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Swift et al.

(54) VERTICAL BANDING MACHINE

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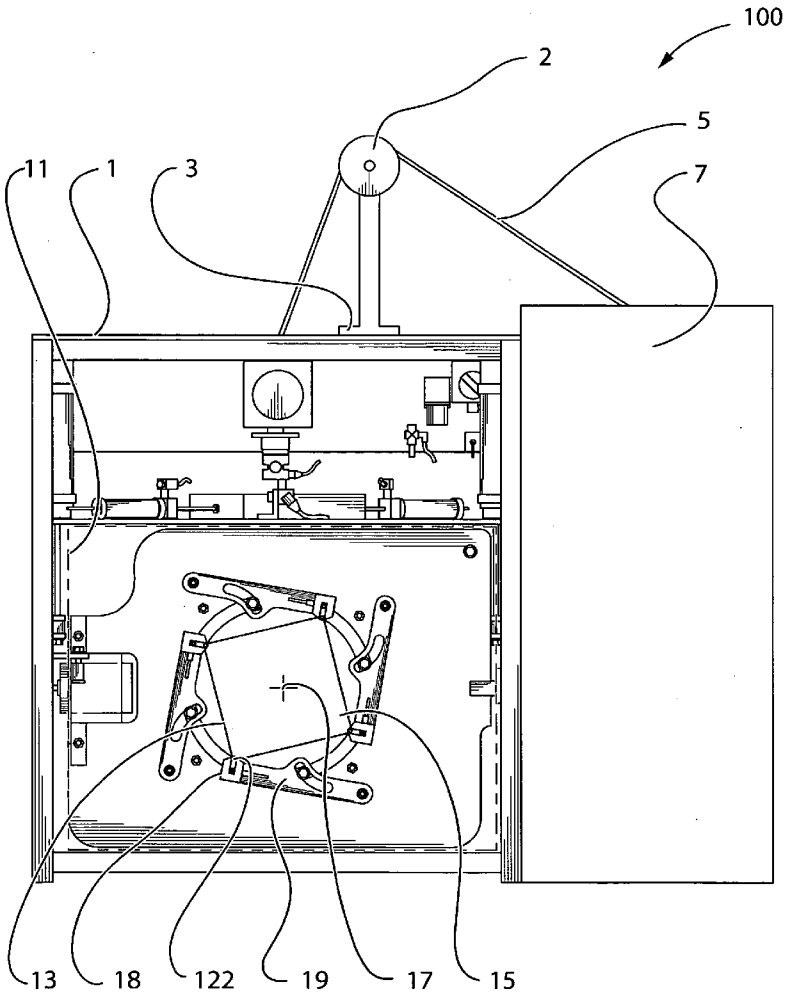
(57) **ABSTRACT**

Machine for applying elastic bands onto objects comprising at least two band holding devices for receiving the elastic band from the elastic band supply mechanism; stretching the elastic band for providing a band opening surrounded by the elastic band for accommodating a plurality of objects for banding therein; and, disengaging the elastic band from the holding devices for deploying the elastic band onto the plurality of objects; an actuator coupled to the band holding devices for moving the band holding devices between a first position for receiving the elastic band and a second position for disengaging the elastic band; and, a flip mechanism having the band holding devices and the actuator mounted thereto for moving the band holding devices from a band receiving position, where the elastic band is disposed in a plane oriented substantially horizontal, to a band disengaging position, where the elastic band is disposed in a plane oriented substantially vertical, wherein in the disengaging position the band holding devices, the actuator, and the flip mechanism are disposed outside a handling space determined by projecting the band opening along a straight line through the band opening and oriented substantially perpendicular thereto.



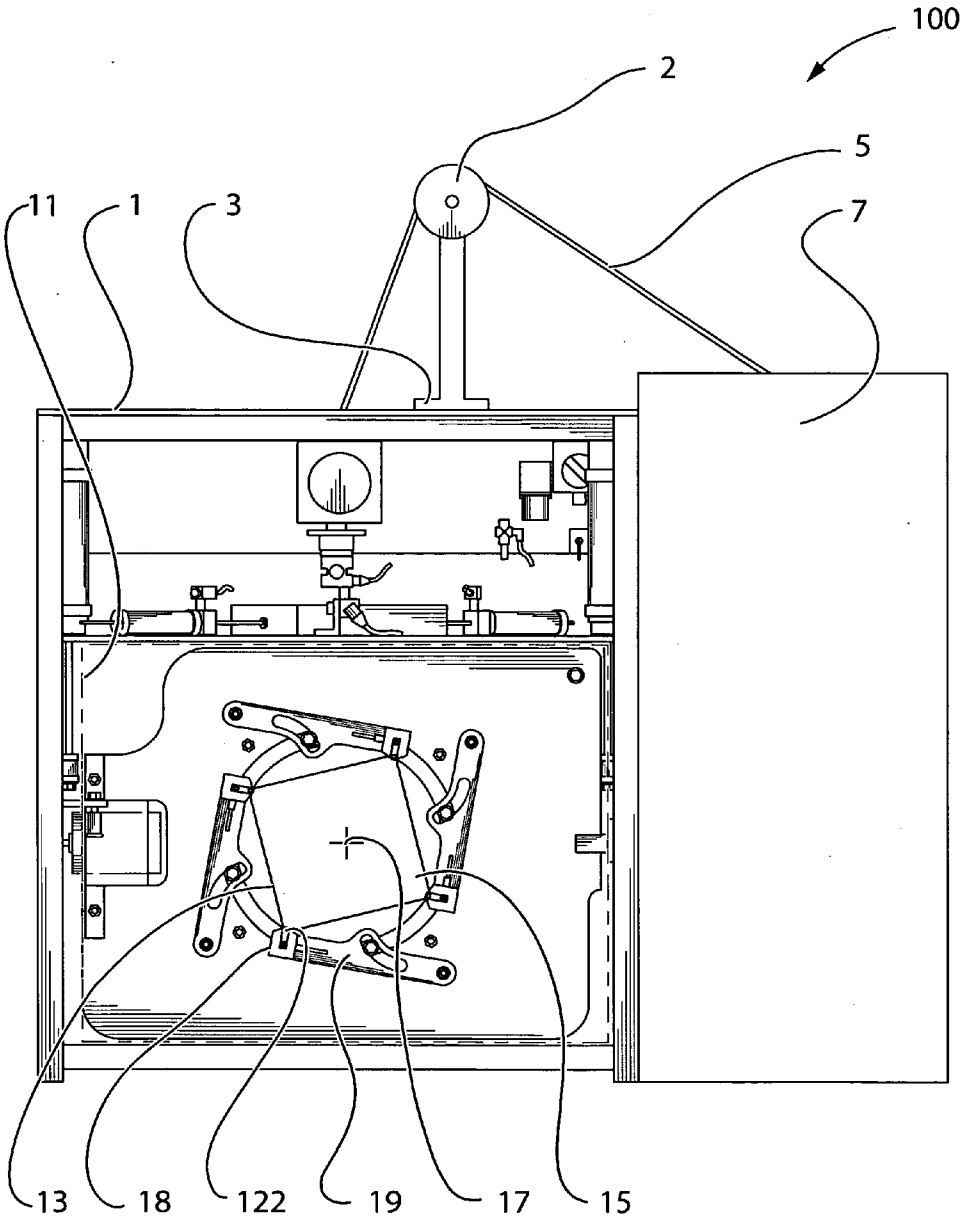


FIG. 1A

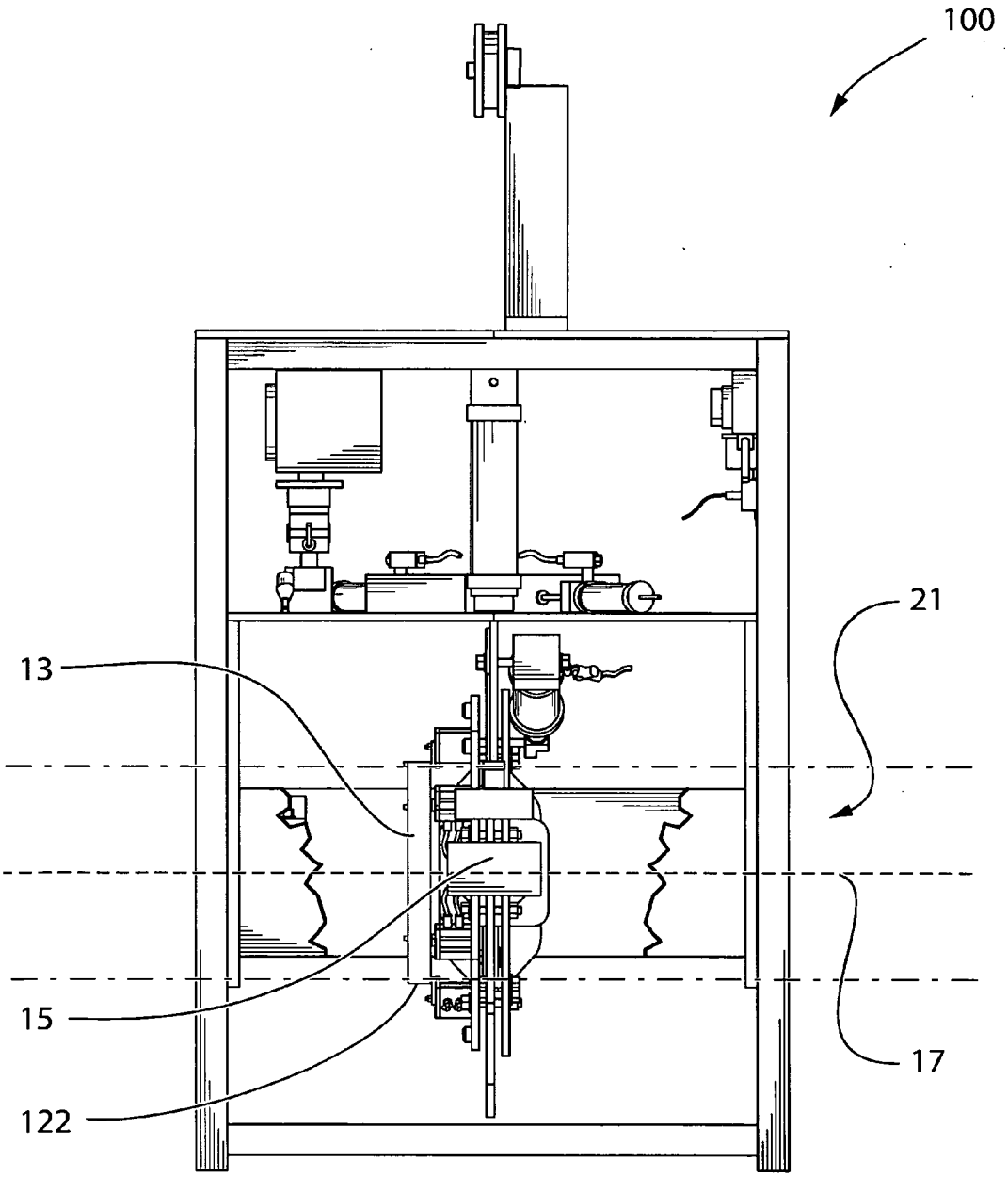


FIG. 1B

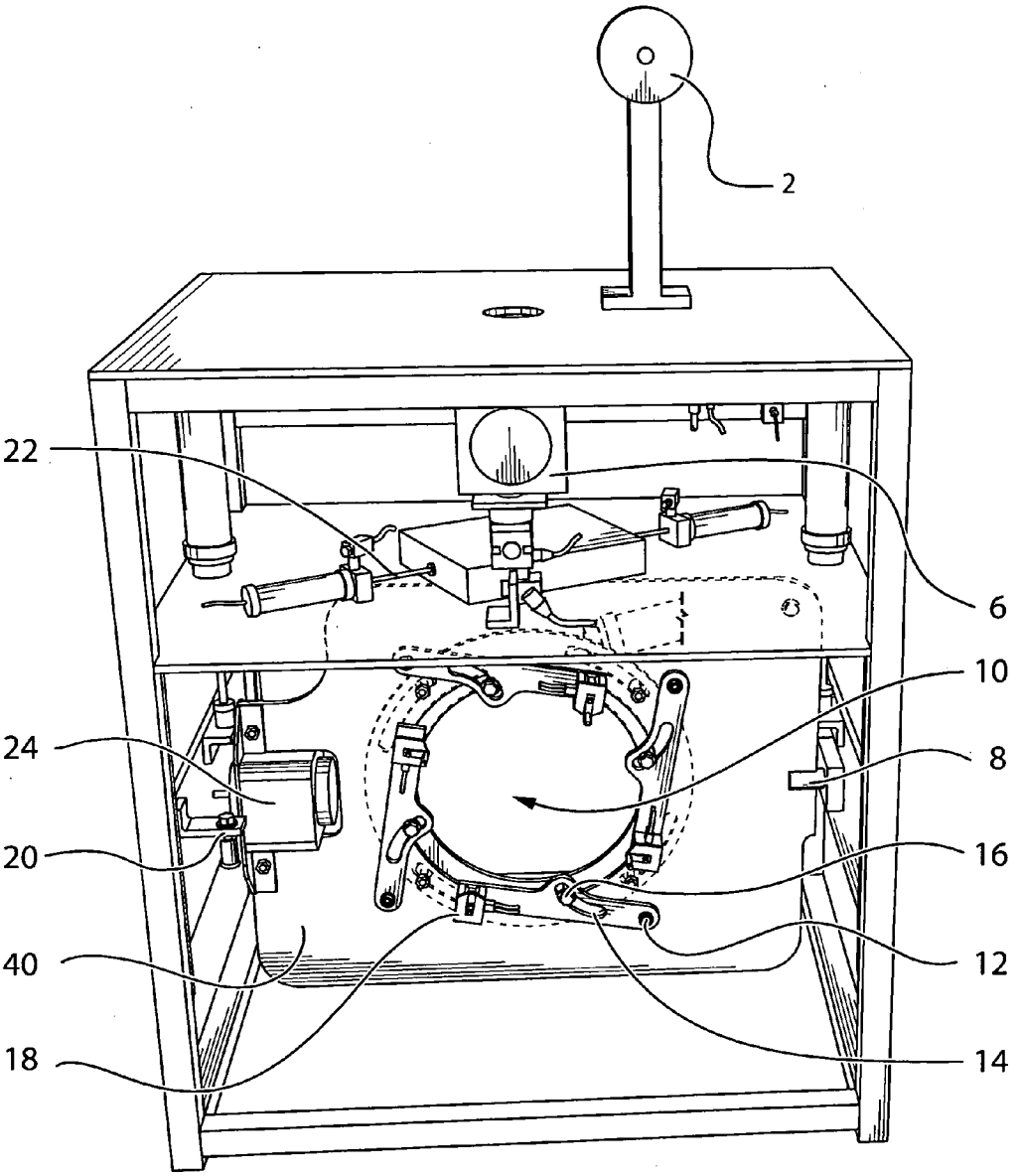


FIG. 1C

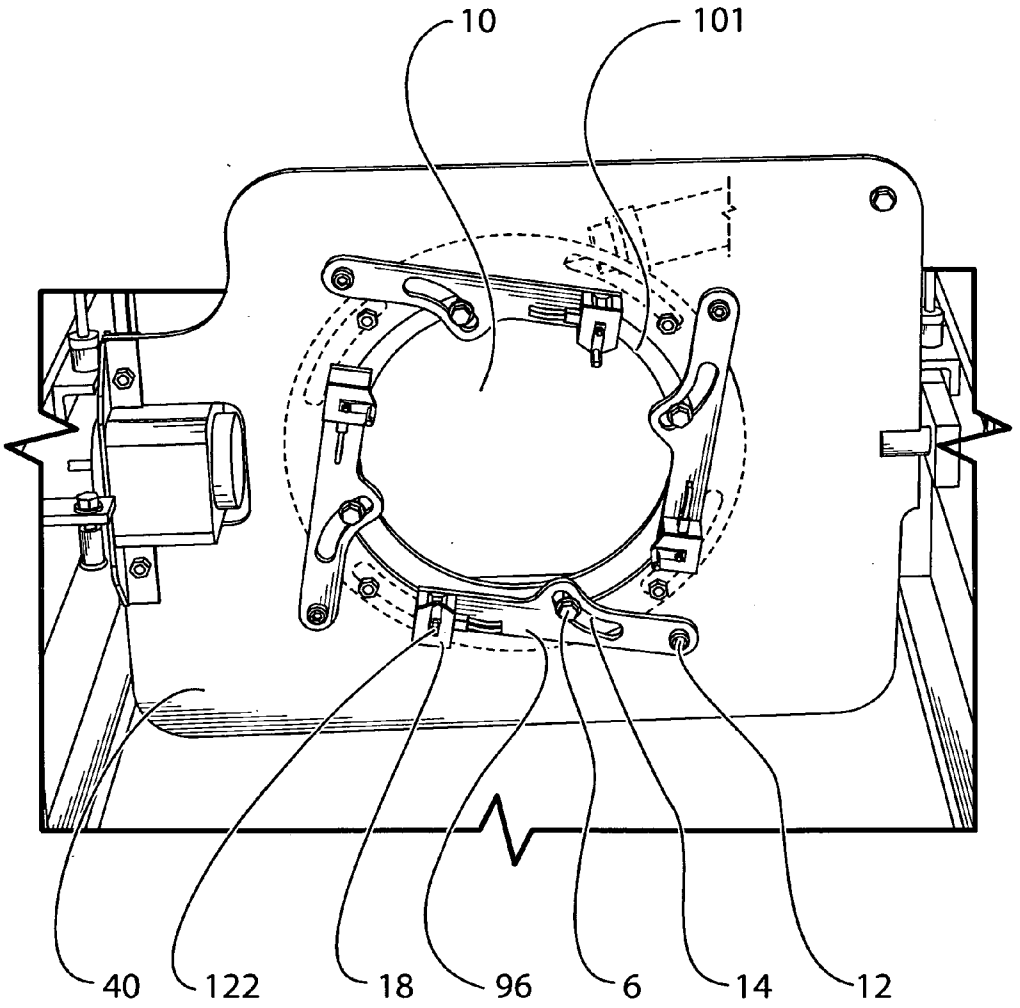


FIG. 2A

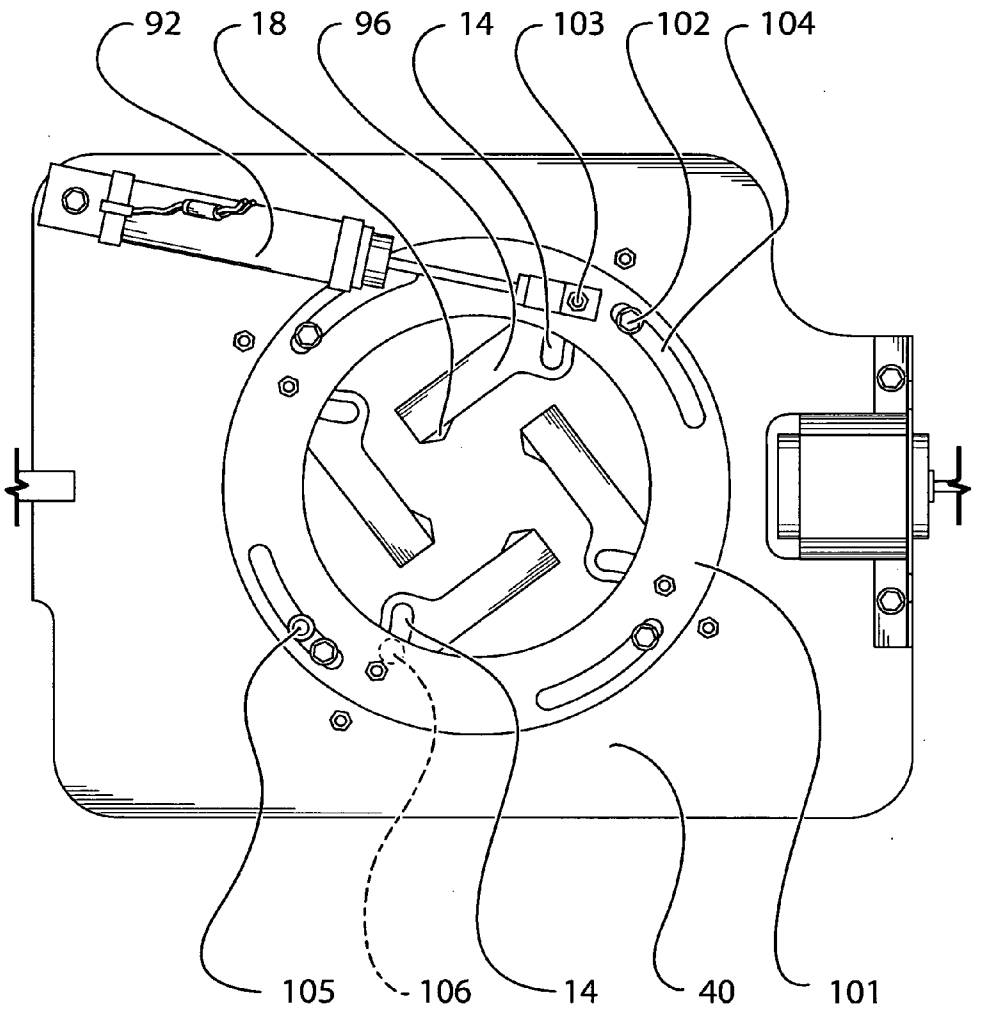


FIG. 2B

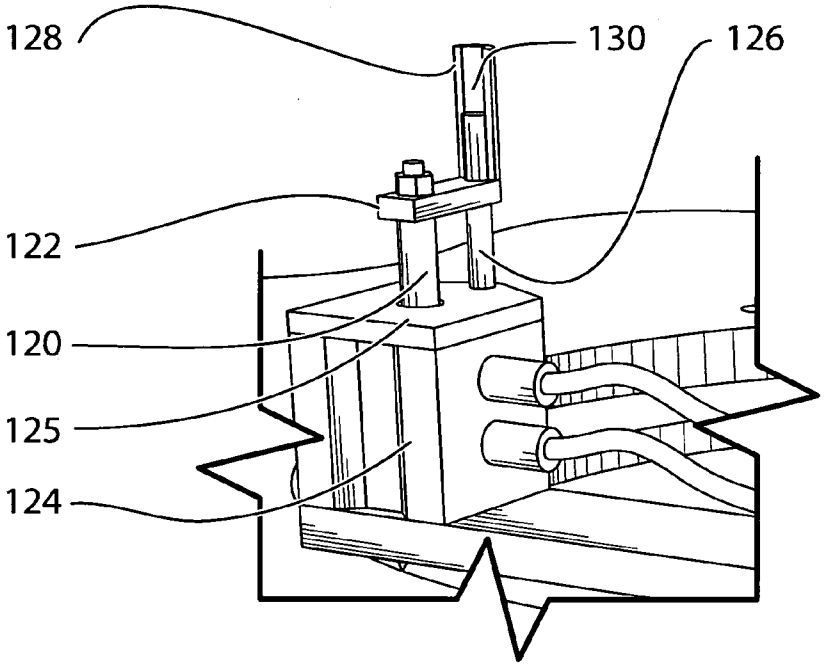


FIG. 2C

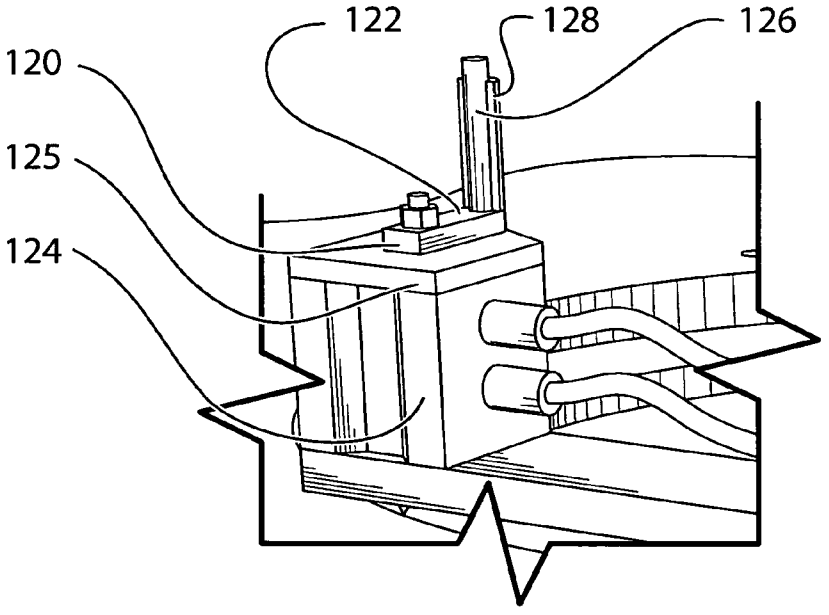


FIG. 2D

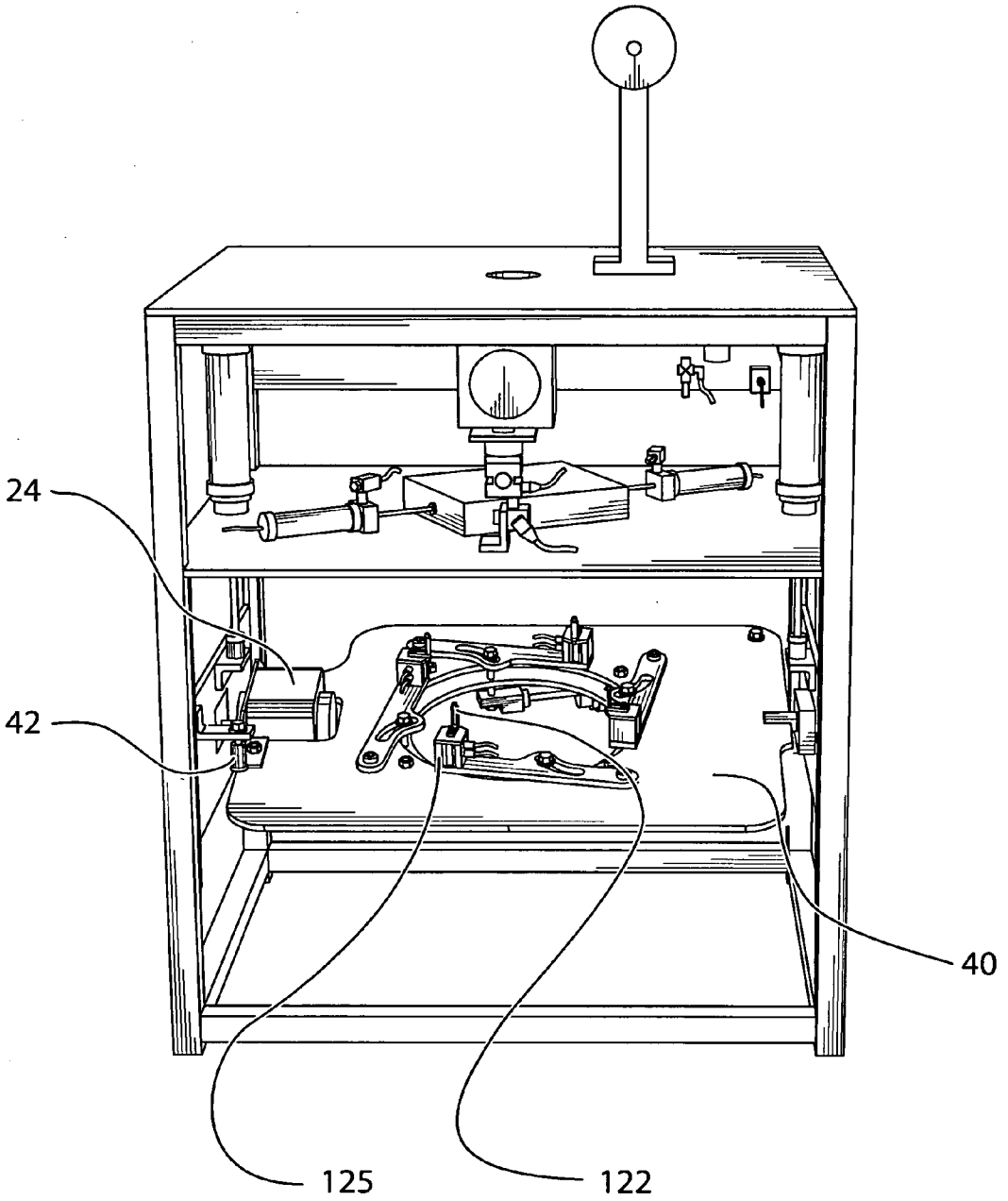


FIG. 3A

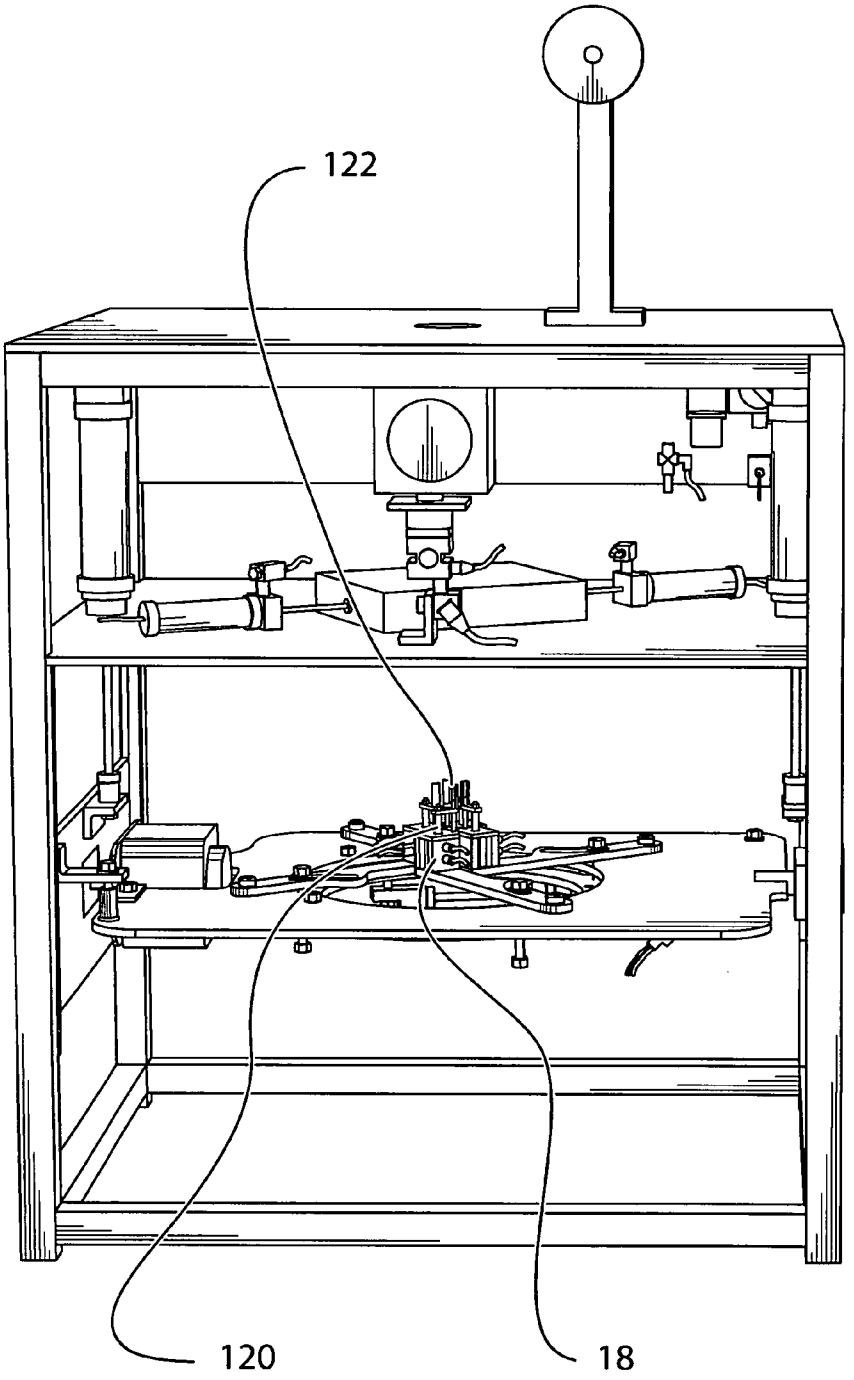


FIG. 3B

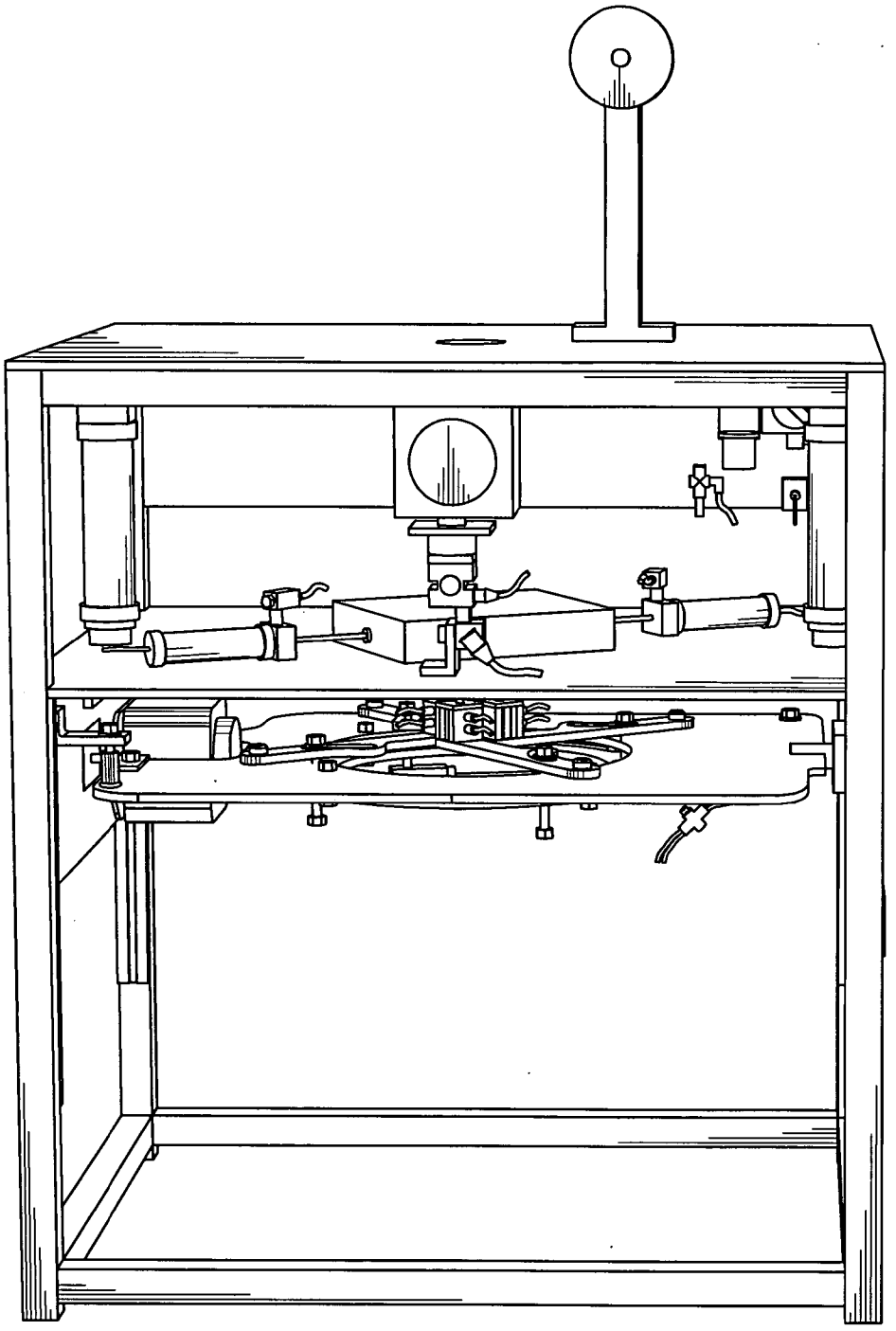


FIG. 3C

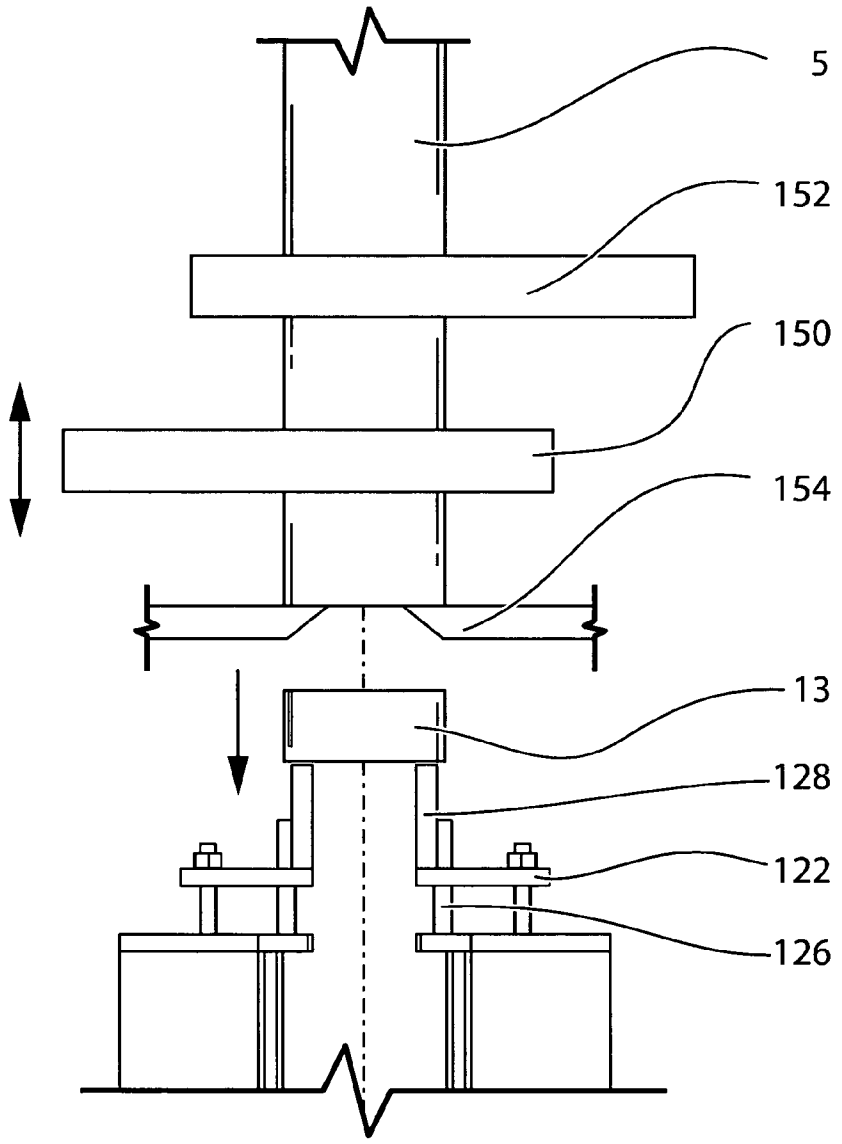


FIG. 3D

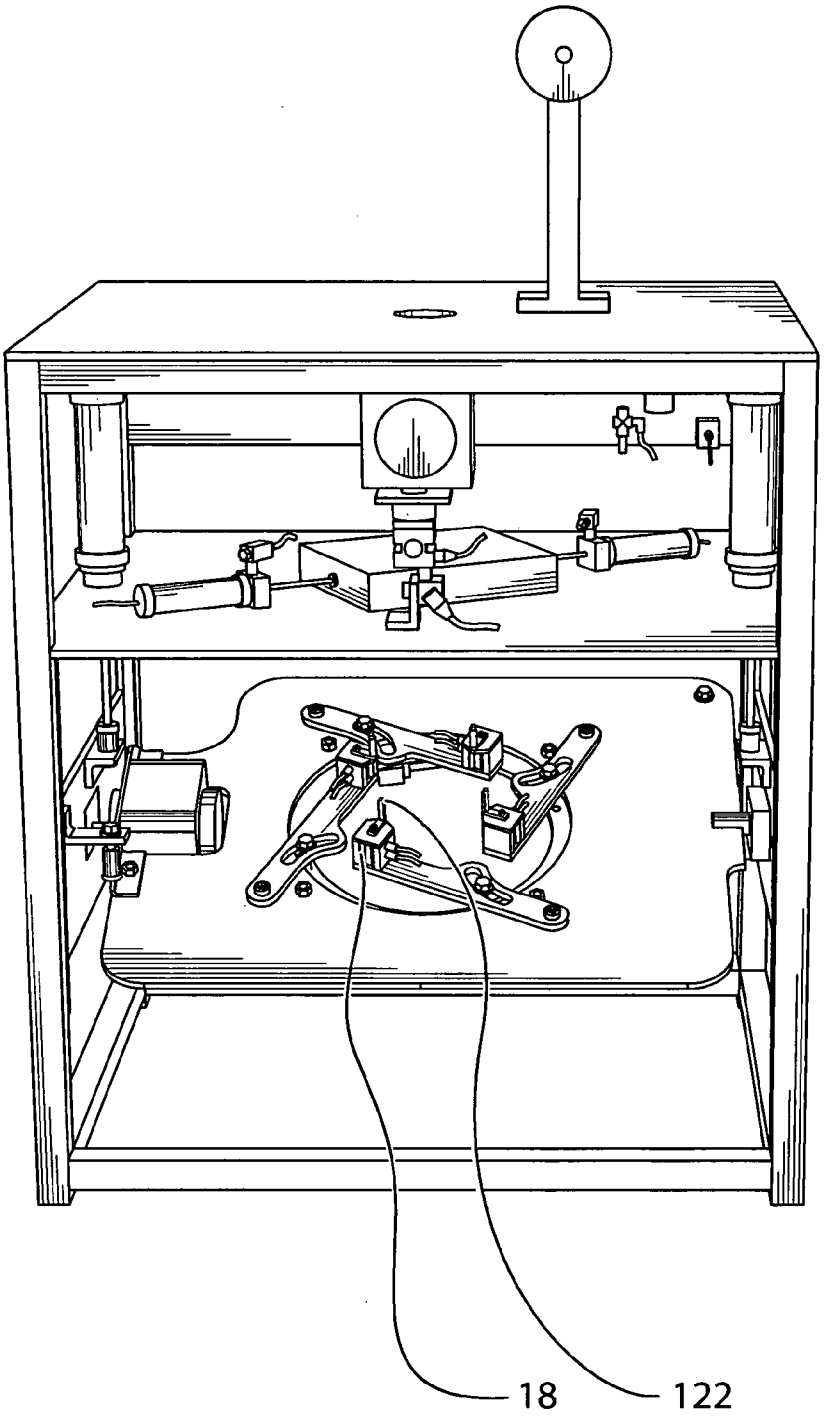


FIG. 3E

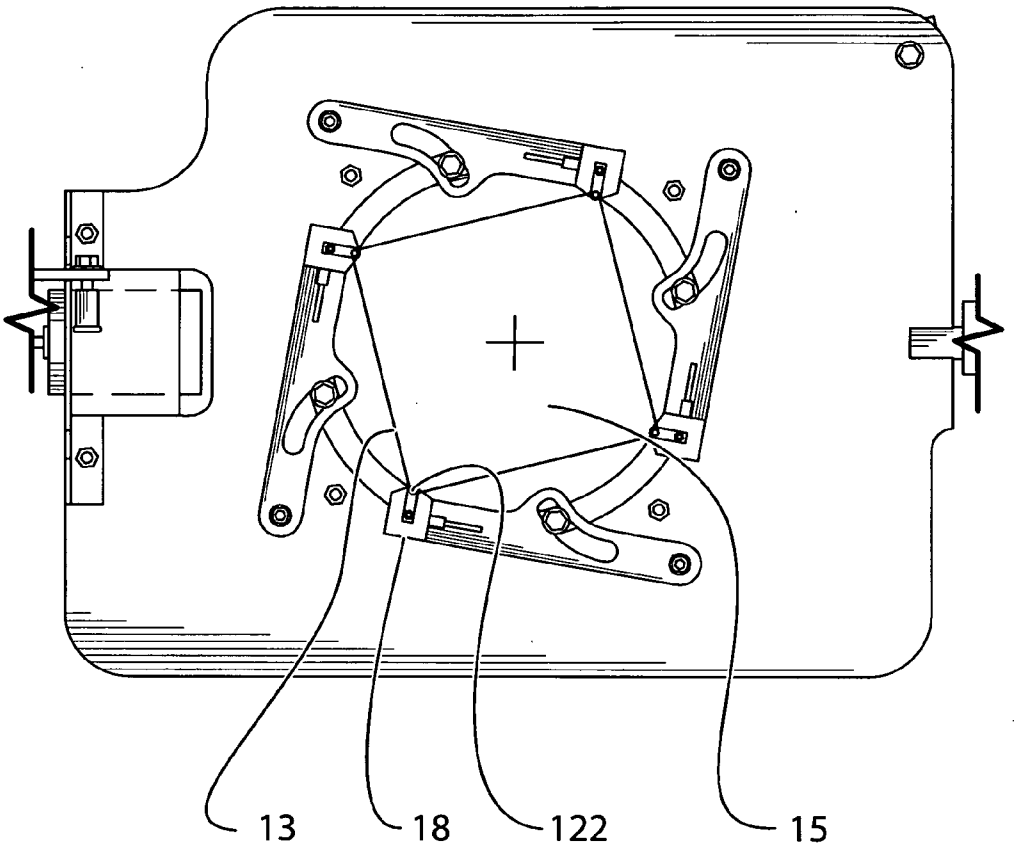


FIG. 3F

VERTICAL BANDING MACHINE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to automated material handling machines, and more particularly to a banding machine for applying elastic bands onto elongated objects.

[0003] 2. Brief Description of the Related Art

[0004] Numerous objects in agriculture or industry are combined in bundles and banded using elastic bands for shipping. In many cases these objects are of elongated nature such as, for example, asparagus, cut flowers, pipes, posts or sticks, to name a few. Typically, these objects are bundled and then hold having a horizontal orientation by one worker while another worker applies an elastic band onto the hold objects at a certain distance to one end of the objects depending on the length of the same. In some instances two elastic bands are applied, placed at different locations along the objects.

[0005] U.S. Pat. No. 7,257,934 issued to Swift et al. teaches a banding machine comprising a mechanism for cutting elastic bands from a tubular elastic band stock, which are then disposed on fingers in a gravity assisted fashion for stretching the elastic band and disposing the same onto the objects.

[0006] The teachings of Swift et al. combine the production of the elastic bands—by cutting the same from the tubular elastic band stock—using a relatively simple mechanism with the mechanism for banding the objects in a single machine. Unfortunately, the finger sub-frame of the banding machine is designed for applying elastic bands on lobster claws or other short objects and does not allow banding of elongated objects.

[0007] It is desirable to provide a banding machine which produces elastic bands from a tubular elastic band stock and enables provision of the elastic bands for banding of elongated objects. It is also desirable to provide a banding machine which disposes the elastic bands onto the fingers in a gravity assisted fashion while the elongated objects are held having a horizontal orientation for banding in order to facilitate handling of the same.

SUMMARY OF THE INVENTION

[0008] Accordingly, one object of the present invention is to provide a banding machine which produces elastic bands from a tubular elastic band stock and enables provision of the elastic bands for banding of elongated objects.

[0009] Another object of the present invention is to provide a banding machine which disposes the elastic bands onto the fingers in a gravity assisted fashion while the elongated objects are held having a horizontal orientation for banding in order to facilitate handling of the same.

[0010] According to one aspect of the present invention, there is provided a vertical banding machine. The vertical banding machine comprises an elastic band supply mechanism for providing an elastic band in a gravity assisted fashion. Below the elastic band supply mechanism at least two band holding devices are disposed for: receiving the elastic band from the elastic band supply mechanism; stretching the elastic band for providing a band opening surrounded by the elastic band for accommodating a plurality of objects for banding therein; and, disengaging the elastic band from the holding devices for deploying the elastic band onto one or a plurality of objects. An actuator coupled to the band holding devices moves the band holding devices between a first position for receiving the elastic band and a second position for disengaging the elastic band. A flip mechanism has the band holding devices and the actuator mounted thereto for moving the band holding devices from a band receiving position, where the elastic band is disposed in a plane oriented substantially horizontal, to a band disengaging position, where the elastic band is disposed in a plane oriented substantially vertical. In the disengaging position the band holding devices, the actuator, and the flip mechanism are disposed outside a handling space determined by projecting the band opening along a straight line through the band opening and oriented substantially perpendicular thereto.

[0011] The advantage of the present invention is that it provides a banding machine which produces elastic bands from a tubular elastic band stock and enables provision of the elastic bands for banding of elongated objects. A further advantage of the present invention is that it provides a banding machine which disposes the elastic bands onto the fingers in a gravity assisted fashion while the elongated objects are held having a horizontal orientation for banding in order to facilitate handling of the same.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] A preferred embodiment of the present invention is described below with reference to the accompanying drawings, in which:

[0013] FIG. **1**A is a front view of the banding machine of one embodiment of the present invention;

[0014] FIG. **1**B is a cross-sectional view from one side of the banding machine of one embodiment of the present invention;

[0015] FIG. **1**C is a perspective view of the front of the banding machine of one embodiment of the present invention;

[0016] FIG. **2**A is a top view of the flip plate of the banding machine of one embodiment of the present invention;

[0017] FIG. **2**B is a bottom view of the flip plate of the banding machine of one embodiment of the present invention;

[0018] FIGS. **2**C and **2**D are perspective views of the band holding device of the banding machine of one embodiment of the present invention;

[0019] FIGS. **3**A to **3**C are perspective views of the front of the banding machine of one embodiment of the present invention at different stages of operation;

[0020] FIG. **3**D is a front view of the elastic band supply mechanism of the banding machine of one embodiment of the present invention;

[0021] FIGS. **3**E and **3**F are perspective views of the front of the banding machine of one embodiment of the present invention at different stages of operation.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0022] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the invention belongs. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, the preferred methods and materials are now described.

[0023] Referring to FIGS. **1**A to **2**D, a vertical banding machine **100** according to a preferred embodiment of the

invention is provided, which produces elastic bands from a tubular elastic band stock and enables provision of the elastic bands for banding of elongated objects having a horizontal orientation.

[0024] As illustrated in FIGS. **1**A to **1**C, the vertical banding machine **100** comprises a frame structure **1** having in an upper portion mounted thereto an elastic band supply mechanism **3** for providing an elastic band in a gravity assisted fashion. The elastic band supply mechanism **3** receives tubing **5** made of elastic material such as, for example, rubber, but is not limited thereto, from a storage container **7** via tubing roller **2** for guiding the tubing **5** between the storage container **7** and tubing feeder **4**. For example, the tubing **5** is moved a predetermined length and held using a combination of moving gripper fingers and holding gripper fingers. An elastic band is then produced by cutting a portion of the tubing having the predetermined length using a cutter assembly. It is noted, that a mechanism for moving and cutting the tubing is disclosed in U.S. Pat. No. 7,257,934 issued to Swift et al. After cutting, the elastic band is dropped onto band holders. An example process of the elastic band production process is described herein below with reference to FIG. **3**D. The gripper fingers and the cutter assembly are, for example, piston driven which are operated in a pneumatic or hydraulic or electric or electro-pneumatic fashion. Alternatively, the elastic band supply mechanism **5** comprises a mechanism for feeding elastic bands from a stock of a plurality of elastic bands.

[0025] With reference to FIG. **1**A, disposed below the elastic band supply mechanism **3** is an elastic band deployment mechanism as indicated by dashed lines. The elastic band deployment mechanism comprises at least two and preferably four band holding devices **18**, an actuator **19** coupled to the band holding devices **18**, and a flip mechanism **11** having the band holding devices **18** and the actuator **19** mounted thereto. The band holding devices **18** receive the elastic band from the elastic band supply mechanism **3**, for example, by being dropped onto respective band holders **122** after cutting; stretch the elastic band **13** for providing a band opening **15** surrounded by the elastic band **13** for accommodating one or a plurality of objects for banding therein; and disengage the elastic band **13** from the band holders **122** for deploying the elastic band **13** onto the one or plurality of objects. The actuator **19** moves the band holding devices **18** between a first position for receiving the elastic band **13** and a second position for disengaging the elastic band **13**. The flip mechanism **11** moves the band holding devices **18** from a band receiving position—the elastic band **13** opening being disposed in a plane oriented substantially horizontal—to a band disengaging position—the elastic band **13** opening being disposed in a plane oriented substantially vertical. FIGS. **1**A and **1**B illustrate the band holding devices **18** in the band disengaging position. In the band disengaging position the band holding devices **18**, the actuator **19** and the flip mechanism **11** are disposed outside a handling space **21** approximately determined by projecting the band opening **15** along a straight line **17** through the band opening **15** and oriented substantially perpendicular to a plane of the band opening **15**. Provision of the handling space **21** enables deployment of the elastic band **13** at any location along elongated objects. As illustrated in FIG. **1**C, the flip mechanism **11** comprises a flip plate **40** which is rotationally movably mounted to the frame **1** such that the flip plate **40** is oriented substantially horizontal in the band receiving position and is oriented substantially vertical in the band disengaging position. The rotational movement is provided on one side of the flip plate **40**, for example, using a pneumatically (hydraulicly or electrically or electro-pneumatically) driven **90** degree rotary actuator **24**, which is available as a standard off-the-shelf unit, while the opposite side of the flip plate **40** is freely rotationally movably mounted using, for example, a rotation pin accommodated in rotation block **8** made of, for example, a type of industrial plastic such as Acetron®. Alternatively, an electric drive is employed for providing the rotational movement. The rotary actuator **24** and the rotation block **8** are vertically movably mounted to the frame **1** using, for example, guide rails and a gear drive such as a toothed wheel interacting with a toothed rack or one of a hydraulic, pneumatic or electro-pneumatic piston, enabling vertical movement of the flip plate **40** between the band receiving position and the band disengaging position. Alternatively, the vertical movement of the flip plate **40** is omitted by enabling sufficient vertical movement, for example, of the band holders **122** leaving sufficient distance between the flip plate **40** to the elastic band supply mechanism **3** for enabling rotation of the flip plate **40**.

[0026] Referring to FIGS. **2**A to **2**D, a preferred embodiment of the flip plate **40**, the band holding devices **18**, and the actuator **19** according to the invention is provided. The flip plate **40** is made, for example, from an aluminum plate having a predetermined thickness to provide sufficient support and stiffness using standard computer controlled processes of cutting, milling and drilling. Optionally, the flip plate **40** is made of a material other than aluminum such as, for example, stainless steel or composite material. The flip plate **40** comprises a flip plate opening **10** which is sufficiently large for accommodating the band opening **15** therein. As shown in FIG. **2**A, the actuator **19** preferably comprises four swing arms **96**. Each swing arm **96** has at a first end portion the band holding device **18** mounted thereto and is rotatably mounted to the flip plate **40** at a second opposite end portion via swing arm rotation pin **12**. Swing arm slot **14** is a curved cam like slot disposed between the first end portion and the second end portion of the swing arm **96**. The swing arm slot **14** interacts with swing arm guide pin **16**, which is mounted to rotation ring **101** and freely movable accommodated in the swing arm slot **14**. As illustrated in FIG. **2**B, the rotation ring **101** is mounted to the flip plate **40** via four rotation ring mounting pins **102**, which are affixed to the flip plate **40** and freely movable accommodated in rotation ring slots **104**. A rotation piston **92** is coupled to the rotation ring **101** via rotation piston clevis attachment bolt **103** to transmit linear motion of the piston **92** into rotational motion of the rotation ring **101**. The rotation piston **92** is driven, for example, in a pneumatic or hydraulic or electro-pneumatic fashion. Movement of the rotation piston **92** causes the rotation ring **101** to rotate, which in turn causes the swing arm guide pins **16** to move in the respective swing arm slots **14** causing the swing arms **96** to rotate about the swing arm rotation pins **12** for moving the band holding devices **18** towards the center of the opening **10** for receiving the elastic band or opposite for stretching and deploying the elastic band. As illustrated in FIG. **2**B, the rotation ring slots **104** are curved such that, in concert with the rotation ring mounting pins **102**, a rotating movement of the rotation ring **101** is enabled. Furthermore, the rotation ring slots **104** have a predetermined length such that movement of the band holding devices **18** between the first position for receiving the elastic band and the second position for disengaging the elastic band is enabled. Optionally, the rotational

movement of the rotation ring **101**—and consequently the movement of the band holding devices **18**—is reduced by inserting a stop pin **105** into a predisposed threaded insertion opening in the flip plate **40** and accommodated in the respective rotation ring slot **104**, thus limiting the stretching of the elastic band **13** and the corresponding elastic band opening **15**. The swing arms **96** and the rotation ring **101** are made, for example, from aluminum plates having a predetermined thickness to provide sufficient support and stiffness using standard computer controlled processes of cutting, milling and drilling. Optionally, the swing arms **96** and the rotation ring **101** are made of a material other than aluminum such as, for example, stainless steel or composite material. The swing arm slots **14** and the rotation ring slots **104** are designed in dependence upon the number of swing arms employed and a given maximum size of the band opening **15** using standard gear engineering technology. The rotation ring **101** is mounted to the flip plate **40** via the rotation ring mounting pins **102**, for example, by disposing a pair of washers having an outside diameter larger than a width of the rotation ring slots **104** on each of the rotation ring mounting pins **102** such that one washer is disposed on each side of the rotation ring **101** and hold in place using a nut interacting with a threaded end portion of the rotation ring mounting pins **102**. The rotation ring mounting pins **102** are, for example, steel bolts having threaded two end portions, one threaded end portion for interfacing the nut and the other end portion for interfacing a threaded bore disposed in the flip plate **40**. As illustrated in FIG. **2**B, guide bushing **106** made, for example, of a low friction plastic material, is disposed surrounding the swing arm guide pins **16** where accommodated in the respective swing arm slots **14** for providing a roller movement between the swing arm slots **14** and the swing arm guide pins **16**, thus reducing wear.

[0027] As illustrated in FIGS. **2**A and **2**B, four swing arms **96** are preferably equally disposed around the opening **10**, but the embodiments of the invention are not limited thereto. Depending on the shape of the band holders **122** and the size and shape of a desired band opening **15**, different numbers—two or more—of swing arms **96** are employed. Furthermore, other than four rotation ring mounting pins **102** are employed.

[0028] Alternatively, an electric drive is employed for rotating the rotation ring **101**, for example, by replacing the rotation piston **92** with a toothed gear drive comprising a driven toothed wheel interacting with a toothed surface disposed on a respective section of the rotation ring **101**.

[0029] Further alternatively, each swing arm **96** is actuated using a separate drive, for example, by rotatable mounting the swing arm **96** to the flip plate **40** at a predetermined location between the first end portion and the second end portion and coupling a piston drive to the second end portion.

[0030] Referring to FIGS. **2**C and **2**D, a preferred embodiment of the band holding devices **18** according to the invention is provided. The band holder **122** is mounted to band holder piston rod **120** of band holder piston drive **124**. The band holder piston drive **124** provides linear movement to the band holder **122**. The band holder piston drive **124** is implemented, for example, using an off-the-shelf pneumatic or hydraulic or electro-pneumatic compact piston drive. The band holder **122** comprises a first portion mounted to the band holder piston rod **120**. The first portion of the band holder **122** is oriented substantially perpendicular to a longitudinal axis of the band holder piston rod **120**. A second portion is oriented substantially parallel to the longitudinal axis of the band holder piston rod **120**. The band holder **122** comprises slightly rounded edges **128** where in contact with the elastic band **13**, as well as a push off clearance groove **130** for accommodating a portion of push off pin **126** therein. The first portion of the band holder **122** comprises an opening for enabling movement of the push off pin **126** there through. The push off pin **126**—for example, a stainless steel pin—is welded to push off mount **125**, which is mounted to the band holder piston drive **124**. The elastic band **13** is dropped onto the band holder **122**and during stretching the elastic band is in contact with the second portion of the band holder **122**. During receipt and stretching, the band holder piston rod **120** is disposed in an extended position such that the push off pin **126** is placed outside the second portion of the band holder **122**. During deployment of the elastic band the band holder piston rod **120** is retracted causing the push off pin **126** to move into the push off clearance groove **130**, therefore, pushing the elastic band off the second portion of the band holder **122**. The slightly rounded edges **128** are provided to prevent cutting of the elastic band during stretching and deployment.

[0031] Optionally, the second portion of the band holder **122** is widened such that a sufficiently large band opening **15** is provided when using only two band holding devices **18**.

[0032] Alternatively, the band holder **122** is fixedly mounted while the push off pin **126** is movable.

[0033] Referring to FIGS. **3**A to **3**F, operation of the preferred embodiment of the band machine **100** according to the invention is described herein below. FIG. **3**A illustrates the banding machine **100** after deployment of the elastic band and rotation of the flip plate **40** into a horizontal oriented position. Stopper **42** made of, for example, a rubber material abuts the flip plate **40** after the 90 degree rotation and provides a cushioned stop thereto. The band holding devices **18**—still in the deployment position—are then moved to the band receiving position with the second portion of the band holders **122** being disposed in close proximity to each other, and the band holder piston rod **120** being disposed in an extended position, as illustrated in FIG. **3**B. The flip plate **40** is then moved vertically towards the elastic band supply mechanism **3** for receiving the elastic band there from. The tubing **5** is moved a predetermined length using moving gripper fingers **150** and then hold using holding gripper fingers **152** for preventing the tubing from any movement, for example, from being pulled back into the storage container. Using cutter assembly **154** a portion of the tubing **5** having the predetermined length is then cut off producing the elastic band **13**, which is then dropped onto the band holders **122**, as illustrated in FIG. **3**D. After receipt of the elastic band, the flip plate **40** is lowered while the band holding devices **18** are moved outward for stretching the elastic band, as illustrated in FIG. **3**E. After reaching a predetermined vertical position which provides a sufficient distance to the elastic band supply mechanism **3** for rotation, the flip plate **40** is rotated 90 degrees into a vertical oriented position while the band holding devices **18** are moved outward to the elastic band deployment position providing a sufficiently large band opening **15** for banding, as illustrated in FIG. **3**F. After deployment of the elastic band, for example, as described herein above with reference to FIGS. **2**C and **2**D, the flip plate **40** is rotated 90 degrees into the horizontal position, as illustrated in FIG. **3**A.

[0034] The FIGS. **3**A to **3**F illustrate a sequence of snapshots of the operation of the banding machine **100**. The various movements of the components are, for example, combined such that the rotation of the flip plate **40**, the vertical

movement of the flip plate **40** and the movement of the band holding devices **18** are executed in a simultaneous fashion. Alternatively, the various movements are executed successively. As described herein above, the various movements are actuated using pneumatic, hydraulic, electric and/or electro-pneumatic drives, which are controlled using a control system made of standard off-the-shelf components for controlling the pneumatic (or hydraulic, electric and/or electro-pneumatic) action in combination with a processor.

[0035] The present invention has been described herein with regard to preferred embodiments. However, it will be obvious to persons skilled in the art that a number of variations and modifications can be made without departing from the scope of the invention as described herein.

What is claimed is:

1. A vertical banding machine comprising:

an elastic band supply mechanism for providing an elastic band in a gravity assisted fashion;

at least two band holding devices for:

receiving the elastic band from the elastic band supply mechanism;

stretching the elastic band for providing a band opening surrounded by the elastic band for accommodating a plurality of objects for banding therein; and,

disengaging the elastic band from the holding devices for deploying the elastic band onto the plurality of objects;

an actuator coupled to the band holding devices for moving the band holding devices between a first position for receiving the elastic band and a second position for disengaging the elastic band; and,

a flip mechanism having the band holding devices and the actuator mounted thereto for moving the band holding devices from a band receiving position, where the elastic band is disposed in a plane oriented substantially horizontal, to a band disengaging position, where the elastic band is disposed in a plane oriented substantially vertical, wherein in the disengaging position the band holding devices, the actuator, and the flip mechanism are disposed outside a handling space determined by projecting the band opening along a straight line through the band opening and oriented substantially perpendicular thereto.

2. A vertical banding machine as defined in claim **1** wherein the flip mechanism comprises a flip plate having the band holding devices and the actuator mounted thereto, the flip plate comprising a flip plate opening which is sufficiently large for accommodating the band opening therein.

3. A vertical banding machine as defined in claim **2** wherein the flip plate is rotational movable mounted to a frame such that the flip plate is oriented substantially horizontal in the band receiving position and is oriented substantially vertical in the band disengaging position.

4. A vertical banding machine as defined in claim **3** comprising a 90 degree rotary actuator for providing rotational movement to the flip plate.

5. A vertical banding machine as defined in claim **3** wherein the elastic band supply mechanism is mounted to a top portion of the frame and wherein the flip plate is vertical movable between the band receiving position and the band disengaging position.

6. A vertical banding machine as defined in claim **2** wherein the actuator comprises at least two swing arms, each swing arm having a band holding device mounted thereto at a first end portion and being rotatable mounted to the flip plate at a second opposite end portion.

7. A vertical banding machine as defined in claim **6** wherein the actuator comprises a rotation ring rotational movable mounted to the flip plate having at least two swing arm guide pins mounted thereto, each swing arm guide pin being movable interfaced with a curved swing arm slot disposed in the respective swing arm such that rotational movement of the rotation ring causes movement of the band holding devices between the first position and the second position.

8. A vertical banding machine as defined in claim **1** wherein each of the band holding devices comprises:

a band holder for holding the elastic band;

a push member for disengaging the elastic band from the band holder; and,

a push actuator mounted to one of the band holder and the push member for providing relative movement between the band holder and the push member.

9. A vertical banding machine as defined in claim **1** wherein the elastic band supply mechanism comprises:

a first gripper for holding a tubing made of elastic band material;

a second gripper for moving the tubing a predetermined length; and,

a cutter for cutting a portion of the tubing having the predetermined length, the predetermined portion forming the elastic band.

10. A vertical banding machine as defined in claim **9** wherein the elastic band supply mechanism comprises a tubular guide and a tubing roller for guiding the tubing from a supply container to the first gripper.

* * * * *