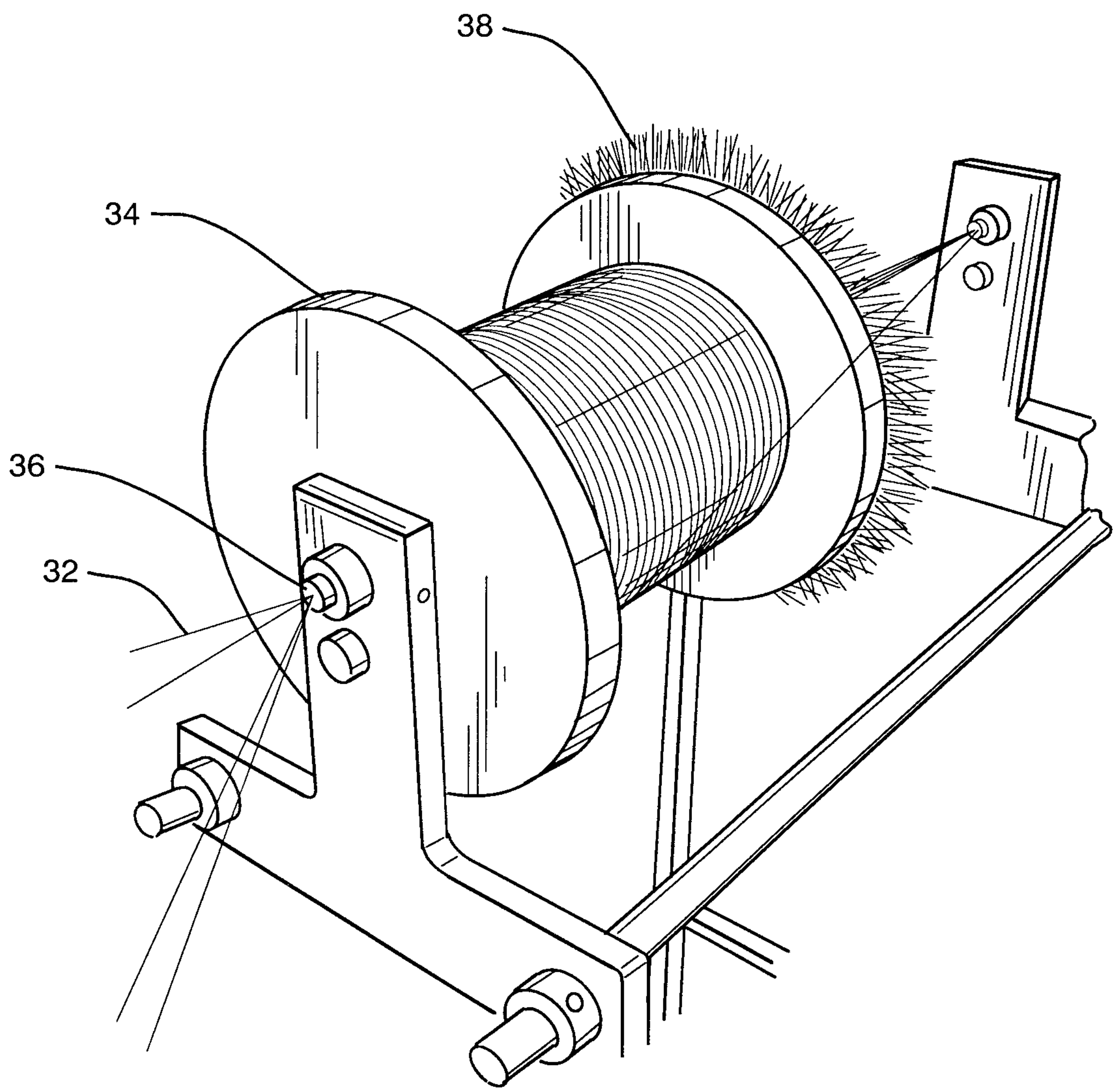


FIG. 9

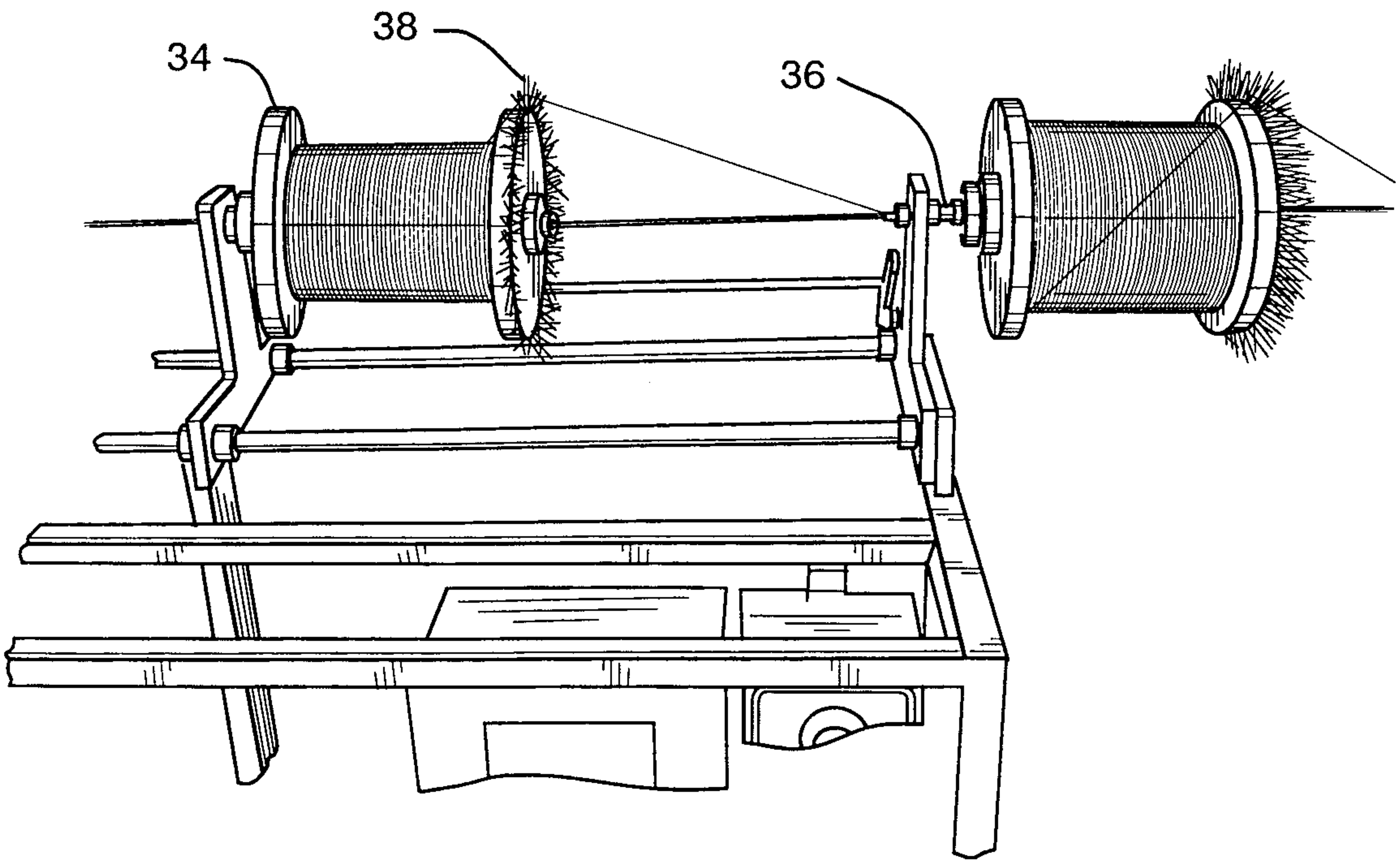


FIG. 10

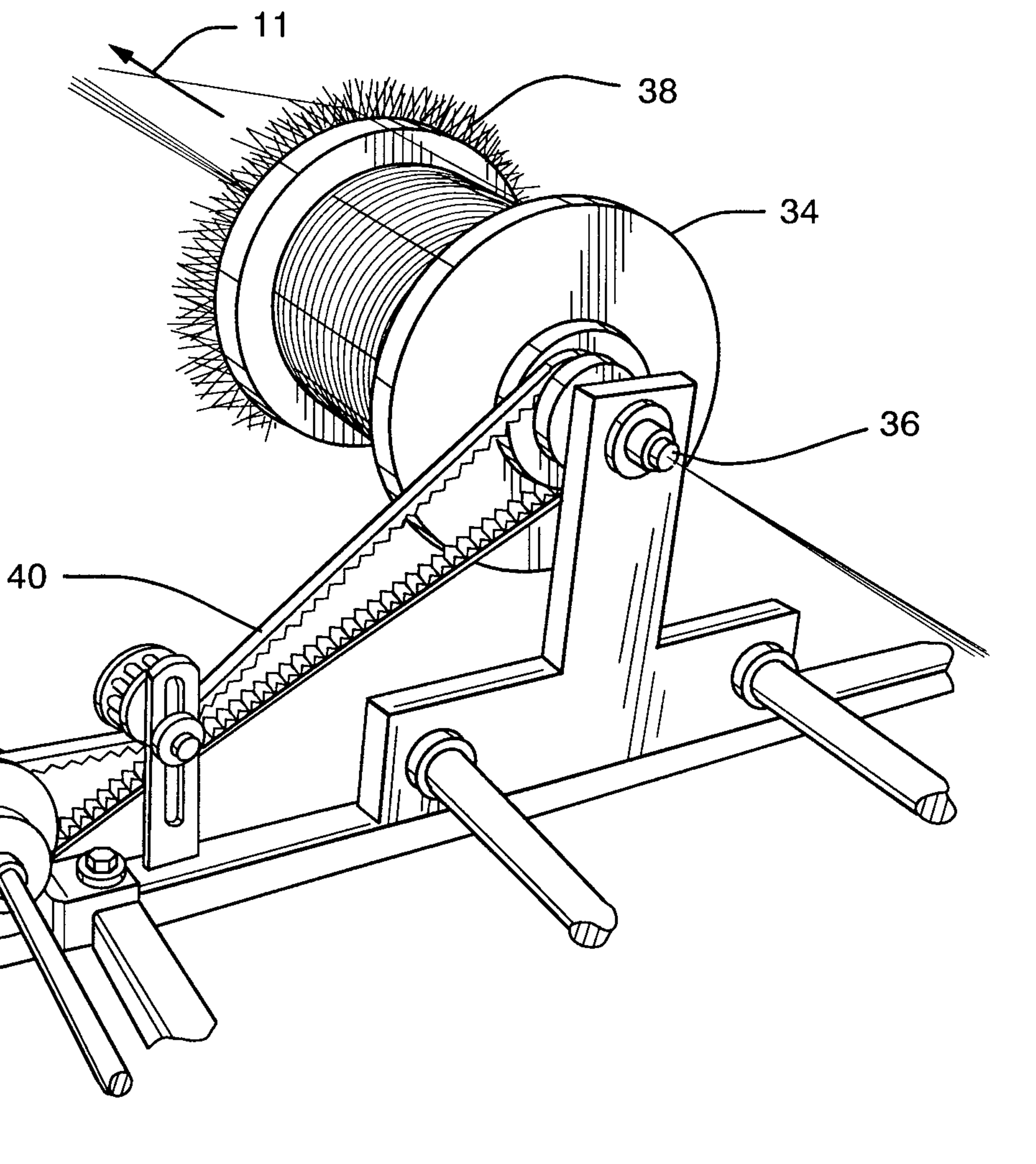
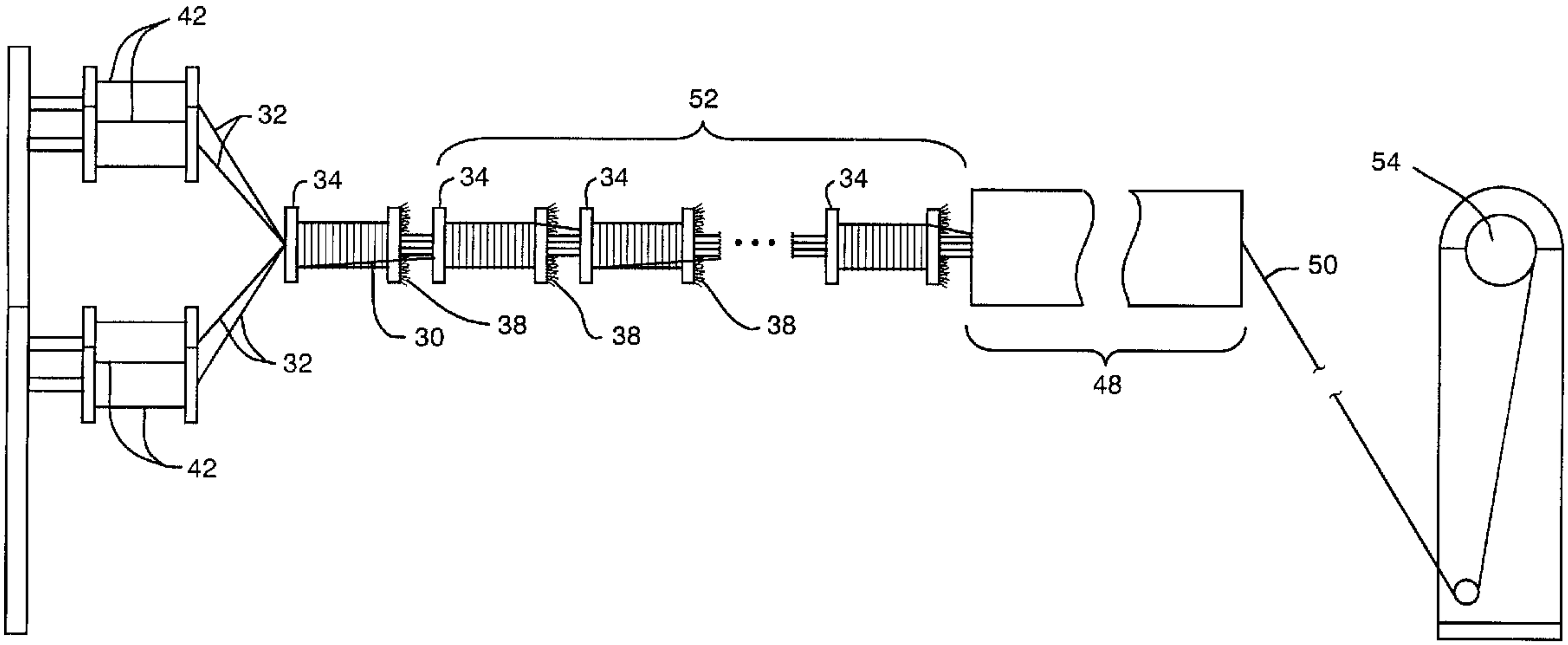


FIG. 11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