



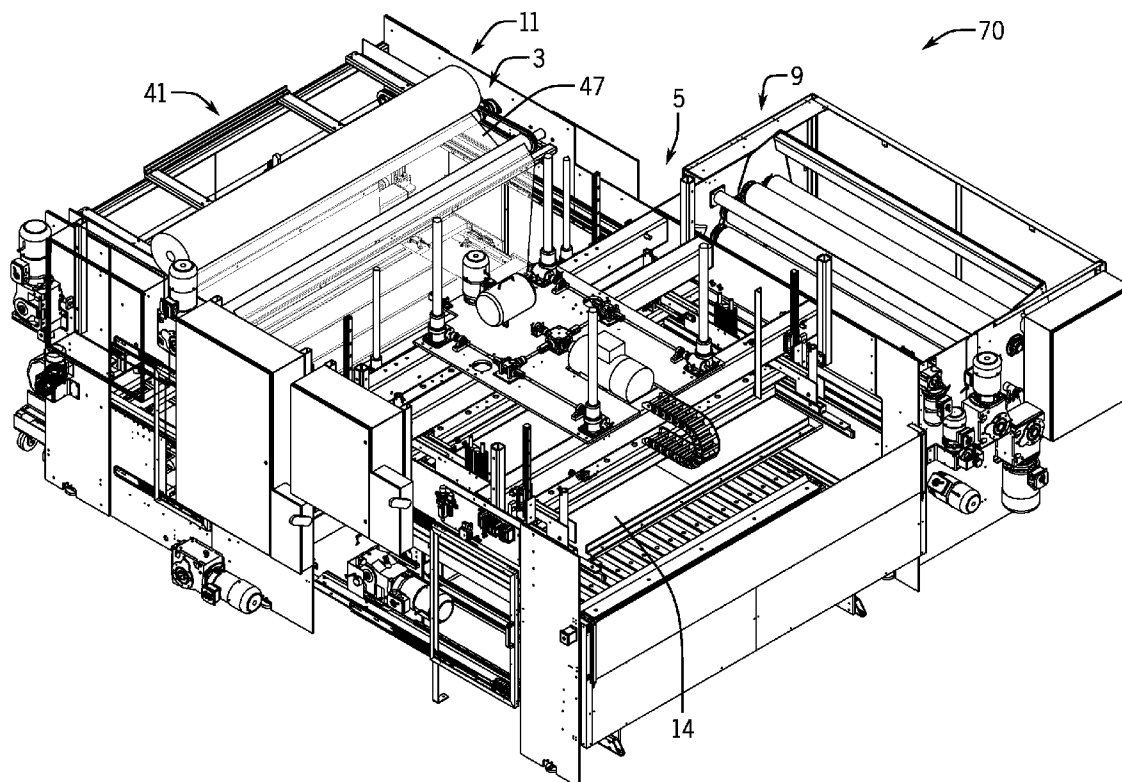
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(19) **United States**(12) **Patent Application Publication****Van De Hey et al.**(10) **Pub. No.: US 2015/0203221 A1**(43) **Pub. Date: Jul. 23, 2015**(54) **SYSTEM AND METHOD FOR PACKAGING A
FOAM PRODUCT****Publication Classification**(71) Applicant: **C3 Corporation**, Appleton, WI (US)(72) Inventors: **Joseph Floyd Van De Hey**, Kaukauna,
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WI (US); **Joseph Richard Mooren**,
Appleton, WI (US)(73) Assignee: **C3 Corporation**, Appleton, WI (US)(21) Appl. No.: **14/594,875**(22) Filed: **Jan. 12, 2015****Related U.S. Application Data**(60) Provisional application No. 61/926,133, filed on Jan.
10, 2014.(51) **Int. Cl.****B65B 11/04** (2006.01)**B65D 85/08** (2006.01)**B65D 75/00** (2006.01)**B65B 51/10** (2006.01)**B65B 63/02** (2006.01)(52) **U.S. Cl.**CPC **B65B 11/04** (2013.01); **B65B 51/10**(2013.01); **B65B 63/02** (2013.01); **B65D****75/002** (2013.01); **B65D 85/08** (2013.01)

(57)

ABSTRACT

A system for packaging a foam product includes a first lateral compressor that applies pressure to a first lateral side of the foam product in a second lateral compressor that applies pressure to a second lateral side of the foam product so as to compress the foam product to a reduced width. The system also includes a roller device configured to roll the compressed foam product into a cylindrical packaged product.



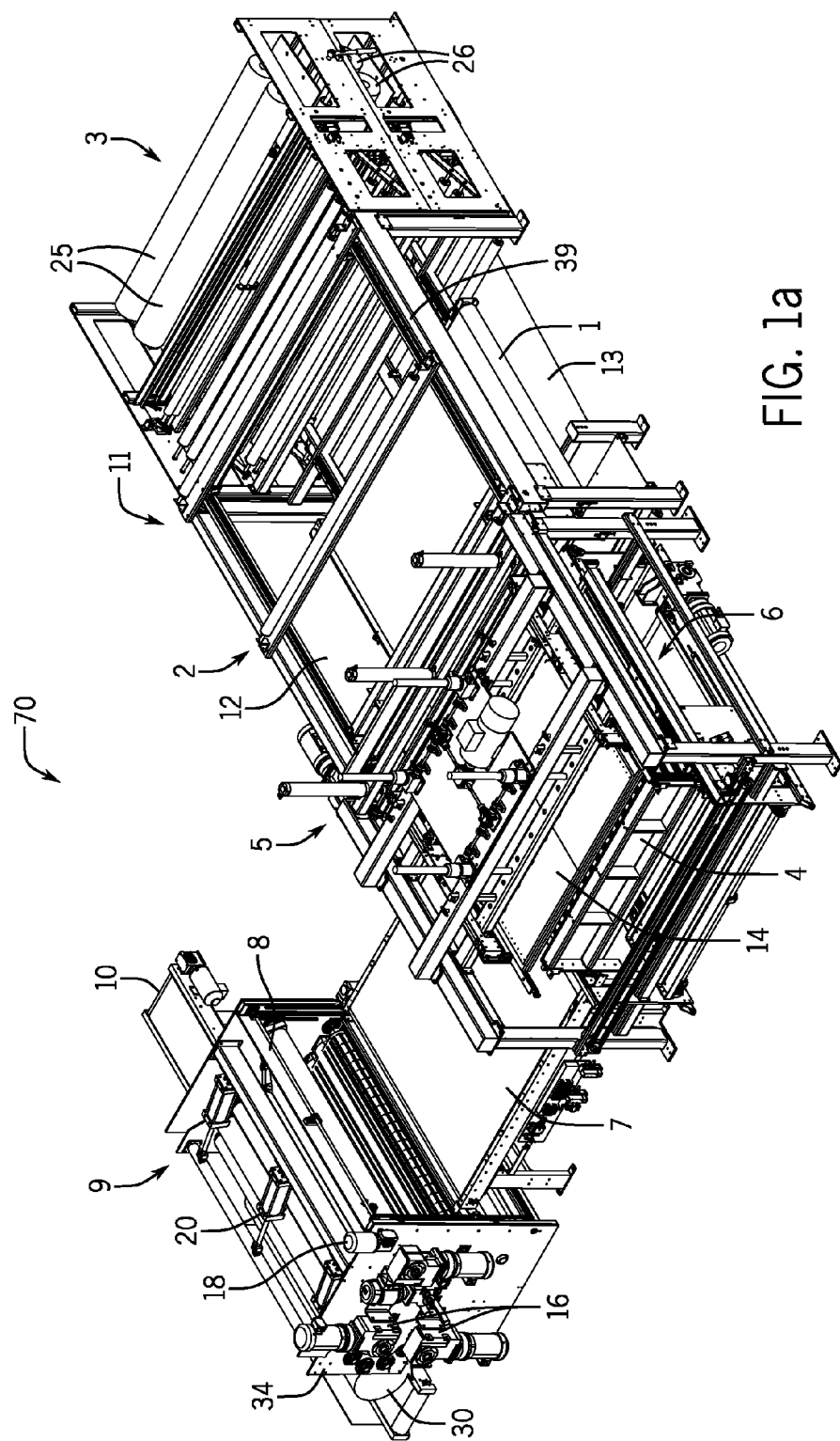


FIG. 1a

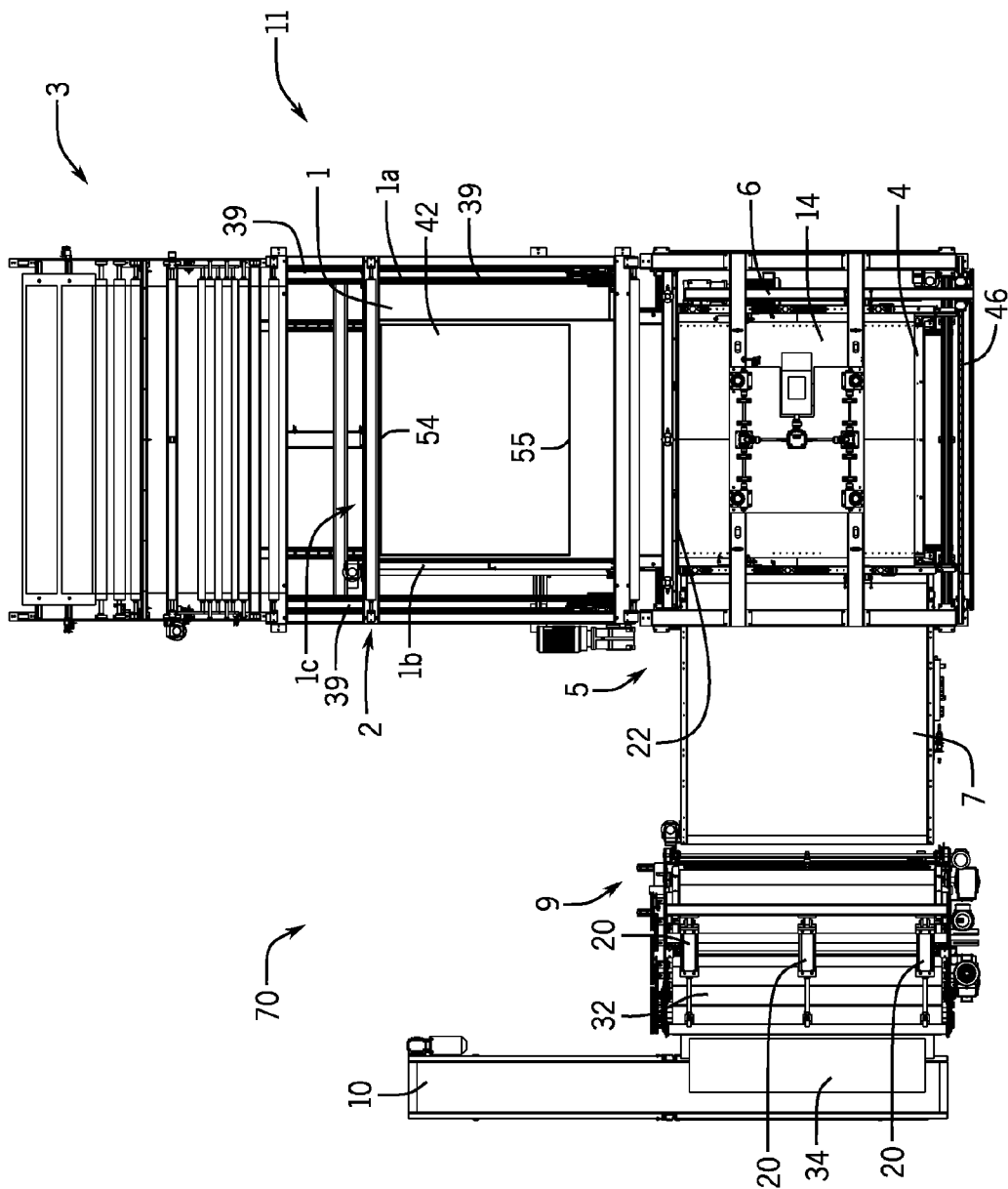


FIG. 1b

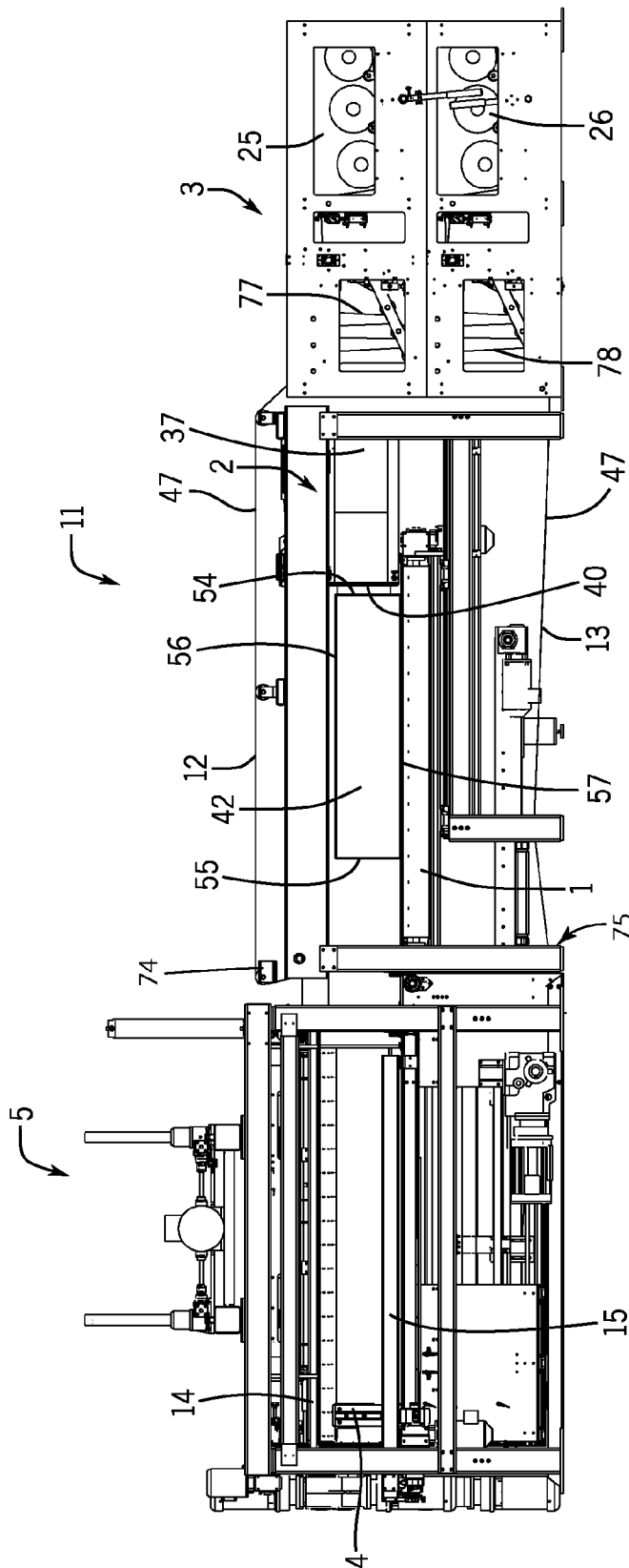


FIG. 1C

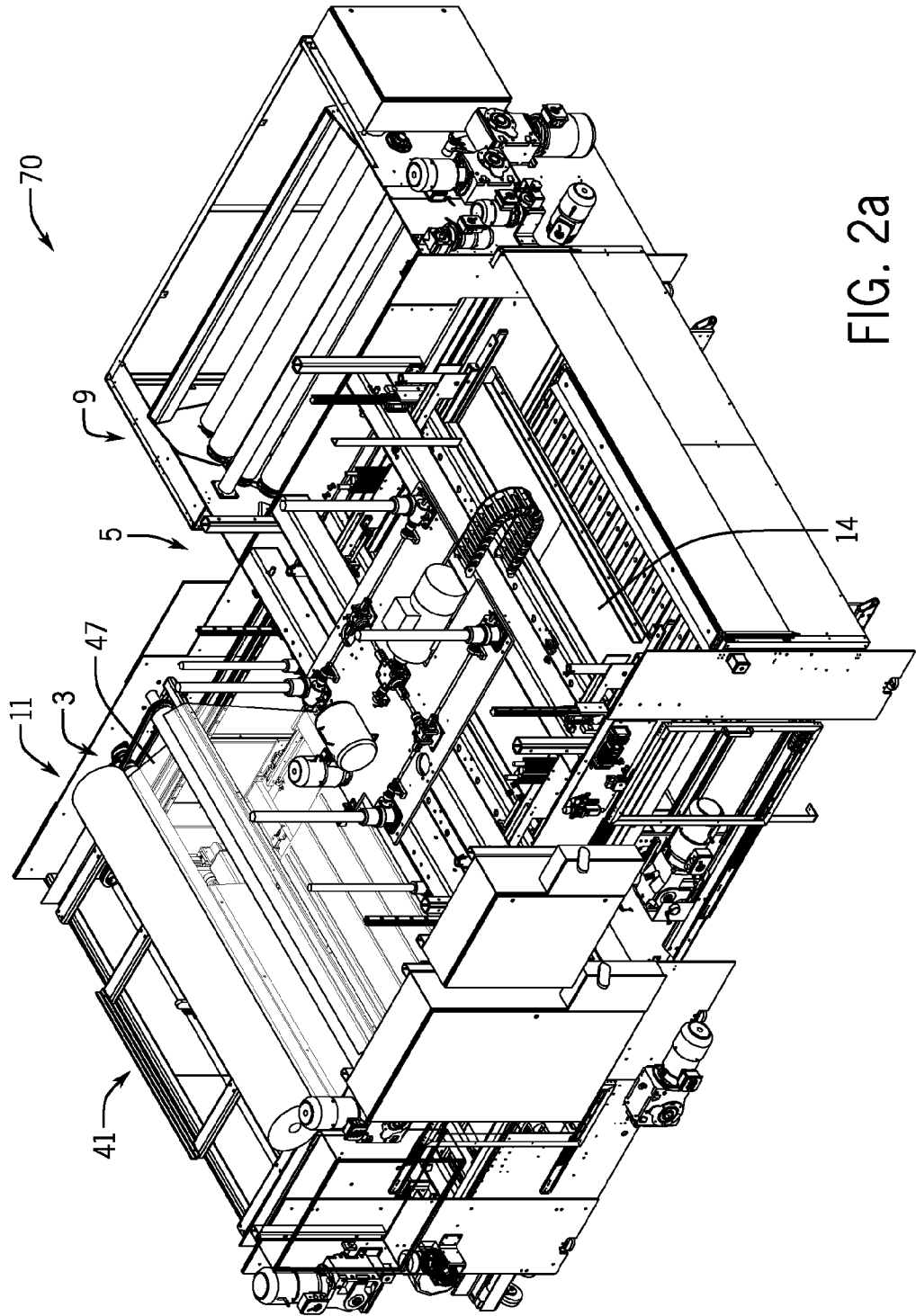


FIG. 2a

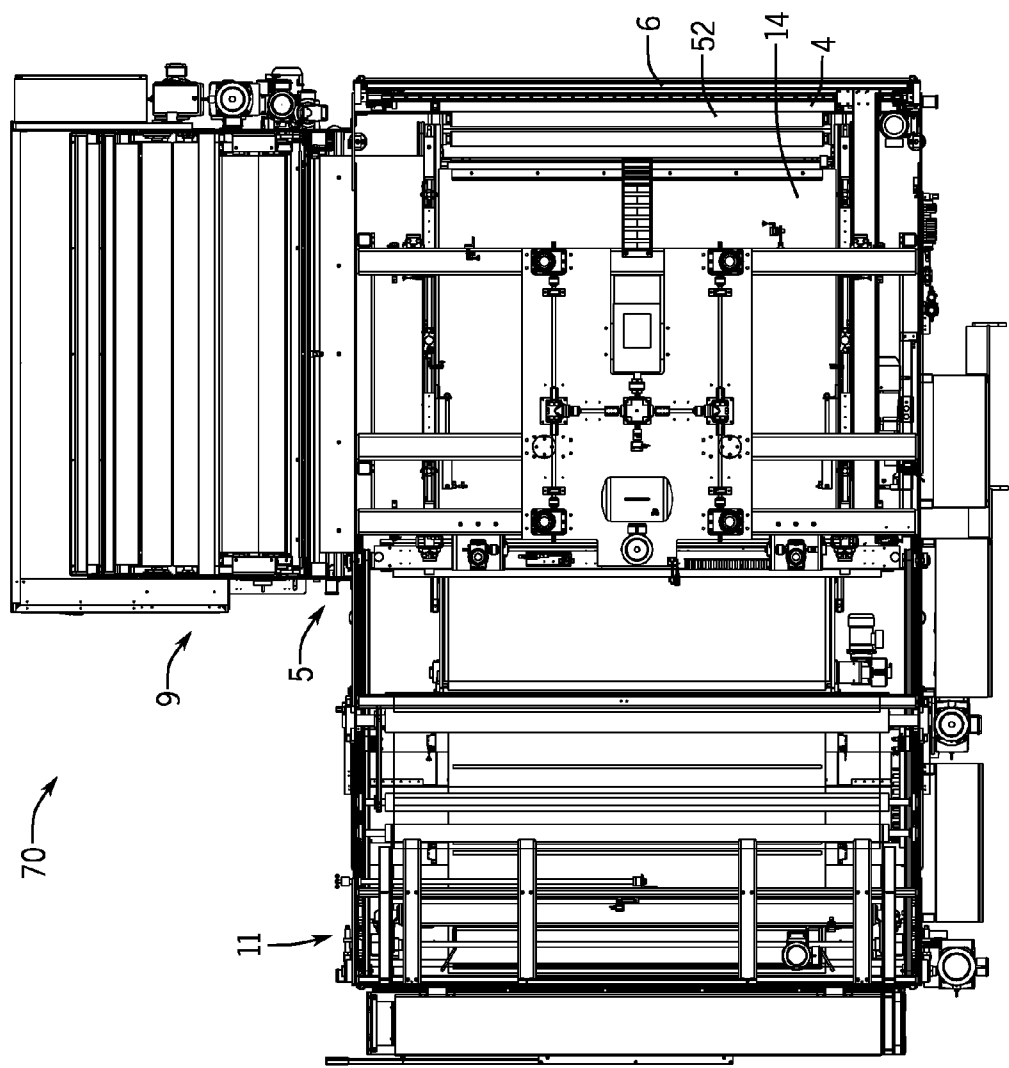


FIG. 2b

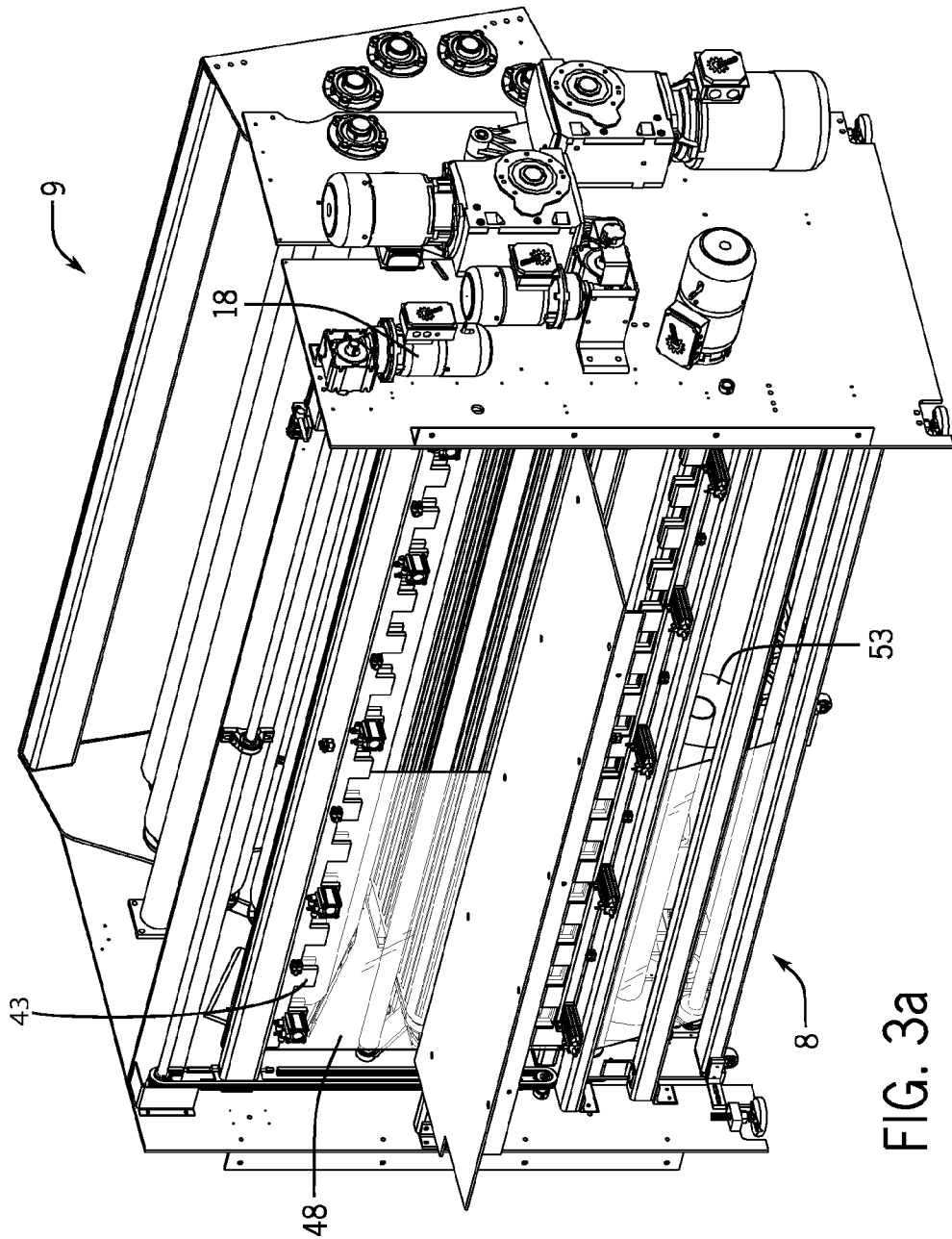


FIG. 3a

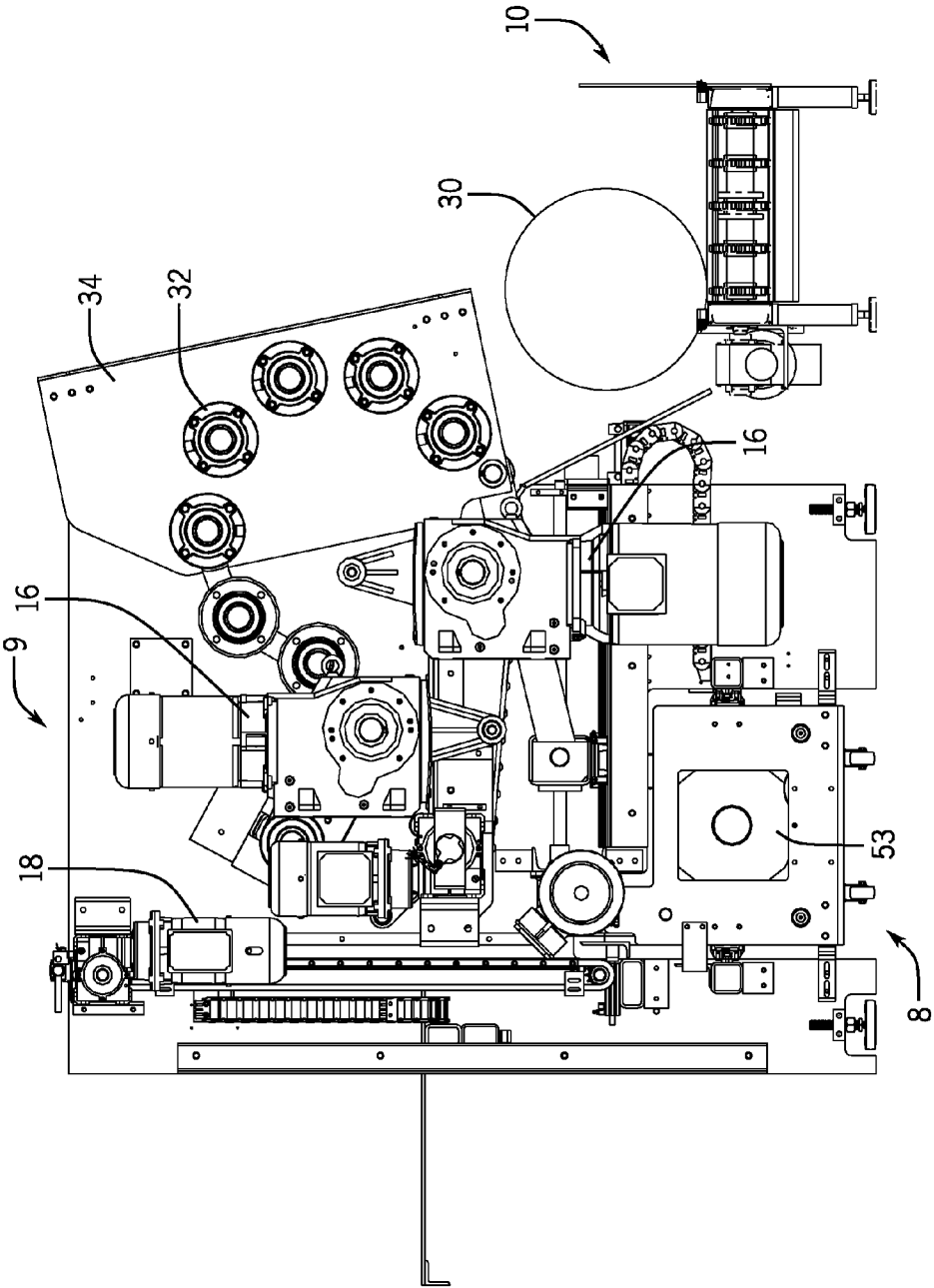


FIG. 3b

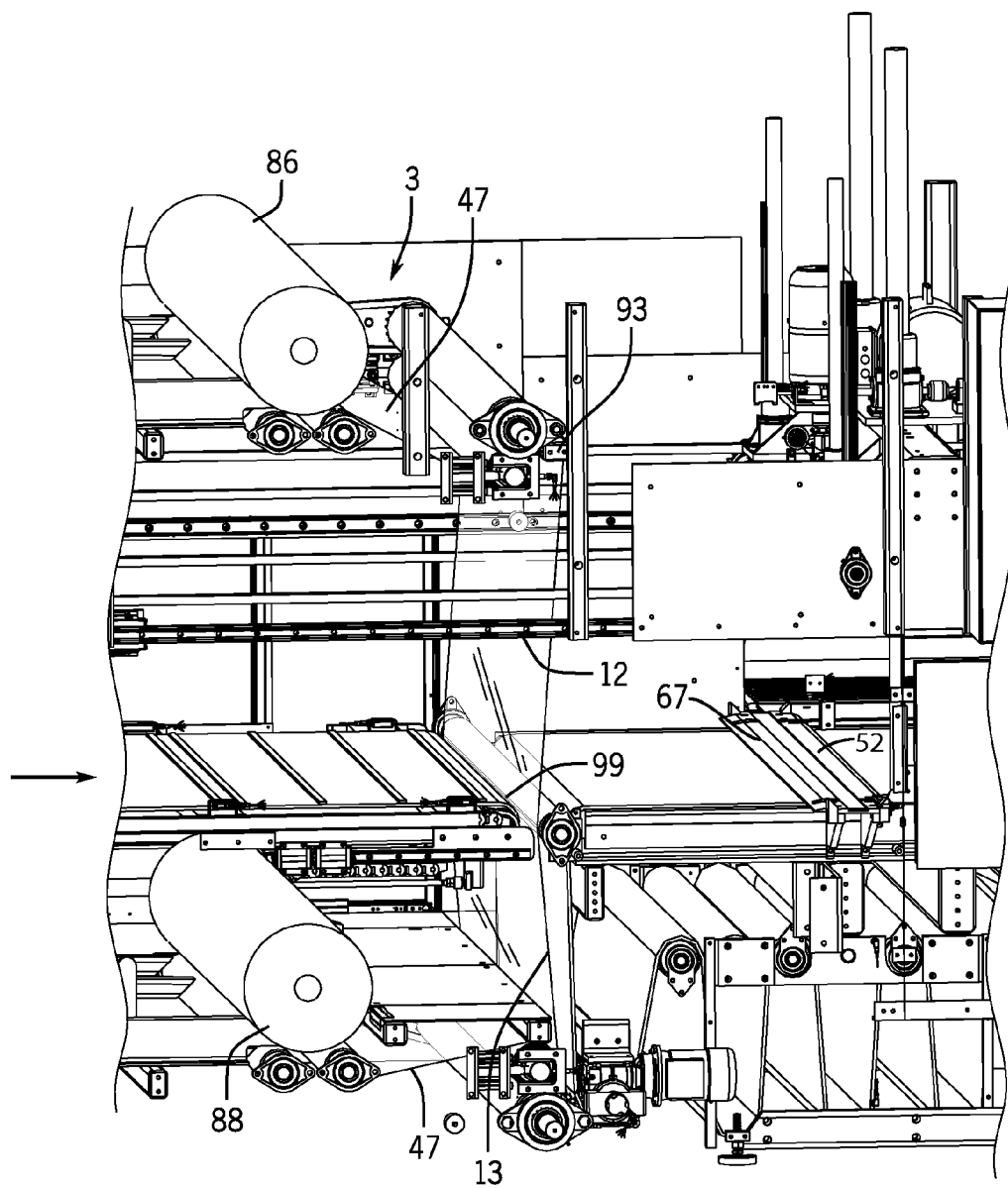
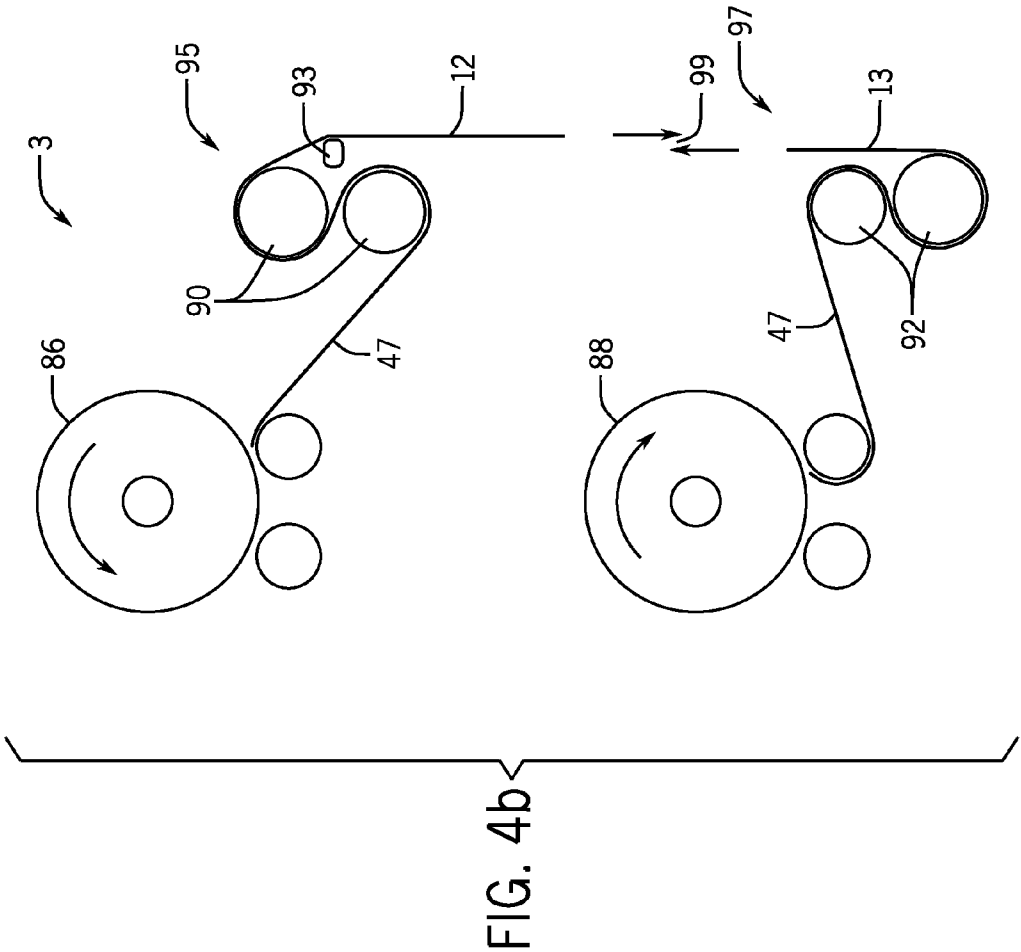


FIG. 4a



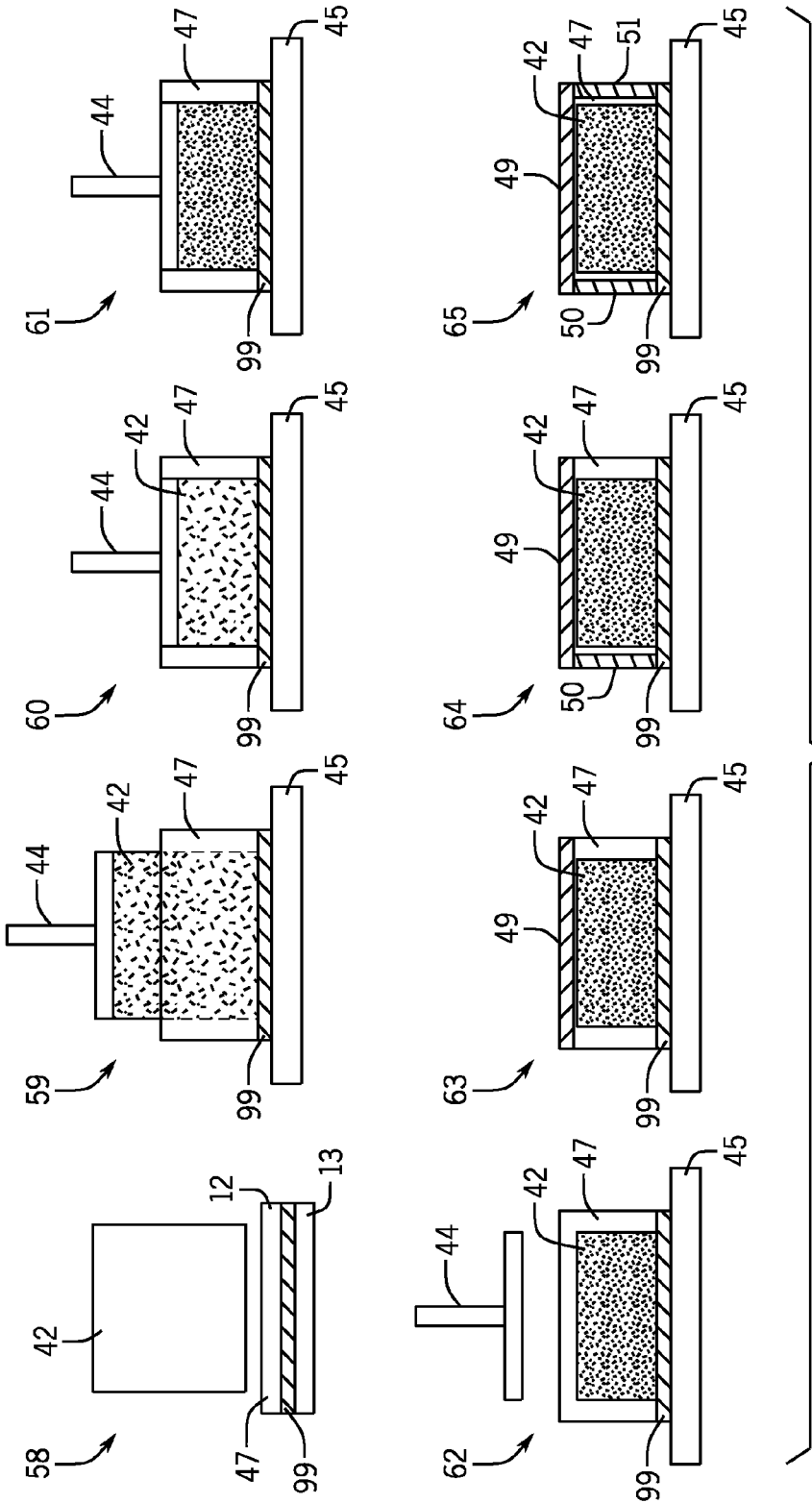
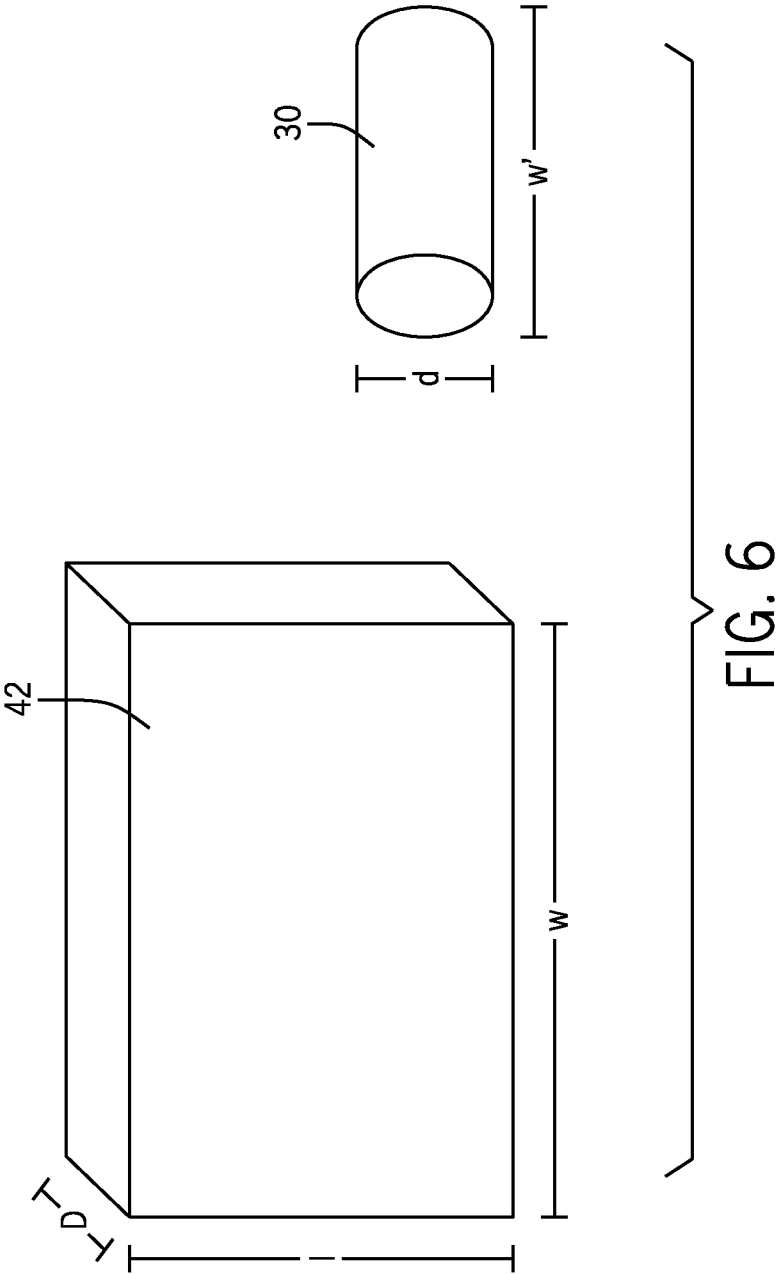


FIG. 5



SYSTEM AND METHOD FOR PACKAGING A FOAM PRODUCT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application is based on and claims priority to U.S. Provisional Patent Application Ser. No. 61/926, 133 filed Jan. 20, 2014, the disclosure of which is incorporated herein by reference.

BACKGROUND

[0002] Foam packaging systems and methods exist that roll foam products, such as memory foam products, into a tubular shape for easier transport. However, such systems and methods do not laterally compress a foam product in order to reduce the width of the final packaged product. Thus, existing systems and methods yield a final packaged product having the same width as the original, pre-packaged product. At most, existing systems and methods for packaging mattresses only offer vertical compression of a product prior to rolling, and thus the final rolled product has a width that is equal to the uncompressed width of the foam product. These wide packaged products occupy too much space and are difficult to transport, especially for an end user. For example, it is difficult to fit a rolled king-size mattress in a sedan or a compact vehicle when the rolled package is 76 inches in width, the standard width of a king-size mattress.

[0003] Some packaging systems and methods are available that fold the foam product in order to reduce the width of the final packaged product. For example, some prior art systems and methods for packaging foam mattresses fold the width of the mattress one or more times before vertically compressing and rolling the mattress. Such folding is unacceptable for many foam products because it damages the foam material, such as by leaving permanent creases or divots.

SUMMARY

[0004] In one embodiment, a system for packaging a foam product includes a first lateral compressor that applies pressure to a first lateral side of the foam product in a second lateral compressor that applies pressure to a second lateral side of the foam product so as to compress the foam product to a reduced width. The system also includes a roller device configured to roll the compressed foam product into a cylindrical packaged product.

[0005] An embodiment of a method of packaging a foam product includes receiving a foam product having a length, an uncompressed width, and an uncompressed depth. The foam product is laterally compressed to a reduced width and vertically compressed to a reduced depth. The compressed foam product is then sealed in a first film to maintain the reduced width and the reduced depth.

[0006] One embodiment of a mattress packaging system comprises an infeed apparatus, a tamp apparatus, and a roller device. The infeed apparatus receives a foam mattress and covers a top portion and a bottom portion of the foam mattress in a first film. The tamp apparatus compresses the foam mattress and includes a first lateral compressor that applies pressure on a first lateral side of the foam mattress and a second lateral compressor that applies pressure on a second lateral side of the foam mattress to compress the foam mattress to a reduced width. The tamp apparatus also includes a sealing mechanism that seals the film around the compressed foam

mattress to retain the reduced width. The roller device rolls to compressed foam product into a cylindrical packaged product and wraps the cylindrical packaged product in a second film. **[0007]** On embodiment of a cylindrical packaged product comprises a compressed foam product rolled along its length to form a cylinder having a width and a circumference. The compressed foam product has an uncompressed width that is laterally compressed to a reduced width and an uncompressed depth that is vertically compressed to a reduced depth. The cylinder is wrapped in a film to retain a width and circumference.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1a depicts a one embodiment of a system for packaging a foam product.

[0009] FIG. 1b depicts a top view of the system in FIG. 1a.

[0010] FIG. 1c depicts a side view of the system in FIGS. 1a and 1b.

[0011] FIG. 2a depicts another embodiment of a system for packaging a foam product.

[0012] FIG. 2b depicts a top view of the system in FIG. 2a.

[0013] FIG. 3a depicts a roller device for a system for packaging a foam product.

[0014] FIG. 3b depicts a side, cross-sectional view of the roller device in FIG. 3a.

[0015] FIG. 4a depicts a side view of an embodiment of an portion of a system for packaging a foam product having an infeed film assembly.

[0016] FIG. 4b depicts a schematic view of the infeed film assembly in the embodiment of FIG. 4a.

[0017] FIG. 5 depicts one embodiment of a method and system for packaging a foam product.

[0018] FIG. 6 depicts an uncompressed foam product next to a cylindrical packaged product.

DETAILED DESCRIPTION

[0019] The present inventors have recognized that a system and method is needed for packaging foam products that reduces the width of the final packaged product without folding or otherwise damaging the product. By compressing the foam product laterally, the size of the final packaged product is significantly reduced. The foam product may also be vertically compressed to further reduce the size of the final packaged product. Such compression can be accomplished without folding or otherwise damaging the foam material. For example, the present inventors recognize that foam products may be laterally, or horizontally, compressed by 40% or more prior to rolling the product, which results in a final rolled product having a significantly reduced width. As one example, a king-size memory foam mattress having a width of 76 inches may be compressed to a rolled package having a width of 40-42 inches without damaging the foam material. Further, some king-sized foam mattress products may be compressed from a width of 76 inches to a width of 30 inches or less without adversely impacting or degrading the foam material. The foam product may be any product containing foam that can be laterally and/or vertically compressed and packaged in its compressed form without materially adversely impacting the form or quality of the product. For example, the foam product may be any bedding product containing foam, including a foam mattress, topper, or pillow, and may also be a foam mattress including coils. Likewise, the foam product may be a furniture product, such as cushions

or filler, or an automotive product containing foam, such as automotive seating. In addition to foam, the product may include springs and/or wire-forms. Furthermore, though the invention is described herein with respect to foam products, the inventors contemplate that the packaging systems and methods may be utilized for packaging similar products having foam-like qualities.

[0020] In embodiments of the present invention that include lateral compression of the product 42, the product packaging system 70 also offers the added benefit of requiring less film to package the product 42. In an exemplary embodiment, if the product is laterally compressed by 40%, the packaging process will consume about 40% less film versus packaging the uncompressed foam product. In another embodiment, the product is compressed by 50% or more and may consume 50% or less film versus the uncompressed foam product. Depending on the shape of the product, vertically compressing the product will also save on the amount of film consumed in packaging the product.

[0021] FIGS. 1a, 1b, and 1c depict one embodiment of a product packaging system 70 capable of packaging a compressible foam product 42 of a broad range of sizes. For example, the packaging system may package foam products 42 ranging in size from a few cubic inches to several hundred thousand cubic inches. Product packaging system 70 includes an infeed system 11, which includes an infeed conveyor 1 that brings the foam product 42 into the system 70, a pusher assembly 2 that moves the foam product 42 through the infeed system 70, and an infeed film assembly 3. The exemplary system 70 of FIGS. 1a-1c further comprises a tamp apparatus 5 including a first lateral compressor (which in this embodiment is the pusher assembly 2) and a second lateral compressor 4 configured to apply pressure on the lateral sides of the foam product 42 in order to laterally compress the foam product 42 to a reduced width. The system 70 also includes roller device 9 that rolls the foam product 42 into a cylindrical packaged product 30.

[0022] Infeed conveyor 1 may receive a foam product 42 that is manually fed into the conveyor. Alternatively, infeed conveyor 1 may be attached to an assembly system, such as a conveyor system that brings the product from another area of manufacturing into infeed conveyor 1. A pusher assembly 2 may be positioned at the exterior side of the infeed conveyor 1 to receive the product and guide the foam product 42 into position in product packaging system 70. Turning to FIG. 1b, a top view of the product packaging system highlights certain features of the exemplary embodiment depicted therein. In FIG. 1b, the pusher assembly is in an outermost position and acts as a guide to align the foam product 42 as it enters the packaging system 70 on the infeed conveyor 1 and to prevent the product from falling off side 1c of the conveyor. When product 42 comes in at a front end 1a of infeed conveyor 1, infeed conveyor 1 moves the product toward back end 1b of the infeed conveyor 1. During that process, pusher assembly 2 is aligned with, or near, side edge 1c of infeed conveyor 1 (the position of the pusher assembly 2 in FIG. 1). Once product 42 is fully received inside packaging system 70, pusher assembly 2 slides along track 39 of pusher assembly 2 to push product 42 toward tamp apparatus 5.

[0023] In one embodiment, pusher assembly 52 is a bar that extends between tracks 39, wherein tracks 39 run above infeed conveyor 1 and perpendicularly to the motion of infeed conveyor 1. A plate or fingers may extend downward from the bar contact the product 42 laying on the infeed conveyor 1. In

another embodiment depicted in FIG. 1c, pusher assembly 2 has a plate 40 that pushes product 42 toward tamp apparatus 5. Additionally, in the embodiment of FIG. 1c plate 40 is connected to an extender 37 that extends plate 40 forward toward tamp apparatus 5 to push the product 42 the final distance between the infeed system 11 and the tamp apparatus 5.

[0024] In the embodiments of FIGS. 1-4, infeed film assembly 3 provides film 47 to cover the foam product 42 in the first stage of packaging. Infeed film assembly 3 supplies a top film feed 12 and a bottom film feed 13 that are adhered together into a unified sheet, or curtain, of film 47. Once the product is fed into packaging system 70, pusher assembly 2 pushes the product into the curtain of film 47 such that the product becomes at least partially covered by the film 47. Pusher assembly 2 continues to push the product, which is now at least partially covered by the film 47, into tamp apparatus 5.

[0025] In one embodiment, pusher assembly 2 includes a plate configured to push the product out of the infeed system 11 and into the tamp assembly 5. For example, the pusher assembly 2 may have a plate 40 (FIG. 1c) that contacts foam product 42 and moves it toward tamp apparatus 5. Plate 40 may be connected to tracks 39 that move pusher assembly 2 from its initial position, where it accepts incoming foam product 42 on the infeed conveyor, to a position at a front side 22 or an interior portion of the tamp assembly 5. In one embodiment, pusher assembly 2 pushes the foam product 42 up against lateral compressor 4. In another embodiment, the pusher assembly 2 pushes the product to front side 22 of the tamp apparatus 5 and lateral compressor 4 then extends towards the pusher assembly 2. In still other embodiments, both the pusher assembly 2 and the lateral compressor 4 move towards one another to contact the foam product 42.

[0026] Once the foam product 42 has been pushed into the tamp apparatus 5 product 42 is then laterally compressed, either by moving lateral compressor 4 towards pusher assembly 2, or vice versa. Thereby, foam product 42 is compressed between pusher assembly 2 (acting as a first lateral compressor) and lateral compressor 4 (acting as a second, opposing, lateral compressor). For example, the pusher device 2 may move towards the lateral compressor 4 to apply pressure to first lateral side 54 of the foam product to press the product against lateral compressor 4, which acts on second lateral side 55 of the foam product 42. Alternatively, lateral compressor 4 and pusher assembly 2 may simultaneously move towards one another to laterally compress the foam product 42. In the depicted embodiments, pusher assembly 2 acts as a lateral compressor that cooperates with the lateral compressor 4 to compress the foam product 42. In other embodiments, the pusher assembly 2 may act only to move the foam product 42 into the tamp assembly, and the compression may be performed by a separate device that cooperates with the lateral compressor 4.

[0027] If the foam product 42 is to be vertically compressed, the top vertical compressor 14 is then lowered down onto the laterally compressed product. The top vertical compressor 14 presses on the top side 56 of the foam product 42 to compress the product against the bottom vertical compressor 15, which acts on the bottom side 57 of the foam product in order to complete the vertical compression. In various embodiments, the foam product 42 may be vertically compressed prior to, simultaneously with, or after the lateral compression.

[0028] The vertical and lateral compression performed by the tamp apparatus 5 may be controlled by various control systems and methods. For example, the tamp apparatus 5 may apply a predefined lateral force to laterally compress foam product 42 and/or predefined vertical force to vertically compress foam product 42. For example, tamp apparatus 5 may apply about 6,000 lbs. of force to laterally compress product 42 and about 18,000 lbs. of force to vertically compress product 42. More specifically, the lateral compressor 4 and/or the pusher assembly 2 may laterally compress product 42 using 6,000 lbs. of force, and vertical compressor 14 may vertically compress product 42 with 18,000 lbs. of force. In another embodiment, the tamp apparatus 5 may compress foam product 42 to a predefined size, such as to a particular vertical and horizontal dimension, or by a predefined amount, such as to a certain percentage of its original size. In still other embodiments, the tamp apparatus 5 may be controlled to alternatively compress the foam product 42 to a predefined size (or by a predefined amount) or to apply a predetermined maximum vertical and/or lateral force on the foam product 42, whichever is reached first. For example, the lateral compressor 4 and/or the pusher assembly 2 may laterally compress product 42 until a maximum of 6,000 lbs. of force is reached or until the product is compressed to a particular lateral width, whichever is first. In one such embodiment, one or more load cells may be placed on the lateral compressor 4 and/or the pusher assembly 2 to sense the force applied on the foam product 42. In an alternative embodiment, one or more motors driving lateral compressor 4, pusher assembly 2, top vertical compressor 14 and/or bottom vertical compressor 15 may be equipped with load detectors to sense the load felt by the motor(s). For example, an encoder may be placed on the motor(s) to determine the pulse rate and current draw for that motor. The force applied to the foam product 42 can then be determined based on the load felt by the motor(s).

[0029] Foam product 42 is at least partially covered in film 47 as it enters tamp apparatus 5. Once product 42 is fully compressed, both vertically and laterally (or horizontally), the film 47 may be sealed around the product in an air tight manner so that the product retains its compressed shape. Prior to sealing, the infeed film assembly 3 may pull the film 47 taut to remove any wrinkles or bulges from the film 47 prior to sealing. Compressed and sealed product 42 is then pushed out of tamp apparatus 5 by exit pusher 6. The exit pusher assembly may include a bar that extends across the length of the product near the outside edge of the tamp apparatus 5. Like the pusher assembly 2, the exit pusher 6 may run on a track 46 that forces the exit pusher 6 to push the compressed and sealed product towards transfer conveyor 7. In such an embodiment, exit pusher 6 pushes on the compressed and sealed product to push product 42 onto transfer conveyor 7 and towards roller device 9. In other embodiments, such as the embodiment depicted in FIGS. 2a and 2b, transfer conveyor 7 may be eliminated and roller device 9 may be positioned immediately adjacent to tamp apparatus 5 such that product 42 is pushed by exit pusher 6 directly into roller device 9.

[0030] In the embodiments in FIGS. 1-4, compressed and sealed foam product 42 is fed into roller device 9 by transfer conveyor 7. Roller device 9 winds compressed and sealed foam product 42 along its length (the center of the rolled product runs parallel to its width) such that rolled foam product 42 has a reduced width W' that is approximately equal to the compressed width of foam product 42 (FIG. 6). Foam product 42 is rolled around itself into a tightly wound roll, or

cylindrical shape. FIGS. 3a and 3b depict roller device 9 having rolling bars 32, rotated by roll cage motors 16 that force the compressed and sealed foam product 42 to wrap around itself in a spiral-like form. For example, the roll cage motors 16 may be 5-7 horsepower motors. In FIGS. 3a and 3b, product 42 enters roller device 9 from the bottom side of the roller cage and roller device 9 rolls the product upwards and counter clockwise (from the perspective shown in these figures) during the roll process, meaning that rolling bars 32 rotate in a the opposite direction. In other embodiments, roller bars 32 force the foam product 42 to roll in the opposite direction. In some embodiments, it may be necessary to place holes in the tail end of the film 47 as the tail end of the compressed product enters roller device 9 so that excess air can escape during the rolling process.

[0031] The rolled product may be covered in a second film 48 acting to retain the compressed size and rolled shape of cylindrical packaged product 30. The second film 48 may be applied during the roll process or after completion of the roll process. In the exemplary embodiment of the roller device 9 depicted in FIGS. 3a-3b, compressed and sealed product 42 passes through a second film 48 as it enters the roller device 9. In an exemplary embodiment, a second film roll 53 is housed above or below roller device 9 and dispenses the second film 48. A curtain of second film 48 is formed at the entrance of the roller device 9. In the depicted embodiment, clamp 43 grabs the second film 48 and stretches the second film 48 across the entrance opening of the roller device 9. Curtain motor 18 operates to open and close the clamp 43 and to move the clamp 43 vertically. More specifically, a curtain of second film 48 is formed by curtain motor 18 moving the clamp 43 down towards the second film roll 53 (see FIG. 3b). The curtain motor 18 operates the clamp 43 to grab the second film 48 and then to bring the film up, covering at least a portion of the entrance opening of the roller device 9. When foam product 42 enters the roller device 9, the film 48 adheres to the front edge of the product 42. The curtain motor 18 opens the clamp 43 to release the film 48. Then, as the foam product 42 is forced further into roller device 9 the second film 48 is continually unrolled so that the film extends beyond the length of the foam product 42. The second film 48 is rolled with product 42 as it rolls onto itself. Once product 42 is entirely rolled, the second film 48 continues to be fed by curtain motor 18 of roll film dispensing unit 8 such that the film 48 continues to wrap around the product 42. In some embodiments, the second film 48 is held taut in order to assist in tightly rolling the foam product 42 into a cylindrical shape. In this way, it is possible to vary the diameter d of the cylindrical packaged product 30 by varying the tension on the second film 48. Once the foam product 42 is completely rolled into a cylindrical packaged product 30, the roller device 9 may continue to turn the product 42, for example two to five more complete turns, to wrap the second film 48 around the cylindrical packaged product 30 in order to retain the shape and size of the cylindrical packaged product 30. Once the cylindrical packaged product 30 is wrapped in second film 48, the second film roll 43 stops feeding the second film 48. In some embodiments, the second film 48 stretched and broken as the cylindrical packaged product 30 continues to roll in the roller device 9. In other embodiments, the second film 48 is cut.

[0032] Once the roll process is complete, cylindrical packaged product 30 is then pushed out of roller device 9 through exit hatch 34 in the back thereof. In FIGS. 3a and 3b, exit

hatch 34 is connected to a portion of rolling bars 32 such that when exit hatch 34 opens, a portion of rolling bars 32 move with exit hatch 34 so as to open roller device 9 and expel cylindrical packaged product 30. For example, air cylinders 20 (FIG. 1a-1b) may be attached to exit hatch 34 and operate to open and close exit hatch 34 such that the packaged product can be expelled from roller cage assembly 9. Air cylinders 20 contract to open exit hatch 34, and then expand to close exit hatch 34. A transfer conveyor 10 may be positioned below exit hatch 34 so that cylindrical packaged product 30 may fall onto transfer conveyor 10 when it exits roller device 9. Transfer conveyor 10 may take the form of any device capable of receiving the cylindrical packaged product 30. For example, FIGS. 1a-1c depict a narrow transfer conveyor 10 that carries cylindrical packaged product 30 in a direction perpendicular to roller cage 9. In other embodiments, transfer conveyor 10 may be another transporting device or may be a final packaging device that places additional packaging materials on cylindrical packaged product 30, such as a box, a bag, or ties to secure the rolled shape and size.

[0033] FIGS. 2a and 2b depict another embodiment of packaging system 70. The embodiment of FIGS. 2a and 2b has a reduced footprint as compared to the embodiment of FIGS. 1a-1c. The foam product 42 enters the infeed system 11 at input end 41. The product is inputted into the input end 41 such that the length 1 of the foam product 42 is oriented perpendicular to the infeed direction. The foam product 42 is then covered at least partially in film 47 and pushed into the tamp apparatus 5 where it is compressed as disclosed herein. Once compressed, either laterally or vertically or both, and sealed in film 47 to retain the compressed width and/or depth, the foam product is fed directly into the roller device 9.

[0034] While an unpackaged, uncompressed foam product 42 is conveyed into packaging system 70 on infeed conveyor 1, infeed film assembly 3 creates a curtain of first film 47 that will be overlaid on uncompressed foam product 42. FIGS. 1a-1c depict one embodiment of an infeed system 11, and FIGS. 2a, 2b, 4a and 4b depict another embodiment of an infeed system 11. In the embodiment of FIGS. 1a-1c, top film feed 12 and bottom film feed 13 are fed around infeed conveyor system 1 and meet at a point between infeed conveyor 1 and tamp apparatus 5. More specifically, the top film feed 12 may be fed around top roller 74 and the bottom film feed may be fed around bottom roller 75. The top and bottom rollers 74 and 75 may be nip-pull rollers capable of grabbing and rolling the film 47 in both the forward and back directions. Further, top dancer system 77 controls the top film feed 12 and a bottom dancer system 78 that controls the bottom film feed 13. The dancers 77 and 78 may each have a bar that applies weight to apply pressure to the film feeding there through in order to keep the top and bottom film feeds 12 and 13 taut. Top film feed 12 and bottom film feed 13 are connected at a seam 99 by the seamer 67. In one embodiment, the film 47 may be a polyethylene film and seamer 67 may be a heat sealer that connects top and bottom film feeds 12 and 13 by melting the edges of the two films together. Alternatively, seamer 67 may be any means known in the art for connecting top and bottom film feeds 12 and 13, including an applicator of tape or glue. In still another embodiment, the material of top and bottom film feeds 12 and 13 may be self-adhering, and seamer 67 may press the two film portions together to cause them to adhere to one another.

[0035] The seamer 67 may be positioned at the location where the top film feed 12 and the bottom film feed 13 meet

together along the path of the film curtain. In a different embodiment depicted in FIG. 4a, the seamer 67 is provided next to the sealing mechanism 52 such that the top and bottom films may be connected together during the packaging cycle of the previous mattress. For example, top and bottom film feeds 12 and 13 may be sealed simultaneously with each lengthwise seal step 63 (FIG. 5). In that embodiment, at step 63 a two lengthwise seals are made along length 49 of compressed product 42, one by seamer 67 and the other by sealing mechanism 52. For example, the seamer 67 and the sealing mechanism 52 may be two parallel heat bars, or seal bars, pressed on to the film 47. A cut may be made between the two seals such that one seal comprises the seal around the compressed product 42 and the other seal forms the seal for the film 47 curtain that will be used in the next product packaging cycle. In another embodiment, the two lengthwise seams, or seals, may be separated by a hotwire between the seamer 67 and the sealing mechanism 52 that severs the film 47 between the two seals. Then, the infeed film assembly 3 pulls the sealed curtain or film 47 back so that the film 47 curtain is in place for the next packaging cycle.

[0036] In various embodiments, the first film 47 applied to seal the compressed foam product 42 and the second film 48 applied to the cylindrical packaged product 30 may be the same film material or may be different materials. For example, the first film 47 may be a 3 millimeter thick poly film, such as a polyethylene material or a nylon-based material. In other embodiments, the first film 47 may be thicker or thinner, depending on the amount of force needed to retain the compressed size of the compressed foam product 42. For example, where the compressed foam product 42 is flat packed rather than rolled, the first film may be a thicker film, such as a 6 millimeter film, so that it can maintain the compressed dimensions over a long period of time. The second film 48 may be a thinner poly film, such as a 2.5 millimeter film, that is designed to stretch along its length and have significant strength in its lengthwise direction. The second film 48 may also be a poly film with clinging properties, such as a clinging stretch wrap, so that it clings to the foam product 42 during the roll process and clings to itself in order to securely contain the cylindrical packaged product 30 without the need for any additional packaging. For example, the second film 48 may be a stretch wrap material, such as a casted film with high cling properties and significant stretch ability. In one embodiment, the cling stretch wrap may stretch 2.5 times its original length before breaking. In other embodiments, however, the film covering the cylindrical packaged product 30 may not be sufficiently self-adhering and the cylindrical packaged product 30 may be covered in additional packaging to retain the final shape thereof.

[0037] In the embodiment of FIGS. 2a-2b and 4a-4b, the infeed film assembly 3 may be oriented on the top and bottom of the infeed system 11 to form a curtain of film 47 in the infeed system 11. The infeed film assembly includes a top feed assembly 95, which includes top film roll 86 positioned on the top of infeed system 11, and bottom feed assembly 97, which includes bottom film roll 88 positioned on the bottom of infeed system 11. Top film roll 86 feeds top film feed 12 and bottom film roll 88 feeds bottom film feed 13. The infeed film assembly 3 is depicted schematically in FIG. 4b. In the top feed assembly 95 the film 47 extends from top film roll 86, winds through top nip-pull rolls 90 and over airbar 93 to top film feed 12. The bottom feed assembly 97 has film 47 extending from bottom film roll 88, winding through bottom nip-

pull rolls 92, and feeding upwards as bottom film feed 13 extends to top film feed 12. The nip-pull rolls 90 and 92 may alternately wind in both rotational directions so as to feed film 47 forward or pull film 47 backward. In one embodiment, the nip-pull rolls 90 and 92 may be closed together in order to pinch, or grab, the film 47. This may provide additional control over the film 47 in order to force the film 47 in a forward or backwards direction. For example, the nip-pull rolls 90 and 92 may be able to pull the film 47 back with significant force in order to apply additional compression force on the foam product 42. The airbar 93, which could also be included in the bottom feed assembly, acts to distance the top film feed 12 from the nip-pull rolls 90 so as to keep the film 47 from sticking to itself or getting tangled in the nip-pull rolls 90. The top and bottom film feeds 12 and 13 are connected together by the seamer 67 as described herein to form a seam 99.

[0038] Once the film 47 curtain is created, uncompressed foam product 42 is pushed into the film 47 curtain such that the film 47 curtain wraps around first lateral side 54 of the product 42. As the product 42 continues to be pushed into tamp apparatus 5, it pulls the film 47 curtain along with it. Top film feed 12 and bottom film feed 13 may be severed when the film 47 covering the mattress reaches an appropriate length. In another embodiment, the film 47 may not be severed until during or after the film 47 is sealed around the compressed product 42, as explained above. The film 47 may be severed by any means known in the art, for example by a knife or serrated teeth. Uncompressed foam product 42, which is at least partially covered in the film 47, is then pushed against lateral compressor 4.

[0039] The infeed film assembly 3 then positions the film 47 in place for the next product 42 that enters packaging system 70. In an embodiment where the film 47 has been cut and top and bottom pieces 12 and 13 are not sealed, the film assembly 3 feeds top film feed 12 and bottom film feed 13 towards one another to create a new curtain. In an embodiment where top and bottom pieces are sealed during the lengthwise sealing step 63, the infeed film assembly 3 may pull the film 47 back so that a taut curtain is formed around the infeed system 11. For example, in the embodiment of FIGS. 4a and 4b, top and bottom feed assemblies 95 and 97 may include nip-pull rollers 90 and 92 capable of pulling the film 47 back after top and bottom film feeds 12 and 13 have been sealed together. Likewise, those nip-pull rollers 90 and 92, may also act to roll the film 47 forward or back to maintain the correct tautness on the film 47 during the infeed, compression, and sealing processes.

[0040] As seen in FIGS. 1a-1c, infeed film assembly 3 may have backup top film rolls 25 and backup bottom film rolls 26 that may be automatically used by infeed film assembly 3 when the current film roll is empty. In one embodiment a motion sensor detects motion in each of top and bottom film rolls feeding the top and bottom film feeds 12 and 13. When the motion of one or more of the film rolls stops during a feed period then the system determines that the film roll is empty and needs to be changed. At that point, the infeed film assembly 3 takes the next backup top film roll 25 or the next backup bottom film roll 26 and grabs the lead edge of film 47 on that roll. The lead edge of the next roll is connected to the tail end of the previous roll such that a continuous film 47 sheet is created. The lead edge and the tail end may be connected by any means known in the art, including heat sealed, taped, glued etc. Preferably, the connection between the lead edge and the tail end is an airtight seal so that the connected film

portion can be used to create an airtight package around the compressed mattress. It should be understood that other embodiments may not have an infeed film system 3 and may not seal the compressed foam product in film 47 prior to rolling the foam product.

[0041] FIG. 5 demonstrates one embodiment of a method executed by product packaging system 70, and primarily by tamp apparatus 5, for compressing a product 42. At step 58 the film 47 is in position, for example the top film feed 12 is connected at seam 99 to the bottom film feed 13 as described above to form a curtain of film 47. Foam product 42 is in position, for example on infeed conveyor 1, and is ready to be pushed through the film 47. At step 59, foam product 42 is pushed through the film 47 so that the film covers at least a portion thereof. The infeed film assembly 3 acts to feed film 47 into the system so that foam product 42 moves into the tamp apparatus 5 and is covered on top and bottom with film 47. Foam product 42 is further pushed against second lateral compressor 45. At 60, first lateral compressor 44 presses foam product 42 against second lateral compressor 45 to laterally compress it. In this embodiment, second lateral compressor 45 is a stationary wall or plate and first lateral compressor 44 moves towards second lateral compressor 45 to perform the compression action. In other embodiments, the second lateral compressor 45 may also move towards the first lateral compressor 44 to perform the compression action.

[0042] At step 61, foam product 42 is vertically compressed, for example, by top vertical compressor 14 of tamp apparatus 5. Foam product 42, having been compressed, now easily fits inside the film 47 and the film 47 can be sealed around compressed product 42. To do that, at step 62, first lateral compressor 44 is retracted. Immediately thereafter, step 63 is executed wherein length 49 of the top and bottom layers of the film 47 are sealed together to maintain the lateral compression of the product 42. At step 64, front side 50 of the top and bottom layers of the film 47 are sealed together, and at step 65 back side 51 of the top and bottom layers of the film 47 are sealed together. Thereby, all four sides of the film 47 are sealed in an air tight manner such that the compressed width and compressed depth of product 42 are retained. The sealing may be performed in any manner known in the art, including heat sealing, gluing, taping, etc. For example, as shown in FIG. 2b, a sealing mechanism 52 may be mounted on each side of the vertical compressor 14 such that, after the vertical compression step, the film 47 may be sealed around each side of the compressed foam product 42. The sealing mechanism 52 may be attached to or part of the top vertical compressor 14, or it may be a separate mechanism that operates at the edges of the foam product 42, such as adjustable heat bars that adjust to the size of the compressed foam product 42 and act to melt the film 47 at the seal points. The sealing mechanism 52 may alternatively be any device capable of sealing the film 47 around the compressed foam product 42. For example, the sealing mechanism 52 may blow hot air on the film 47 or may apply tape or glue to adhere the film 47 to itself. In embodiments where the film 47 has self-adhering properties, the sealing mechanism 52 may press the top and bottom film layers together to form a seal around the compressed product 42. The compressed and sealed foam product 42 is then forced out of tamp apparatus 5 by exit pusher 6.

[0043] In other embodiments, product 42 may be covered in film by another method, such as wrapping the product in stretch wrap. In such an embodiment, the stretch wrap may be

configured around product 42 in its uncompressed state such that the stretch wrap allows air to escape during the compression process, but prevents air from re-entering the product 42 after the compression process. In still other embodiments, product 42 may enter the compression process without any film or wrapper, and the film 47 or wrapper may be applied onto the product once the product is already compressed. For example, the compressed product may be wrapped in stretch wrap such that the compressed size of product 42 is maintained. In still other embodiments a vacuum may be used to remove air from the wrapped product 42 prior to sealing. In still other embodiments, the compressed product may not be sealed in film at all and may be fed directly into the roller device 9, where it may be rolled to form a cylindrical packaged product 30 that is packaged to maintain its size and shape, such as wrapped in second film 48 as disclosed above.

[0044] In yet another embodiment, tamp assembly 5 may only laterally compress product 42 and not vertically compress product 42. The laterally compressed product may then be passed to the roller device 9, where infeed rollers may be positioned to vertically compress the product 42 as it enters the roller device 9. In embodiments wherein lateral compression of the product 42 is performed, product packaging system 70 offers the added benefit of consuming less film 47 and of providing a smaller package width. However, in still other embodiments, tamp apparatus 5 may not perform any lateral compression at all, such that product 42 is only vertically compressed and the film 47 is sealed around the vertically compressed product. In such an embodiment, the film 47 must be large enough to cover the entire uncompressed foam product 42 as it comes into the tamp apparatus 5 because the product 42 will not be laterally compressed in order to fit into a smaller size film 47.

[0045] As described herein, product 42 is compressed and sealed and pushed out of tamp apparatus 5. In one embodiment, the compressed and wrapped product 42 may be sent to the roller device 9 via the transfer conveyor 7. In an alternative embodiment, the compressed and wrapped product 42 may be exposed to a heating apparatus designed to further shrink the film 47 sealed around product 42. More specifically, film 47 may be a plastic film that shrinks in size, in the lateral and/or vertical directions, when exposed to heat. For example, film 47 may shrink in size up to 60% when exposed to temperatures between 200° F. and 300° F. To achieve such shrinking, system 70 may include any heating device capable of heating at least a portion of film 47 on product 42. For example, the heating device may be a heat tunnel or an oven placed at the exit end of tamp apparatus 5. In another embodiment, the heating device may be integrated into tamp apparatus 5, such as heating elements integrated into the top vertical compressor 14. In an embodiment where the heating device is integrated into the tamp apparatus 5, the shrinking step may occur simultaneously with the compression and sealing steps represented in FIG. 5. Such shrinking may act to remove any slack from the film 47 wrapped around the compressed product 42. Furthermore, such shrinking may stabilize and further seal the film 47 wrapped around the compressed product 42 such that the film 47 can maintain the compressed size of the product 42 for months or years without needing further reinforcement from additional packaging materials. In such an embodiment, the compressed product 42 may be flat-packed instead of rolled. Thus, the system 70 may not contain a roller device 9, and the compressed product 42 may be pushed out

of the tamp apparatus 5 onto a flat-packing apparatus, or onto a conveyor system that leads to a flat-packing apparatus.

[0046] FIG. 6 provides a comparison between an exemplary, uncompressed foam product 42 and a final cylindrical packaged product 30. While the representative foam product 42 in FIG. 6 is depicted as rectangular in shape, foam product 42 may take on any shape and may be comprised of any foam capable of being compressed as described herein. The unpackaged product 42 in FIG. 6 may be, for example, a foam mattress, such as a king size foam mattress. The unpackaged product 42 has a width W, and the cylindrical packaged product 30 has a width of W'. In the exemplary embodiment of a king size foam mattress, the foam mattress may have a width W of around 76 inches, a length L around 80 inches, and a depth D ranging from 7 to 16 inches. Employing one exemplary embodiment of the product packaging system 70 and method described herein, the exemplary king mattress can be compressed and rolled into a cylindrical packaged product 30 having a width W' of about 40-42 inches and a diameter d of 13-17 inches. In such an embodiment, tamp apparatus 5 laterally compresses the foam product 42 to a reduced width of 40-42 inches and vertically compresses the product to a reduced depth of 0.8 to 2 inches. In other embodiments, the width and depth of the exemplary king foam mattress may be compressed to a size that is slightly smaller or larger in order to fit desired requirements.

[0047] The inventors recognized that a foam product 42 can typically be compressed to a reduced depth that is approximately $\frac{1}{8}^{th}$ its uncompressed height and a reduced width that is approximately $\frac{1}{2}$ its uncompressed width without damaging the foam material. However, depending on the type of foam material, in some embodiments the foam product may be compressed to less than $\frac{1}{8}^{th}$ its original size. In some embodiments, foam products may be compressed to $\frac{1}{15}^{th}$ their original size or smaller. The maximum compressions factor that can be accomplished without materially damaging the foam product is based on the properties of the material(s) comprising the foam product, including the density, weight, and elasticity of the foam, as well as the volume of the foam and the surrounding conditions, such as temperature and humidity. The present inventors also recognize that at a certain compression point there is an inverse relationship between the maximum lateral compression factor and the maximum vertical compression factor that can be achieved without damaging the foam material. In order to achieve the smallest possible width W' of cylindrical packaged product 30, the diameter d of cylindrical packaged product 30 will have to be increased from its minimum compressed size in order to avoid damaging the foam material. Likewise, in order to achieve a final package 30 with a smaller diameter, the width W' may need to be increased from its minimum size.

[0048] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to make and use the invention. The patentable scope of the invention is designed by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements and/or method steps that do not differ from the literal language of the claims, or if they include equivalent structural elements and/or method steps with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A system for packaging a foam product, the system comprising:

- a first lateral compressor that applies pressure to a first lateral side of the foam product and a second lateral compressor that applies pressure to a second lateral side of the foam product to compress the foam product to a reduced width; and
- a roller device configured to roll the compressed foam product into a cylindrical packaged product.

2. The system of claim 1 further comprising a top vertical compressor that applies pressure to a top side of the foam product and a bottom vertical compressor that applies pressure to a bottom side of the foam product to a reduced depth prior to rolling.

3. The system of claim 2 wherein at least one of the first lateral compressor, the second lateral compressor, the top vertical compressor, or the bottom vertical compressor is controlled to apply no more than a predefined maximum force to the foam product.

4. The system of claim 1 wherein the roller device wraps the cylindrical packaged product in a film to retain its cylindrical shape and size.

5. The system of claim 4 further comprising an infeed film assembly that covers a top portion and a bottom portion of the foam product in a film prior to compressing the product.

6. The system of claim 5 wherein the infeed film system comprises a top film roll supplying a top film feed, a bottom film roll supplying a bottom film feed, and a seamer to connect the top film feed to the bottom film feed.

7. The system of claim 6 wherein the film is comprised of polyethylene and the seamer is a heat bar that melts the top film feed to the bottom film feed.

8. A method of packaging a foam product, the method comprising:

- receiving a foam product having a length, an uncompressed width, and an uncompressed depth;
- laterally compressing the foam product to a reduced width;
- vertically compressing the foam product to a reduced depth; and

sealing the compressed foam product in a first film to maintain the reduced width and the reduced depth.

9. The method of claim 8 further comprising rolling the compressed foam product along its length to form a cylindrical packaged product.

10. The method of claim 9 further comprising wrapping the cylindrical packaged product in a second film to retain its shape and size.

11. The method of claim 10 wherein the first film is comprised of a polyethylene material and the second film comprised of a casted poly film with high cling properties.

12. The method of claim 8 further comprising covering a top portion and a bottom portion of the foam product in the film prior to compressing the foam product, wherein the film has a width that is less than the uncompressed width of the foam product; and

wherein the reduced width of the compressed foam product is less than the width of the film.

13. The method of claim 8 wherein the step of sealing comprises applying heat to the film around the compressed foam product.

14. The method of claim 13 further comprising pulling film taut prior to sealing.

15. The method of claim 8 wherein the reduced width is no more than 70 percent of the uncompressed width.

16. The method of claim 13 wherein the reduced width is no more than 60 percent of the uncompressed width.

17. The method of claim 8 wherein the step of laterally compressing is controlled to apply no more than a predetermined maximum lateral force on the foam product, and the step of vertically compressing is controlled to apply no more than a predetermined maximum vertical force on the foam product.

18. A mattress packaging system comprising:

an infeed apparatus that receives a foam mattress and covers a top portion and a bottom portion of the foam mattress in a first film;

a tamp apparatus that compresses the foam mattress, the tamp apparatus comprising:

- a first lateral compressor that applies pressure on a first lateral side of the foam mattress and a second lateral compressor that applies pressure on a second lateral side of the foam mattress to compress the foam mattress to a reduced width;

a sealing mechanism that seals the film around the compressed foam mattress to retain the reduced width;

a roller device that rolls the compressed foam product into a cylindrical packaged product and wraps the cylindrical packaged product in a second film.

19. The mattress packaging system of claim 18 wherein the tamp apparatus further comprises a first vertical compressor that applies pressure on a top side of the foam product and a second vertical compressor that applies pressure on a bottom side of the foam product to a reduced depth prior to rolling.

20. The mattress packaging system of claim 18 wherein the sealing mechanism is one or more heat bars.

21. A cylindrical packaged product, the packaged product comprising:

- a compressed foam product rolled along its length to form a cylinder having a width and a circumference, the compressed foam product having an uncompressed width that is laterally compressed to a reduced width and an uncompressed depth that is vertically compressed to a reduced depth; and

the cylinder wrapped in a film to retain the width and the circumference.

22. The cylindrical packaged product of claim 21 further comprising the compressed foam product being contained in a film to maintain the reduced width and the reduced depth.

23. The cylindrical packaged product of claim 21 wherein the width of the cylindrical packaged product is approximately equal to the reduced width of the compressed foam product.

24. The packaged product of claim 23 wherein the reduced width no more than 70 percent of the uncompressed width.

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