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(54) **APPARATUS AND METHOD FOR ROLL PACKING COMPRESSIBLE MATERIALS**

VORRICHTUNG UND VERFAHREN ZUR ROLLENVERPACKUNG KOMPRIMIERBARER MATERIALIEN

APPAREIL ET PROCEDE PERMETTANT DE CONDITIONNER DES MATERIAUX COMPRESSIBLES SOUS FORME DE ROULEAUX

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Description

Field of the Invention

[0001] This invention relates to the packaging of compressible materials such as mattresses and foam and spring assemblies used in the manufacture of mattresses and the like, and is more particularly directed to an apparatus for packaging such compressible materials into a roll.

Background of the Invention

[0002] Conventional packaging and transportation of compressible materials such as finished mattresses, as well as foam or spring assemblies used in the manufacture of mattress products, generally involves handling of the materials in an uncompressed state. As such, the shipping and storage of the materials requires much more space than would be required if the materials were provided in a compressed state. To improve the efficiency of shipping and storage, foam mattress cores have been packaged in a compressed state by flattening the foam and sealing it in an evacuated bag. See, for example, U.S. Patent No. 4,711,067 to Magni. This method of packaging foam cores, however, is not useful in packaging spring assemblies. In addition, storage and transportation efficiencies of the foam could be further improved by packaging the flattened cores into a tight roll.

[0003] Roll packing generally involves winding-up a desired material to form a roll and then securing the roll to prevent uncoiling of the roll during handling. In the case of compressible materials such as mattresses and foam or spring cores, it is often desired to compress the materials during the roll packing process to obtain a more dense and compact roll. Various devices have been used to achieve compression of roll packed materials. U.S. Patent No. 3,927,504 to Forrister discloses an apparatus for rolling resilient foamed sheet material without the use of a mandrel. This machine is not useful for packaging spring assemblies and does not have the capability to package multiple units of a compressible material into a large roll. The device further does not provide for packaging a compressible material with a barrier layer between successive turns of the roll, which barrier layer is desirable to prevent adhesion between successive layers of foam.

[0004] Some roll packing systems further include a mandrel which facilitates winding the material. For example, US Patent No. 2,114,008 to Wunderlich discloses a spring packing machine having a radially collapsible arbor for use in roll packing spring assemblies. A barrier layer between successive turns of the roll keeps the spring assemblies separate and permits easy removal of a single assembly from the roll. However, this machine is not useful for roll packing foam material due to the presence of a pressure bar 50, between belt 15 and the collapsible arbor, which would tend to snag a compressed foam as it passed beneath.

[0005] Roll packing machines of the prior art are generally very labour intensive, requiring the close attention of an operator at various stages of the roll packing process. For example, in the apparatus disclosed by Wunderlich, an operator must manually start the feeding of packing material to a mandrel for winding the spring assemblies into a roll. Operators must also manually feed the compressible spring assemblies to the mandrel and manually cut and secure the packing material at the end of a roll to prevent premature uncoiling of the roll packed assemblies. When a roll of spring assemblies is complete, the operator must remove the mandrel from the machine and manually collapse the mandrel to remove the finished roll. The arbor must then be replaced in the machine before another roll can be formed. Similarly, US Patent No. 6,098,378 to Wyatt and US Patent No. 4,711,067 to Magni each disclose a mandrel comprising two semi-mandrels that, after winding, are axially separated from each other to remove the mandrel from a wound core of material. US Patent No. 4,669,247 to Wofffendin discloses a machine for packing spring units in a web material on a winding mandrel. The finished winding is removed from the mandrel using a pusher assembly. Operation of these machines is very labour intensive and ergonomically inefficient.

[0006] US Patent No. 2,668,405 to Droll discloses a machine for winding mattresses including a mandrel that can move between expanded and collapsed states using sliding linkages, in accordance with the preamble of appended claim 1.

[0007] Another drawback of prior roll packing machines is that operators must manually change out rolls of packing material to switch to a new type of material or to replace a spent roll. These labour intensive operations consume a considerable amount of time, often during which time the roll packing machine may not be operated. Labour intensive operations also increase the possibility for human error which lead to inconsistent quality of roll packed material.

[0008] There is thus a need for simple apparatus capable of roll packing multiple units of various compressible materials, such as foam mattress cores, mattress spring assemblies, and finished mattress products which reduces labour intensive operations and improves efficiency and ergonomics of roll packing various compressible materials and which is capable of providing a barrier layer between successive turns of a formed roll.

Summary of the Invention

[0009] The present invention provides a simple machine for roll packing a variety of compressible materials such as foam cores, spring assemblies, and fiber materials used in the manufacture of mattress products, as well as finished mattresses themselves. The machine has a radially collapsible mandrel that permits finished roll packed materials to be easily removed from the ma-

chine by sliding the roll off of the mandrel. This radially collapsible mandrel permits rolled materials to be removed without any telescoping or tearing of the materials which is usually caused by binding of the roll packed material on the mandrel. The machine of the present invention is especially useful in roll packing foam materials which are highly susceptible to binding against a mandrel. The simplicity of design of the machine of the present invention further permits use in roll packing practically any compressible material, even materials as diverse as coiled spring assemblies for mattresses and foam cores.

[0010] In accordance with the present invention, an apparatus and method is provided as defined in the independent claims, to which reference should now be made. Preferred features are defined in the dependent claims.

[0011] In one exemplary embodiment, a pneumatic cylinder is used to adjust the position of the compression roller relative to the mandrel.

[0012] In another exemplary embodiment, the mandrel is supported on a pivot arm which rotates to vary the spacing between the mandrel and the compression roller. The mandrel is driven at one end by a driving mechanism including, for example, a motor and gearbox, and has a bearing plate at the opposite end. The bearing plate is movable away from the end of the mandrel so that a finished roll of material can be easily pushed off of the mandrel after it has been collapsed. In another exemplary embodiment, the apparatus includes a roll pusher associated with the mandrel to facilitate the removal of finished rolls from the mandrel, and further includes a roll handler for receiving the finished roll as it is pushed off the mandrel.

[0013] Accordingly, the invention provides a simple apparatus and method for roll packing a variety of compressible materials and which has a collapsible mandrel that facilitates the easy removal of finished rolls without tearing, telescoping, or otherwise damaging the roll packed material. These and other objects and advantages of the present invention shall be made apparent from the accompanying drawings and description.

Brief Description of the Drawings

[0014] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with a general description of the invention given above, and the detailed description given below, serve to explain the invention.

FIG. 1 is a perspective view showing an exemplary roll packing apparatus according to the principles of the present invention;

FIG. 2 shows detail of the mandrel and compression roller of the apparatus of FIG. 1, where an in-fed material is being compressed between the mandrel and compression roller;

FIG. 3 shows a cross-sectional view of the mandrel of the present invention, taken along line 3-3, showing the collapsed state of the mandrel in solid lines and the expanded state of the mandrel in dashed lines;

FIG. 4A is a partial side-view of the apparatus of FIG. 1, depicting the start of a winding operation with an expanded mandrel;

FIG. 4B shows the partial side-view of the apparatus of FIG. 1, depicting a partially wound roll on the expanded mandrel;

FIG 4C shows the partial side-view of the apparatus of FIG. 1, depicting a fully wound roll and the mandrel in its collapsed state;

FIG. 5 is an elevational view of another exemplary roll packing apparatus of the present invention;

FIG. 6 is an elevational view of the roll packing apparatus of FIG. 5 depicting a spring assembly being fed between precompression rollers and directed to the mandrel;

FIG. 7 is an elevational view of the roll packing apparatus of FIG. 5 depicting a fully wound roll of spring assemblies on the mandrel;

FIG. 8 is an elevational view of the roll packing apparatus of FIG. 5 depicting a finished roll of spring assemblies in position against the fixed compression roller after a gluing step;

FIG. 9 is a plan view of the roll packing apparatus of the present invention, further including a finished roll manipulator, a pallet magazine, and a finished roll palletizer.

Detailed Description

[0015] An apparatus and method are provided for roll packing compressible materials in a simple and efficient manner without damaging the materials, and wherein the materials can be stored and shipped in a compact state. The present invention may be described and understood by a description of an exemplary apparatus.

[0016] With reference to FIG. 1, there is shown an illustration of one embodiment of roll packing apparatus 10 incorporating the principles of the present invention. The apparatus 10 includes a collapsible mandrel 12 for receiving in-fed materials 14 and winding them into a roll. The mandrel 12 is fixed to a shaft 16 that is driven at a first end 18 by a driving mechanism, for example motor 20 and gearbox 22 connected to the shaft 16. The invention further includes a compression roller 24, which is located proximate the mandrel 12 and which is fixed to a compression roller shaft 26 that is substantially parallel to the mandrel shaft 16. Thus, the rotational axis of mandrel 12 is substantially parallel to the rotational axis of compression roller 24. The compression roller 24 is adjustable such as by means of an actuator 28 fixed to the roller shaft 26 whereby the spacing 30 (see FIGS. 2 and 4A) between the compression roller 24 and the mandrel

12 may be adjusted to vary or maintain the amount of compression on the in-fed materials 14. A feed table 32 located upstream of the mandrel 12 and compression roller 24 directs in-fed compressible materials 14 between the mandrel 12 and compression roller 24 as the material 14 is wound upon the mandrel 12. In one example of the present invention, not shown, the feed table 32 includes a jig plate to ensure proper alignment of the in-fed materials 14 with respect to the mandrel 12 and compression roller 24. A disc brake 34 may be attached to the roller shaft 26 to control rotation of the compression roller 24.

[0017] The apparatus 10 further includes a packing material dispenser 36 which supplies packing material 38, such as paper, plastic or fiber material, to a surface 40 of the in-fed compressible materials 14 as they are fed through the mandrel 12 and compression roller 24. The packing material is then wound with the compressed in-fed material to create a barrier layer between successive turns of the rolled material. In this manner, the barrier layer protects successive layers of in-fed material such as foam and prevents adhesion of the successive layers. The packing material dispenser 36 may further include a guide roller 42, pinch rollers 44, 46, and a tension roller 48 to aid in directing packing material 38 to the in-fed compressible material 14 and also to maintain proper tension and alignment of the packing material 38.

[0018] A bearing plate 50 is located at a second end 52 of the mandrel shaft 16, opposite the drive motor 20, and is movable to expose an end of the mandrel 12 so that a finished roll of material 54 may be removed from the mandrel 12. The apparatus further includes a roll handler 58 for facilitating easy removal of the finished rolls 54. In the exemplary embodiment of FIG. 1, the roll handler 58 is a trough-shaped cradle that is pivotally connected to a support (not shown) and can be placed in a first position near the end of the mandrel 12 for receiving a finished roll of material 54. A roll pusher 60 associated with the mandrel 12 aids in removing a finished roll 54 from the collapsed mandrel 12 onto the roll handler 58. The roll handler 58 may then be placed in a second position (shown in phantom) to permit operators to subsequently remove the roll 54 from the machine 10.

[0019] As depicted more fully in FIGS. 2 and 3, the collapsible mandrel 12 includes a series of elongated plates 62 attached to the mandrel shaft 16 and positioned about the shaft 16 in an overlapping arrangement to create a substantially tubular surface 64 along the length of the shaft 16. The plates 62 are slidably connected to the shaft 16 and move toward or away from the shaft 16 along radially extending paths 66 to increase or decrease the diameter 67 of the tubular surface 64 formed by the overlapping plates 62. Rods 68 connected to each plate 62 engage a cam 70 attached to the shaft 16, whereby rotational operation of the cam 70 causes the plates 62 to move either toward or away from the shaft 16 to correspondingly collapse or expand the mandrel diameter 67.

[0020] Referring to FIGS. 4A-4C, the method of the present invention, as it relates to operation of the exemplary apparatus 10 of FIGS. 1-3, will be described. The spacing 30 between the mandrel 12 and compression roller 24 is adjusted to provide a desired amount of compression in the in-fed compressible material 14. Packing material 38 from the packing material dispenser 36 is fed through the guide roller 42, pinch rollers 44, 46, and tension roller 48 and then directed between the compression roller 24 and mandrel 12 while the mandrel 12 is turned to wind an initial length of packing material 38 upon the mandrel 12, as depicted in FIG 4A. In-fed compressible material 14, which is supported on feed table 32, is directed between the mandrel 12 and compression roller 24. The motor 20 (FIG. 1) is started and the mandrel 12 rotates to wind up the in-fed compressible material 14 and packing material 38 as it is compressed between the mandrel 12 and compression roller 24. The actuator 28 (FIG. 1) attached to the compression roller shaft 26 may be operated to vary the spacing 30 between the mandrel 12 and compression roller 24 as the roll 54 gets bigger, as can be seen in FIG. 4B, to maintain uniform compression in the roll 54. When a sufficient amount of compressible material 14 has been wound upon the mandrel 12, the motor 20 is stopped. The finished roll 54 is secured, for example, with tape, straps, or other suitable material, and bearing plate 50 (FIG. 1) is moved to expose an end of the mandrel 12. The mandrel 12 is then collapsed, as depicted in FIG. 4C, so that the finished roll 54 may be removed from the mandrel 12 under the operation of the roll pusher 60 (FIG. 1). The roll pusher 60 pushes the finished roll 54 into the roll handler 58 (FIG. 1) and the roll handler 58 then pivots to a second position so that operators can maneuver the finished roll 54 away from the machine 10.

[0021] With reference to FIG. 5, there is shown an illustration of another exemplary roll packing apparatus 110 incorporating the principles of the present invention. The apparatus 110 includes a radially collapsible mandrel 112 for receiving in-fed spring assemblies 114 and winding them into a roll. Collapsible mandrel 112 is attached to a pivot arm 116 having pivot axis 118. The collapsible mandrel 112 has a rotational axis 120 which is substantially parallel to the pivot axis 118. A fixed compression roller 122 is located proximate the mandrel 112 and has a rotational axis 124 substantially parallel to the rotational axis 120 of the mandrel 112.

[0022] Pivot arm 116 pivots about pivot axis 118 to position the mandrel 112 relative to the fixed compression roller 122 to compress in-fed spring assemblies 114 in a controllable manner as they are wound upon the mandrel 112. The apparatus 110 further includes a precompression guide roller 126 upstream of the mandrel 112 for receiving in-fed spring assemblies 114 and directing them toward the mandrel 112 and fixed compression roller 122. The precompression guide roller 126 provides a gradual initial compression of the spring assemblies 114 prior to being further compressed between the mandrel 112 and fixed compression roller 122, as illus-

trated in FIG. 6. Advantageously, the precompression guide roller 126 provides precompression to spring assemblies 114 having tall or small diameter springs which are susceptible to shifting that would otherwise occur if they were subjected to rapid compression by being directed to the fixed compression roller 122 and mandrel 112 without any precompression.

[0023] A feed table 128 upstream of the precompression guide roller 126 supports in-fed spring assemblies 114 and directs them toward the precompression guide roller 126. The feed table 128 includes a plurality of rollers 130 disposed on a support surface 132 of the feed table 128 to transport spring assemblies 114 toward the precompression guide roller 126. The feed table 128 further includes a precompression conveyer 134 which operates in conjunction with the precompression guide roller 126 to precompress spring assemblies 114 and automatically feed the spring assemblies 114 between the mandrel 112 and fixed compression roller 122. Moving side guides 136 on the feed table 128 aid in automatically in-feeding the spring assemblies 114 and ensure proper spacing between the in-fed spring assemblies 114. The feed table 128 includes a frame 138 having casters 140 located at the bottom of the frame 138 to allow movement of the feed table 128 toward and away from the precompression guide roller 126. The casters 140 are positioned on guide rails 142 which control the path of the feed table 128. Drive motors (not shown) coupled to the feed table frame 138, the feed table rollers 130, the side guides 136, and the precompression conveyor 134 provide the motive forces to move spring assemblies 114 along the feed table 128 and between the precompression roller 126 and conveyor 134 to be directed to the mandrel 112 for winding.

[0024] The apparatus 110 includes one or more packing material dispensers 152 positioned near the mandrel 112 for receiving and dispensing packing material 154, such as paper, foil, or various fabric materials, to the in-fed spring assemblies 114 as they are being wound upon the mandrel 112. Each packing material dispenser 152 has associated packing material feed rollers 156 and a tension compensator 158 for feeding and directing packing material 154 from the dispenser 152 toward the mandrel 112 and fixed compression roller 122. The packing material feed rollers may be supported on pneumatic cylinders whereby the position of the feed rollers may be adjusted. As spring assemblies 114 are directed through the precompression guide roller 126 toward the mandrel 112 and fixed compression roller 122, packing material 154 is pushed toward the mandrel 112 by the spring assemblies 114. The mandrel 112 includes a vacuum system which draws the packing material 154 toward a surface 160 of the mandrel 112 so that it is wound tightly upon the mandrel 112 prior to compressing and winding of spring assemblies 114 upon the mandrel 112. Referring further to FIG. 6, as spring assemblies 114 are wound upon the mandrel 112, pivot arm 116 pivots about pivot axis 118 to move the mandrel 112 away from the fixed compression roller 122 in a controlled manner so that successive spring assemblies 114 are uniformly compressed and rolled upon the mandrel 112.

[0025] The apparatus 110 further includes an automated cutting and gluing unit 162 in line between the packing material dispensers 152 and the mandrel 112. The cutting and gluing unit 162 automatically cuts the packing material 154 near the end of a finished roll 164 of compressed spring assemblies 114 and applies adhesive to a final layer of packing material 154, which is wound to secure the finished roll 164. Referring to FIG. 7, pivot arm 116 holds the finished roll 164, still on the mandrel 112, against the fixed compression roller 122 to provide pressure to the end of the final layer of packing material 154 until the adhesive has cured and the finished roll 164 may be removed from the mandrel 112. Referring to FIG. 8, pivot arm 116 rotates to move the finished roll 164 away from the fixed compression roller 122 and places the finished roll 164 on a finished roll support 166. At this point, the mandrel 112 may be collapsed radially inward to release the finished roll 164 and a roll pusher 168 is activated to push the finished roll 164 off the mandrel 112 along the finished roll support 166.

[0026] Referring to FIG. 9, the apparatus 110 further includes a controller 170 connected to the various drive motors and to sensors positioned at various locations on the apparatus 110 for controlling the automated roll packing of spring assemblies 114, as described above. The controller 170 is also configured to count the number of spring assemblies 114 that have been wound upon the mandrel 112. A power supply 172 provides electrical current to the apparatus 110 and its components. While the apparatus 110 is designed for completely automated roll packing of spring assemblies, it can also be used without an automated feed table 128 when manual feeding of spring assemblies 114 is desired. As more clearly shown in FIG. 5, the roll packing apparatus 110 includes a frame structure 174 for supporting the components described above. The frame structure 174 may be configured to have a modular design, wherein various sections of the apparatus 110 may be separately assembled and disassembled to facilitate transportation and assembly of the apparatus 110.

[0027] Referring to FIG. 9, an automated system 180 for providing roll packed spring assemblies 114 includes a roll packing apparatus 110, as described above, and further includes a finished roll manipulator 182 which receives finished rolls 164 of spring assemblies 114 from the finished roll support 166 and moves them to a finished roll palletizer 184. The finished roll palletizer 184 includes a pallet magazine 186, a roll wrapping machine 188 for wrapping finished rolls 164 for shipment and storage, and a conveyor 190.

[0028] In one exemplary embodiment, a roll packing apparatus 110 according to the principles of the present invention has a radially collapsible mandrel 112 having a diameter of about 300 mm. The exemplary apparatus 110 can receive rolls of packing material 154 up to about

2100 mm in width and about 1000 mm in diameter, and can accommodate spring assemblies 114 up to about 200-mm wide and about 240-mm high. The exemplary apparatus 110 can produce finished rolls 164 of spring assemblies 114 of up to about 650 mm in diameter, each roll containing 10-12 spring assemblies 114, at a rate of about 12-20 rolls per hour.

[0029] While the present invention has been illustrated by the description of an embodiment thereof, and while the embodiment has been described in considerable detail, it is not intended to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. The invention in its broader aspects is therefore not limited to the specific details, representative apparatus and method and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the scope of applicant's general inventive concept.

Claims

1. An apparatus (10) for roll packing compressible material (14), comprising:

an elongated, radially collapsible mandrel (12), said mandrel having a rotational axis along its length, whereby compressible material may be wound upon said mandrel by rotating said mandrel, said mandrel comprising:

a elongate shaft (16),
a plurality of elongated plates (62) connected to said shaft and arranged about said shaft to form a substantially tubular surface (64) wherein each plate overlaps a longitudinal edge of an adjacent plate, each plate being movable along a direction radial to the rotational axis of said mandrel to increase or decrease the diameter (67) of said surface formed by said overlapping plates, **characterised by**
a cam (70) disposed on said shaft (16) and operatively connect to said plurality of plates (62), said cam configured to move said plates toward or away from said axis of said mandrel (12) along paths (66) extending radially from said shaft when said cam is rotated, such that said surface formed by said overlapping plates increases or decreases in diameter under the operation of said cam;
a compression roller (24) operatively associated with said mandrel (12) and spaced therefrom and having a rotational axis substantially parallel to said rotational axis of said mandrel;
said mandrel (12) and said compression roller (24) configured to vary the spacing therebetween, whereby compressible material (14) may be compressed between said mandrel and said compression roller as it is wound upon said mandrel; and
a roll pusher (60) proximate said mandrel (12) and configured to engage a finished roll of material (54) on said mandrel and push the roll of said mandrel.

2. The apparatus of claim 1, further comprising:

a pivot arm (116) having a pivot axis (118) about which said pivot arm may be rotated; said mandrel (112) rotationally supported on said pivot arm whereby said mandrel may be moved relative to said compression roller (122) to vary the spacing therebetween.

3. The apparatus of either claim 1 or claim 2, wherein said compression roller (24) is configured for movement relative to said mandrel (12) to vary the spacing therebetween.

4. The apparatus of any preceding claim, further comprising:

a precompression guide roller (126) proximate said mandrel for receiving in-fed compressible material (114) and directing the compressible material toward said mandrel (112) while simultaneously compressing the compressible material; and
a feed table (128) upstream of said precompression guide roller (126) for supporting the in-fed compressible material and directing the compressible material toward said precompression guide roller.

5. The apparatus of any preceding claim, further comprising:

a feed table (128) upstream of said mandrel (112) for supporting the in-fed compressible material (114) and directing the compressible material toward said mandrel.

6. The apparatus of any preceding claim, further comprising:

at least one packing material dispenser (152) proximate said mandrel (112) for receiving and dispensing packing material to the compressible material as it is wound upon said mandrel.

7. The apparatus of claim 6, further comprising:

at least one feed roller (156) associated with said packing material dispenser (152) to direct the packing material from said dispenser to the compressible material as it is wound upon said mandrel.

8. The apparatus of either claim 6 or claim 7, further comprising:

a vacuum system operatively associated with said mandrel, the vacuum system operating to draw packing material toward said mandrel (112)and facilitate winding of the packing material (154) on said mandrel.

9. The apparatus of any one of claims 6 to 8, further comprising:

a cutting and gluing module (162) upstream of said mandrel (112) and constructed to cut the packing material (154) near the end of a finished roll (164) and to apply adhesive to the end of the packing material to secure the finished roll.

10. The apparatus of any preceding claim, further comprising:

a roll handler (58) proximate an end of said mandrel (12) and configured to receive a roll of material from said mandrel and reposition the roll relative to the apparatus (10) for subsequent processing.

11. The apparatus of claim 10, wherein said roll handler (58) is an elongate, trough-shaped cradle pivotally mounted at a first end to a support, whereby the cradle may be placed in a first position to be substantially axially aligned with the mandrel (12) to receive a finished roll (54) from the second end of the mandrel, and whereby the cradle may be pivoted to a second position to permit subsequent handling of the finished roll.

12. The apparatus of any preceding claim, further comprising:

a finished roll manipulator (182); and
a finished roll palletizer (184), said finished roll palletizer including:

a pallet magazine (186); and
a roll wrapping machine (188).

13. The apparatus of any preceding claim, further comprising a support bearing (50) located at a distal end of said mandrel, said support bearing being movable to expose said end of said mandrel (12) to allow removal of a finished roll of material (54) from said mandrel.

14. A method of roll packing compressible material (14) in a roll packing machine (10) having a radially collapsible mandrel (12) and a compression roller (24) proximate the mandrel comprising an elongated shaft (16) having a rotational axis along its length, a plurality of elongated plates (62) connected to the shaft and arranged about said shaft to form a substantially tubular surface (64), wherein each plate overlaps a longitudinal edge of an adjacent plate, each plate being movable along a direction radial to the rotational axis of said shaft to increase or decrease the diameter (67) of said surface formed by said overlapping plates and a cam (70) disposed on the shaft (16) and operatively connected to the plurality of plates (62), the cam configured to move the plates towards or away from the axis of the shaft along paths (66) extending radially from the shaft when the cam is rotated, such that the surface formed by the overlapping plates increases or decreases in diameter under the operation of the cam, the method comprising the steps of:

providing the mandrel (12) in a non-collapsed position;
adjusting the spacing between the compression roller (24) and the mandrel (12) to obtain a desired compression of the compressible material;
directing compressible material (14) between the mandrel and the compression roller such that compressible material can be wound upon the mandrel (12) by rotating the mandrel;
rotating the mandrel (12) to wind the compressible material onto the mandrel;
stopping rotation of the mandrel (12) when a desired quantity of compressible material has been wound onto the mandrel;
rotating the cam (70) to move the mandrel from the non-collapsed position to a collapsed position to release a roll from an outer surface of the mandrel; and
removing the roll of compressible material (54) from the mandrel.

15. The method of claim 14, wherein the roll packing machine further includes a packing material dispenser (152), the method further comprising:

applying packing material to the compressible material as it is wound upon the mandrel

16. The method of either claim 14 or 15, further comprising:

securing the roll packed compressible material (54), prior removal from the mandrel (12), to prevent unrolling.

Patentansprüche

1. Vorrichtung (10) zum Rollenverpacken von komprimierbarem Material (14), die Folgendes umfasst:

eine längliche, radial zusammenklappbare Spindel (12),

wobei die genannte Spindel eine Rotationsachse über ihre Länge hat, so dass komprimierbares Material durch Drehen der genannten Spindel auf diese gewickelt werden kann,
wobei die genannte Spindel Folgendes umfasst:

eine längliche Welle (16),
mehrere längliche Platten (62), die mit der genannten Welle verbunden und um die genannte Welle herum angeordnet sind, um eine im Wesentlichen tubuläre Fläche (64) zu bilden, wobei jede Platte eine Längskante einer Nachbarplatte überlappt, wobei jede Platte in einer Richtung radial zur Rotationsachse der genannten Spindel beweglich ist, um den Durchmesser (67) der genannten, von den genannten überlappenden Platten gebildeten Fläche zu vergrößern oder zu verkleinern, **dadurch gekennzeichnet, dass**
eine Nocke (70) auf der genannten Welle (16) angeordnet und betriebsmäßig mit den genannten mehreren Platten (62) verbunden ist, wobei die genannte Nocke so konfiguriert ist, dass sie die genannten Platten zu der genannten Achse der genannten Spindel (12) hin oder davon weg über Bahnen (66) bewegt, die radial von der genannten Welle ausgehen, wenn die genannte Nocke gedreht wird, so dass der Durchmesser der genannten, von den genannten überlappenden Platten gebildete Fläche unter der Wirkung der genannten Nocke zunimmt oder abnimmt;
eine Kompressionswalze (24), die betriebsmäßig mit der genannten Spindel (12) assoziiert und davon beabstandet ist und eine Rotationsachse hat, die im Wesentlichen parallel zu der genannten Rotationsachse der genannten Spindel ist;

wobei die genannte Spindel (12) und die genannte Kompressionswalze (24) so konfiguriert sind, dass der Abstand zwischen ihnen variiert, so dass das komprimierbare Material (14) zwischen der genannten Spindel und der genannten Kompressionswalze komprimiert werden kann, während es auf die genannte Spindel gewickelt wird; und
einen Rollenschieber (60) in der Nähe der genannten Spindel (12), der so konfiguriert ist, dass er in eine fertige Materialrolle (54) auf der genannten Spindel eingreift und die Rolle von der genannten Spindel schiebt.

2. Vorrichtung nach Anspruch 1, die ferner Folgendes umfasst:

einen Schwenkarm (116) mit einer Schwenkachse (118), um die der genannte Schwenkarm gedreht werden kann; wobei die genannte Spindel, (1112) rotatorisch auf dem genannten Schwenkarm gelagert ist, so dass die genannte Spindel relativ zu der genannten Kompressionswalze (122) bewegt werden kann, um den Abstand dazwischen zu variieren.

3. Vorrichtung nach Anspruch 1 oder Anspruch 2, wobei die genannte Kompressionswalze (24) für eine Bewegung relativ zu der genannten Spindel (12) konfiguriert ist, um den Abstand dazwischen zu variieren.

4. Vorrichtung nach einem der vorherigen Ansprüche, die ferner Folgendes umfasst:

eine Vorkompressionsführungswalze (126) in der Nähe der genannten Spindel zum Aufnehmen von zugeführtem komprimierbarem Material (114) und zum Leiten des komprimierbaren Materials in Richtung auf die genannte Spindel (112) und zum gleichzeitigen Komprimieren des komprimierbaren Materials; und
einen Zustelltisch (128) oberhalb der genannten Vorkompressionsführungswalze (126) zum Tragen des zugeführten komprimierbaren Materials und zum Leiten des komprimierbaren Materials in Richtung auf die genannte Vorkompressionsführungswalze.

5. Vorrichtung nach einem der vorherigen Ansprüche, die ferner Folgendes umfasst:

einen Zustelltisch (128) oberhalb der genannten Spindel (112) zum Tragen des zugeführten komprimierbaren Materials (114) und zum Leiten des komprimierbaren Materials in Richtung auf die genannte Spindel.

6. Vorrichtung nach einem der vorherigen Ansprüche, die ferner Folgendes umfasst:

wenigstens einen Verpackungsmaterialspender (152) in der Nähe der genannten Spindel (112) zum Aufnehmen und Ausgeben von Verpackungsmaterial zu dem komprimierbaren Material, während es auf die genannte Spindel gewickelt wird.

7. Vorrichtung nach Anspruch 6, die ferner Folgendes umfasst:

wenigstens eine Zuführungswalze (156) in Ver-

bindung mit dem genannten Verpackungsmaterialspender (152), um das Verpackungsmaterial von dem genannten Spender zu dem komprimierbaren Material zu führen, während es auf die genannte Spindel gewickelt wird.

8. Vorrichtung nach Anspruch 6 oder Anspruch 7, die ferner Folgendes umfasst:

ein Vakuumsystem, das betriebsmäßig mit der genannten Spindel assoziiert ist, wobei das Vakuumsystem die Aufgabe hat, Verpackungsmaterial in Richtung auf die genannte Spindel (112) zu ziehen und das Wickeln des Verpackungsmaterials (154) auf die genannte Spindel zu erleichtern.

9. Vorrichtung nach einem der Ansprüche 6 bis 8, die ferner Folgendes umfasst:

ein Schneid- und Klebmodul (162) oberhalb der genannten Spindel (112), das so aufgebaut ist, dass es das Verpackungsmaterial (154) in der Nähe des Endes einer fertigen Rolle (164) abschneidet und Klebstoff auf das Ende des Verpackungsmaterials aufbringt, um die fertige Rolle zu befestigen.

10. Vorrichtung nach einem der vorherigen Ansprüche, die ferner Folgendes umfasst:

eine Rollenhandhabungsvorrichtung (58) in der Nähe eines Endes der genannten Spindel (12), die so konfiguriert ist, dass sie eine Materialrolle von der genannten Spindel nimmt und die Rolle relativ zur Vorrichtung (10) für eine nachfolgende Bearbeitung umpositioniert.

11. Vorrichtung nach Anspruch 10, wobei die genannte Rollenhandhabungsvorrichtung (58) eine längliche, trogförmige Ablage ist, die schwenkbar an einem ersten Ende an einem Lager montiert ist, so dass die Ablage in einer ersten Position platziert werden kann, in der sie im Wesentlichen axial mit der Spindel (12) fluchtet, um eine fertige Rolle (54) vom zweiten Ende der Spindel aufzunehmen, und so dass die Ablage in eine zweite Position geschwenkt werden kann, um eine nachfolgende Handhabung der fertigen Rolle zuzulassen.

12. Vorrichtung nach einem der vorherigen Ansprüche, die ferner Folgendes umfasst:

einen Fertigrollenmanipulator (182); und
einen Fertigrollenpalettisierer (184), wobei der genannte Fertigrollenpalettisierer Folgendes beinhaltet:

ein Palettenmagazin (186); und
eine Rollenwickelmaschine (188).

13. Vorrichtung nach einem der vorherigen Ansprüche, die ferner ein Stützlager (50) umfasst, das sich an einem distalen Ende der genannten Spindel befindet, wobei das genannte Stützlager so bewegt werden kann, dass es das genannte Ende der genannten Spindel (12) exponiert, so dass eine fertige Materialrolle (54) von der genannten Spindel genommen werden kann.

14. Verfahren zum Rollenverpacken von komprimierbarem Material (14) in einer Rollenverpackungsmaschine (10) mit einer im Wesentlichen zusammenklappbaren Spindel (12) und einer Kompressionswalze (24) in der Nähe der Spindel, die Folgendes umfasst: eine längliche Welle (16) mit einer Rotationsachse über ihre Länge, mehrere längliche Platten (62), die mit der Welle verbunden und um die genannte Welle herum angeordnet sind, um eine im Wesentlichen tubuläre Fläche (64) zu bilden, wobei jede Platte mit einer Längskante einer Nachbarplatte überlappt, wobei jede Platte in einer Richtung radial zur Rotationsachse der genannten Wellen beweglich ist, um den Durchmesser (67) der durch die genannten überlappenden Platten gebildeten Oberfläche zu vergrößern oder zu verkleinern, und eine Nocke (70), die auf der Welle (16) angeordnet und betriebsmäßig mit den mehreren Platten (62) verbunden ist, wobei die Nocke so konfiguriert ist, dass sie die Platten zur Achse der Welle hin oder davon weg über Bahnen (66) bewegt, die radial von der Welle verlaufen, wenn die Nocke gedreht wird, so dass der Durchmesser der durch die überlappenden Platten gebildeten Fläche unter der Wirkung der Nocke zunimmt oder abnimmt, wobei das Verfahren die folgenden Schritte beinhaltet:

Bereitstellen der Spindel (12) in einer nicht zusammengeklappten Position;
Einstellen des Abstands zwischen der Kompressionswalze (24) und der Spindel (12), um eine gewünschte Kompression des komprimierbaren Materials zu erhalten;
Leiten von komprimierbarem Material (14) zwischen der Spindel und der Kompressionswalze, so dass das komprimierbare Material durch Drehen der Spindel (12) auf die Spindel gewickelt werden kann;
Drehen der Spindel (12), um das komprimierbare Material auf die Spindel zu wickeln;
Stoppen der Rotation der Spindel (12), wenn eine gewünschte Menge an komprimierbarem Material auf die Spindel gewickelt wurde;
Drehen der Nocke (70), um die Spindel von der nicht zusammengeklappten Position in eine zusammengeklappte Position zu bewegen, um ei-

ne Rolle von einer Außenfläche der Spindel zu lösen; und
Abnehmen der Rolle von komprimierbarem Material (54) von der Spindel.

15. Verfahren nach Anspruch 14, wobei die Rollenverpackungsmaschine ferner einen Verpackungsmaterialspender (152) aufweist, wobei das Verfahren ferner das Aufbringen von Verpackungsmaterial auf das komprimierbare Material beinhaltet, während dieses auf die Spindel gewickelt wird.

16. Verfahren nach Anspruch 14 oder 15, das ferner das Befestigen des rollenverpackten komprimierbaren Materials (54) vor dem Abnehmen von der Spindel (12) beinhaltet, um ein Abwickeln zu verhüten.

Revendications

1. Appareil (10) pour emballer sous forme de rouleau un matériau compressible (14), comprenant :

un mandrin allongé, rétractable radialement (12), ledit mandrin ayant un axe de rotation sur sa longueur, par lequel ledit matériau compressible peut être enroulé sur ledit mandrin par rotation dudit mandrin, ledit mandrin comprenant :

un arbre allongé (16) ;
une pluralité de plaques allongées (62) raccordées audit arbre et agencées autour dudit arbre afin de former une surface sensiblement tubulaire (64) où chaque plaque chevauche un bord longitudinal d'une plaque adjacente, chaque plaque étant mobile dans un sens radial à l'axe de rotation dudit mandrin afin d'augmenter ou de diminuer le diamètre (67) de ladite surface formée par lesdites plaques chevauchantes, **caractérisé par**
une came (70) disposée sur ledit arbre (16) et raccordée opérationnellement à ladite pluralité de plaques (62), ladite came étant configurée pour rapprocher ou éloigner lesdites plaques dudit axe dudit mandrin (12) le long de chemins (66) s'étendant radialement depuis ledit arbre quand ladite came est tournée, de telle sorte que ladite surface formée par lesdites plaques chevauchantes augmente ou diminue en diamètre avec le fonctionnement de la came ;
un rouleau de compression (24) associé opérationnellement audit mandrin (12) et espacé de celui-ci et ayant un axe de rotation sensiblement parallèle audit axe de rotation dudit mandrin ;
ledit mandrin (12) et ledit rouleau de compression (24) étant configurés pour faire varier l'espacement entre eux, par lequel le matériau compressible (14) peut être compressé entre ledit mandrin et ledit rouleau de compression au fur et à mesure qu'il est enroulé sur ledit mandrin ; et
un poussoir de rouleau (60) proche dudit mandrin (12) et configuré pour engager un rouleau fini de matériau (43) se trouvant sur ledit mandrin et éjecter le rouleau dudit mandrin.

2. Appareil selon la revendication 1, comprenant en outre :

un bras pivot (116) ayant un axe pivot (118) autour duquel ledit bras pivot peut être tourné ; ledit mandrin (112) étant supporté en rotation sur ledit bras pivot de telle sorte que ledit mandrin puisse être déplacé par rapport audit rouleau de compression (122) afin de modifier l'espacement entre eux.

3. Appareil selon la revendication 1 ou 2, dans lequel ledit rouleau de compression (24) est configuré pour se déplacer par rapport audit mandrin (12) de façon à modifier l'espacement entre eux.

4. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre :

un rouleau de guidage de précompression (126) proche dudit mandrin pour recevoir un matériau compressible alimenté (114) et diriger le matériau compressible vers ledit mandrin (112) tout en compressant le matériau compressible ; et
une table d'alimentation (128) en amont dudit rouleau de guidage de précompression (126) pour supporter le matériau compressible alimenté et diriger le matériau compressible vers ledit rouleau de guidage de précompression.

5. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre :

une table d'alimentation (128) en amont dudit mandrin (112) pour supporter le matériau compressible alimenté (114) et diriger le matériau compressible vers ledit mandrin.

6. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre :

au moins un distributeur de matériau de conditionnement (152) proche dudit mandrin (112) pour recevoir et distribuer un matériau de conditionnement sur le matériau compressible au fur et à mesure qu'il est enroulé sur ledit man-

drin.

7. Appareil selon la revendication 6, comprenant en outre :

au moins un rouleau d'alimentation (156) associé audit distributeur de matériau de conditionnement (152) afin de diriger le matériau de conditionnement depuis ledit distributeur jusqu'au matériau compressible au fur et à mesure qu'il est enroulé sur ledit mandrin.

8. Appareil selon la revendication 6 ou 7, comprenant en outre :

un système de vide associé opérationnellement audit mandrin, le système de vide fonctionnant pour avancer un matériau de conditionnement vers ledit mandrin (112) et faciliter l'enroulement du matériau de conditionnement (154) sur ledit mandrin.

9. Appareil selon l'une quelconque des revendications 6 à 8, comprenant en outre
un module de coupe et de collage (162) en amont dudit mandrin (112) et construit pour couper le matériau de conditionnement (154) près de l'extrémité d'un rouleau fini (164), et appliquer un adhésif sur l'extrémité du matériau de conditionnement afin de sceller le rouleau fini .

10. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre :

un dispositif de manutention de rouleau (58) proche d'une extrémité dudit mandrin (12) et configuré pour recevoir un rouleau de matériau depuis ledit mandrin et repositionner le rouleau par rapport à l'appareil (10) pour son traitement ultérieur.

11. Appareil selon la revendication 10, dans lequel ledit dispositif de manutention de rouleau (58) est un berceau allongé en forme d'auge monté de façon pivotante au niveau d'une première extrémité à un support, au moyen duquel le berceau peut être placé dans une première position afin d'être aligné sensiblement axialement au mandrin (12) pour recevoir un rouleau fini (54) depuis la seconde extrémité du mandrin, et au moyen duquel le berceau peut être pivoté sur une seconde position pour permettre la manipulation suivante du rouleau fini.

12. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre :

un manipulateur de rouleau fini (182) ; et
un palettiseur de rouleau fini (184), ledit palettiseur de rouleau fini comportant :

un magasin à palettes (186) ; et
une machine d'emballage de rouleau (188) ;

13. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre un palier de support (50) situé à une extrémité distale dudit mandrin, ledit palier de support étant déplaçable pour exposer ladite extrémité dudit mandrin (12) et permettre le retrait d'un rouleau fini de matériau (54) dudit mandrin.

14. Procédé de conditionnement en rouleau d'une matériau compressible (14) dans une machine de conditionnement en rouleau (10) comportant un mandrin rétractable radialement (12) et un rouleau de compression (24) près du mandrin comprenant un arbre allongé (16) ayant un axe de rotation sur sa longueur, une pluralité de plaques allongées (62) raccordées à l'arbre et agencées autour dudit arbre afin de former une surface sensiblement tubulaire (64), dans lequel chaque plaque chevauche un bord longitudinal d'une plaque adjacente, chaque plaque étant mobile dans un sens radial à l'axe de rotation dudit arbre afin d'augmenter ou de diminuer le diamètre (67) de ladite surface formée par lesdites plaques chevauchantes et une came (70) disposée sur l'arbre (16) et raccordée opérationnellement à ladite pluralité de plaques (62), ladite came étant configurée pour rapprocher ou éloigner les plaques de l'axe de l'arbre le long de chemins (66) qui s'étendent radialement depuis l'arbre quand la came est tournée, de telle sorte que la surface formée par les plaques chevauchantes augmente ou diminue en diamètre avec le fonctionnement de la came, le procédé comprenant les étapes suivantes :

préparation du mandrin (12) en position non rétractée ;
ajustement de l'espacement entre le rouleau de compression (24) et le mandrin (12) afin d'obtenir une compression souhaitée du matériau compressible ;
passage d'un matériau compressible (14) entre le mandrin et le rouleau de compression de telle sorte que le matériau compressible puisse être enroulé sur le mandrin (12) par rotation du mandrin ;
rotation du mandrin (12) afin d'enrouler le matériau compressible sur le mandrin ;
arrêt de la rotation du mandrin (12) quand une quantité souhaitée de matériau compressible a été enroulée sur le mandrin ;
rotation de la came (70) pour déplacer le mandrin de la position non rétractée a une position rétractée afin de libérer un rouleau d'une surface

externe du mandrin ; et
retrait du rouleau de matériau compressible (54) du mandrin.

15. Procédé selon la revendication 14, dans lequel la machine de conditionnement en rouleau comporte en outre un distributeur de matériau de conditionnement (152), le procédé comprenant en outre :

l'application de matériau de conditionnement sur le matériau compressible au fur et à mesure qu'il est enroulé sur le mandrin.

16. Procédé selon la revendication 14 ou 15, comprenant en outre :

le scellement du matériau compressible conditionné en rouleau (54) avant son retrait du mandrin (12) afin d'empêcher son déroulement.

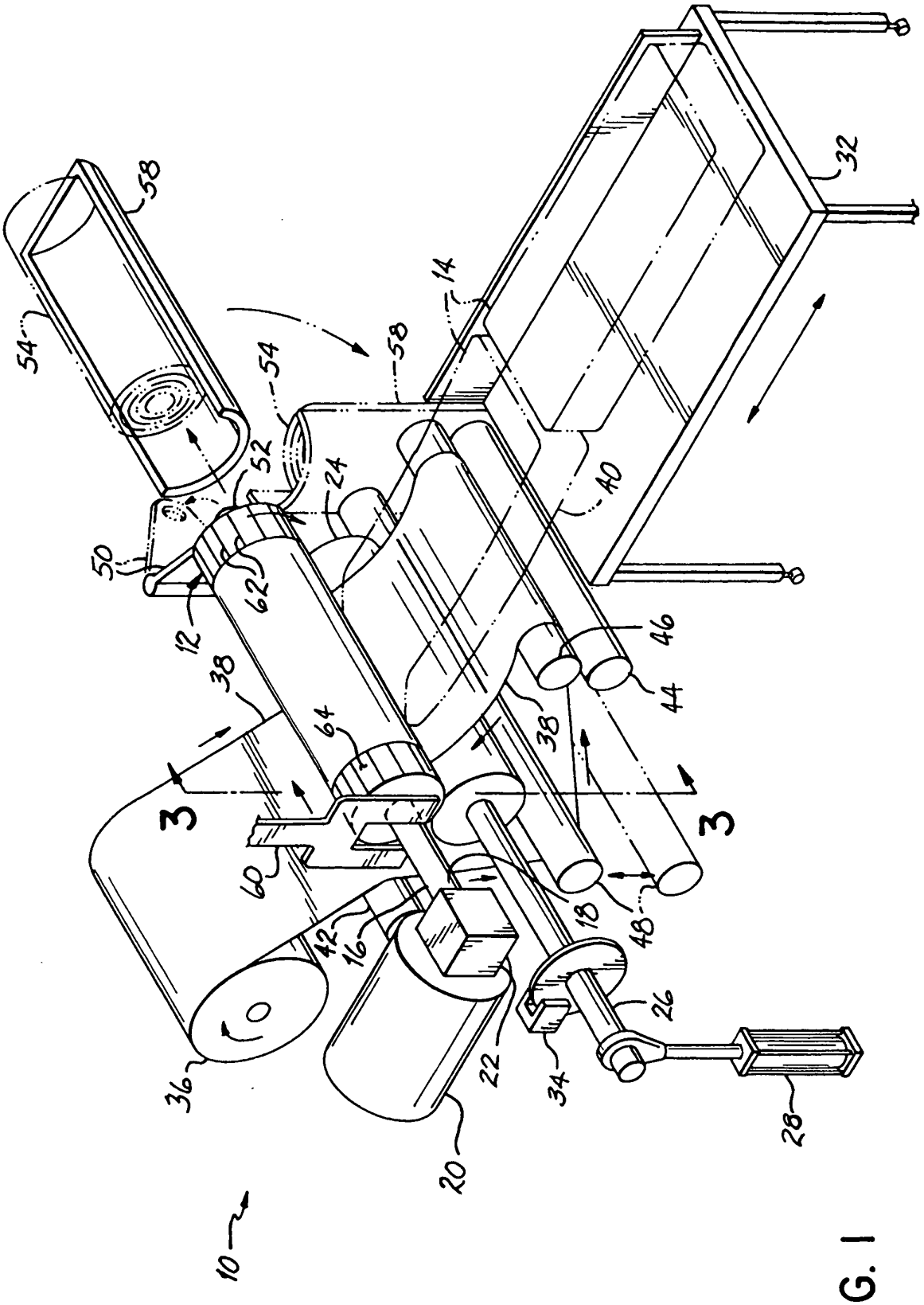
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FIG. 1

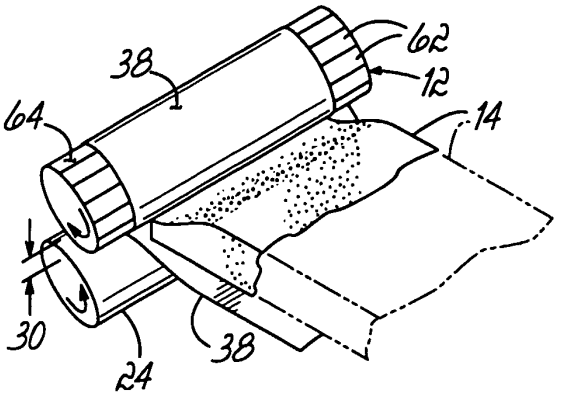

FIG. 2

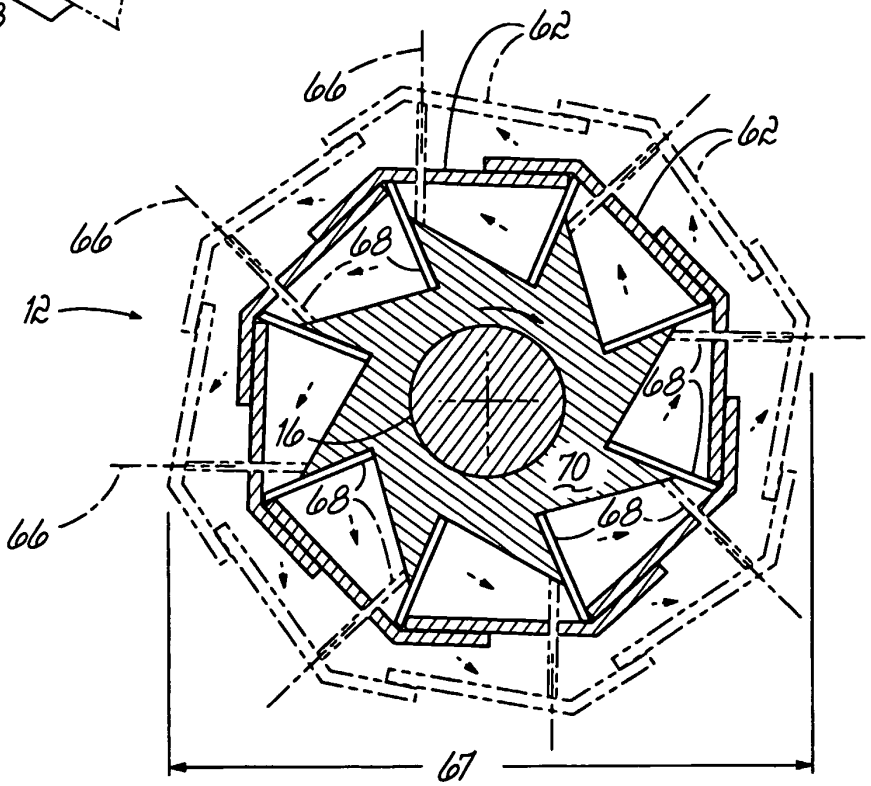

FIG. 3

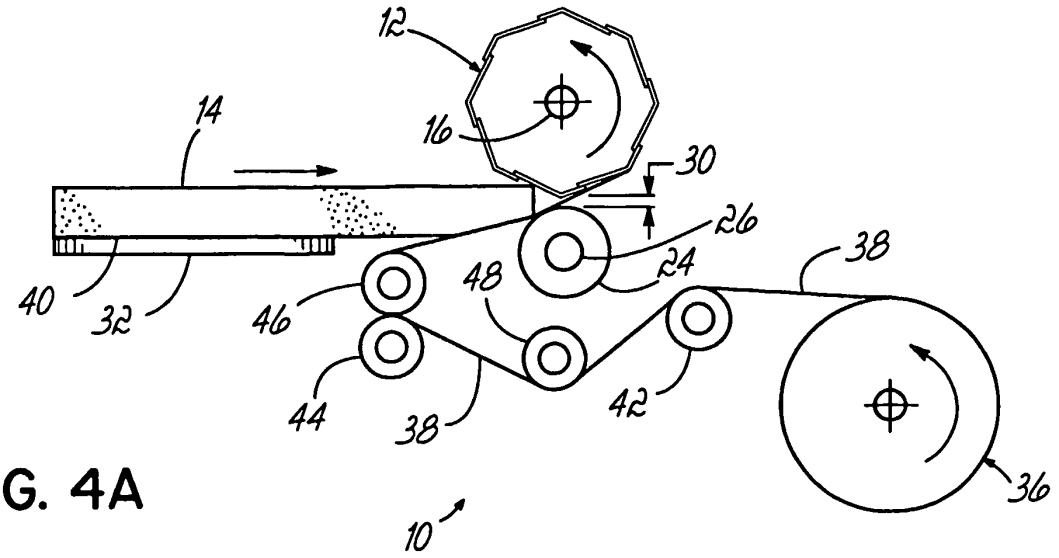

FIG. 4A

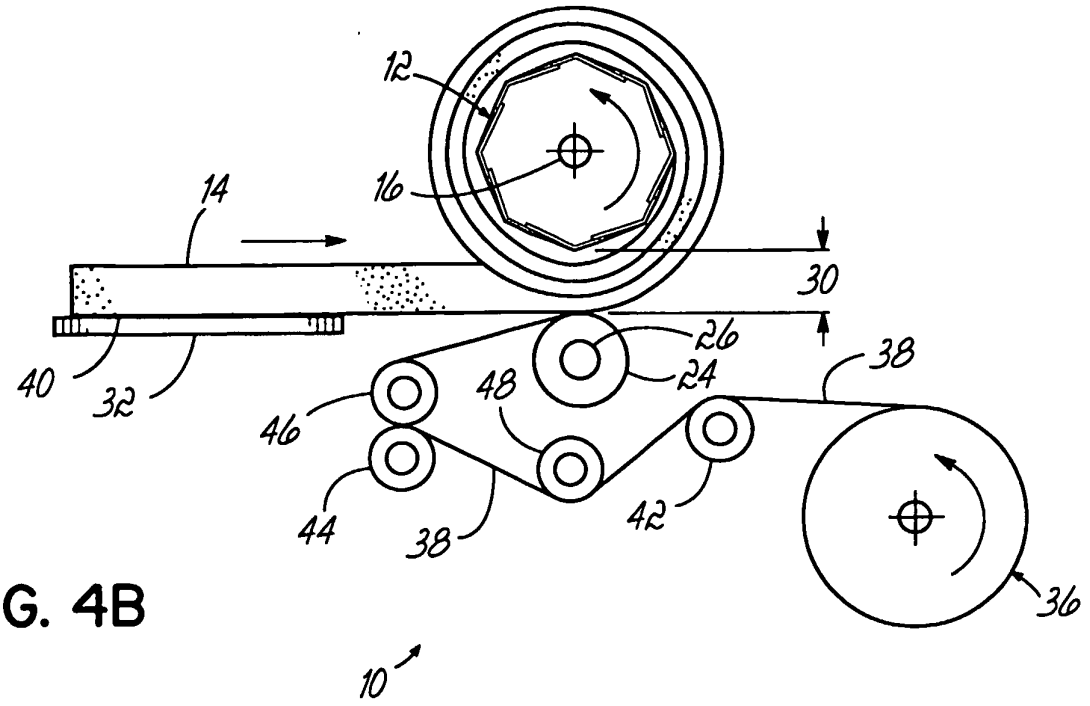
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FIG. 4B

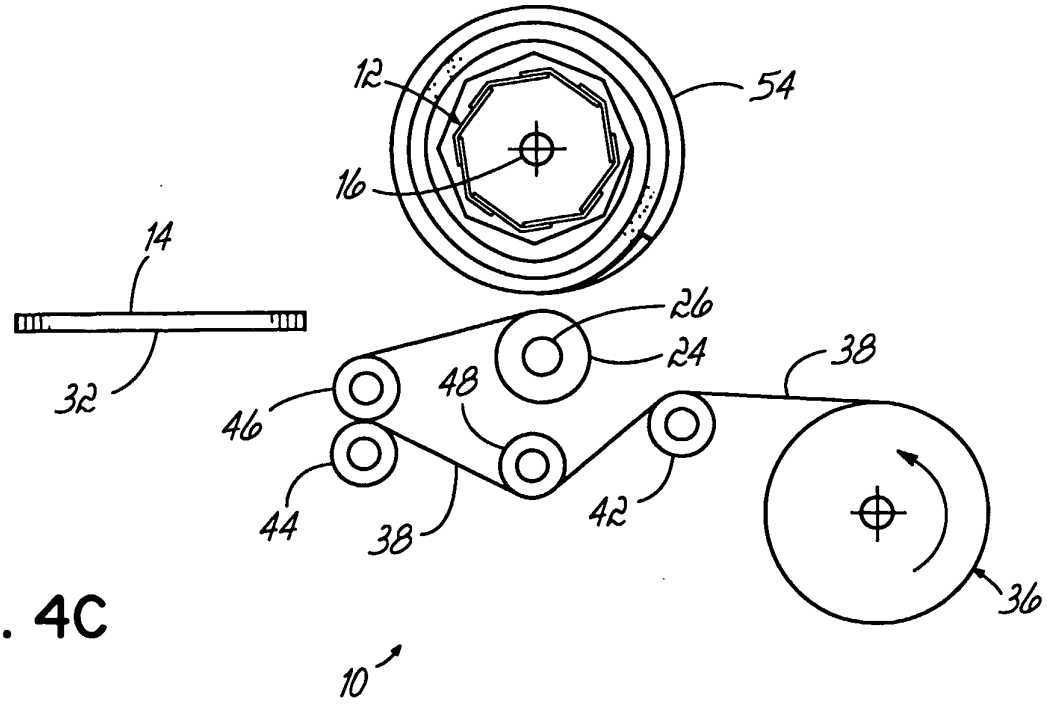
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FIG. 4C

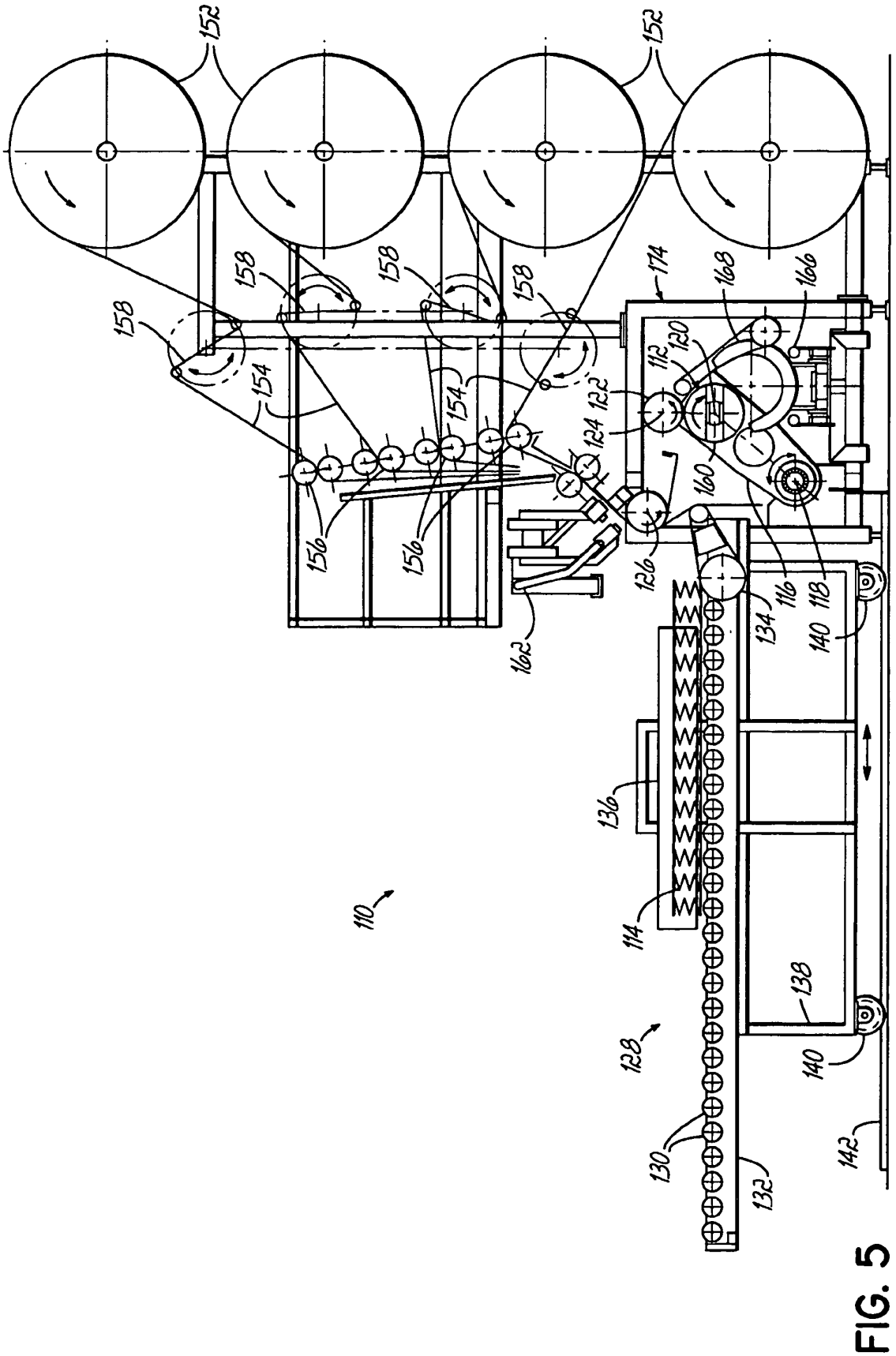
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FIG. 5

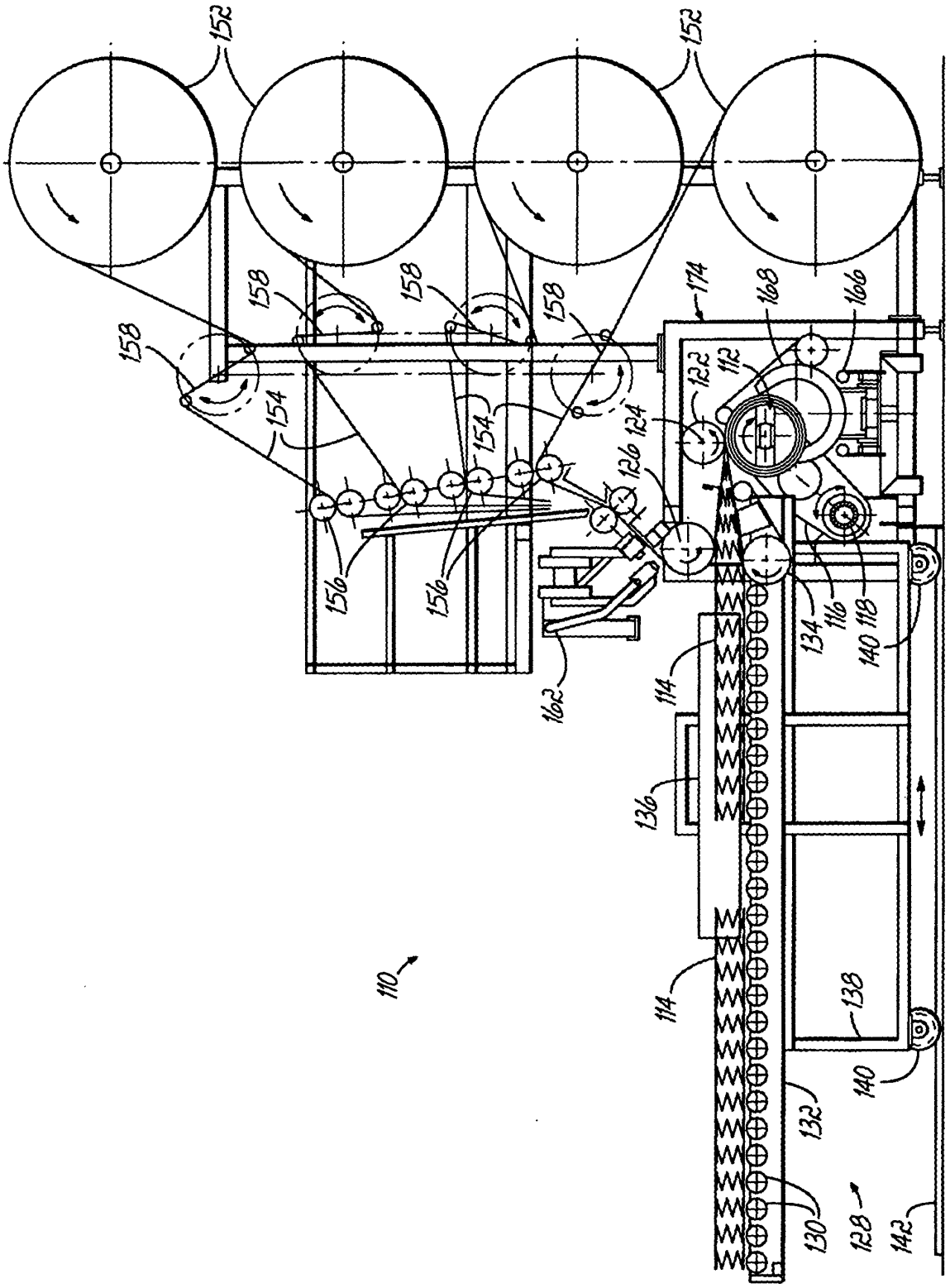
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FIG. 6

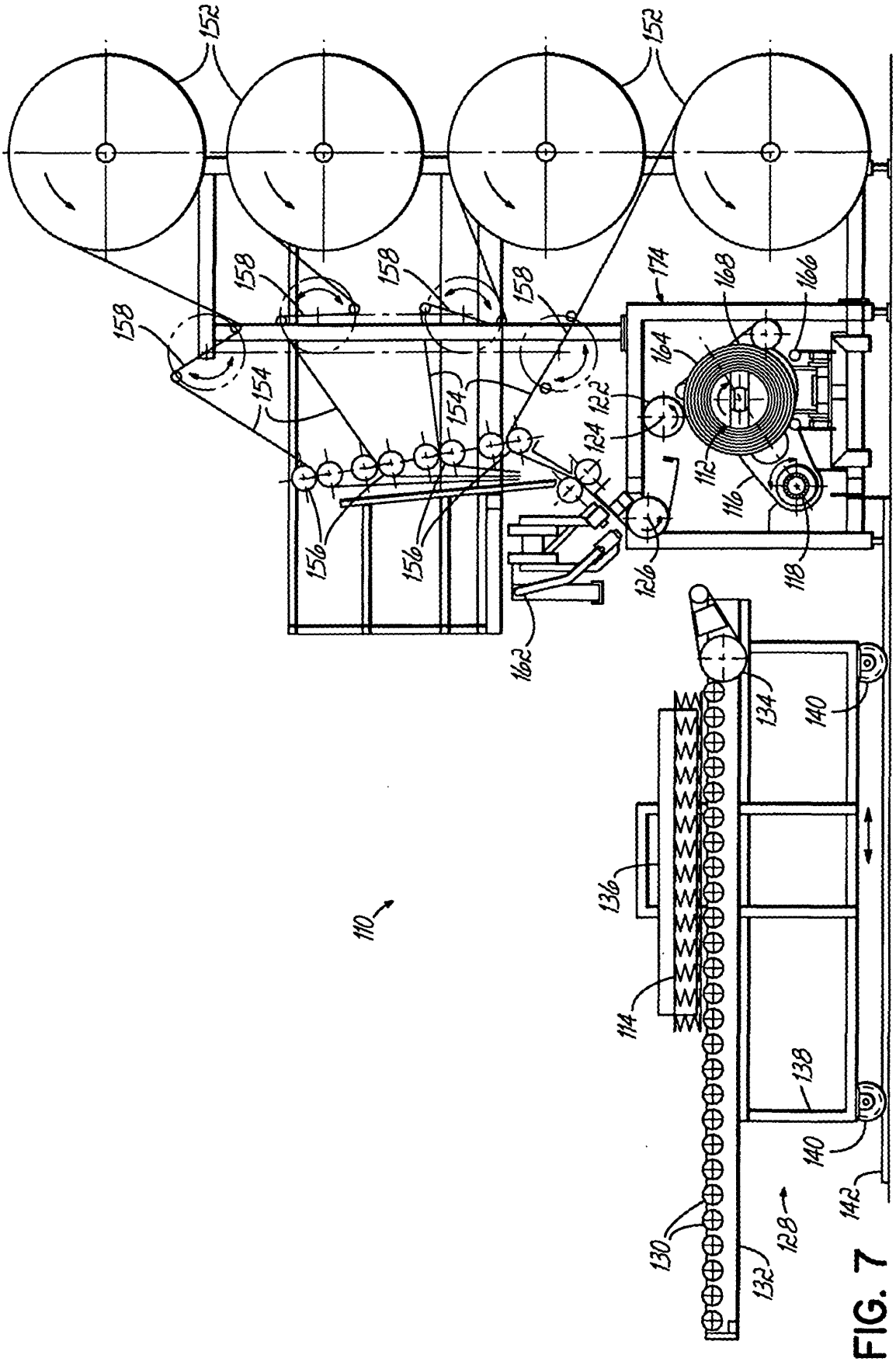
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FIG. 7

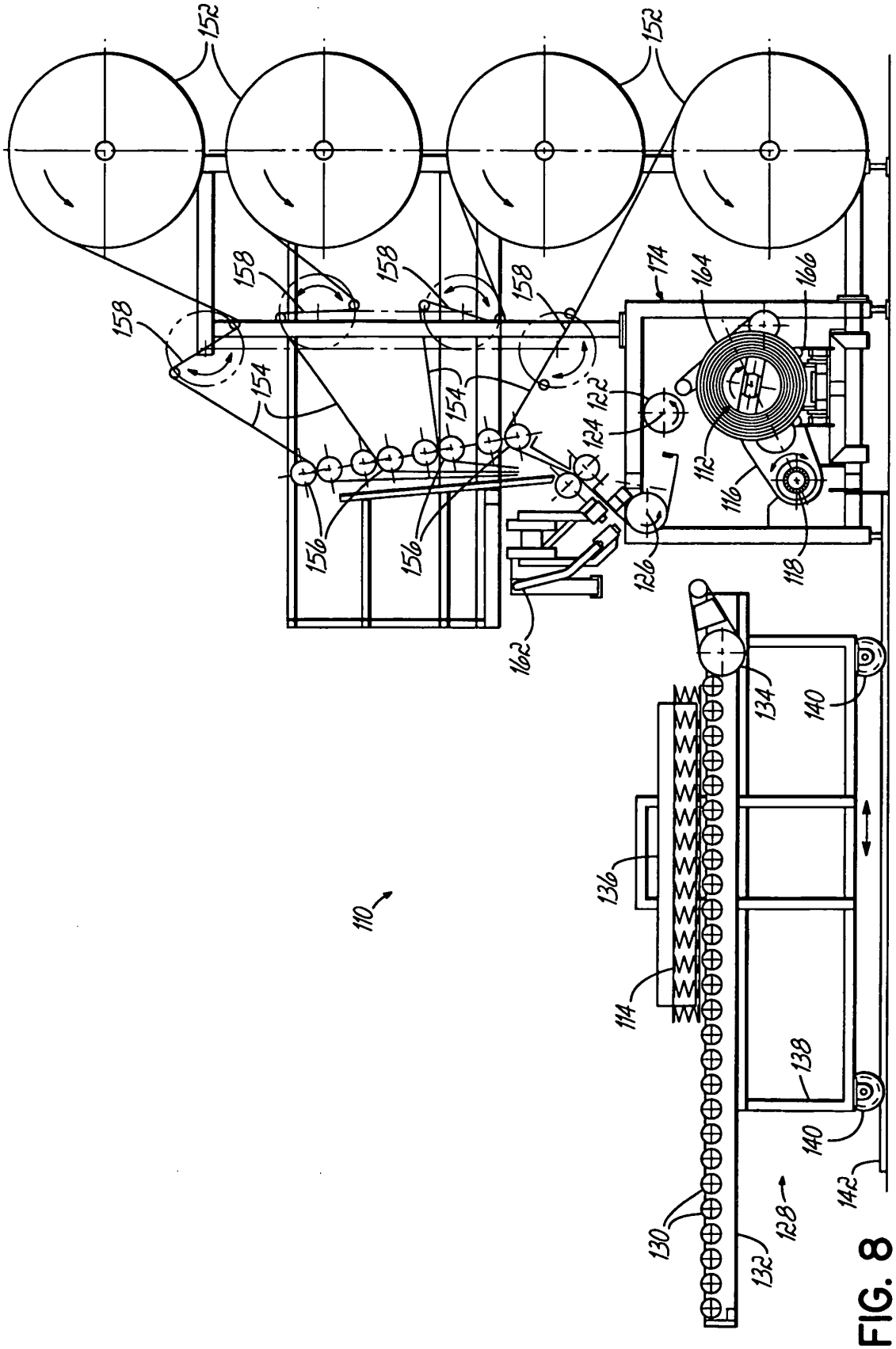
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FIG. 8

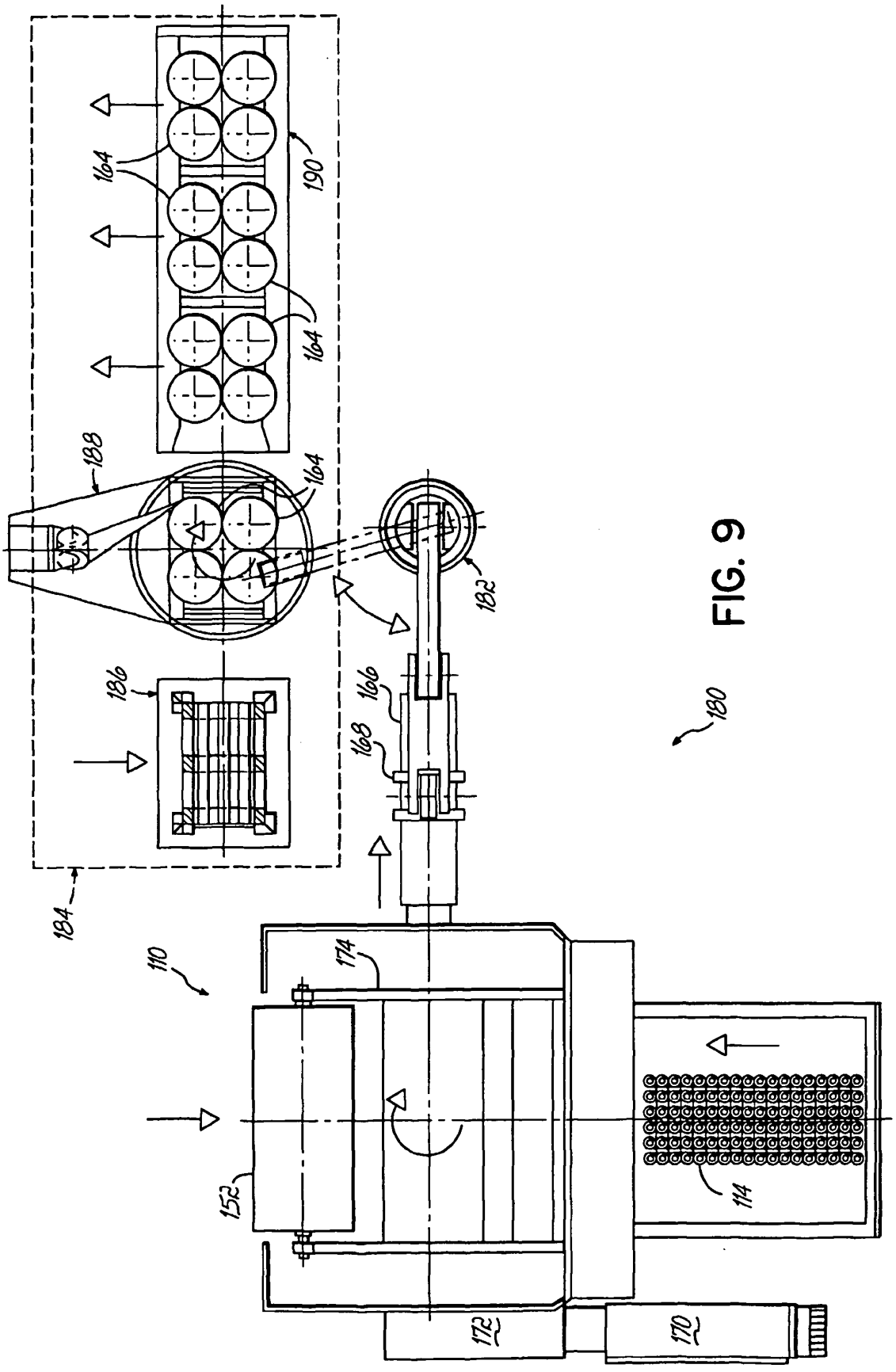
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FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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