(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 May 2008 (02.05.2008)

PCT

(10) International Publication Number
WO 2008/052025 A2

(51) International Patent Classification:
D04B 25/08 (2006.01)

(21) International Application Number:
PCT/US2007/082327

(22) International Filing Date: 24 October 2007 (24.10.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/853,948 24 October 2006 (24.10.2006) US

(71) Applicant *(for all designated States except US)*: **TUBULAR TEXTILE MACHINERY, INC.** [US/US]; 113 Woodside Drive, Lexington, NC 27292 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **HOLMES, Gregory, A.** [US/US]; 173 Teakwood Drive, Winston-Salem, NC 27127 (US).

(74) Agent: **SCHWEITZER, Fritz, L., Jr.**; Schweitzer Cornman Gross & Bondell LLP, 292 Madison Avenue - 19th Floor, New York, NY 10017 (US).

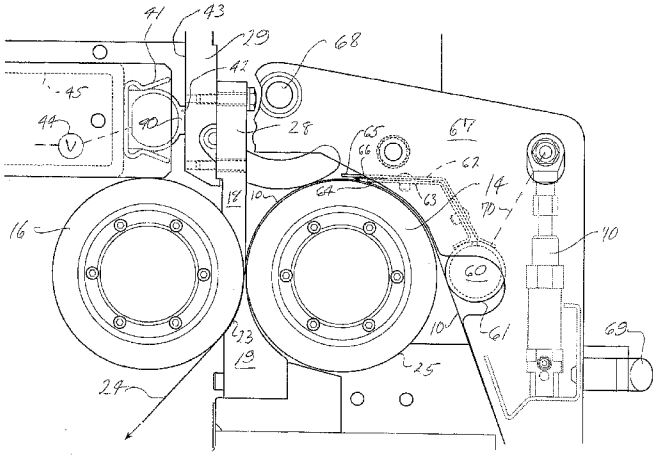
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv))*

Published:
— *without international search report and to be republished upon receipt of that report*

(54) **Title:** COMPACTOR, ESPECIALLY FOR OPEN WIDTH KNITTED FABRIC



(57) **Abstract:** A compacting apparatus, especially for open width knitted fabrics. Cooperating feeding and retarding rollers are spaced closely together, separated by entry and exit side compactor blades extending between them and defining angular compacting zone where the fabric transfers from the feed roller surface moving at a first speed to the retarding roller surface, operating at a slower speed. An inflatable element applies pressure across the width of the entry side blade, to urge it toward the feed roller. Fabric is pressed across its full width by a corner area of the entry side blade which also forms the entrance to the compacting zone, providing essentially a line contact between the blade and the roller for highly efficient feeding of the fabric. Steam is injected on the fabric inches in advance of the compacting zone, while the fabric is traveling over the feed roller, resulting in extraordinary efficiencies in the consumption of steam during operations. The use of double bearings at each end of the feeding and retarding rollers enables small diameter rollers to be utilized in machines of very large width, with multiple attendant advantages.

WO 2008/052025 A2

COMPACTOR, ESPECIALLY FOR OPEN WIDTH KNITTED FABRIC

Background of Invention

The present invention relates to methods and apparatus for compacting fabrics, particularly knitted fabrics, and especially but not necessarily exclusively knitted fabrics processed in open width form. The construction of knitted fabrics is such that, during the various processing steps involved in preparing the fabric for cutting, the fabric can become significantly elongated relative to its intended geometry. Unless this elongation is removed before cutting, the resulting garments made from the fabric will be subject to excessive shrinkage when washed and dried.

The Milligan U.S. Patents 4,802,819 and 5,016,329 disclose commercially significant procedures and equipment for compacting knitted fabrics. Many of the teachings of these patents remain viable at this time. However, whereas the Milligan patents were directed primarily (although not exclusively) to the processing of tubular knitted fabric, worldwide demand by fabric processors is increasingly in the direction of processing knitted fabric in open width form.

Open width processing creates certain problems due to the fact that the fabric widths are much greater, requiring the machine parts to be significantly wider. Inasmuch as the compacting of knitted fabric requires the fabric to be directed through very narrow passageways, which must be held to very tight tolerances, the problems of maintaining those tolerances over the extended widths involved in open width processing can be very difficult. Moreover, pricing restraints dictate that solutions to these troublesome issues must be provided on a highly competitive cost basis.

Summary of the Invention

In accordance with the present invention, a new and improved compacting system is provided, adapted particularly for the processing of knitted fabric in open width form, which achieves a superior compacting result with equipment that is cost competitive to manufacture and, importantly, more economical to operate than existing equipment. The system of the invention incorporates certain features of the before mentioned Milligan U.S. Patents 4,802,819 and 5,016,329, the disclosures of which are incorporated herein by reference. The new system, however, incorporates important improvements for reducing the cost of equipment manufacture while at the same time achieving an improved result. Additionally, the system of the invention incorporates new features enabling it to achieve significant cost savings in steam consumption, resulting in significantly lower processing costs.

In the system of the before mentioned Milligan patents, feeding and retarding rollers are positioned in closely spaced relation, and are controllably driven to have slightly different surface speeds. Incoming fabric is confined against the surface of the feed roller by means of an arcuately contoured shoe, which mounts an entry side compacting blade at its forward edge. The compacting blade extends downward between the two rollers, to a position at or near a plane containing the axes of the two rollers. An opposing, exit side compacting blade extends upward from below, into the area between the two rollers. The upper and lower compacting blades define between them a short, narrow compacting zone extending downward and away from the feed roller at an angle of, for example, 45 degrees or more. Fabric is caused to enter the compacting zone while traveling at the surface speed of the feed roller, and is allowed to exit from the compacting zone at a speed corresponding to the slower surface speed of the retarding roller. The speed differential causes the fabric to be compressed or compacted in a lengthwise direction while being closely confined within the compacting zone, between the tips of the upper and lower compacting

blades. The extent of compressive shrinkage or compacting is a function of the surface speed differential between the feeding and retarding rollers.

Positioning of the upper compacting blade, and its support, in relation to the surface of the feed roller is an important condition in achieving proper compacting across the width of the fabric web. In the equipment disclosed in the Milligan patents, this is performed by means of controllable adjustments, acting on opposite ends of the blade support, which is of a heavy, rigid construction. By controllable tilting of the support about a fixed axis, the compacting blade may be controllably pivoted toward and away from the surface of the feed roller, as well as adjusted bodily toward and away from the feed roller. This system works very well for narrower widths of fabric, such as in the treatment of webs of tubular knitted fabric. However, with open width fabrics, the machine width is much greater, effectively twice the width of equipment required for processing a corresponding fabric in tubular form. With these significantly greater widths, it becomes more difficult to maintain the desired uniformity of positioning of the upper compacting blade across the full width of the feed roller.

Accordingly, in a preferred embodiment of the invention, a new and significantly improved mounting arrangement is provided for the upper or entry side compacting blade. The arrangement according to the invention includes a controllably inflatable tube extending laterally across the full width of the upper compacting blade, at a level as close as practicable to the region of its contact with the feed roller. The mounting for the upper compactor blade preferably includes pivot means above the blade, supporting the blade for pivotal movement toward and away from the feed roller. The elongated inflatable tube is positioned adjacent the back side of the blade and, when inflated, urges the blade toward the feed roller, applying a constant, accurately controlled fluid pressure across the entire width of the blade. This results in exceptional uniformity of blade pressure across

the width of the fabric, which is an important condition to achieving uniform, controllable, compacting results.

In accordance with another aspect of the invention, the arcuately contoured in-feed shoe utilized in the system of the Milligan patents, is eliminated in the apparatus of the invention. Instead of the confining the fabric against the feed roller over a substantial arc of the roller, according to existing practice, superior results are achieved by relying upon the compacting blade itself to confine the fabric against the surface of the feed roller over a very narrow contact area. The upper compactor blade is preferably configured in such manner as to create what is, in essence, a line contact between the compactor blade and the fabric passing over the feed roller, at a location immediately at the entrance to the compacting zone. The driving action between the feed roller and the incoming fabric is achieved, if not exclusively, at least primarily by this line contact, by controllably pressing a "corner" of the upper compactor blade toward the feed roller and in effect pinching the fabric between the upper compacting blade and the feed roller. The "corner" is effectively the entrance to the compacting zone.

In accordance with yet another aspect of the invention, an improved arrangement is provided for mounting of the feeding and retarding rollers, enabling the rollers to be much smaller and less costly than rollers of equivalent width utilizing conventional technology. Heretofore, feeding and retarding rollers typically have been mounted at opposite ends by means of pillow blocks. These are single bearings which are designed to accommodate a degree of axial misalignment, resulting particularly from inherent sag, and/or deflection which tends to result when the long rollers are supported only at their opposite ends. Excessive sag and/or deflection in the feeding and retarding rollers obviously can create serious problems in maintaining proper alignment and clearances between the rollers and the respective entry side and exit side compacting blades, as required in the compacting process. Accordingly, it has been the practice to

design these rollers to be excessively large and heavy in order to make them as stiff as feasible. For example, in a compactor having a processing width of, say, 100 inches (2540mm), the feeding and retarding rollers typically may be about 12 inches (305mm) in diameter, with a wall thickness of as much as 2 inches (50.8mm). These rollers are very expensive to manufacture and require large and heavy mounting structure. In addition, these large rollers, in operation, require significant heat-up periods before the equipment can be re-started after a shutdown. Pursuant to the present invention, the feeding and retarding rollers are provided at their opposite ends with extended mounting necks, which are supported in the rigid machine frame by means of a pair of spaced-apart bearings at each end. The spaced-apart pairs of bearings hold the roll necks rigidly and do not accommodate significant sagging and deflection, as with pillow blocks. As a result of this design, the diameter of the rolls, for a 100 inch (2540mm) machine, can be reduced from a typical 12 inches (305mm) to about 6 inches (152mm), and the wall thickness can be reduced from a typical 2 inches (50.8mm) to about 1.5 inches (38.1mm) with no sacrifice in performance. This results in highly significant savings in material and machining costs, and also allows the overall equipment to be reduced significantly in size and weight, with a considerably smaller footprint on the factory floor. Additionally, the smaller rollers are more easily heated, reducing start-up time, and enabling thermal requirements to be reduced overall by presenting a smaller surface area through which heat is lost to the ambient.

In accordance with still another aspect of the invention, a significantly improved arrangement is provided for applying steam to the fabric before compacting. In this respect, it is conventional practice to apply steam to knitted fabric as part of the compacting sequence, in order to heat and moisten the fibers and the knitted fabric loops, making them more receptive to compacting operation and more likely to retain the compacting action provided to it in passing through the compacting rollers. Heretofore, it has been a common practice to subject the fabric to the action of steam jets a considerable distance upstream of the

compacting nip, where the actual compacting work is performed. Because the steam is necessarily at an elevated temperature, a considerable amount flashes off to the ambient, and some of the imparted heat is also lost while the fabric travels from the steaming station to the compacting nip. The before mentioned Milligan U.S. Patent 5,016,329 (Fig. 1) illustrates typical location of steam applicator nozzles positioned at a distance upstream from the compactor rolls.

Pursuant to the invention, an improved steam application arrangement is provided which comprises a steam jet nozzle positioned at the feed roller location, oriented to direct a jet of steam directly onto the fabric supported on the surface of the feed roller, just a few inches in advance of the compacting nip. Multiple advantages are realized from this arrangement. In this respect, the steam interacts with the fabric only a few inches away from the compacting location, such that there is an absolute minimal opportunity for heat and moisture loss to occur, and the flash off losses of steam to the ambient is greatly reduced. Additionally, part of the process of compacting the knitted fabric involves heating of the feed roller and the compacting blades. By injecting the steam at the fabric while it is on the feed roller, inches away from the compacting blades, some of the heat that would otherwise be lost to the ambient is imparted by the steam to the feed roller and to the compacting blades, resulting in a reduction in the thermal requirements for heating those elements. With the system of the invention, overall steam usage may be reduced significantly, in an optimal case from around 300 lbs./hour to, for example, to around 100 lbs/per hour for a 100 inch (2540mm) machine. The improved arrangement also results in a reduction of re-start time, after the equipment has been shut off.

For a more complete understanding of the above and other features and advantages of the invention, reference should be made to the following detailed description of a preferred embodiment, and to the accompanying drawings.

Description of the Drawings

Fig. 1 is a highly enlarged fragmentary, cross sectional view showing details of a fabric compacting machine configured in accordance with the principles of the invention.

Fig. 2 is a fragmentary perspective view illustrating the principal components of the compacting apparatus, including feeding and retarding rollers, and entry and exit compactor blades associated therewith.

Fig. 3 is a fragmentary perspective view similar to Fig. 2, with the feed roller removed.

Fig. 4 is a side elevational view of the compacting apparatus according to the invention, with parts broken away and parts removed.

Fig. 5 is an enlarged, side elevational view showing fabric passing through the compactor station of the apparatus.

Fig. 6 is an elevational view similar to Fig. 4, showing the equipment in an open condition.

Fig. 7 is a simplified and representative elevational view showing an improved arrangement for mounting of the feeding and retarding rollers of the apparatus of the invention.

Description of a Preferred Embodiment

Referring now to the drawings, and initially to Fig. 4 thereof, the reference numeral 10 represents incoming fabric to be processed. Typically, the incoming fabric is first passed over an entry frame (not shown) which draws the material from a supply, such as a pallet or truck (not shown). The entry frame smoothes

and applies light tension to the fabric to enable it to be properly controlled as it approaches the compacting station. In the apparatus of Fig. 4, the incoming fabric 10 passes around a guide roller 11 and then around an aligning roller 12. The aligning roller 12, which is not a feature of the invention, has a surface comprising a plurality of slideable slats which can be shifted laterally as the roller turns, causing the incoming fabric 10 to be shifted laterally as necessary for proper alignment with the compacting station ahead.

After passing over the aligning roller 12, the fabric 10, is passed around a second guide roller 13 and then is directed upward and onto the outer surface of a feed roller 14, which is supported at opposite ends in the machine frame 15 and is adjustably driven to rotate at a desired surface speed, in a counterclockwise direction as viewed in Fig. 4. A retarding roller 16 is mounted in the machine frame 15 adjacent to and parallel with the feed roller 14. The respective longitudinal axes of the feed and retarding rollers 14, 16 lie in a common plane 17 (Fig. 1). In the illustration of Fig. 4, the plane 17 is horizontal, but can be of various orientations.

As shown in Figs. 1 and 5, the feed and retarding rollers 14, 16 are not in contact with each other, but are separated by about 2-2.5mm at the point of closest approach, which is coincident with the plane 17 containing the axes of the respective rollers. Entry side and exit side compactor blades 18, 19 respectively extend into the space between the rollers 14, 16. The compactor blades have confronting end surfaces 20, 21, which are closely parallel to each other and are disposed at an angle to the plane 17, which may be referred to for convenience as the compacting plane. The two confronting surfaces 20, 21 are separated by an adjustable distance of about 0.6mm, and define between them a short compacting zone 22 of approximately 4mm in length. This relatively short length is advantageous to the compacting process, and is made possible in the present equipment by features which enable the feeding and retarding rollers 14, 16 to be

placed very close together, and features that enable relatively thin entry side and exit side compactor blades to be accurately positioned during compacting operations.

In accordance with some of the broader principles of the Milligan et al. U.S. Patent 5,016,329, the fabric 10 is advanced by contact with the outer surface of the feed roller 14 until it reaches the entrance end of the compacting zone 22. After passing through the zone 22, the fabric is engaged between the outer surface of the retarding roller 16 and the back surface 23 of the exit side compactor blade 19, as shown in Fig. 1. Pursuant to known principles, the retarding roller 16 is driven to have a surface speed which is controllably less than the surface speed of the feed roller 14. Accordingly, fabric is advanced to the entrance of the compacting zone 22 at a higher speed than it is carried away from the zone by the retarding roller 16. The fabric within the zone 22 is thus compressed lengthwise and compacted in a precise and controllable manner. Compacted fabric 24 (Fig. 5), after exiting from the confined passage between the retarding roller 16 and the arcuate back wall 23 of the exit side compacting blade 19, is conveyed away, typically to a folding apparatus for the like (not shown).

In accordance with one aspect of the invention, in-feed of the fabric 10 into the compacting zone 22 is controlled by cooperation between the entry side compactor blade 18 and the outer surface 25 of the feed roller. In this respect, the feed roller is formed with a slightly roughened surface, advantageously provided by a tungsten carbide coating, which has good friction with the incoming fabric 10 as it passes over almost half of the circumference of the feed roller during its approach to the compacting zone. In prior equipment, such as represented by the Milligan et al. U.S. Patent 5,016,329, fabric being driven toward the compacting zone was closely confined over a substantial arc of the feed roller by a large, arcuate guide shoe. The entry side compacting blade was carried by the guide shoe and the blade itself was provided with an arcuate surface forming the last

portion of the fabric confinement as it approached the compacting zone. In the apparatus of the present invention, however, the fabric is not confined over any significant distance as it approaches the compacting zone. Instead, driving of the fabric into the compacting zone is accomplished by urging a lower front corner 26 of the entry side compactor blade toward the driving surface of the feed roller, effectively "pinching" the fabric between the corner 26 and the surface of the feed roller, to provide a substantially positive drive of the fabric into the compacting zone. As is evident in Fig. 1, the corner area 26 of the compactor blade 18 comprises a relatively sharp edge (e.g., a radius of about 0.005 inch – 0.127mm). It thus forms essentially a line contact with the fabric at the entrance to the compacting zone. Upstream from the corner area 26, the front face of the blade 18 is relatively flat, such that the driving surface 25 of the feed roller and the front surface 27 of the entry side compactor blade rapidly diverge. The fabric thus is largely unconfined as it approaches the corner 26 where it is pressed firmly against the feed roller. This has important advantages in the compacting process, as it minimizes or avoids imparting a sheen or polish to the outer fabric surface, sometimes experienced with prior equipment as the fabric traveled in confinement along the surface of the guide shoe. This problem is effectively avoided with the arrangement of the present invention.

In the illustrated form of the invention, the entry side compactor blade 18 is rigidly secured along an upper portion 28 thereof to a mounting plate 29. The mounting plate itself is secured to a rigid beam structure 30 extending across the full width of the machine, which may be on the order of 100 inches (2540mm). The beam 30 is fixed to an end plate 31 at each end, and the end plate in turn is adjustably secured to a pivot plate 32 at each end. The end plates 31 are adjustable with respect to the pivot plates 32, by means of adjusting bolts 33, 34, to accommodate initial precision positioning adjustments of the compactor blade 18, although once the initial alignment of the blade 18 has been completed, these adjustments would be infrequently used. Precision raising and lowering of the

entry side compactor blade 18, to enlarge or narrow the compacting zone 22, can be accomplished by means of an eccentrically mounted pivot shaft 35, which is controllably rotatable by means of a handle 36 which can be rotated about its shaft 37 and rotates the eccentric shaft 35 through suitable mechanical chain or gear drive means (not shown).

The geometry of the pivotal mounting for the entry side compactor blade 18 is such that the entire pivoting mechanism is overweighted toward the front of the machine and thus tends to pivot by gravity to a tilted position as shown in Fig. 6, which shows the compacting equipment in an "open" position as for cleaning, threading in of a new piece of fabric, etc. If necessary or desirable, actuator means can be provided for moving the pivoting mechanism to the "open" position.

Positioning of the entry side compactor blade 18 with respect to the feed roller 14 for compacting operations is accomplished by means of a fluid-inflatable element 40, which exerts controllable pressure against the blade 18 across its entire width. The inflatable element is contained within an elongated channel 41 and has a front portion 42 arranged to press forwardly against the back surface 43 of the mounting plate 29, when the element 40 is under pressure. The channel 41 is fixed to a rigid tube 45 which extends across the width of the machine.

To advantage, the fluid-inflatable element 40 may be an elongated elastic tube, extending across the full width of the mounting plate 29, which is coextensive in width with the compactor blade 18. The inflatable element may, to advantage, be a "Pneuma-Seal" element available from Pawling Corporation, Pawling, New York. An air-inflatable element 40 is preferred for its simplicity, although other fluids, including liquids, may be employed in appropriate circumstances. Likewise, although a single element extending across the full width of the machine is preferred, a plurality of inflatable elements, placed end-to-end may also be employed.

When the inflatable element is not under pressure, it resiliently inverts into the confining channel 41, allowing the mounting plate 29 and entry side compactor blade 18 to pivot rearwardly about a shaft 38, indicated in Figs. 4 and 6. When the equipment is in operation, the element 40 is inflated and expanded, as shown in Fig. 5, pivoting the entire mounting structure for the compactor blade 18 forwardly and uniformly pressing the forward corner 26 of the compactor blade 18 against the fabric 10 supported on the feed roller 14. The amount of pressure applied by the blade corner 26, to pinch the fabric against the feed roller surface, can be controlled with great precision by controlling the air pressure supplied to the inflatable element 40. An adjustable valve for this purpose is symbolically illustrated at 44 in Fig. 5.

An important aspect of the fluid actuator system for acting on the entry side compactor blade is that it guarantees uniform pressure across the full width of the blade. This in turn enables the use of a thinner blade, defining a very short compacting zone 22 and thus enabling superior compacting results to be achieved. Additionally, this arrangement, by assuring uniform pressure across the width of the blade, enables the incoming fabric to be driven by an essentially line contact area of engagement of the fabric between the corner 26 of the entry side blade 18 and the surface 25 of the feed roller 14. The ability to employ a very narrow line of contact pressure on the fabric, rather than providing an extended arcuate area of confinement, gives better control of the fabric and, importantly, prevents buffing and shining of one surface of the fabric as it slides over an immovable confining surface as it approaches the compacting zone.

In the illustrated form of the equipment, the feed roller 14 may be mounted on a generally fixed axis in the machine frame 15. The retarding roll 16, on the other hand, is mounted by means of heavy supports 46 (Fig. 6), pivoted in a lower portion (not shown) of the machine frame 15 for movement between operating and

retracted positions (shown in Figs. 5 and 6 respectively) by means of a fluid cylinder 47, acting through toggle links 48, 49.

The supports 46 are pivoted to move the retarding roller 16 away from the feed roller 14 in order to provide access to the compacting region for cleaning, threading, servicing, etc. When the cylinder is extended, the supports 46 move the retarding roller 16 into operating position, as shown in Figs. 4 and 5. In its operating position the retarding roller is urged toward the fabric and the exit side blade 19 by controlled fluid pressure in the cylinder 47. Adjustable fluid pressure regulating means (not shown) are provided for this purpose.

The exit side compactor blade 19 is mounted on a large, rigid beam 54, extending across the full width of the machine and supported at each end by a pair of heavy brackets 50 at each side of the machine. The brackets 50 are pivoted about an axis 51, and are operated by cylinders 52 acting on lever arms 53 at each side. When the cylinders 52 are retracted, the exit side compactor blade 19 is pivoted away from the feed roller, as shown in Fig. 6. This enables the compacting area to be completely opened for cleaning, inspection, servicing, etc. It will be understood, of course, that before the exit side blade 19 is moved to an open position, as shown in Fig. 6, the entry side blade 18 must first be retracted by depressurizing the inflatable element 40, allowing the pivot plates 32 to swing the blade 18 rearwardly under the action of gravity.

When the cylinders 52 are extended, the levers 53 move upward to fixed positions preferably seated against fixed stops (not shown) on the machine frame to position the lower blade in the manner as shown in Figs. 1, 4 and 5. Initial precision adjustment of the exit side blade 19 is provided by means of adjusting bolts 55, 56 at each side which enable the position of the beam 54 to be manipulated vertically and laterally at each side to precisely position the exit side blade with its upper extremity 57 (Fig. 1) in close proximity to the surface 25 of the

feed roller. The clearance space between the tip 57 and the surface 25 is very small to prevent the incoming fabric 10 from entering between the blade 19 and the feed roller 14. Instead, the fabric is diverted along the surface 21 and into the compacting zone 22.

In the apparatus of the invention, improved arrangements are provided for applying steam to the fabric prior to its entering the compaction zone, in order to moisten and lubricate the fibers of the fabric and facilitate readjustment and longitudinal compression of the fabric. As shown best in Fig. 5, the steaming system of the invention comprises a steam outlet assembly 60 including a tubular header 61 extending across the full width of the machine and positioned a short distance in front of the feed roller 14. Joined with upper portions of the header 61 are upper and lower sheet metal nozzle sections 62, 63 which define a narrow nozzle passage, extending the full width of the equipment and communicating with the interior of the header 61. The forward edge 64 of the lower nozzle section 63 is positioned to lie directly above the top of the feed roller 14, almost in contact with the upper surface of the fabric 10 passing thereover. The forward edge 65 of the upper nozzle section 62 extends somewhat farther forward than the edge 64, overlying upper extremities of the feed roller, more or less in tangential relation. Steam under pressure is supplied to the header 61, passes upward and forward between the nozzle sections 62, 63 and is discharged directly onto and toward the fabric as it exits the steam nozzle outlet 66 at the forward edge of the nozzle section 64.

Steam thus ejected from the outlet 66 is directed into the fabric, more or less in the plane of the fabric, rather than at right angles thereto in accordance with prior practice. Not only does this result in superior moisture penetration into the fabric, but the steam injection into the fabric occurs only a few inches before the fabric enters the compaction zone 22, such that the opportunity for steam to flash off and evaporate before the fabric is processed in the compaction zone, is

reduced to a minimum. The fabric at the point of steam injection is supported on the surface of the feed roller, so no portion of the steam can simply pass through the fabric and evaporate on the other side. Overall, as compared to conventional steaming operations, which typically are performed at least a foot or two in advance of the compacting zone and typically inject steam through the fabric at right angles, highly significant savings in steam costs can be realized. A reduction in steam costs of at least 50% can be realized, and in some cases savings will be significantly greater than that.

In addition to the greater efficiency in applying steam to the incoming fabric, the system of the invention serves to reduce the operating thermal requirements of the equipment. As set forth in the Milligan et al. U.S. Patent 6,047,483, proper heating of the various working elements of a compacting machine is a significant operating consideration. In the illustrated apparatus, it is contemplated that a fluid heating medium, such as heating oil, will be circulated through the mounting for the lower compacting blade 19, through the interior of the feed roller 14, and through the mounting for the entry side compacting blade 18, in sequence, in order to keep these elements at a desired elevated temperature. With the steaming system of the present invention, steam that is ejected toward the fabric through the nozzle outlet 66 serves not only its primary function, to moisten and lubricate the fabric, but also imparts some heat to the feed roller 14, and to the entry side compactor blade 18. This heat content, which otherwise might be lost to the ambient, contributes to the heating of the aforementioned functioning elements and thus proportionately reduces the thermal requirements of the heating system.

In the illustrated form of the invention, the heating assembly 60 is mounted at opposite sides in mounting brackets 67, which are pivotally mounted at 68 to the machine frame. For initial threading of the fabric into the equipment, and/or for cleaning or inspection, the mounting brackets 67 may be pivoted upwardly, as

shown in Fig. 6, opening up the entire front area of the equipment. A handle 69 may be provided for engaging and manually pivoting the steam mechanism.

For certain fabrics, it may be desirable to provide an initial, relatively positive in-feed, in order to initially pull fabric up and around the feed roller 14 and out through the exit side. For this purpose, it may be convenient to provide a pair of cylinders 70 on each of the mounting brackets 67, associated with supports for the steam assembly 60. This is symbolically indicated at 70 in Fig. 5. When the cylinders 70 are retracted, the steam assembly is moved slightly relative to the brackets 67, such that the cylindrical header 61 bears on the fabric, pressing it lightly against the surface of the feed roller 14. When used, this is a momentary operation, simply to allow the leading edge of the fabric to pass up and over the top of the feed roller for threading purposes.

In accordance with another aspect of the invention, improved arrangements are made for rotatably mounting the feed and retarding rollers 14, 16 providing much more rigid support for the rollers against sagging and deflection, as compared to conventional equipment used for this purpose. Conventional equipment utilized in this operating environment typically utilizes pillow blocks to support opposite ends of the feeding and retarding rollers. Where the equipment is of rather extreme width, such as 100 inches (2540mm) contemplated herein, sag and deflection becomes a significant problem, which historically has been dealt with by making the rollers of very large diameter, with very thick cylinder walls, to impart stiffness. The size and weight of these huge rolls is disadvantageous in many respects, relating to the cost and weight thereof, and the overall size of the equipment needed to utilize them, resulting in excessive use of factory floor space. The massive rollers also require significant start-up times, in order to bring them up to initial operating temperatures, and require significant thermal input during the continuing operations.

According to the invention, the feeding and retarding rollers are provided at opposite ends with extended mounting necks of relatively large diameter, which are mounted in widely spaced pairs of bearings, which hold the roll necks in rigid alignment and are not accommodative of sag and deflection. Of course, sag and deflection cannot be totally eliminated. However, the arrangement of the invention enables the feeding and retarding rollers to be reduced in size from about 12 inches in diameter, for a 100 inch machine, to about 6 inches in diameter while maintaining sag and deflection within acceptable tolerances. Similarly, the wall thickness of the cylinders can be reduced from about 2 inches to about 1 1/2 inches.

In the illustrative example, the rollers 14, 16, shown schematically in Fig. 7, are of approximately 6 inches in diameter over their working bodies, of a width of about 100 inches. The supporting necks 80 are in the form of hollow cylinders and extend axially outward from the working bodies 81 of the rollers for a distance of approximately 7 inches. The diameter of the neck portions preferably is large in relation to the diameter of the working body portions 81 of the rollers. For example, the neck portions 80 may have a diameter of about 4.33 inches for a roller body 81 of about 6 inches in diameter. Bearings 82, 83, which preferably are roller or needle bearings, are spaced apart a substantial distance on the roller necks 80, for example about 5.35 inches center-to-center for the nominal 6 inch roller. The bearings themselves are rigidly mounted in the machine frame at 84. The bearings for the feed roller 14 are mounted in fixed portions of the machine frame, while the bearings for the retarding roller 16 are rigidly mounted in the pivoted supports 46 (Fig. 6).

The ability to utilize small diameter feeding and retarding rollers in wide, open width compacting equipment is extraordinarily beneficial. The reduction in the size and weight of the rollers, in addition to saving significant initial costs in the rollers themselves, allows the entire mechanism of the compacting equipment,

including the frame and other supports, to be reduced in size. The overall machine thus occupies less factory floor space. Thermal and start-up requirements are also reduced, and mounting arrangements for the respective entry side and exit side compactor blades are simplified, among other benefits.

The apparatus of the invention represents a significant advance over known equipment for compacting open width knitted fabrics, both in terms of superior performance, in terms of lower manufacturing cost, and in terms of more efficient utilization of factory floor space. A unique configuration of the compacting station, using an inflatable element for applying highly uniform pressure to the entry side compactor blade, combined with the use of a substantially line contact between the entry side blade and the incoming fabric, enable superior compacting results to be achieved. The location of the line of contact is directly at the entrance to the compacting zone, providing optimum control over the fabric at a critical stage of the procedure.

Additional improvements are realized by injecting steam into the fabric while it is on the feed roller and just inches away from entering the compacting zone. This close-coupled arrangement greatly increases the efficiency of steam usage, resulting in significant savings in operating costs, and also assures optimum uniformity in heat and moisture conditioning of the fabric as it enters the compacting zone.

Multiple advantages are also realized through the utilization of double bearing mountings for the elongated processing rollers, enabling the size and mass of the rollers to be greatly reduces without sacrificing performance and, indeed, while improving performance in many respects.

It should be understood, however, that the specific form of the equipment herein shown and described is representative only as certain changes may be

made therein without departing from the clear teachings of the disclosure. Accordingly, reference should be made to the appended claims in determining the full scope of the invention.

Claims:

1. Apparatus for effecting lengthwise compacting of open width knitted fabric, and of the type comprising

(a) a feed roller mounted and driven for rotation at a first controllable surface speed,

(b) a retarding roller mounted and driven for rotation at a second surface speed controllably less than the surface speed of said feed roller,

(c) said feed and roller being positioned in opposing relation with their respective longitudinal axes in a common plane and having respective outer surfaces spaced apart a short distance at said common plane to form a compacting region,

(d) entry side and exit side compactor blades extending along the length of said feed and retarding rollers and projecting into said compacting region,

(e) said compactor blades having closely spaced, opposed end surfaces in the region of said common plane and disposed at an angle to said common plane,

(f) said opposed end surfaces forming a compacting zone for the close confinement of said fabric as it is advanced through said zone,

(g) said entry side compactor blade cooperating with said feed roller to controllably feed fabric into an entry end of said compactor zone at a first speed,

(h) said exit side compactor blade cooperating with said retarding roller to effect controllable removal of said fabric from an exit end of said compactor zone at a second speed less than said first speed, characterized by

(i) support structure extending lengthwise along said entry side compactor blade on a side thereof opposite said feed roller,

(j) a fluid inflatable bladder positioned between said support structure and said entry side compactor blade, and

(l) a controllable source of fluid under pressure associated with said fluid inflatable bladder for controllably inflating said bladder to controllably urge said entry side compactor blade toward said feed roller.

2. An apparatus according to claim 1, further characterized by

(a) said entry side compactor blade being mounted for pivoting movement about a pivot axis toward and away from said feed roller,

(b) said pivot axis being so located as to cause said entry side compactor blade to be urged by gravity to pivot away from said feed roller, and

(c) said inflatable bladder being positioned to urge said entry side compactor blade to pivot in a direction toward said feed roller.

3. An apparatus according to claim 1, further characterized by

(a) the end surface of said entry side compactor blade forming one side of said compacting zone, joining at an angle with an adjacent surface to form a corner,

(b) said corner being configured to form substantially a line of pressure contact with fabric advancing with said feed roller to controllably advance said fabric into said compacting zone.

4. Apparatus for effecting lengthwise compacting of open width knitted fabric, and of the type comprising

(a) a feed roller mounted and driven for rotation at a first controllable surface speed,

(b) a retarding roller mounted and driven for rotation at a second surface speed controllably less than the surface speed of said feed roller,

(c) said feed and roller being positioned in opposing relation with their respective longitudinal axes in a common plane and having respective outer surfaces spaced apart a short distance at said common plane to form a compacting region,

(d) entry side and exit side compactor blades extending along the length of said feed and retarding rollers and projecting into said compacting region,

(e) said compactor blades having closely spaced, opposed end surfaces in the region of said common plane and disposed at an angle to said common plane,

(f) said opposed end surfaces forming a compacting zone for the close confinement of said fabric as it is advanced through said zone,

(g) said entry side compactor blade cooperating with said feed roller to controllably feed fabric into an entry end of said compactor zone at a first speed,

(h) said exit side compactor blade cooperating with said retarding roller to effect controllable removal of said fabric from an exit end of said compactor zone at a second speed less than said first speed, characterized by

(i) said entry side compactor blade having a front surface intersecting with the end surface thereof to form an angled corner,

(j) said front surface being divergently related to said feed roller, and

(k) means for urging said entry side compactor blade toward an outer surface portion of said feed roller whereby said angled corner forms a line of pressure contact with fabric advancing on said feed roller.

5. An apparatus according to claim 4, further characterized by

(a) said means for urging said entry side compactor blade comprising controllably inflatable means acting on said entry side blade across substantially the full width of the blade.

6. An apparatus according to claim 5, further characterized by

(a) said controllably inflatable means comprising a single inflatable tube extending substantially the full width of the blade.

7. Apparatus for effecting lengthwise compacting of open width knitted fabric, and of the type comprising

(a) a feed roller mounted and driven for rotation at a first controllable surface speed,

(b) a retarding roller mounted and driven for rotation at a second surface speed controllably less than the surface speed of said feed roller,

(c) said feed and roller being positioned in opposing relation with their respective longitudinal axes in a common plane and having respective outer surfaces spaced apart a short distance at said common plane to form a compacting region,

(d) entry side and exit side compactor blades extending along the length of said feed and retarding rollers and projecting into said compacting region,

(e) said compactor blades having closely spaced, opposed end surfaces in the region of said common plane and disposed at an angle to said common plane,

(f) said opposed end surfaces forming a compacting zone for the close confinement of said fabric as it is advanced through said zone,

(g) said entry side compactor blade cooperating with said feed roller to controllably feed fabric into an entry end of said compactor zone at a first speed,

(h) said exit side compactor blade cooperating with said retarding roller to effect controllable removal of said fabric from an exit end of said compactor zone at a second speed less than said first speed, characterized by

(i) means for applying steam to the fabric prior to compacting comprising a narrow, laterally elongated steam nozzle positioned in immediate adjacency to said feed roller for directing steam onto fabric supported on said roller immediately in advance of said compacting zone.

8. An apparatus according to claim 7, further characterized by

(a) said steam nozzle is oriented to eject steam in a direction approximately tangent to an adjacent surface portion of said feed roller, at fabric supported on said surface portion and in the same direction as said fabric is being advanced by said feed roller.

9. An apparatus according to claim 8, further characterized by

(a) said surface portion of said feed roller is displaced from said compacting zone by an arc not substantially greater than 90°.

10. Apparatus for effecting lengthwise compacting of open width knitted fabric, and of the type comprising

(a) a feed roller mounted and driven for rotation at a first controllable surface speed,

(b) a retarding roller mounted and driven for rotation at a second surface speed controllably less than the surface speed of said feed roller,

(c) said feed and roller being positioned in opposing relation with their respective longitudinal axes in a common plane and having respective outer surfaces spaced apart a short distance at said common plane to form a compacting region,

(d) entry side and exit side compactor blades extending along the length of said feed and retarding rollers and projecting into said compacting region,

(e) said compactor blades having closely spaced, opposed end surfaces in the region of said common plane and disposed at an angle to said common plane,

(f) said opposed end surfaces forming a compacting zone for the close confinement of said fabric as it is advanced through said zone,

(g) said entry side compactor blade cooperating with said feed roller to controllably feed fabric into an entry end of said compactor zone at a first speed,

(h) said exit side compactor blade cooperating with said retarding roller to effect controllable removal of said fabric from an exit end of said compactor zone at a second speed less than said first speed, characterized by

(i) said feed and retarding rollers having axially elongated working portions of a predetermined diameter and having elongated, axially extending neck portions at each end,,

(j) said neck portions having a diameter greater than one-half said predetermined diameters of said feeding and retarding rollers,

(k) a machine frame for rigidly supporting said neck portions including a spaced apart pair of bearings engaging each of said neck portions at spaced apart locations thereon,

(l) the bearing of each of said pairs thereof being spaced apart a distance greater than the diameters of said neck portions.

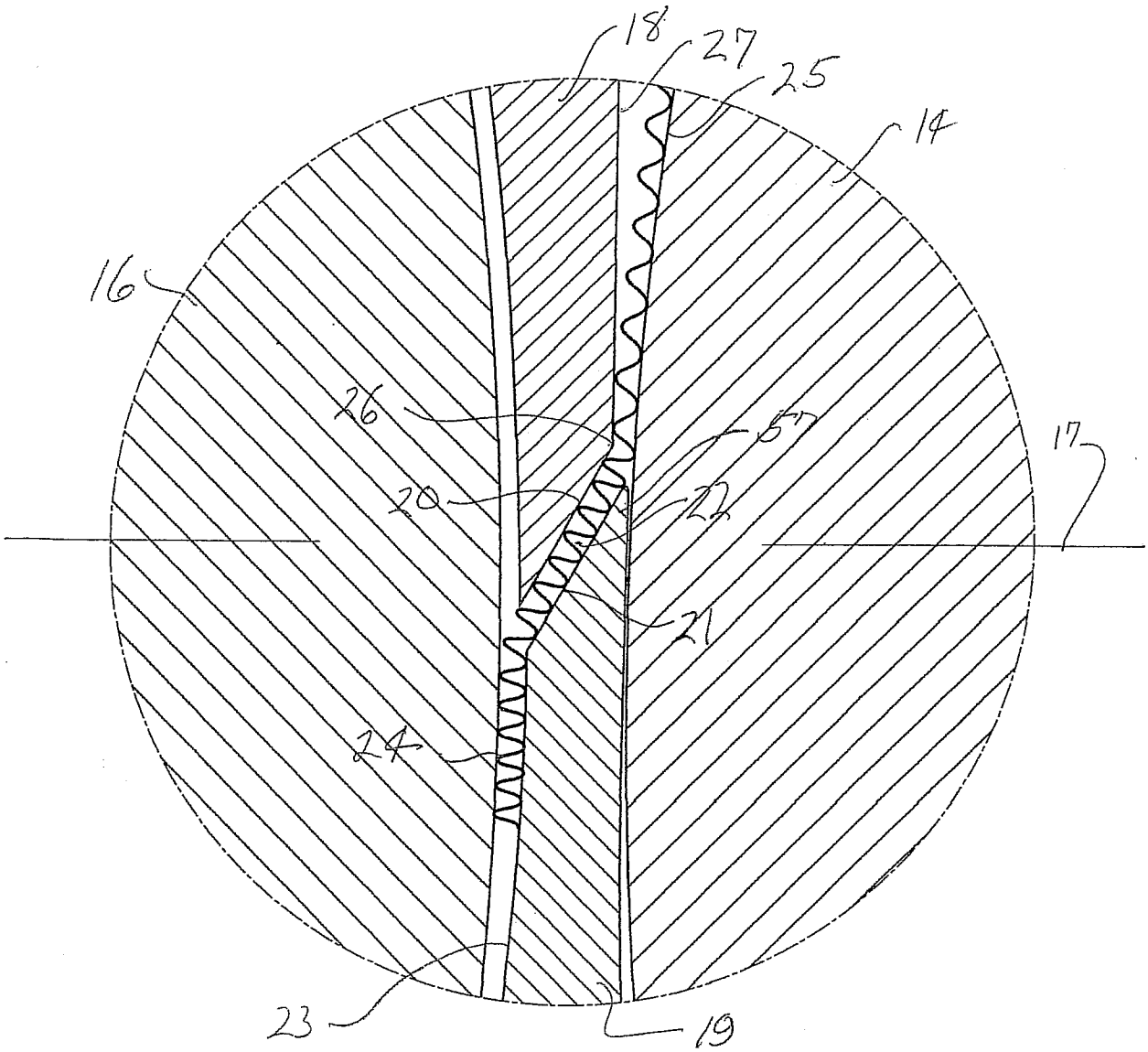


FIG. 1

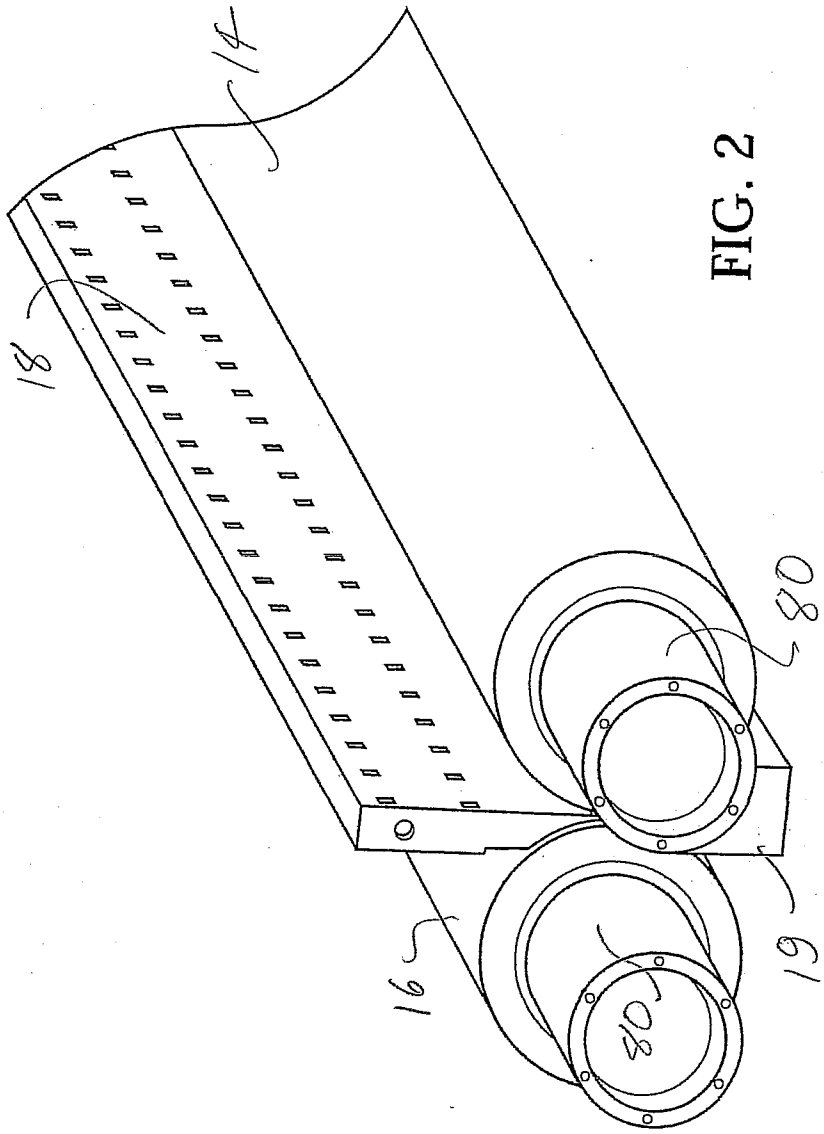


FIG. 2

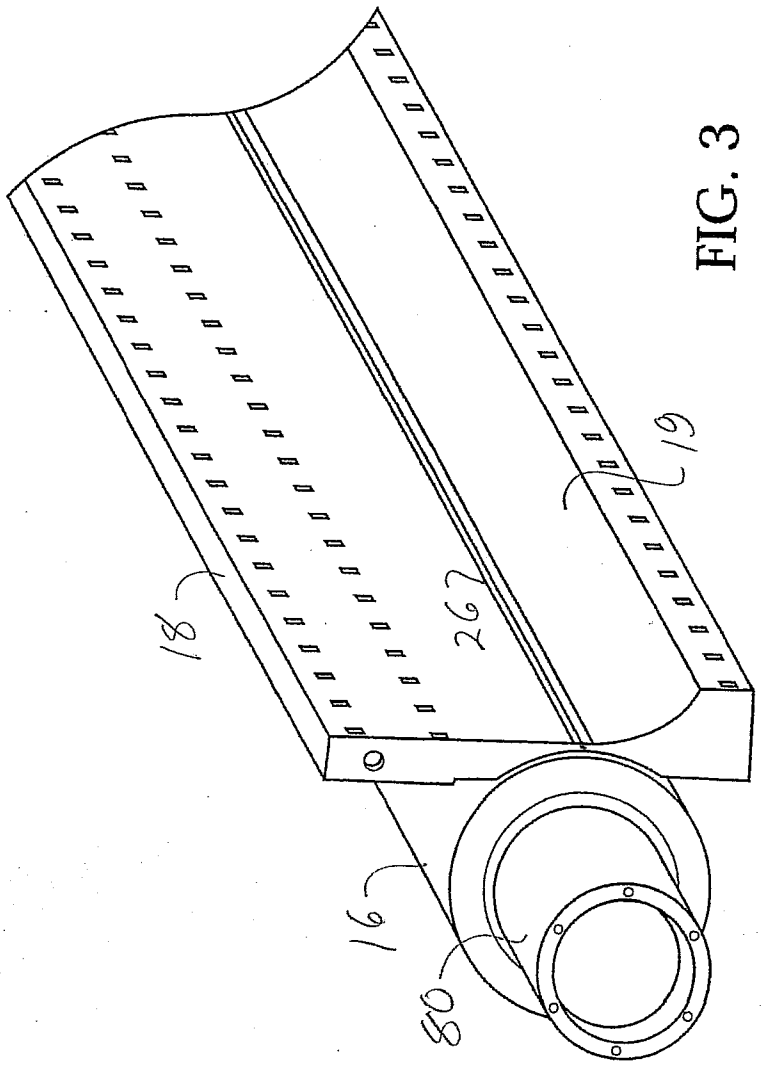


FIG. 3

FIG. 4

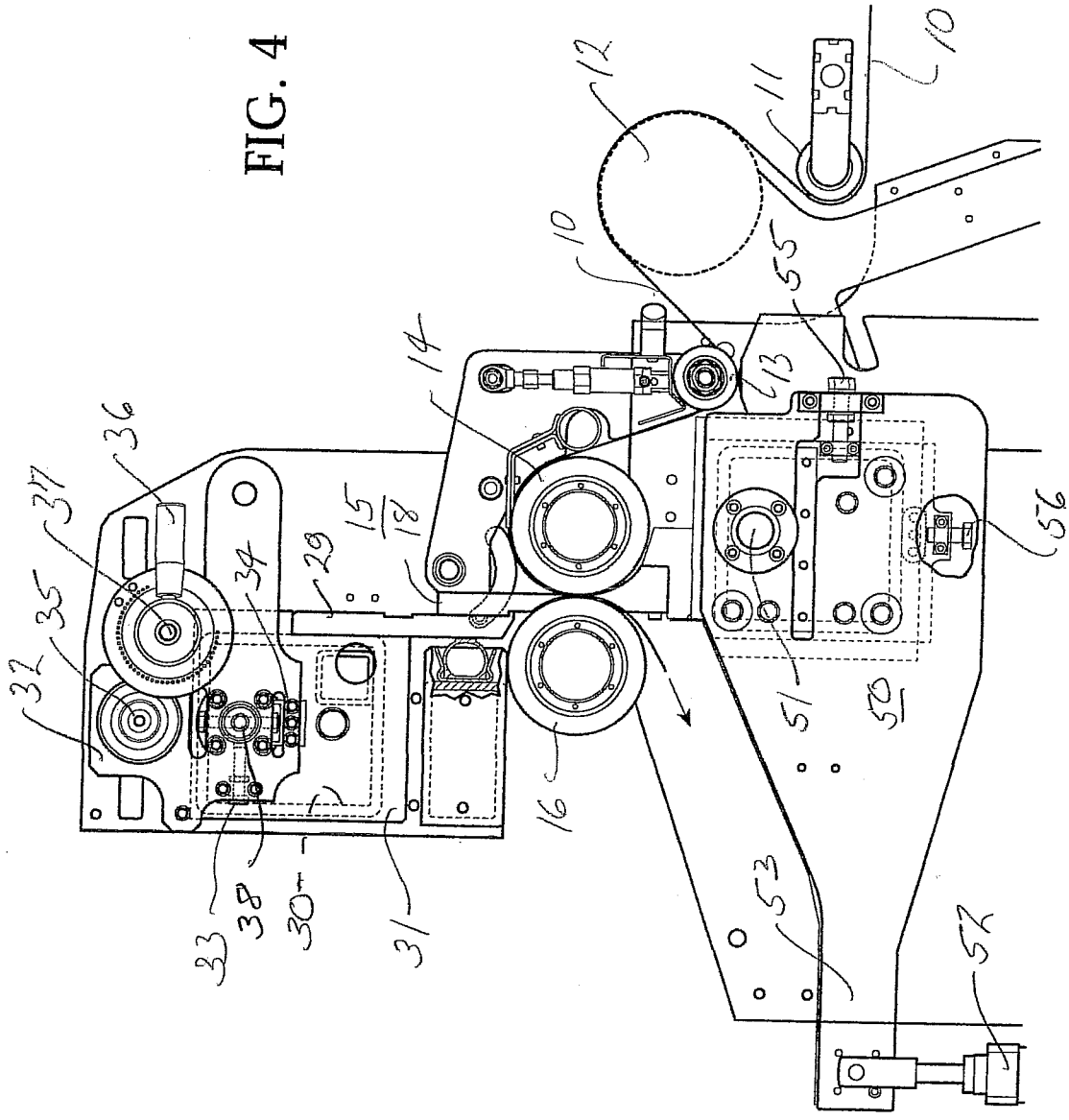

10
12
11
10
55
13
14
36
37
35
32
34
29
15
18
56
51
50
16
53
57
33
38
30
31

FIG. 5

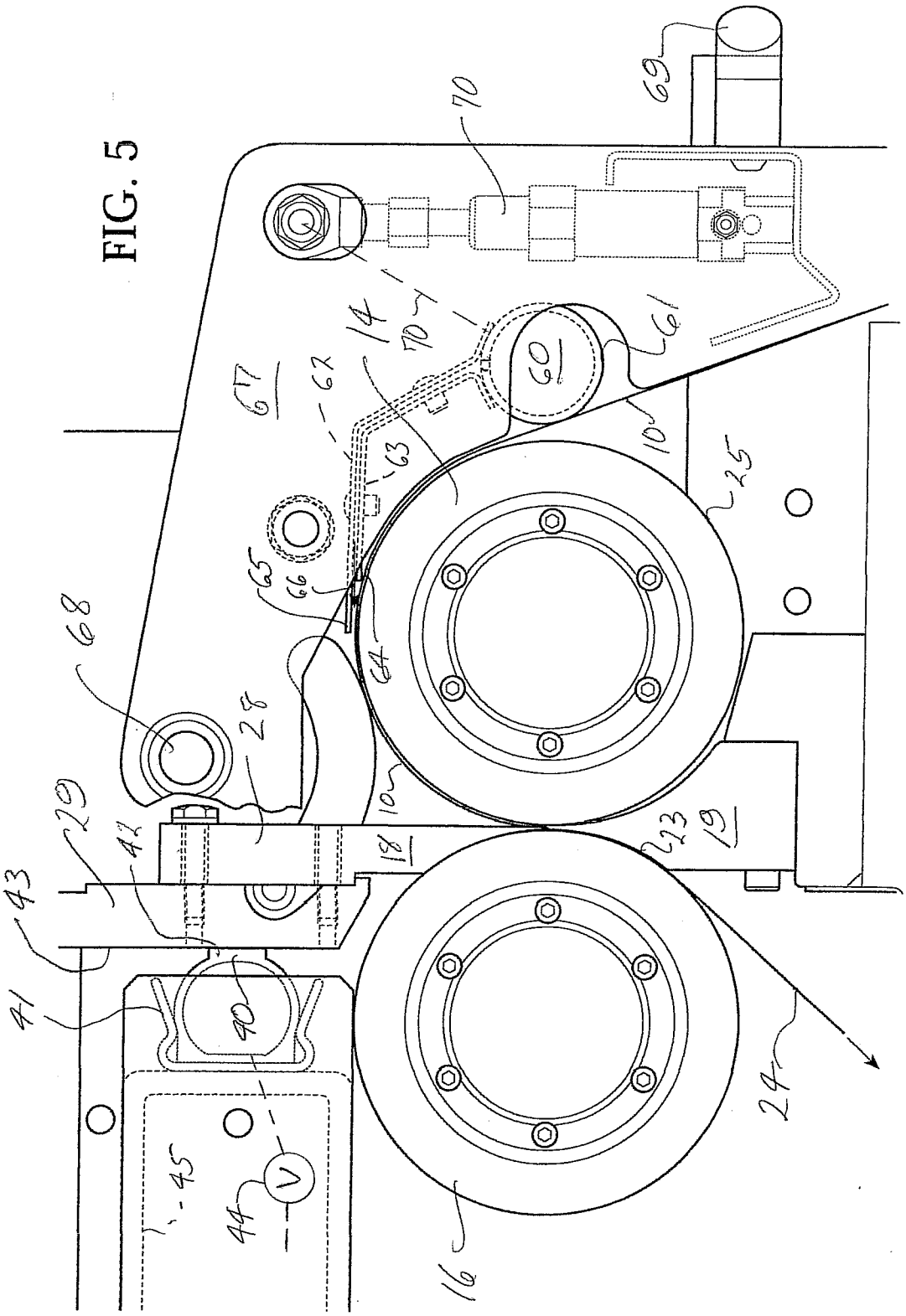
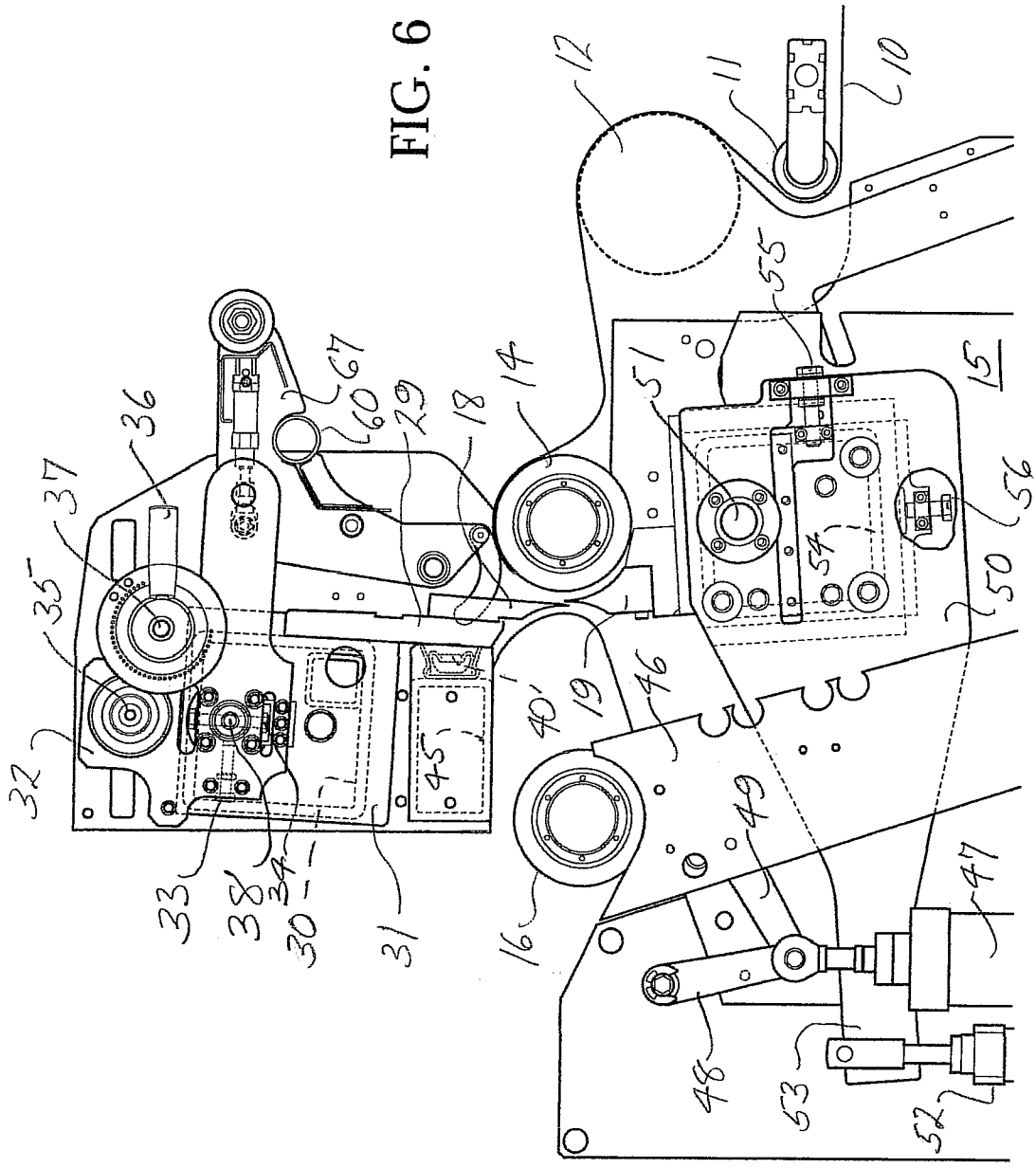

69
70
14
72
61
60
67
62
63
10
25
65
66
64
68
28
20
42
18
23
19
43
41
40
45
44
V
24
16

FIG. 6


12
11
10
55
15
51
14
67
60
29
18
36
37
35
56
54
50
32
40'
19
46
45
49
33
38
34
30
31
16
47
48
53
52

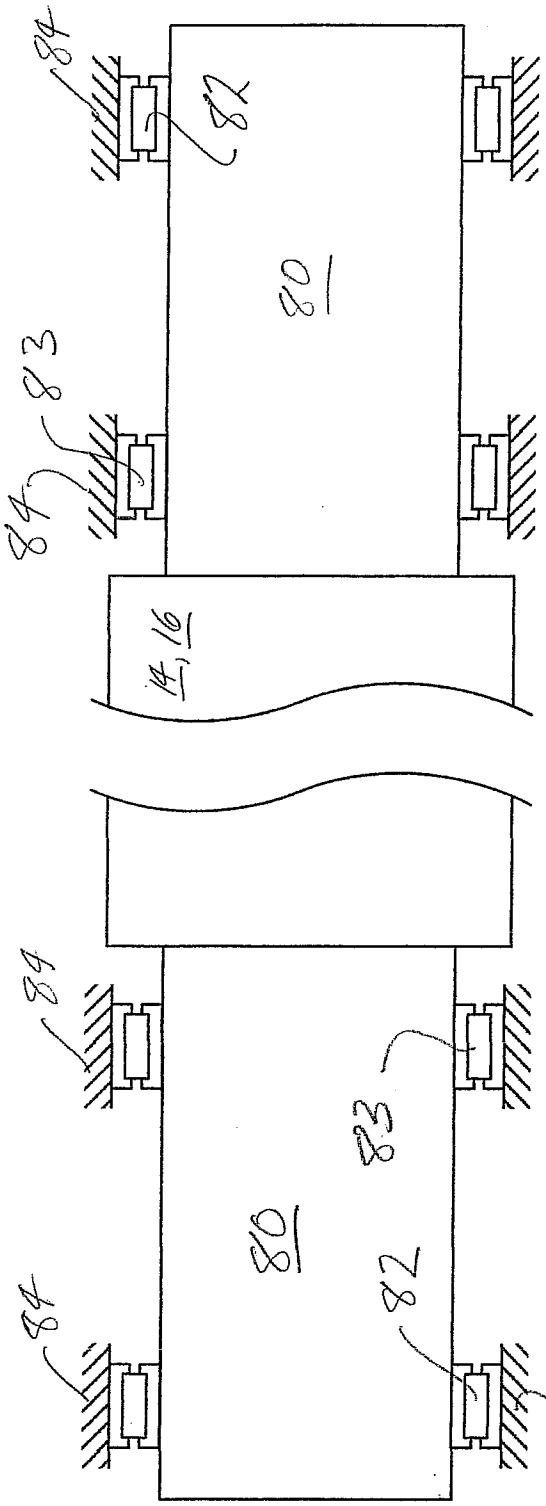


FIG. 7