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(54) **SYSTEM FOR CUTTING AND UNLOADING PORTIONS**

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A22C 17/00 (2006.01)
B65G 47/91 (2006.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
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USPC 99/588, 589, 592, 537, 538, 539, 540, 99/545, 546, 548, 635, 643; 700/114, 700/223, 97, 173; 83/53, 177, 155.1; 248/121, 124.1, 124.2, 125.1, 125.7, 248/125.8, 125.9, 48, 248; 715/771;
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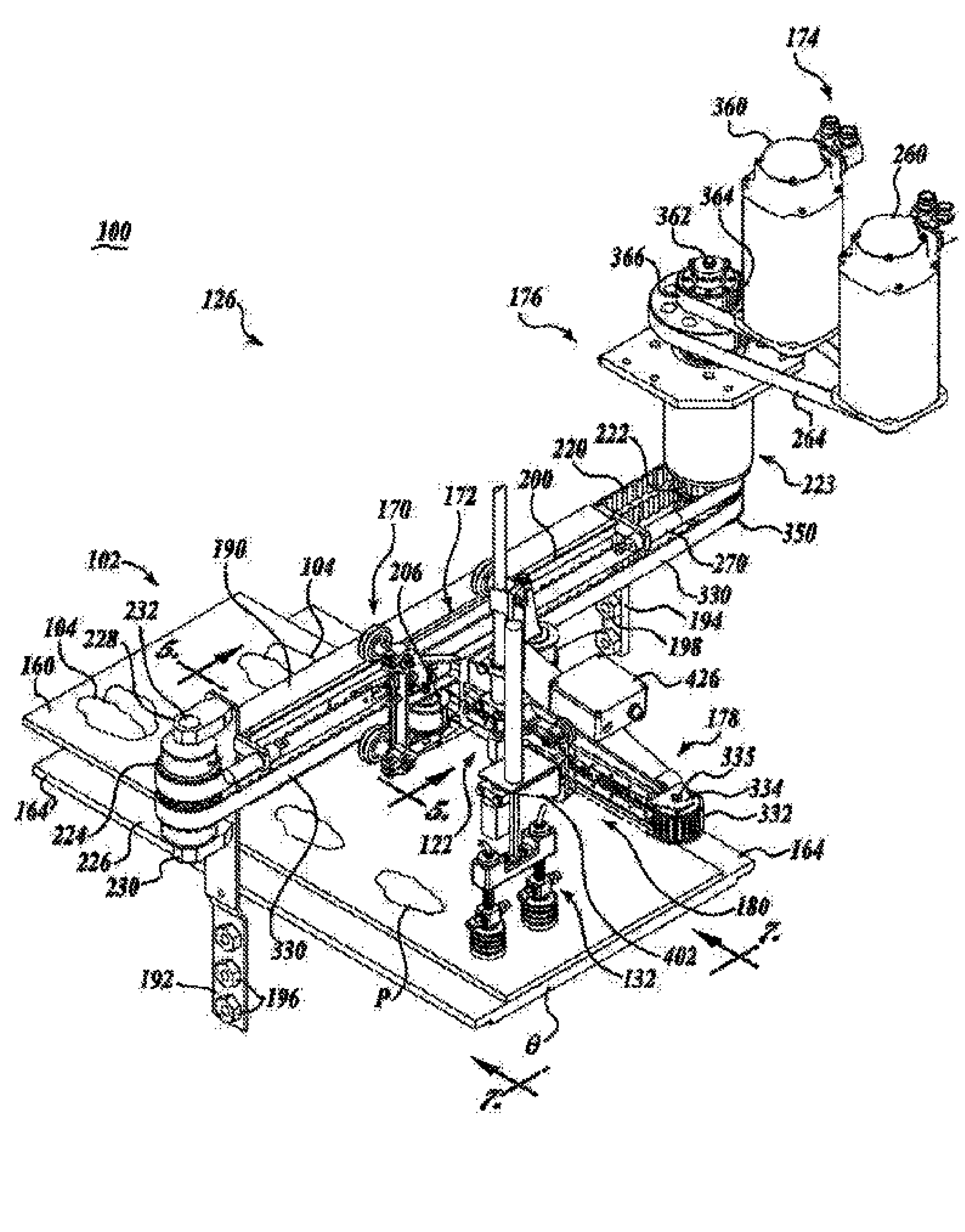
(57) **ABSTRACT**

A system (**100**) for cutting work product (**104**) into portions (P) and unloading the portions includes a conveyance system (**102**) for carrying the workpieces and portions, as well as a scanner (**110**) for scanning the work products. A cutter system (**120**) composed of cutter assemblies (**122**) carried by carrier systems (**124**) may be arranged in an array or series along the conveyance system for cutting, trimming, and portioning the work products (**104**) into end pieces (P) of desired sizes or other physical parameters. An unloading system (**130**) composed of one or more unloading assemblies/units/apparatus (**132**) are carried by the same carrier systems (**124**) used to carry the cutter assemblies (**122**) to pick up the portioned pieces (P) and either move them to a different location or replace the portioned workpieces back onto the conveyance system after the trim of the workpiece has been removed.

36 Claims, 14 Drawing Sheets



(52) **U.S. Cl.**
CPC ***A22C 17/0086*** (2013.01); ***A22C 17/0093*** (2013.01); *B65G 47/912* (2013.01); *G05B 2219/35162* (2013.01); *G05B 2219/37558* (2013.01); *G05B 2219/45044* (2013.01)

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USPC 452/150, 157, 171, 134, 184; 198/339.1, 198/536.1
See application file for complete search history.

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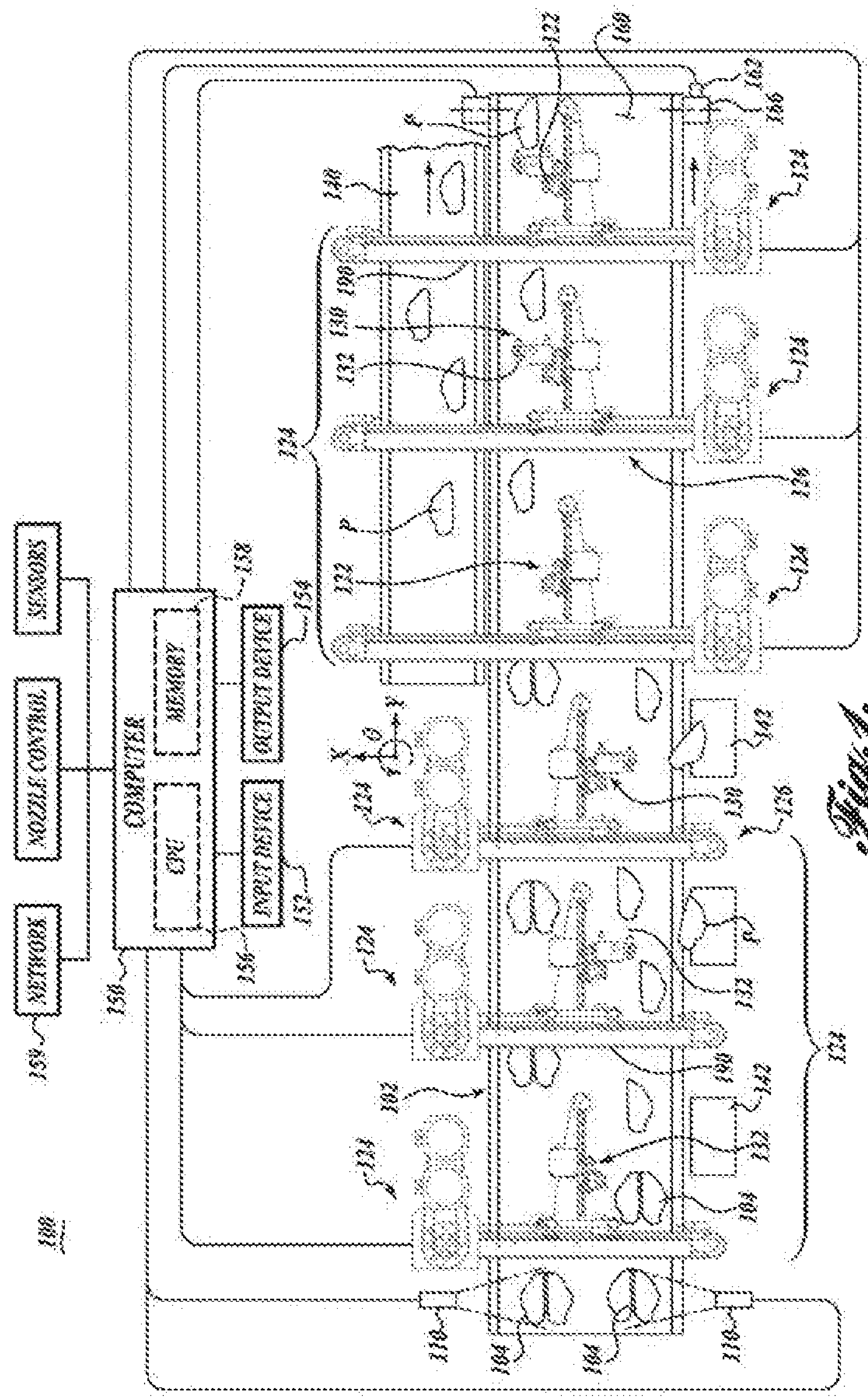
NETWORK
NOZZLE CONTROL
SENSORS
COMPUTER
CPU
MEMORY
INPUT DEVICE
OUTPUT DEVICE

Fig. 1.

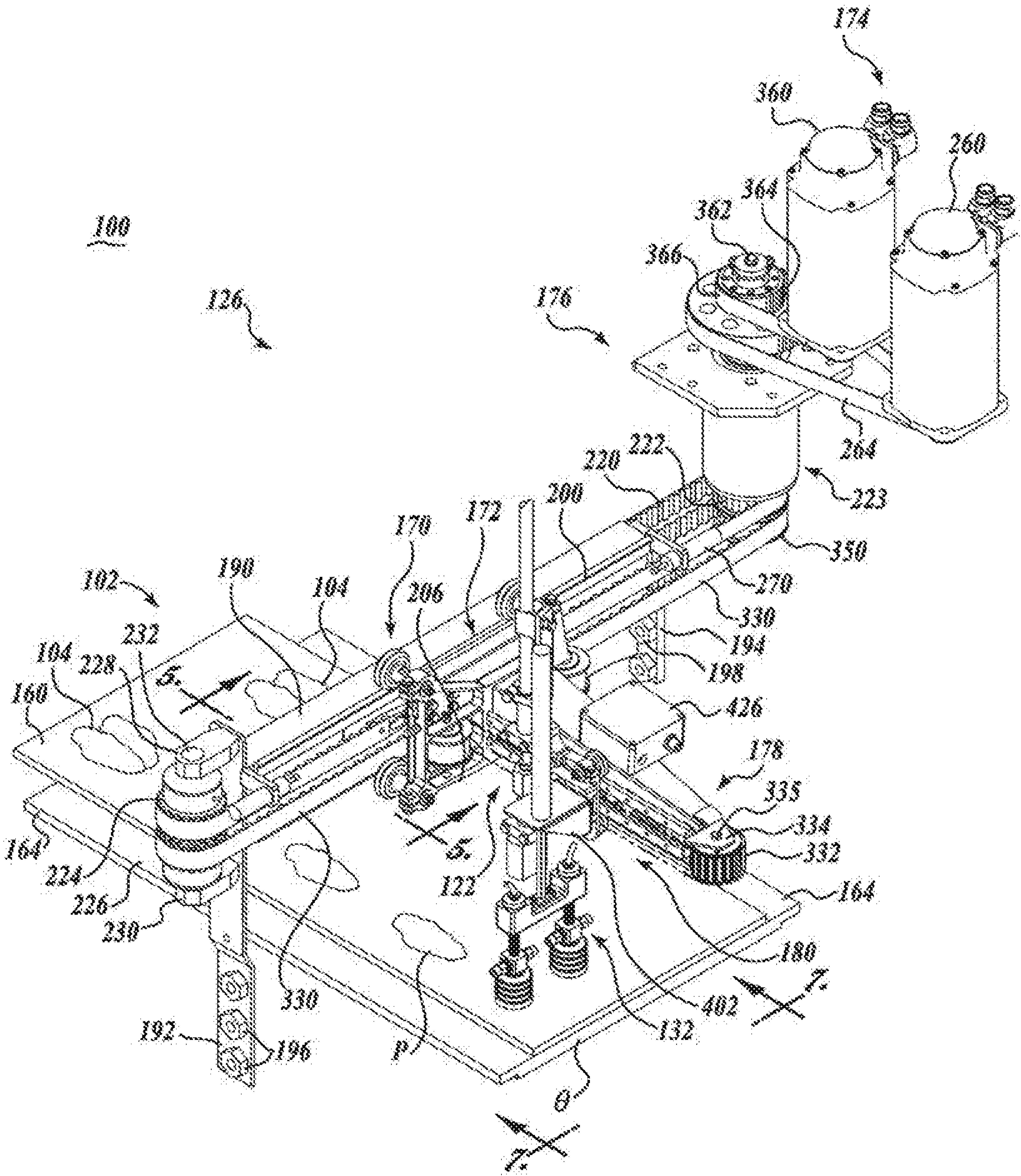
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Fig. 2.

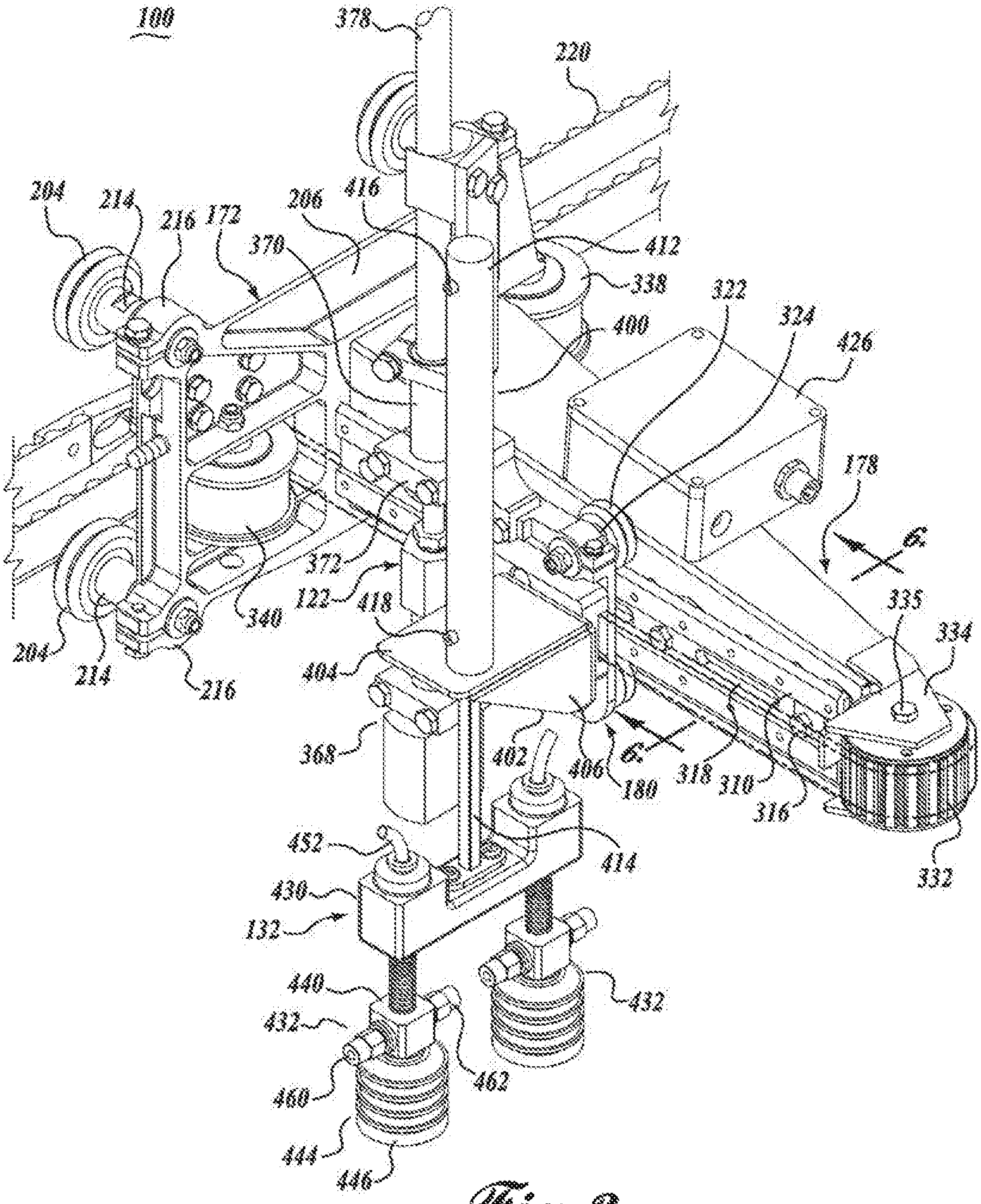
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Fig. 3.

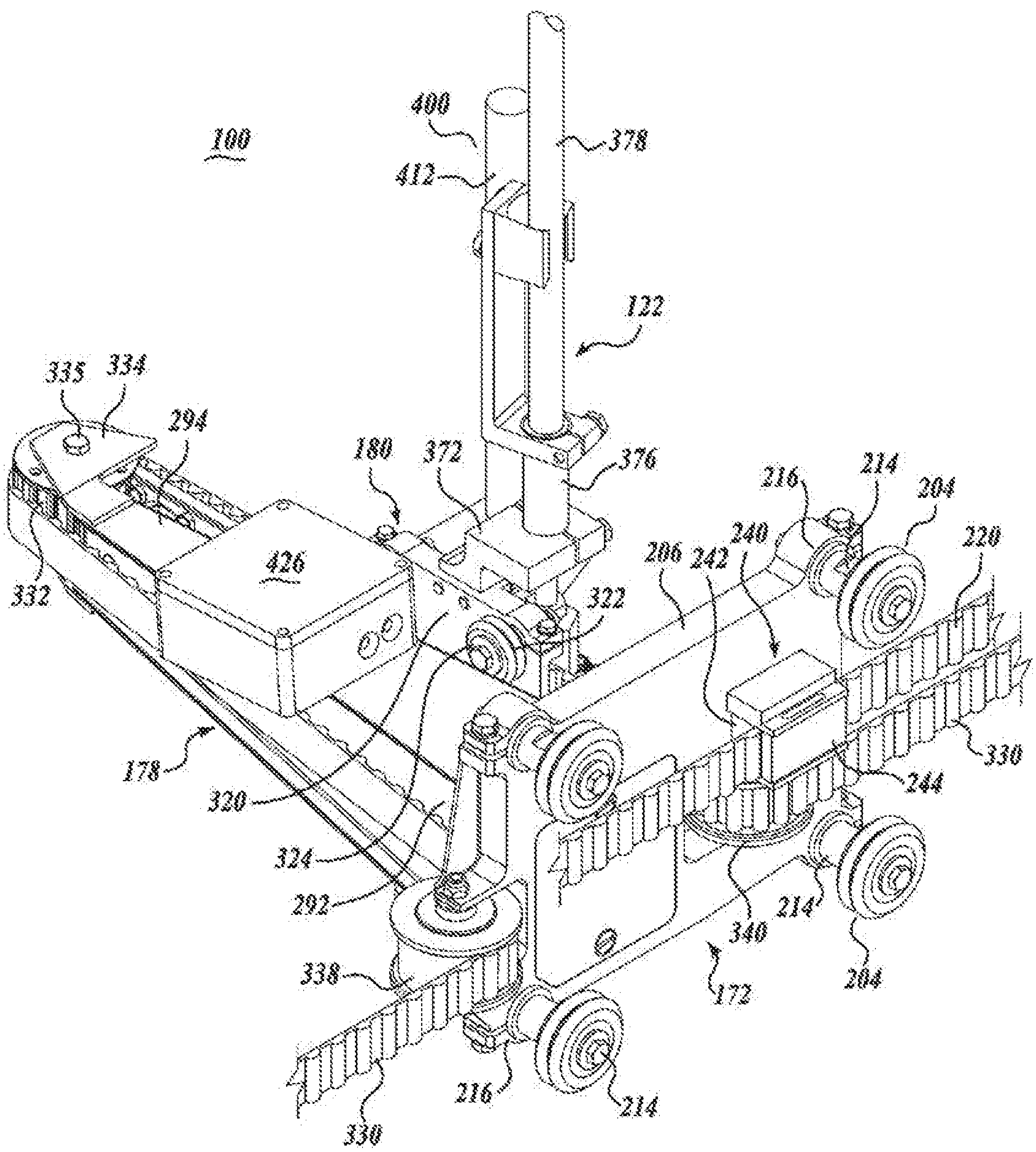
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Fig. 4.

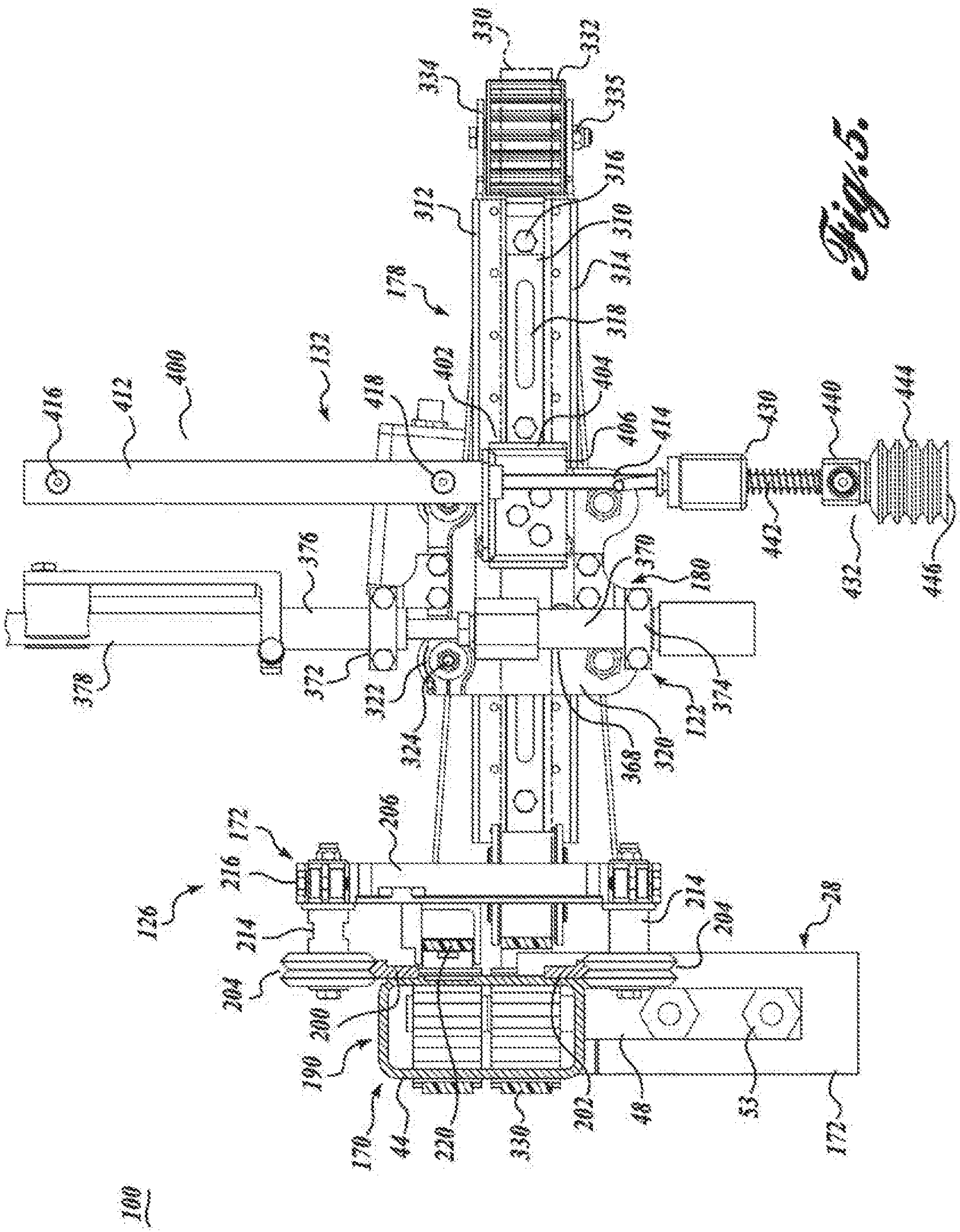
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Fig. 5.

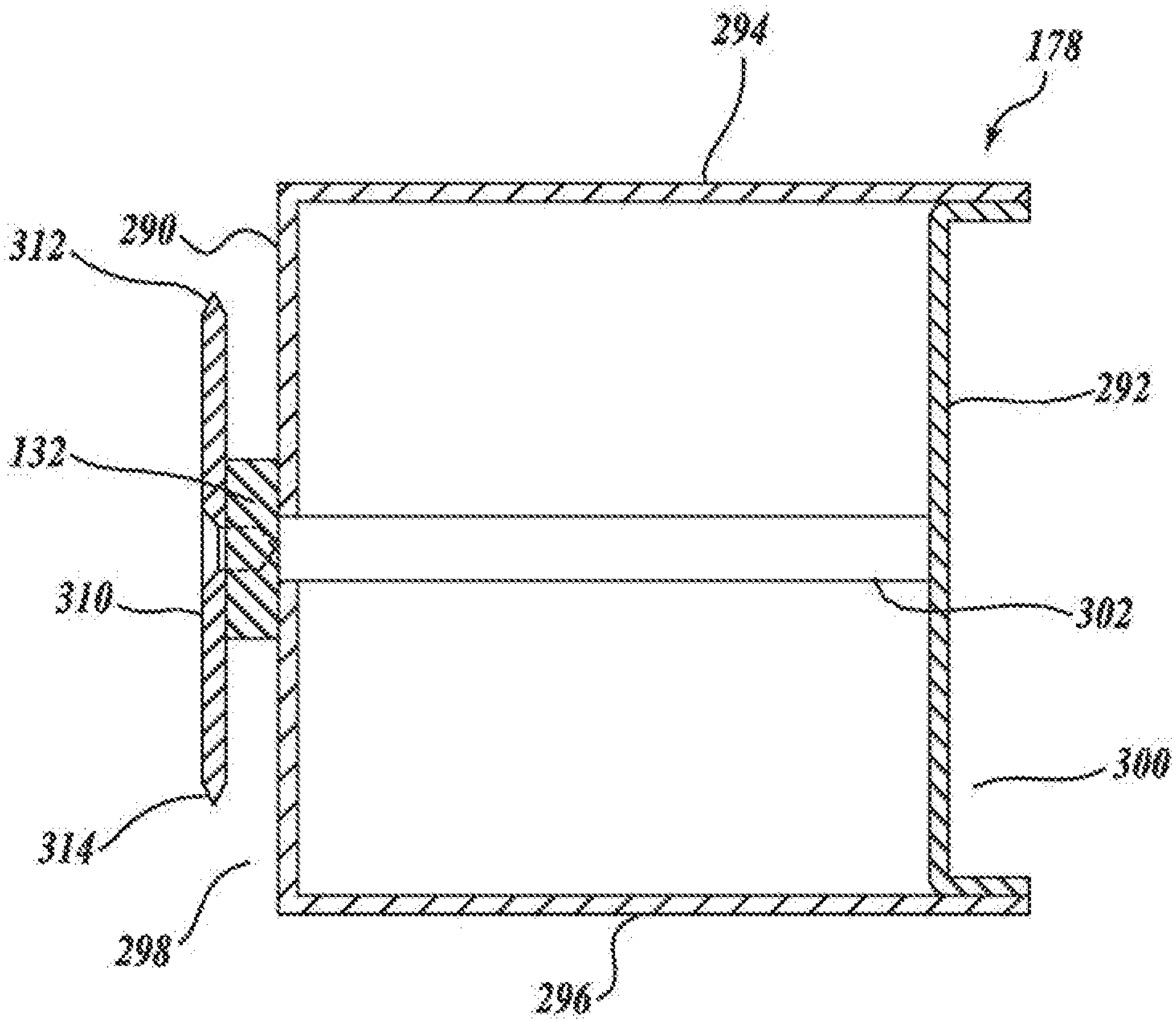

Fig. 6.

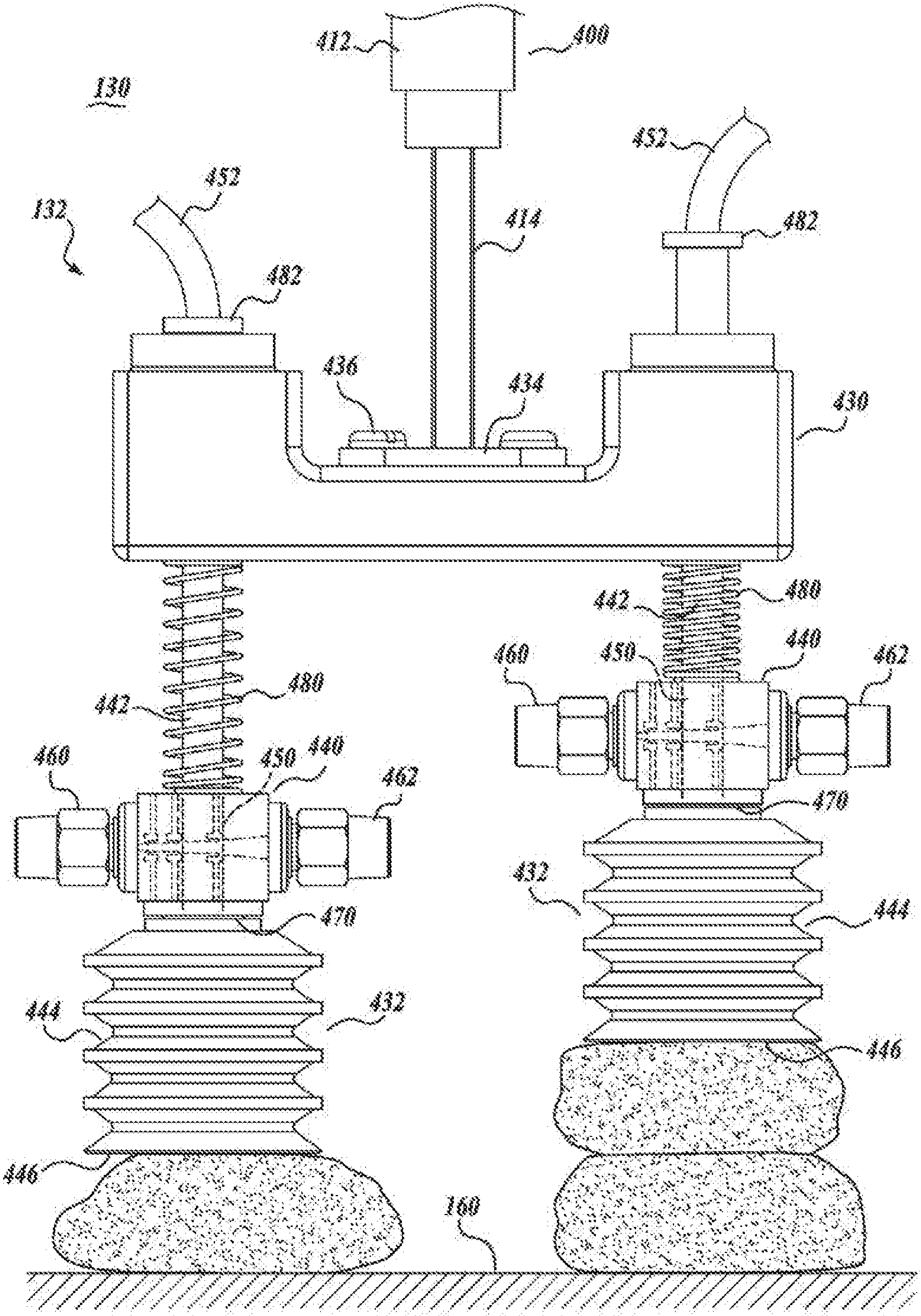
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Fig. 7.

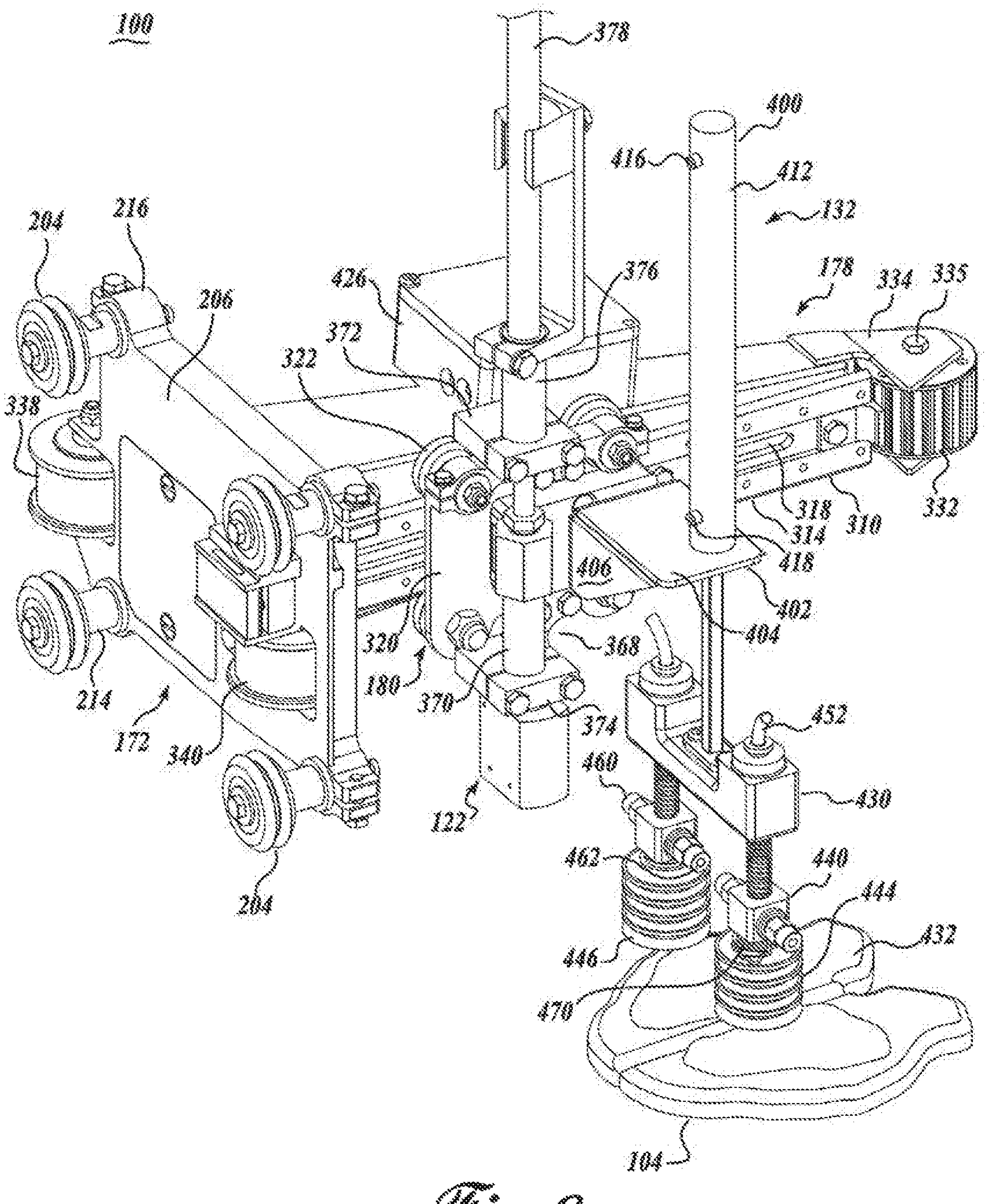
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Fig. 8.

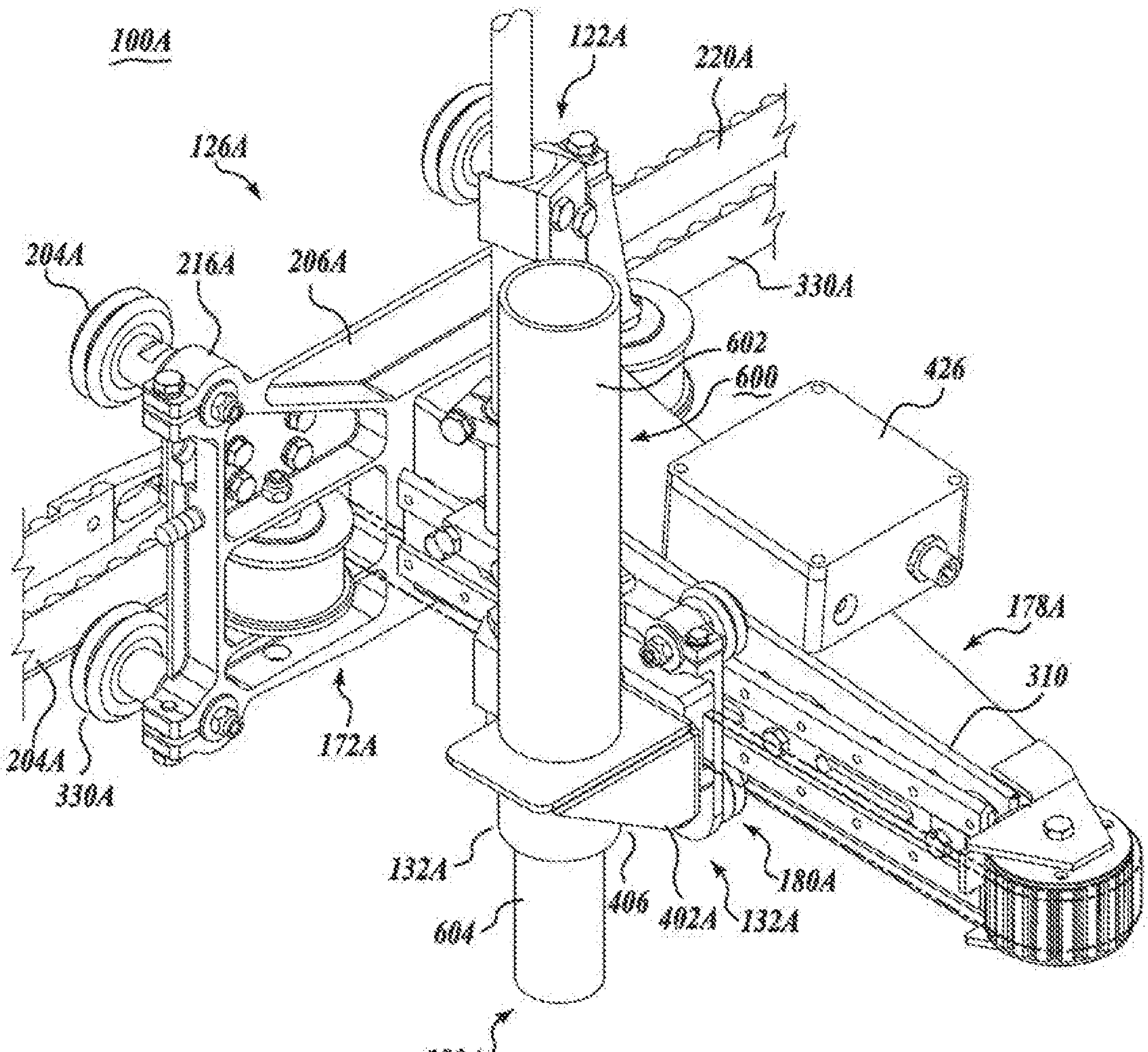
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Fig. 9.

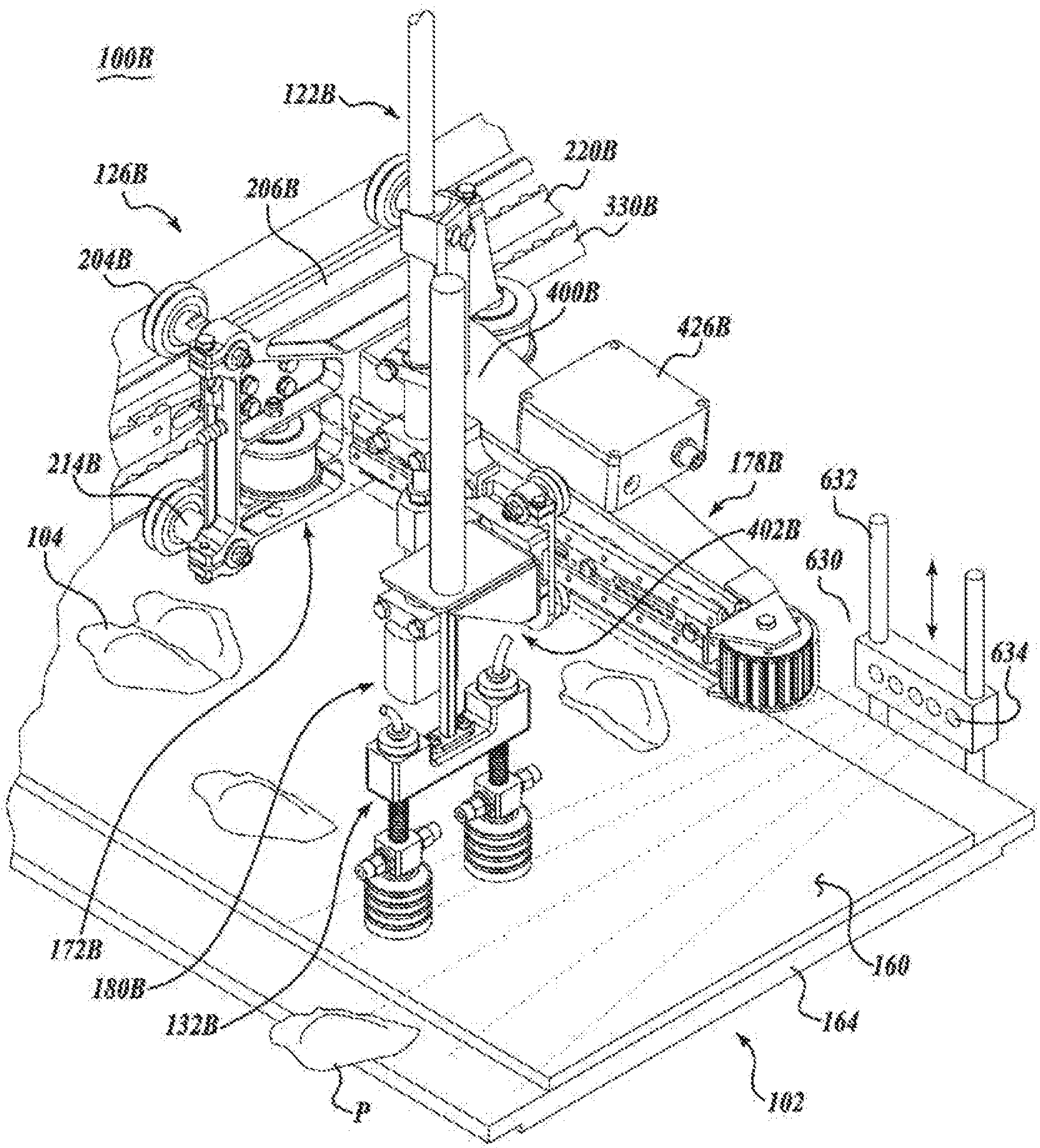
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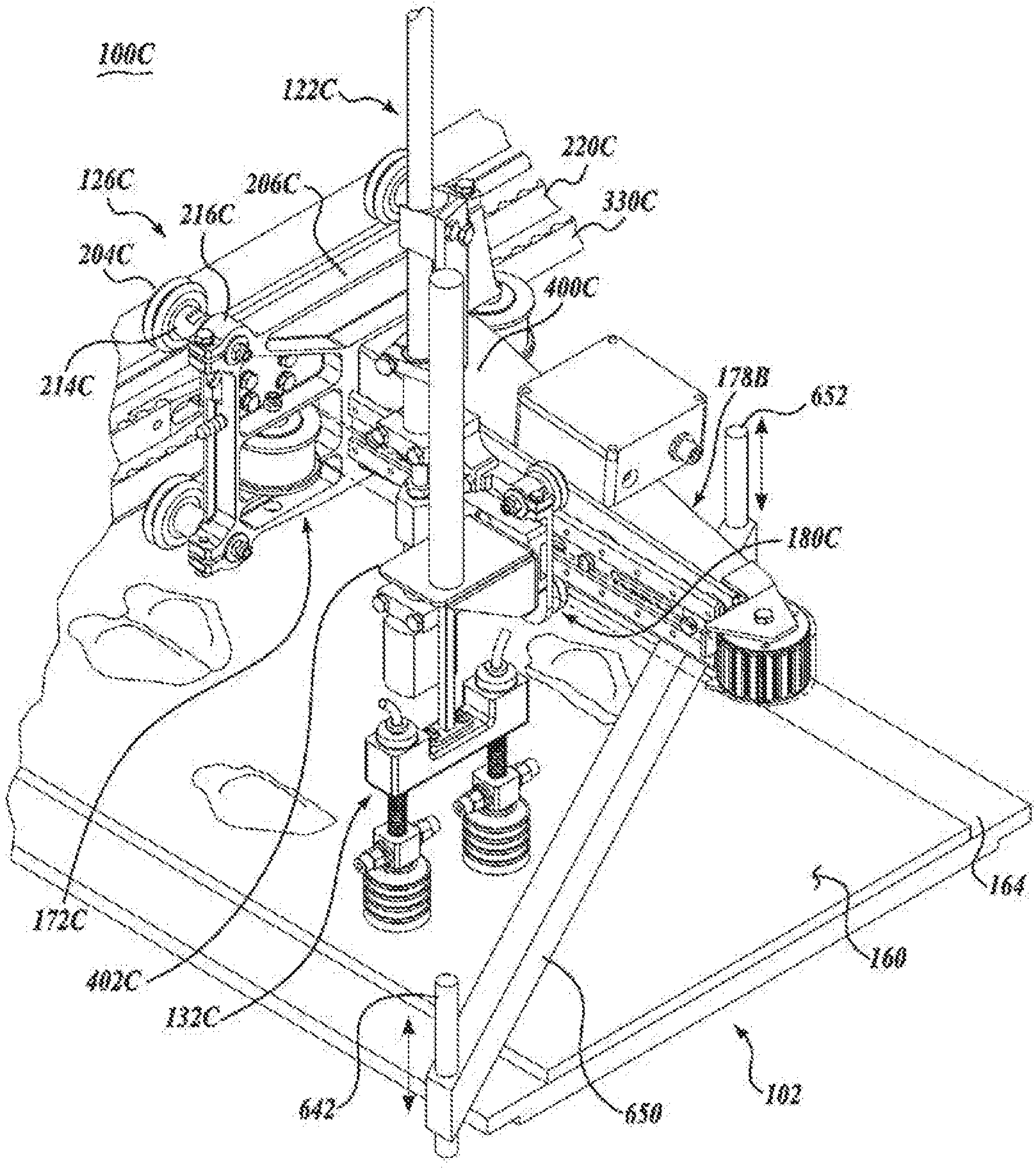
Fig. 10.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642
650

Fig. 11.

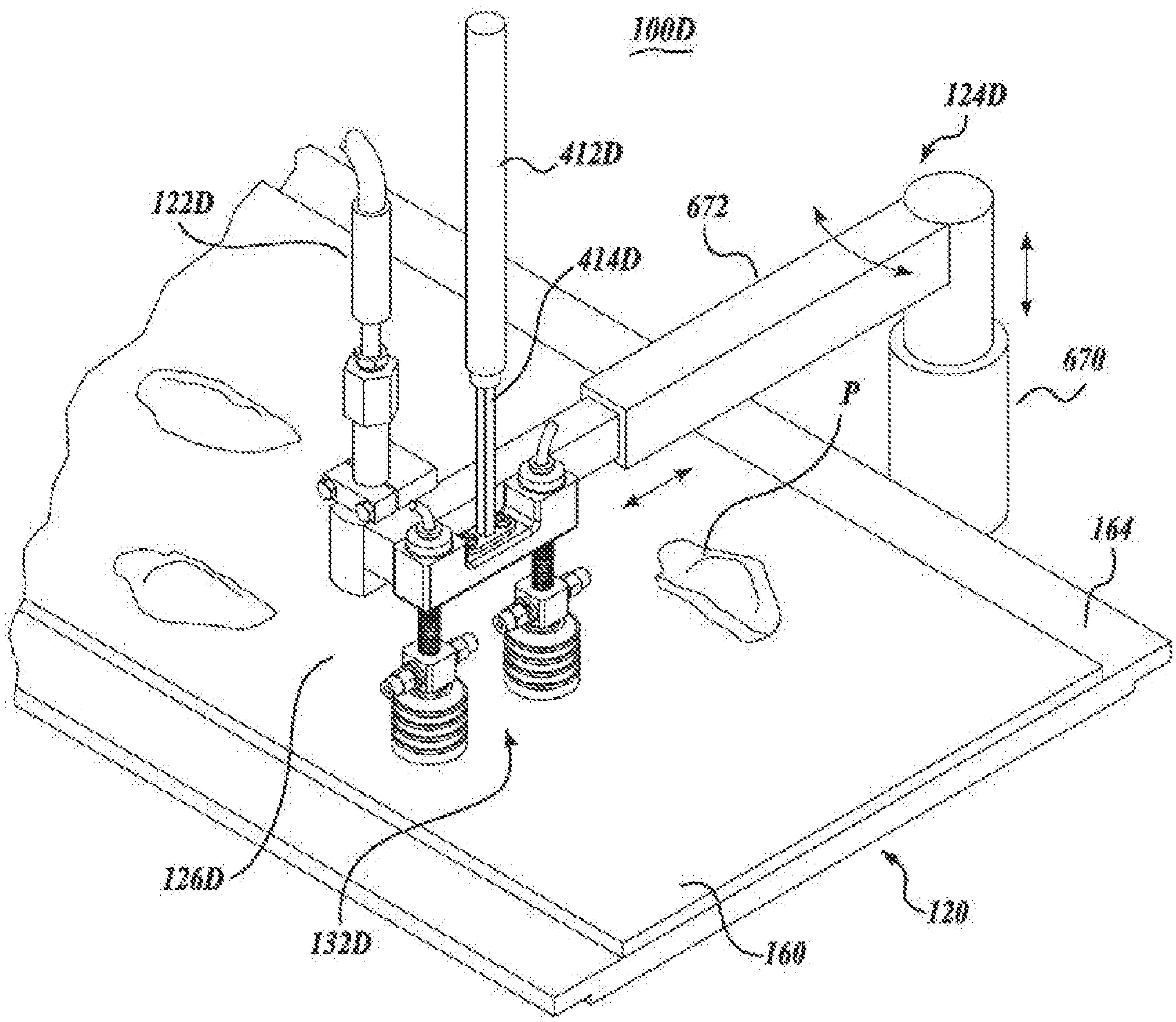

Fig. 12.

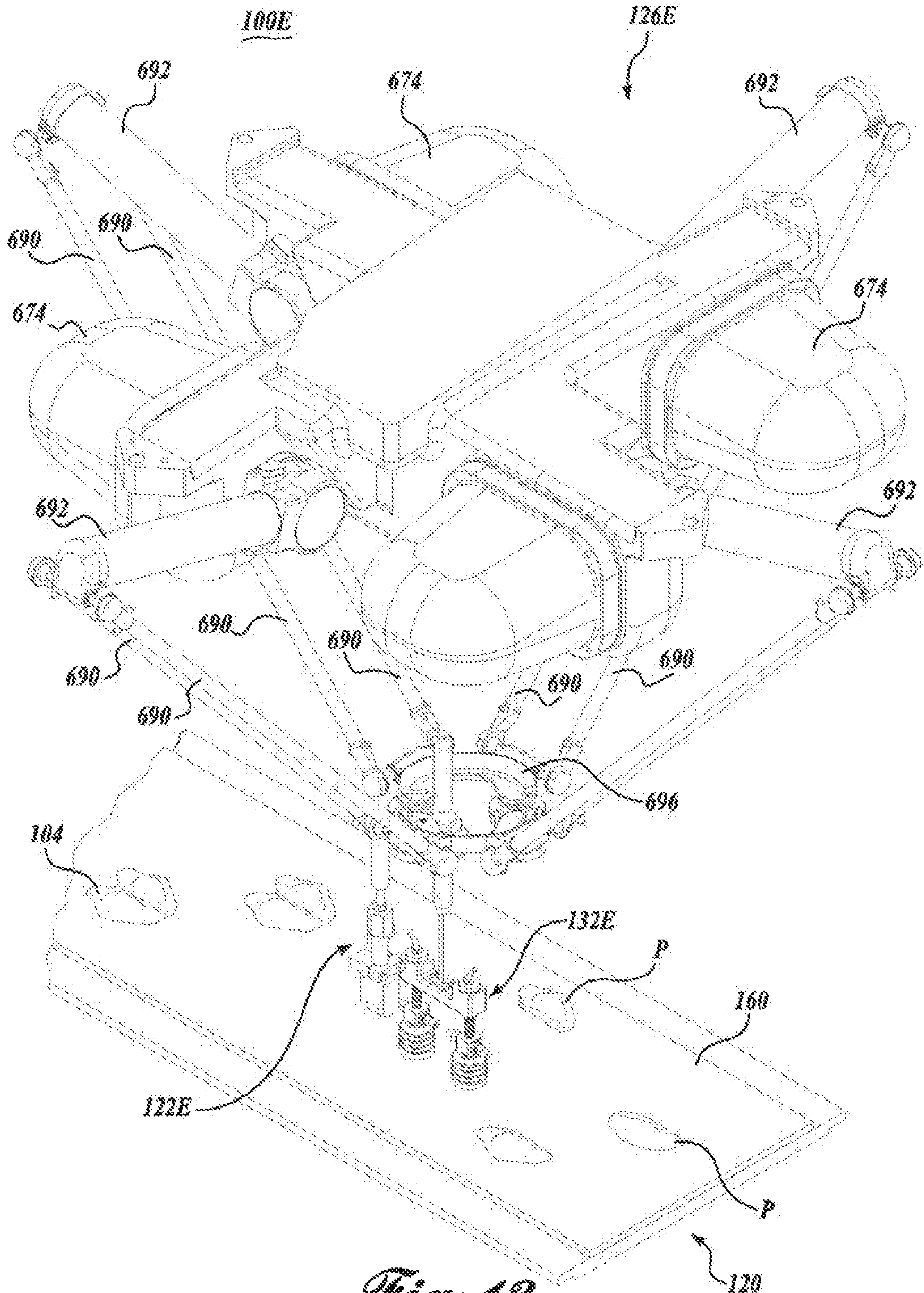
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Fig. 13.

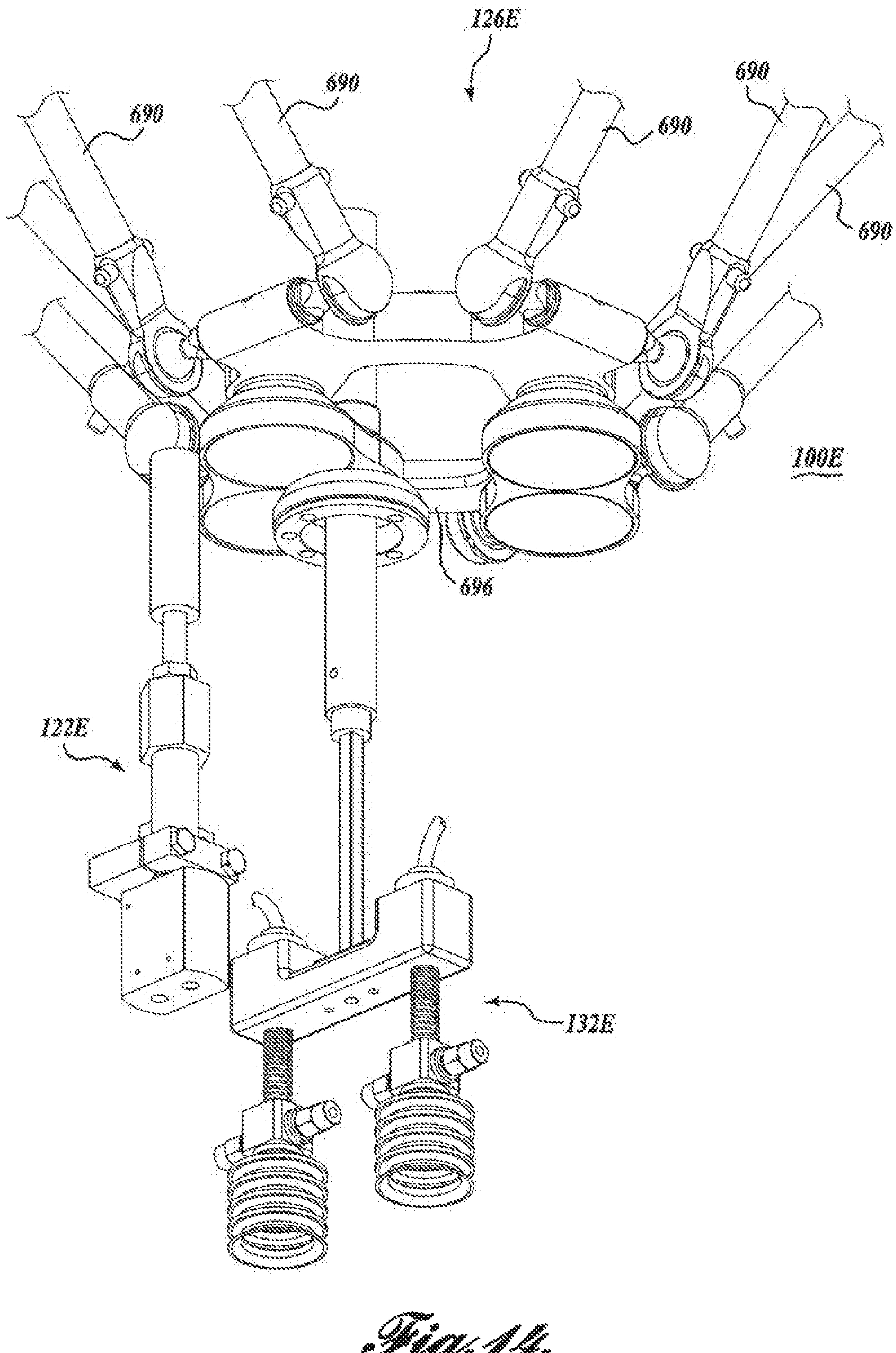

Fig. 14.

SYSTEM FOR CUTTING AND UNLOADING PORTIONS

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS-REFERENCE TO RELATED APPLICATION

The present application is a reissue application of U.S. Pat. No. 9,778,651, issued Oct. 3, 2017, the disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates generally to an apparatus for portioning and/or trimming workpieces, and more particularly to an apparatus for portioning or trimming workpieces by shape, weight, or other physical parameter and then automatically off-loading the portioned workpieces.

BACKGROUND OF THE INVENTION

Workpieces, including food products, are cut or otherwise portioned into smaller portions by processors in accordance with customer needs. Also, excess fat, bone, and other foreign or undesired materials are routinely trimmed from food products. It is usually highly desirable to portion and/or trim the workpieces into uniform sizes, for example, for steaks to be served at restaurants or chicken fillets used in frozen dinners or in chicken burgers. Much of the portioning/trimming of workpieces, in particular food products, is now carried out with the use of high-speed portioning machines. These machines use various scanning techniques to ascertain the size and shape of the food product as it is being advanced on a moving conveyor. This information is analyzed with the aid of a computer to determine how to most efficiently portion the food product into optimum sizes. For example, a customer may desire chicken breast portions in two different weight sizes, but with no fat or with a limited amount of acceptable fat. The chicken breast is scanned as it moves on a conveyor belt and a determination is made through the use of a computer as to how best to portion the chicken breast to the weights desired by the customer, so as to use the chicken breast most effectively.

Portioning and/or trimming of the workpiece can be carried out by various cutting devices, including high-speed water jet cutters or rotary or reciprocating blades, as the food product continues to travel on the conveyor. Once the portioning/trimming has occurred, the resulting portions are off-loaded from the conveyor by hand to be placed on a second takeaway conveyor for further processing or, perhaps, to be placed in a storage bin. The manual off-loading of portioned pieces is often unsatisfactory because it is difficult for the worker to visually distinguish between portions that might vary by only a few ounces. As a result, the portioned piece may be placed onto the wrong conveyor or into the wrong storage bin. Also, the portioning of food products, especially fish, poultry or meat, typically occurs at relatively low temperatures, in the range of 40 degrees. Performing the same repetitive off-loading tasks in this cold environment can lead to physical ailments as well as creating an undesirable work environment. As such, relatively high worker turnover is not uncommon.

Automated systems have been developed for picking up portioned pieces and offloading the portioned pieces into a second takeaway conveyor, a takeaway chute, a storage bin, etc. Such offloading systems are located downstream of the location of the portioning/trimming cutters. Oftentimes, a significant number of offloader units are required to keep pace with the portioning/trimming cutters when seeking to maximize throughput. Also, a separately activated carrier system is used for the offloading units.

The present invention seeks to increase the accuracy (and thereby reduce the level of human error) with which cut portions are categorized and also potentially to increase the throughput of portioning machines while at the same time keeping the equipment requirements of such machines to a minimum. The present disclosure also seeks to provide flexibility to change or alter the number of portioning cutters and/or offloader units to better match the types of portioning occurring, including the number of portions being cut from a workpiece. It will be appreciated that if two breast pieces are cut from a chicken breast, the offloading requirements are not nearly as onerous as opposed to if the chicken breast is being cut into nuggets, resulting in numerous nuggets per chicken breast workpiece.

SUMMARY

This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This summary is not intended to identify key features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

A system for cutting portions from a workpiece and then unloading the cut portions to separate the cut portions from the remaining workpiece trim comprises a conveyance system for conveying the workpiece, a scanning system for scanning the workpiece, a cutting system for cutting portions from the workpiece, a carrier system for moving the cutting system laterally and longitudinally of a conveyance system along cutting paths to cut the workpiece into desired shapes and/or sizes, and an unloading system operably associated with the carrier system operable to remove the cut portions from the conveyance system. The system further includes a control system processor operable to process the scanning data and portion specification settings to determine what cutting paths are required to achieve a desired shape and/or size portions from the workpiece. The control system also directs the cutting system to perform the required cuts and directs the unloading system to pick up the cut portions and deposit the cut portions at desired locations based on the known location of the cut portions, as determined in the scanning and cutting steps.

The carrier system includes an X-Y gantry system disposed over the conveyance system, wherein the cutting system is mounted on a powered carriage of the gantry system. The unloading system is also carried by an X-Y gantry system. In accordance with a further aspect of the present invention, the unloading system is mounted on the same carriage on which the cutting system is mounted.

In accordance with a further aspect of the present invention, the cutting system is carried by a rotatable and extendible actuator located alongside the conveyance system. The unloading system is operably associated with the actuator used to carry the cutting system.

In accordance with a further aspect of the present invention, the unloading system is carried by the same type of actuator used for carrying the cutting system. In a further aspect of the present invention, the unloading system is carried by the same actuator used to carry the cutting system.

In accordance with a further aspect of the present invention, the carrier system comprises an automated, multi-directional actuator capable of moving at least along, across, and diagonally relative to the conveyance system. In accordance with a further aspect of the present invention, the actuator system is also capable of moving upward and downward relative to the conveyance system.

In accordance with a further aspect of the present invention, the unloading system comprises at least one vacuum-operated actuator for attaching to the cut portions.

In accordance with a further aspect of the present invention, the at least one vacuum actuator comprises a vacuum head for attaching to the cut portions and connectable to a vacuum stream in fluid communication with the vacuum head. A separation screen is positioned between the vacuum head and the vacuum stream, and a pressurized fluid is directable at the separation screen in a direction toward the vacuum head so as to remove debris from the separation screen.

In accordance with a further aspect of the present invention, a plurality of vacuum actuators is arranged in sets for use in unloading a plurality of cut portions from the conveyance system simultaneously.

In accordance with a further aspect of the present invention, the unloading system comprises a suction head connectable in suction flow communication with a source of suction. The suction head has an inlet of a minimum size large enough to enable the cut portions to pass through the suction head for removing the cut portions from the conveyance system.

In accordance with a further aspect of the present invention, the control system is operable to direct the cutting system to cut the work product and then direct the operation of the unloading system to pick up the cut portions of the work product from the conveyance system before the cut portions travel beyond range of the carrier system on which the cutting system and corresponding unloading system are mounted.

In accordance with a further aspect of the present invention, the cutting system can be replaced with one or more unloading systems, and the unloading system can be replaced with one or more cutting systems.

In accordance with a further aspect of the present invention, a trim sweep system is provided to remove the trim relative to the conveyance system to one or more desired locations on the conveyance system and/or to one or more locations off of the conveyance system.

DESCRIPTION OF THE DRAWINGS

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a top schematic view of a system for cutting and unloading portions in accordance with the present disclosure;

FIG. **2** is a pictorial view of a carrier system for a cutter system and unloading system;

FIG. **3** is an enlarged fragmentary view of FIG. **2**;

FIG. **4** is an enlarged fragmentary view taken from the back side of FIG. **3**;

FIG. **5** is an elevational view of a portion of FIG. **2** partially in cross-section;

FIG. **6** is a cross-sectional view of FIG. **3**;

FIG. **7** is an enlarged elevational view of a portion of FIG. **2** directed at a portion of an unloading system taken in the direction of **7-7**;

FIG. **8** is a perspective view similar to FIG. **3** but rotated in a counter-clockwise direction relative to FIG. **3**;

FIG. **9** is a further embodiment of the present disclosure;

FIG. **10** is a further embodiment of the present disclosure;

FIG. **11** is a further embodiment of the present disclosure;

FIG. **12** is a further embodiment of the present disclosure;

FIG. **13** is a further embodiment of the present disclosure; and

FIG. **14** is a fragmentary pictorial view of a portion of FIG. **13**.

DETAILED DESCRIPTION

The detailed description set forth below in connection with the appended drawings, where like numerals reference like elements, is intended as a description of various embodiments of the disclosed subject matter and is not intended to represent the only embodiments. Each embodiment described in this disclosure is provided merely as an example or illustration and should not be construed as preferred or advantageous over other embodiments. The illustrative examples provided herein are not intended to be exhaustive or to limit the disclosure to the precise forms disclosed. Similarly, any steps described herein may be interchangeable with other steps, or combinations of steps, in order to achieve the same or substantially similar result.

In the following description, numerous specific details are set forth in order to provide a thorough understanding of exemplary embodiments of the present disclosure. It will be apparent to one skilled in the art, however, that many embodiments of the present disclosure may be practiced without some or all of the specific details. In some instances, well-known process steps have not been described in detail in order not to unnecessarily obscure various aspects of the present disclosure. Further, it will be appreciated that embodiments of the present disclosure may employ any combination of features described herein.

The present application includes references to directions, such as "forward," "rearward," "upward," "downward," "extended," "advanced," and "retracted." These references and other similar references in the present application are only to assist in helping describe and understand the present invention and are not intended to limit the present invention to these directions. Also, references to "work product," "workpiece," "food product," "food piece," "portion" are understood to be interchangeable and are not meant to be limiting in nature.

In the following description, various embodiments of the present disclosure are described. In the following description and in the accompanying drawings, the corresponding systems assemblies, apparatus and units are identified by the same part number, but with an alpha suffix. The descriptions of the parts/components of such systems assemblies, apparatus and units that are the same or similar are not repeated so as to avoid redundancy in the present application.

Overall System

FIG. **1** schematically illustrates a system **100** for cutting and unloading portions suitable for implementing an embodiment of the present disclosure. The system **100** includes a moving support surface in the form of a conveyance system **102** for carrying work products **104**, which may be arranged in multiple lanes or windrows, extending along the conveyance system, to be trimmed and/or cut into portions P. The work products **104** may be a food product, such as meat, poultry, or fish, that are spaced along the conveyance system. Other types of work products may include items composed of, for example, fabric, rubber, cardboard, plastic, wood or other types of material spaced along the conveyance system.

In a scanning aspect of the present disclosure, the system **100** includes a scanner **110** for scanning the work products **104**. In a cutting/trimming/portioning aspect of the present disclosure, the system **100** includes a cutter system **120** composed of one or more cutter assemblies/units/apparatus **122**, which may be arranged in an array or series of cutter assemblies, for cutting/trimming/portioning the work products **104** into end pieces P of desired sizes or other physical parameters. The cutter assemblies **122** are carried by a powered carrier system **124** to move the cutter assemblies longitudinally and laterally relative to the conveyance system.

In an unloading aspect of the present disclosure, an unloading system **130** composed of one or more unloading assemblies/units/apparatus **132** are operatively associated with carrier system **124**. In this regard, the unloading system may be carried by the same type of carrier system used to carry the cutter assemblies **122**. In a specific, but an optimal embodiment of the present disclosure, the unloading assembly **130** may actually be carried by the same carrier used to carry a cutter assembly **122**. The unloading system **130** picks up the cut portions P from the conveyance system **102** and transfers the cut portions to takeaway locations, which could include side conveyors **140**, chutes **142**, or other locations away from the conveyance system. Alternatively, the unloading system **130** may pick up the portioned workpieces P so that the remaining workpiece trim can be removed, and then replace the portioned workpieces onto the conveyance system at a location closely corresponding to the location from which the portioned workpieces were initially picked up by the unloading system.

The conveyor system **102** and scanner **110**, cutting system **120**, carrier system and unloading system **130**, are coupled to and controlled by a processor or computer **150**. As illustrated in FIG. **1**, the processor/computer **150** includes an input device **152** (keyboard, mouse, touchpad, etc.) and an output device **154** (monitor, printer). The computer **150** also includes a CPU **156** and at least one memory unit **158**. Rather than using a single processor or computer, one or more of the conveyor systems, scanners, cutting systems, carrier system and/or unloading system may utilize its own processor or computer. Also, processor/computer may be connected to a network **159** that ties system **100** to other aspects of the processing or workpieces **104**, such as downstream processing of portions P.

Generally the scanner **110** scans the work products **104** to produce scanning information representative of the work products **104**, and forwards the scanning information to the processor/computer **150**. The processor/computer, using a scanning program, analyzes the scanning data to determine the location of the work products on the conveyance system and develop a length, width, area, and/or volume distribution of the scanned work product. The processor/computer **150** may also develop a thickness profile of a scanned work product. The processor/computer **150** can then model the work product to determine how the work product may be divided, trimmed, and/or cut into end pieces P composed of specific physical criteria, including, for example, shape, area, weight, and/or thickness. In this regard, the processor/computer **150** takes into consideration that the thickness of the work product may be altered, either before or after the work product is cut by the cutter system **120**, or by a slicer, not shown. The processor/computer **150** using the scanning program or portioning program, determines how the work product may be positioned into one or more end piece product sets. The processor/computer using the portioning software then functions as a controller to control the cutter system **120** to portion the workpiece **104** according to the selected end product/pieces P, and then control the unloading system **130** to remove the portioned workpieces P from the conveyance system and place the portioned workpieces at one or more desired locations, either away from the conveying system, or back on the conveying system after the trim has been removed.

Conveyance System

Referring specifically to FIGS. **1**, **2**, **12**, and **13**, the conveyance system **102** includes a moving belt **160** that slides over an underlying support or bed **164**. The belt **160** is driven by drive rollers carried by a frame structure (not shown) in a standard manner. The drive rollers are in turn driven at a selected speed by a drive motor **166**, also in a standard manner. The drive motor **166** can be composed of a variable speed motor to thus adjust the speed of the belt **160** as desired as the work product **104** is carried past scanner **110**, cutter system **120** and offloading system **130**.

An encoder **162** is integrated into the conveyance system **102**, for example, at drive motor **166** to generate electrical pulses at fixed distance intervals corresponding to the forward movement of the conveyor belt **160**. This information is routed to processor/computer **150** so that the location(s) of the particular work product **104**, or the portions P cut from the work product, can be determined and monitored as the work product or portions travel along system **100**. This information can be used to position cutter assembly **122** and unloading assembly **132**, as well as for other purposes.

Scanning

Describing the foregoing system **100** and corresponding method in more detail, the conveyor **102** carries the work products **104** beneath the scanning system **110**. The scanning system may be of a variety of different types, including a video camera (not shown) to view the work products **104** illuminated by one or more light sources. Light from the light source **168** is extended across the moving conveyor belt **160** of the conveying system **102** to define a sharp shadow or light stripe line, with the area forwardly of the transverse beam being dark. When no work product **104** is being carried by the conveyor belt **160**, the shadow line/light stripe forms a straight line across the conveyor belt. However, when the work products **104** pass across the shadow line/light stripe, the upper, irregular surface of the work product produces an irregular shadow line/light stripe as viewed by a video camera angled downwardly on the work product and the shadow line/light stripe. The video camera detects the displacement of the shadow line/light stripe from the position it would occupy if no work product were present on the conveyor belt **160**. This displacement represents the thickness of the work product along the shadow line/light stripe. The length of the work product is determined by the distance of the belt travel that shadow line/light stripes are created by the work product. In this regard, the encoder **162** integrated into the conveyance system generates pulses at fixed distance intervals corresponding to the forward movement of the conveyor belt **160**.

In lieu of a video camera, the scanning station may instead utilize an X-ray apparatus (not shown) for determining the physical characteristics of the work product, including its shape, mass, and weight. X-rays may be passed through the object in the direction of an X-ray detector (not shown). Such X-rays are attenuated by the work product in proportion to the mass thereof. The X-ray detector is capable of measuring the intensity of the X-rays received thereby, after passing through the work product. This information is utilized to determine the overall shape and size of the work product **104**, as well as the mass thereof. An example of such an X-ray scanning device is disclosed in U.S. Pat. No. 5,585,603, incorporated by reference herein. The foregoing scanning systems are known in the art and, thus, are not novel per se. However, the use of these scanning systems, in conjunction with the other aspects of the described embodiments, is believed to be new.

The data and information measured/gathered by the scanning device(s) are transmitted to the processor/computer **150**, which records and/or notes the location of the work products **104** on the conveyor, as well as data pertaining to, inter alia, the lengths, widths, and thicknesses of the work products about the entire work products. With this information, the processor, operating under the scanning system software, can develop an area profile as well as a volume profile of the work products. Knowing the density of the work products, the processor can also determine the weight of the work products or segments or sections thereof.

Although the foregoing description discusses scanning by use of a video camera and light source, as well as by use of X-rays, other three-dimensional scanning techniques may be utilized. For example, such additional techniques may be by ultrasound or moiré fringe methods. In addition, electromagnetic imaging techniques may be employed. Thus, the present invention is not limited to the use of video or X-ray methods, but encompasses other three-dimensional scanning technologies.

Carrier System

Carrier system **124** is illustrated in FIGS. **1-5** and **8** as composed of a plurality of carrier assemblies/units/apparatus **126** spaced along the conveyance system **102**. The carrier assemblies **126** are adapted to carry and move cutter systems **120** and unloading systems **130**, together or separately, relative to the conveyance system **102**.

Referring specifically to FIGS. **2-5** and **8**, the carrier assemblies **126** in basic form includes a gantry **170** extending across the conveyance system **102** for supporting and guiding a carriage **172** for movement transversely to the direction of movement of the conveyor belt. The carriage **172** is powered by a drive system including, in part, the motive system **174** and a drive train **176**. A second, longitudinal support structure or beam **178** is cantilevered outwardly from the carriage **172** in a direction generally aligned with the direction of movement of the conveyor belt **160**. A second longitudinal carriage **180** is adapted to move along the beam structure **178** by a drive system which in part includes the motive system **174**, to power the longitudinal carriage **180** through the drive train **176**. A cutter assembly **122** and an unloading assembly **132** are mounted on the carriage **180** to move longitudinally of the conveyor belt **160**, as the cutter assembly operates on the underlying work products **104** being carried by the conveyance system, and also while the unloading assembly **132** is used to pick up the portioned workpieces P and move the portioned workpieces to a desired location.

The gantry **170** is composed of a support structure **190** that spans transversely across the conveyor belt **160** at an elevation spaced above the belt. The support structure **190** can be composed of a hollow, rectangular construction, but may be formed in other manners and shapes without departing from the spirit or scope of the present invention. The ends of support structure **190** are supported by elongated upright brackets **192** and **194**. As shown in FIG. **2**, bracket **192** is fixed to the adjacent ends of the support structure **190** to extend downwardly for mounting relative to conveyor system **102**. A plurality of hardware members **196** extend through clearance holes (not shown) formed in the lower, offset portion of bracket **192** to attach the bracket to the conveyor system or to a frame structure for the conveyor system. Bracket **194** extends downwardly from the opposite end of the support structure for attachment relative to the conveyor system or frame thereof. In this regard, hardware members **198** extend through clearance holes provided in the lower end of bracket **194** to attach the bracket to the conveyor or frame. In this manner, the support structure **190** is mounted securely and stationarily relative to the conveyor system or the frame therefor.

Gantry **170** also includes a track for guiding transverse carriage **172** along support structure **190**, composed of an upper rail **200** and the lower rail **202** attached to the face of the support structure facing the carriage. As illustrated in FIG. **5**, the upper rail **200** extends along the upper corner of the support structure whereas the lower rail **202** extends along the lower corner of the support structure. As also illustrated, the upper surface of the upper rail and the lower surface of the lower rail are crowned to engage with the concave outer perimeters of rollers **204** of carriage **172**. As such, the carriage **172** is held captive on the track while traveling back and forth along the support structure.

As illustrated in FIGS. **2-5** and **8**, carriage **172** includes a substantially planar, generally rectangularly shaped bed portion **206** having a reinforced outer perimeter for enhanced structure integrity. The carriage rollers **204** are attached to the corners of the bed **206** by stub axles **214** which engage within through-bores formed in bosses **216** which extend transversely from each of the four corners of the carriage bed **206**. Antifriction bearings (not shown) are utilized between the rollers **204** and the stub axles **214** to enhance the free rolling of carriage **172** along support structure **190**.

Carriage **172** is powered to move back and forth along support structure **190** by motive system **174**. In this regard, a timing belt **220** extends around a driven pulley **222** located at the lower end of drive shaft assembly **223** of motive system **174** and also around an idler pulley **224** of an idler assembly **226** mounted on the upper end of bracket **192** by upper and lower bracket ears **228** and **230**. As such, the belt **220** makes a loop around the support structure **190**, extending closely along the sidewalls of the structure. The idler pulley **224** is adapted to rotate freely about central shaft **232** of the idler assembly **226** through the use of an antifriction bearing (not shown) with the upper and lower ends of the shaft being retained by bracket ears **228** and **230**.

The belt **220** is connected to the backside of carriage bed **206**. As most clearly shown in FIG. **4**, a spring-loaded clamping structure **240** connects the belt **220** to the carriage bed **206** so that if the carriage becomes jammed or locked along the support structure, if the carriage **172** is ever in a "runaway" condition or if motive system **174** malfunctions tending to cause the carriage to overrun support structure **190**, the belt **220** can slide or move relative to the carriage **172**. As such, potential damage to cutter apparatus **122** and unloader apparatus **132** may be avoided or at least minimized.

The clamping structure **240** includes a base or back block **242** mounted to the back face of the carriage bed **206**. A face plate **244**, mounted to the back block **242**, is resiliently clamped against the toothed surface of belt **220**. The surface of face plate **224** interfacing with the belt **220** is ridged to match the contours of the belt **220**. Normally the clamping force that clamps the face plate **244** to the block **242** securely clamps the belt **220** to the clamping structure. However, if the tension in the belt **220** extends a certain level, then the belt **220** is able to slip relative to the clamping structure.

Referring to FIG. **2**, the motive system **174** includes a servo motor **260** programmable to control the movement of the carriage **172** back and forth along support structure **190** as desired. The servo motor **260** is positioned at a location substantially insulated from moisture or other contaminants that may be associated with the work/processing being carried out on the work products **104**. A hollow drive shaft (not shown) extends down through drive shaft assembly **223**. The driven pulley **222** is attached to the lower end of the hollow drive shaft and a drive pulley **262** is attached to the upper end of the hollow drive shaft. The drive pulley **262** is connected by belt **264** to an output drive pulley (not visible) powered by servo motor **260**. It will be appreciated that by the foregoing construction, the servo motor **260** is located remotely from the carriage **172**, with the driving force applied to the carriage **172** by the lightweight timing belt **220**.

By the foregoing construction, motive system **174** is capable of quickly accelerating and decelerating carriage **172** for movement along support structure **190**. Although ideally motive system **174** utilizes a servo motor, other types of electrical, hydraulic, or air motors may be employed without departing from the spirit or scope of the present invention. Such motors are standard articles of commerce.

Next, referring specifically to FIGS. **2-6** and **8**, the longitudinal support structure or beam **178** cantilevers transversely from carriage **172** to be carried by the carriage. The beam **178** is composed of a vertical sidewall **290** which is substantially perpendicular to the adjacent face of carriage bed **206**. The opposite sidewall **292**, rather than being substantially perpendicular to the carriage bed **206**, tapers towards sidewall **290** in the direction away from the carriage bed. Likewise, the top and bottom walls **294** and **296** of beam **178** taper towards the free end of the beam, thereby to cooperatively form a generally tapered shape. As will be appreciated, this enhances the structural integrity of the beam while reducing its weight relative to a parallel-piped structure.

As illustrated in FIG. **6**, in one form the beam **178** may be of hollow construction, composed of two channel-shaped members **298** and **300**. Channel member **300** is shallower than channel member **298** and nests within channel-shaped member **298** so that the flanges of channel member **300** overlap the free end edges of the flanges of channel-shaped member **298**, as shown in FIG. **6**. A plurality of spacers **302** are disposed within the beam member **178** and located along its length to bear against the sidewalls **290** and **292** of the channel members **298** and **300**. The flanges of the two channel members are attached together and the spacers **302** are attached to the channel members by any convenient means, including by weldments. It will be appreciated that by the foregoing construction, beam **178** is not only lightweight, but also of sufficient structural integrity to carry significant weight without deflection. Lastly, beam **178** may be secured to the carriage bed **206** by any appropriate technique, including by hardware fasteners, weldments, etc.

Referring to FIGS. **2** and **3**, an elongate track **310** for carriage **180** is mounted on and extends longitudinally on beam sidewall **290**. Track **310** includes formed upper and lower edge portions **312** and **314** that are spaced away from sidewall **290** to define upper and lower rails for guiding the longitudinal carriage **180**. The track **310** is attached to beam sidewall **290** by a plurality of hardware members **316** and extend through clearance holes formed in the track and through spacers (not shown) fixedly mounted to sidewall **290** at the back side of the track to engage the beam **178**. Also to minimize the weight of track **310**, cut-out oval openings **318** are formed in the track.

The longitudinal carriage **180** is adapted to travel along track **310**. In this regard, the carriage **180** includes a substantially planar, rectangularly shaped bed portion **320** and a pair of upper rollers **322** and a pair of comparable lower rollers (not shown) having concave outer perimeter portions sized to closely engage with the correspondingly crowned track upper and lower rail edge portions **312** and **314**. The upper and lower rollers **322** are mounted on stub shafts **324** extending transversely from the carriage bed **320**. Ideally, but not shown, anti-friction bearings are utilized between the stub shafts **324** and the rollers to enhance the free movement of the carriage **180** along track **310**.

Carriage **180** is moved back and forth along track **310** by the motive system **174** that powers a timing belt **330**. To this end, an idler pulley **322** is mounted on the free end of support beam structure **178** by a formed bracket **334** which is fixedly attached to the beam structure **178**. A pivot shaft **335** extends through the center of an antifriction bearing mounted within pulley **322**, with the ends of the shaft retained by the upper and lower ears of bracket **334**.

The ends of belt **330** are attached to the bed **320** of carriage **180**. This attachment can be carried out in a number of ways, including the use of a system that is similar to that described above regarding the attachment of belt **220** to carriage **172** described above. Also, the belt **330** extends partially around directional pulleys **338** and **340**, anti-frictionally mounted on carriage bed **206** to direct the belt along support structure **190** and along longitudinal support structure **178**.

Rotation of a drive pulley **350** angled downwardly from drive shaft assembly **223** results in movement of the belt **330** which in turn causes the carriage **180** to move along track **310**. In this regard, the motive system **174** includes a servo motor **360** which is drivingly connected with drive pulley **350** by a drive shaft **362** that extends downwardly through drive shaft assembly **223**. A driven pulley **364** is attached to the upper end of drive shaft **362**, which pulley is connected via timing belt **366** to a drive pulley (not visible) powered by motor **360**. The drive shaft **362** is disposed within the hollow drive shaft extending between pulleys **222** and **262**.

As with motor **260**, other types of well-known and commercially available rotational actuators may be utilized in place of servo motor **360**. Also, as noted above, motive system **170** is located remotely from not only transverse carriage **172**, but also longitudinal carriage **180**. As a result, the mass of the motive system **174** is not carried by either of the two carriages; rather the motive system is positioned at a stationary location, with the drive force being transferred from motive system **174** to carriage **180** by a lightweight timing belt **330**. As a consequence, the total mass of the moving portions of carrier system **124** (carriage **172**, support beam **178** and carriage **180**) is kept to a minimum. This allows extremely high speed movement of the two carriages, with accelerations exceeding eight gravities.

Cutting System

A work tool in the form of a cutter apparatus **122** depicted as in the form of a high pressure liquid nozzle assembly **368** is mounted on the longitudinal carriage **180** to move therewith. The nozzle assembly emits a very focused stream of high pressure water disposed in a downward cutting line that is nominally transverse to the plane of conveyor belt **160**. The nozzle assembly **368** includes a body portion **370** that is secured to the carriage bed **320** by a pair of vertically spaced apart brackets **372** and **374**. The nozzle assembly includes a lower outlet directed downwardly toward conveyor belt **160**. A fitting **376** is attached to the upper end of nozzle body **370** for connecting the nozzle body **370** to a high pressure fluid inlet line **378**. High pressure liquid nozzles of the type embodied by work tool **122** are well-known articles of commerce.

Unloading System

Referring specifically to FIGS. **2**, **3**, and **5**, an unloading apparatus **132** is also illustrated as mounted on the longitudinal carriage **180** along the side of cutter apparatus **122** thereby to move with the carriage. However, the unloading apparatus may be mounted on a different carriage or even on a different type of actuator/carriage, but operably also associated with carriage **180** and/or cutter apparatus **122**.

The unloading apparatus includes a linear actuator **400** mounted on a bracket **402** which in turn is mountable on carriage bed **320**. The bracket **402** is illustrated as having top plate **404** and generally triangularly shaped side gusset plates **406** extending between the underside of top plate **404** and face plate **408** for attaching the bracket **402** to the carriage bed **320**. The linear actuator **400** is illustrated as having an upper cylinder portion **412** and piston rod **414** extendable downwardly from the cylinder **412**. The piston rod can be a square or other non-circular cross-section so as to prevent the piston rod from rotating about its longitudinal axis relative to the cylinder **412**. Of course, other means can be provided for preventing the piston rod from rotating relative to the cylinder. Also, the linear actuator **400** is illustrated as being of a double-acting type so that both the extension of the piston rod **414** and the retraction of the piston rod is activated by a fluid medium introduced into the cylinder through extension fitting **416** located on the upper portion of the cylinder **412** and the retraction fitting **418** located in the lower portion of the cylinder. Fittings **416** and **418** are articles of commerce. The linear actuator **400** may be operated with pressurized fluid, for example, air or other type of gas or hydraulic fluid delivered to and expelled from the linear actuator **400** via fittings **416** and **418**.

It will be noted that the linear actuator **400** will require fast motion and very short cycle times in order to handle the offloading of portioned pieces P from work products **104** in a timely manner. To this end, preferably the valve or other control system utilized to operate the extension and retraction of piston rod **414** is located close by, for example, in housing **426** positioned on the top wall **294** of the support structure **178**. By positioning the valve or other control system within the housing **426**, relatively short fluid lines can be used between the housing and fittings **416** and **418** of the linear actuator **400**. As an alternative, the valving required for linear actuator **400** may be built into the linear actuator. The valve suitable for incorporating into the structure of a linear actuator is articles of commerce.

A yoke **430** for mounting a pair of suction pickup units **432** is attached to the bottom end of piston rod **414** by appropriate hardware members for engaging with the threaded lower end portion of a rod. The free end of rod as shown is attached to the central portion of the yoke **430** by a bracket **434** and hardware members **436**.

Each of the pickup units is illustrated as having suction tip or head **440** attached to a lower end of a tube shaft **442** that slidably engages through an upright bore formed in the enlarged end portions of the yoke **430**. A compressible bellows cup assembly **444** is attached to the suction tip **440** to project downwardly from the suction tip. The bottom **446** of the bellows assembly is cup-shaped so as to achieve a secure attachment with portioned workpieces to be picked up. The suction head **440** has a vertical bore **450** extending therethrough to intersect with the hollow interior of the tube shafts **442**. The upper ends of the tube shafts **442** are connectable to forces of pressurized fluid via connecting tubes **452**.

Suction is applied to the suction tips **440** through the use of a venturi assembly built into the suction head **440**. Pressurized air is applied to a venturi assembly disposed within the suction head **440**. To this end, pressurized air is applied to the venturi assembly through inlet fitting **460** via supply line connectable to the fitting **460**. The venturi creates a source of reduced air pressure in a standard manner which is transmitted to the bore **450** by the venturi transversely intersecting the bore. The exhaust from the venturi is emitted from the suction head via outlet fitting **462** disposed on the opposite side of the suction head from fitting **460**. Pressurized air can be directed into fitting **462** when desiring to break the suction connection between the cup assembly **444** and the portioned workpiece P. The positive pressure air source passing through the venturi via the outlet fitting **462** can also be used to "backblow" the suction head **450** to assist in cleaning out the suction head or removing matter from the workpieces that may have become lodged therein.

So as to assist in preventing matter from the workpieces **104** from clogging the venturi, a screen **470** is positioned at the intersection of the suction head **440** and the bellows cup assembly **444** in an effort to prevent the matter from the workpieces from passing into the venturi located within the suction head. The screen can be of various composition, include from wire mesh, plastic mesh, expanded metal, porous ceramic, or sintered metal filters, for example. The backblow described above produced by pressurized air introduced into the suction head **440** via fitting **462** may not be sufficient from keeping the screen **470** from becoming clogged. The present disclosure provides a means for seeking to removing matter or debris from the screen **470**. To this end, pressurized air is directed to tube shafts **442** via inlet lines **452**. Such pressurized air is directed at the screen **470** in the direction opposite to the suction stream created by the venturi located within the suction head **440**. The speed of the compressed air or other fluid flowing through the tube shafts **442** can be increased by utilizing a converging/diverging nozzle so that the fluid velocity can achieve even supersonic speeds in the localized area near the center of the screen **470**, thereby clearing away any debris or matter that may have become lodged on the screen.

Referring specifically to FIG. **7**, a compression spring **480** is disposed over tube shaft **442** between the upper side of the suction head **440** and the under side of yoke **430**. The compression spring nominally will cause the slide tube **442** to be positioned in a downward, extended position relative to the yoke **430**. When the slide tube is in a fully downward position, a retaining nut or head **482** bottoms against the upper side of yoke **430**. The retaining spring **480** allows the tube shaft **442** to slide or retract upwardly relative to the yoke **430**, for instance, when the cup assembly **444** makes contact with the upper side of a workpiece portion P. FIG. **7** illustrates the situation wherein when one bellows cup assembly **444** is lowered to pick up a workpiece portion P, the second bellows assembly **444** may have already picked up a workpiece portion P and then when the yoke **430** is lowered, the workpiece portion P attached to the second bellows cup assembly **444** may stack on top of another workpiece portion P. If this situation occurs, the associated spring **480** compresses as the tube shaft **442** slides upwardly through a close fitting bore formed in the yoke **430**. As a consequence, the maximum force that is applied to workpieces and workpiece portions by the pickup units **432** is limited to a controlled level. It can be appreciated that this allows for very fast motion of the pickup units **432** to extend downwardly and pick up work products and portions thereof without damaging the work products or portions, or damaging the pickup units **432**. Also, it will be appreciated that by utilizing a tapered compression spring, the spring can collapse down to roughly one wire diameter for maximum retraction of slide tube **442**.

FIGS. **2**, **3**, **7** and **8** illustrate two pickup devices mounted on yoke **430**. The pickup devices can be spaced apart from each other based on the types of work products being processed. For instance, if a chicken breast butterfly is being cut into two halves, a spacing between the two pickup units **432** may be such that the bellows cup assemblies **444** are able to each pick up one of the portioned chicken breast halves at the same time. However, if the spacing between the bellows cup assembly **444** does not match that required for the work product being processed, then the pickup devices can be actuated one at a time. A first chicken breast half can be picked up and then the yoke **430** moved slightly to pick up the second chicken breast half. Nonetheless, significant time is saved because the distance that the bellows cup assembly **442** needs to be moved to pick up the second chicken breast half is minimized.

Rather than utilizing two pickup units **432**, a larger number of pickup units, for example, four pickup units may be utilized. Further, the spacing among the four pickup units **432** may be designed based on the work product being processed. For example, if chicken nuggets are being cut, the pickup units **432** may be positioned relative to each other so as to efficiently pick up the chicken nuggets from the conveyance system for removal therefrom.

Referring specifically to FIG. **1**, the portions cut from work products **104** when lifted off the conveyor belt **160** by unloading apparatus **132** may be placed on a takeaway conveyor **140** extending along the side of conveyance system **102**. From conveyor **140**, the portion pieces P may proceed for further processing. Alternatively, the portioned pieces may be placed within chutes **142** shown in FIG. **1** as disposed along the opposite side of the conveyor belt **160** from the location of the takeaway conveyor **140**. Rather than using a single side conveyor **140**, side conveyors similar to conveyor **140** can be vertically stacked or side conveyors can be positioned on both sides of the main conveyance system **102** so that different portion pieces P are placed on different conveyors based on various criteria, such as the size, thickness, weight of the portioned pieces, or other characteristics. Also, the different conveyors can transmit the portioned pieces for different types of subsequent processing. The unloading system **130** may place the portioned workpieces P into the chutes **142** from which the portioned pieces P may drop down into a conveyor or bin (not shown) for further processing.

A further embodiment to the present disclosure is illustrated in FIG. **9**, wherein the conveyance system **100**A is illustrated as of similar construction with conveyance system **100**, but with the different unloading system **130**A. The components of system **100**A that are similar to system **100** are identified with the same part numbers. The description of these parts are set forth above, and thus will not be repeated here.

As noted above, the main difference between system **100** and system **100**A is that in system **100**A, unloading system **130**A replaces unloading system **130**. Unloading system **130**A includes a relatively large diameter suction system **600** for lifting portioned workpieces upwardly from the conveyor belt **160** for transport to other locations for further processing of the portioned workpieces. To this end, suction system **600** includes a suction tube **602** connectable to the upper end portion of a suction nozzle **604** that is attached to carriage **180** by a mounting bracket **402**A. The nozzle **604** is telescoping so as to be downwardly extendable and upwardly retractable relative to conveyor belt **160**. The vacuum for unloading system **130**A can be generated by relatively small local vacuum generators, not shown, in vacuum flow communication with suction tube **602**.

It will be appreciated that the carrier system **124** is capable of moving the suction nozzle **604** over the portion to be removed from the conveyor belt. Alternatively, rather than using unloading system **130**A for removal of portions, the system can instead be used to remove the work product trim from the conveyor belt instead. Moreover, when the portioned pieces are in the form of relatively small units, such as chicken nuggets, often it is difficult to remove the nuggets from the conveyor belt at any rate of speed. The use of the unloading system **130**A can be quite helpful in this regard. Once the portioned product, nuggets, trim, etc., are removed from the belt and lifted into suction tube **602**, a conventional vacuum conveyance system can be utilized for the unloading of the portions/nuggets/trim and further processing thereof.

FIG. **10** illustrates a trim sweep system for removing the trim from the conveyor belt **160** after the portions have been lifted off the belt by the unloading system **130**. As shown in FIG. **10**, the trim sweep system illustrated consists of a nozzle manifold **630** located along the side of conveyor belt **60**. The manifold **630** is mounted to be able to raise and lower on lifting guides **632**. Also, although not shown, the nozzle manifold **630** can be adapted to tilt so as to aim the air streams emitted from the manifold at a desired direction, typically downward toward the surface of the conveyor belt **160**. A series of outlet nozzles **634** are spaced along the length of the nozzle manifold **630** to emit an air stream from each of the nozzles. The air stream pattern from the nozzles **634** and the air velocity of such air streams can be selected to blow the workpiece trim off of the conveyor belt **160** and into a trough, chute, side conveyor, collection bin, etc., on the opposite side of the conveyor belt. It is to be appreciated that the nozzle manifold **630** can be placed appropriately along the length of the conveyance system **102** so that once the trim has been removed from the conveyor belt **160**, the portioned pieces lifted off the conveyor by the pickup units **432** can be replaced back on to the conveyor belt at the same location or close to the same location on the belt that the portions were removed from the belt initially.

It will be understood that rather than blowing the trim completely off of the belt **160**, the trim could instead be blown to another location on the belt, for instance, to form a windrow along the belt. In this situation, the trim would be removed from the portions so that the portions can be replaced onto the belt, in the same location as lifted off the belt, as noted above, or in a different arrangement. In this regard, the trim could be swept to the middle of the belt, thereby retaining the outside sections of the belt for the larger portions. Also, it may be that part of the trim is cut into nuggets, and then such nuggets are swept to a desired location across the belt or even off the belt by the air sweeping system. Other possibilities in this regard are within a scope of the present disclosure.

As noted above, the nozzle manifold **630** is illustrated as mounted alongside the conveyor belt **160**. The nozzle manifold or other type of air sweep system can instead be mounted on the unloading apparatus **132** to perform the same functions described above carried out by the nozzle manifold **630**. Pressurized air, as noted above, is supplied to the unloading system **130**, and thus such pressurized air can also be used for the sweep system.

Referring to FIG. **11**, a further disclosure of a trim/nugget sweep system is illustrated as composed of a blade **650** extending diagonally across the conveyor system **102**. The blade **650** is mounted for raising and lowering by lifting guides **652** disposed alongside conveyor belt **160**. The blade **650** is designed to cause the trim and/or nuggets remaining from the portioning process to be moved laterally relative to the belt **160** and off a side edge of the belt into one or more side conveyors, chutes, troughs, containers, etc. As noted above, with respect to nozzle manifold **630**, the blade **650** can be located relative to the carrier systems **124** to enable the portioned pieces lifted off the belt by the pickup units **432** to be replaced back onto the belt at a location that is the same or corresponding to the location removed from the belt. It will be appreciated that the blade **650** can be lowered into operational position or raised into a retracted position relative to the conveyor belt **160** as desired. Also, rather than being static (other than moving up and down), the plate **450** can be mounted on an actuator to move across the belt **160** to actively push trim and/or nuggets off of the belt **160**.

It will be understood that, rather than using the blade **650** that spans across the entire width of the belt, instead one or more blades of other shapes can be utilized so as to move the desired work products either to a desired location on the belt or off the belt. For example, such blades can move the trim and/or nuggets to a specific location laterally of the belt or off the edge of the belt. For example, it may be desirable to sweep the trim and/or nuggets toward the middle of the belt, thereby retaining the side sections of the belt for the cut portions.

Also, rather than mounting the blade **650** or other type of blade utilized for the sweeping system on the conveyer frame or other stationary structure, such blade can instead be mounted on the unloading system **130**. In this regard, the blade can be mounted on the pickup units **432** or mounted elsewhere relative to carriage **172**.

A further aspect to the present disclosure is illustrated in FIG. **12**, wherein system **100**D is illustrated as composed of carrier system **124**D in the form of a rotatable, elevatable, and extendable carrier apparatus **126**D. As shown in FIG. **12**, the carrier apparatus **126**D includes a rotatable and elevatable post assembly **670** mounted along the side conveyance system **102**. The post assembly is powered to raise and lower relative to the surface of the conveyor belt **160** and also to rotate a telescoping beam **672** over the conveyor belt **160**. The beam **672** is powered to extend and retract along its length so as to position a cutter assembly **122**D and unloading assembly **132**D at desired locations over the surface of the conveyor belt **60**. The cutter assembly **122**D is mounted to one side of the free end of the beam **672** and the unloading assembly **132**D is mounted to the opposite side of the free end of the beam. It will be appreciated that the cutter assembly **122**D and unloading assembly **132**D are structurally and operationally similar or identical to the corresponding cutter assembly **122** and unloading assembly **132** described above. In this regard, the unloading assembly **132**D may include a cylinder **412**D with corresponding piston rod **414**D in the manner of the unloading assembly **132**. Or, alternatively, the unloading assembly **132**D may rely on the ability of the post assembly **670** to raise and lower relative to the conveyor belt **160**. It will be appreciated that the system **100**D shown in FIG. **12** can provide the same operational functions and advantages as provided by systems **100**-**100**C described above.

Next, referring to FIGS. **13** and **14**, a further embodiment of the present disclosure includes a system **100**E for both portioning work products **104** and unloading the cut portions from conveyance system **102**. As shown in FIGS. **13** and **14**, system **100**E is composed of a carrier system **124**E in the form of a robotic structure **126**E. The structure **126**E is composed of four sets of powered arm pairs **690** that are connected to each other at one end (upper end) to a powered pivot arm **692**, which in turn is connected to a rotary actuator **694** that is powered to rotate about a horizontal axis. Each of the four pivot arms **692** extend outwardly from a central axis in a quadrant arrangement. The lower or opposite ends of the arm pairs **690** are connected to a carrier head or ring **696** to which a cutter assembly **122**E and an unloading assembly **132**E are mounted.

The carrier system **124**E is capable of moving the carrier head **696**, and thus the cutter assembly **122**E and unloading assembly **132**E in any direction over the conveyor **160**, including side to side, longitudinally, up and down, as well as diagonally. The carrier system **124**E is also capable of tiling the cutter assembly **122**E and unloading assembly **132**E away from vertical into a desired orientation. As such, the cutter assembly **122**E is capable of cutting the work products **140** in a desired manner, and the unloading assembly **132**E is able to grasp the portioned work products P in a desired manner. Although a singular carrier system **124**E is shown in FIGS. **13** and **14**, multiple carrier systems can be utilized, as in systems **100**, **100**A, **100**B, **100**C, and **100**D noted above. Also, as in the systems **100**, **100**A, **100**B, **100**C, and **100**D noted above, sweeping systems for moving or sweeping the trim and/or nuggets and/or portioned pieces may be utilized in conjunction with the carrier system **124**E.

While illustrative embodiments have been illustrated and described, it will be appreciated that various changes can be made therein without departing from the spirit and scope of the invention.

For example, while various carrier systems **124**, **124**B, and **124**C have been described above, other carrier systems may be utilized. For example, a carrier system may be composed of other types of robotic apparatus described above.

As another example, although the pickup units **432** have been described as utilizing suction action to grasp the portioned workpieces; other types of methods can be employed in this regard. For example, if the workpiece is composed of magnetically conductive material, the pickup device may utilize a magnet. Alternatively, the pickup device may consist of a clamp, jaw, or fingers structure capable of physically grasping the workpiece for lifting off of the conveyance system **102** and then releasing the workpiece portions at one or more desired remote locations. As a further alternative, the pickup device may include forks or tines in place of the suction head **440** to spear the workpiece portions. As another alternative, the pickup device may consist of very cold (below freezing temperature) heads that "stick" to the workpiece thereby to pick up the workpiece from the conveyance system.

In addition, the carriage **180** can be configured so that the rather mounting a cutter assembly **122** and an unloading assembly **132**, two or more cutter assemblies, or two or more unloading assemblies can be mounted on the carriage. This may be carried out, for example, by forming the applicable hole patterns on the carriage bed **320** for the hardware members used to mount the cutter assemblies and also unloading assemblies to the carriage bed.

It will be appreciated that, by the foregoing construction, the same type of carrier system may be used to carry both cutter assemblies **122** and unloading assemblies **132**, thereby resulting in commonality of components of the system **100**. This enables the carrier apparatus **126** to be used to carry either cutter assemblies, unloading assemblies, or both. Further, this result in efficiency of spare parts required for the carrier assemblies **126**.

The invention claimed is:

1. A system for cutting portions from a workpiece based on desired physical specifications of the cut portions resulting in one or more cut portions and remaining trim, and then unloading the cut portions to separate the cut portions from any remaining workpiece trim, comprising:

(a) a conveyance system for conveying the workpiece;

(b) a scanning system for scanning the workpiece and generating data pertaining to physical specifications of the workpiece and to the location of the workpiece on the conveyance system;

(c) a cutting system for cutting one or more portions from the workpiece;

(d) at least one carrier system for supporting and moving the cutting system laterally and longitudinally of the conveyance system along cutting paths to cut the workpiece into portions per desired physical specifications;

(e) at least one powered unloading system operatively associated with the at least one carrier system, said unloading system operable to **[**grasp the cut portions,**]** lift the cut portions off the conveyance system to remove the cut portions from the conveyance system, and deposit the cut portions at desired locations; and

(f) a control system processor operable to:

(i) process the scanning data and the desired physical specifications of the portions to determine the cutting paths required to cut the workpiece to achieve the desired physical specifications for the portions;

(ii) direct the cutting system to perform the required cuts; and

(iii) direct the at least one powered unloading system to pick up the cut portions from locations on the conveyance system as determined by the scanning data and **[**and**]** deposit the cut portions at desired locations.

2. The system according to claim **1**, wherein the at least one carrier system comprises an X-Y gantry system disposed over the conveyance system.

3. The system according to claim **2**, wherein said X-Y gantry system comprises a powered carriage on which the cutting system is mounted for moving relative to the conveyance system.

4. The system according to claim **3**, wherein the at least one powered unloading system is mounted on the same carriage on which the cutting system is mounted.

[5. The system according to claim **2**, wherein the at least one powered unloading system is supported and moved by the X-Y gantry system.**]**

6. The system according to claim **1**, wherein the cutting system is carried by a rotatable and extendable actuator located alongside the conveyance system.

7. The system according to claim **6**, wherein the at least one powered unloading system is operatively associated with the actuator used to carry the cutting system.

[8. The system according to claim **7**, wherein the at least one powered unloading system is carried by the same type of actuator used to carry the cutting system.**]**

[9. The system according to claim **8**, wherein the at least one powered unloading system is carried by the same type of actuator used to carry the cutting systems.**]**

10. The system according to claim **1**, wherein the carrier system comprises an automated, multi-directional actuator system capable of moving at least along, across, and diagonally relative to the conveyance system.

11. The system according to claim **10**, wherein the multi-directional actuator system is also capable of moving upward and downward relative to the conveyance system.

12. The system according to claim **11**, wherein the multi-directional actuator system comprises a plurality of sets of powered arm pairs, said arm pairs having upper ends and lower ends, the upper ends of the arm pairs are connected to a power pivot arm which in turn is connected to a powered rotor actuator, and the lower ends of the arm pairs are connected to a hub to which is mounted the cutting system.

13. The system according to claim **12**, wherein the at least one powered unloading system is carried by the same hub used to carry the cutting system.

[14. The system according to claim **12**, wherein the at least one powered unloading system is carried by the same type of hub used to carry the cutting system.**]**

[15. The system according to claim **12**, wherein the at least one powered unloading system is operably associated with the actuator system used to carry the cutting system.**]**

16. The system according to claim **1**, wherein the cutting system is selected from the group consisting of high-speed fluid jets, high-speed water jets, laser beams, knives, and saws.

17. The system according to claim **1**, wherein the at least one powered unloading system comprises at least one vacuum-operated actuator for attaching to the cut portions.

18. A system for cutting portions from a workpiece based on desired portion physical specifications resulting in one or more cut portions and remaining trim, and then unloading the cut portions to separate the cut portions from the remaining workpiece trim, comprising:

(a) a conveyance system for conveying the workpiece;

(b) a scanning system for scanning the workpiece and generating data pertaining to physical attributes of the workpiece;

(c) a cutting system for cutting portions from the workpiece;

(d) a carrier system for moving the cutting system laterally and longitudinally of the conveyance system along cutting paths to cut the workpiece into desired shapes and/or sizes:

(e) an unloading system operatively associated with the carrier system used to carry the cutting system, said unloading system operable to remove the cut portions from the conveyance system;

(f) a control system processor operable to:

(i) process the scanning data and portion physical specifications to determine cutting paths required to achieve desired portion physical specifications for the workpiece;

(ii) direct the cutting system to perform the required cuts; and

(iii) direct the unloading system to pick up the cut portions from the conveyance system and deposit the cut portions in desired locations based on the known location of the cut portions as determined by scanning and cutting the workpiece; and

(g) wherein the at least one unloading system comprises at least one vacuum-operated actuator for attaching to the cut portions, the at least one vacuum-operated actuator comprising:

(i) a vacuum head for attaching to the cut portions and connectable to a vacuum stream in flow communication with the vacuum head;

(ii) a separation screen between the vacuum head and the vacuum stream; and

(iii) a source of pressurized fluid to direct pressurized fluid at the separation screen in a direction toward the vacuum head.

19. The system according to claim **18**, further comprising an actuator system connected to the vacuum head to raise and lower the vacuum head.

[20. The system according to claim **19**, comprising a plurality of vacuum actuators disposed in sets for unloading a plurality of cut portions from the conveyance system.**]**

21. The system according to claim **1**, wherein the at least one powered unloading system comprises a suction head connectable in suction flow communication with a source of suction, said suction head having an inlet of a minimum width large enough to enable entry of the cut portions through the suction head for removing the cut portions from the conveyance system.

22. The system according to claim **1**, wherein said at least one carrier system comprises a traveling head movable laterally and longitudinally relative to the conveyance system and adapted to carry one or both of the cutting system and the at least one powered unloading system.

23. The system according to claim **1**, further comprising a plurality of carrier systems for carrying together both a cutting system and at least one powered unloading system to remove the cut portions from the conveyance system and place said removed cut portions at selected locations away from the conveyance system.

[24. The system according to claim **23**, wherein said carrier systems are positioned and controlled to operate within designated areas of the conveyance system, said designated areas comprising at least two areas in a direction laterally of the direction of travel of the conveyance system.**]**

[25. The system according to claim **1**, wherein the cutting system can be replaced with one or more unloading systems and the unloading system can be replaced with one or more cutting systems.**]**

26. The system according to claim **1**, wherein the control system processor is operable to control the cutting system to cut the workpiece; and then control one or both the unloading system and the conveyance system to pick up the cut portions of the workpiece from the conveyance system before the cut portions travel beyond the range of the at least one carrier system on which the cutting system and powered unloading system are both mounted.

[27. The system according to claim **1**, wherein the control system processor is selectively operable to:

operate the cutting system while the unloading system remains inoperative; and

operate the at least one powered unloading system while the cutting system remains inoperable.**]**

28. The system according to claim **1**, further comprising a trim sweep system to move the trim relative to the conveyance system to one or more desired locations on the conveyance system and/or to one or more locations off of the conveyance system.

29. The system according to claim **28**, wherein the trim sweep system is selected from the group consisting of: a fluid stream; an air knife; a blade mounted on the unloading system; a blade mounted on the conveyance system; and a blade mounted on a frame adjacent the conveyance system.

[30. A system for cutting portions from workpieces based on desired portion physical specifications of the cut portions resulting in one or more cut portions and remaining trim and then unloading the cut portions to separate the workpiece cut portions from any workpiece trim, comprising:

(a) a conveyance system to convey the workpieces;

(b) a scanning system for scanning the conveyed workpieces and generating data related to the physical specifications of the workpiece and to the location of the workpiece on the conveyance system;

(c) a powered cutting system for cutting the workpieces into portions of desired specifications;

(d) a carrier system for supporting and moving the cutting system laterally and longitudinally of the conveyance system, thereby to move the cutting system along desired paths relative to the workpieces to cut the workpieces into portions of desired specifications;

(e) an unloading system movable laterally and longitudinally relative to the conveyance system and vertically relative to the conveyance system to attach to the cut portions of the workpieces, lift the cut portions off the conveyance system, and move the lifted cut portions to desired locations;

(f) a trim sweep system to move or sweep the workpiece trim remaining subsequent to the cutting of portions from the workpieces to one or more desired locations on the conveyance system and/or to one or more locations removed away from the conveyance system; and

(g) a control system to:

process the scanning data and portioning specifications to determine the cut paths required to achieve the desired shapes and sizes of the cut portions; and

direct the powered cutting system to perform the required cuts of the workpieces;

control the unloading system to pick up the cut portions of the workpieces based on the known location of the cut portions on the conveyance system as determined by the scanning data and deposit the cut portions at desired locations; and

direct the workpiece trim sweeping system to remove the workpiece trim to the one or more desired locations on the conveyance system and/or the one or more desired locations remote from the conveyance system.**]**

[31. The system according to claim **30**, wherein after the removal of the trim, the unloading system deposits the portions lifted from the conveyance system back on to the conveyance system in the same general location that the portions were removed from the conveyance system.**]**

[32. The system according to claim **30**, wherein the trim sweep system comprises: one or more air nozzles; one or more air knives or a source of compressed air, carried by the same carrier used to carry the unloading system.]

[**33**. The system according to claim **30**, further comprising a frame for supporting the cutting system and the unloading system, and wherein the trim sweeping system comprises: air nozzles; air knives or a source of compressed air, mounted on the frame.]

[**34**. The system according to claim **30**, wherein the trim sweep system comprising one or more blades mounted on the unloading system or mounted on a frame adjacent the conveyance system.]

35. A system for cutting portions from food products based on desired portion physical specifications resulting in one or more cut portions and remaining trim and then unloading the cut portions to separate the cut portions from the trim, comprising:

(a) a conveyor to convey the food products to be cut;

(b) a scanner for scanning the food products and generating data pertaining to the physical specifications of the food product and the location of the food product on the conveyor;

(c) a cutter for cutting the food products into portions of desired physical specifications;

(d) a carrier for supporting and carrying the cutter to move both along and transversely to the conveyor;

(e) an unloader carried by a powered actuator to move relative to the conveyor both along and transversely to the conveyor, said unloader comprising:

a suction head capable of connection to a vacuum stream from a vacuum source;

a screen disposed between the suction head and the vacuum source to restrict the size of portions of the food product capable of entering the vacuum stream;

the suction head capable of receiving pressurized fluid for directing the pressurized fluid at the screen in a direction toward the suction head; and

(f) a controller operable to:

process the scanning data and portioning specification settings to determine the cut paths through which the cutter must be moved to achieve portions of desired physical specifications;

direct the cutter along the determined cut paths; and

direct the unloader to pick up the cut portions and deposit the cut portions at desired locations based upon the location of the cut portions as determined by the scanning data.

36. The system according to claim **35**, wherein the controller is also operable to direct the pressurized fluid at the screen in the direction toward the suction head.

37. The system according to claim **1**, wherein the at least one powered unloading system comprises at least one vacuum-actuator connectable to a vacuum stream and configured to attach to the cut portions, said vacuum-actuator comprising a filter to restrict the size of the cut portions capable of entering the vacuum stream.

38. The system according to claim **1**, wherein the control system processor controls the at least one powered unloading system to deposit the cut portions at specific locations based on the physical specifications of the cut portions.

[**39**. The system according to claim **20**, wherein the plurality of vacuum actuators are operable to unload a plurality of cut portions from the conveyance system simultaneously.]

40. A system for cutting portions from a workpiece based on desired physical specifications of the cut portions resulting in one or more cut portions and remaining trim, and then unloading the cut portions from a conveyance system, comprising:

(a) a scanning system for scanning the workpiece and generating data pertaining to physical specifications of the workpiece and to the location of the workpiece on the conveyance system;

(b) a cutting system for cutting one or more portions from the workpiece;

(c) at least one carrier system for supporting and moving the cutting system to cut the workpiece into portions per desired physical specifications;

(d) at least one powered unloading system operatively associated with the at least one carrier system, said unloading system operable to lift the cut portions off the conveyance system to deposit the cut portions at desired locations; and

(e) wherein the at least one powered unloading system comprises a suction head connectable in suction flow communication with a source of suction, said suction head having an inlet of a minimum width large enough to enable entry of the cut portions through the suction head;

(f) a control system processor operable to:

(i) process the scanning data and the desired physical specifications of the portions to determine the cutting paths required to cut the workpiece to achieve the desired physical specifications for the portions;

(ii) direct the at least one powered unloading system to pick up the cut portions from locations on the conveyance system as determined by the scanning data and deposit the cut portions at desired locations.

41. The system according to claim 40, wherein the cutting system is carried by a rotatable and extendable actuator located alongside the conveyance system.

42. The system according to claim 40, wherein the carrier system comprises an automated, multi-directional actuator system capable of moving at least along, across, and diagonally relative to the conveyance system.

43. The system according to claim 42, wherein the multi-directional actuator system is also capable of moving upward and downward relative to the conveyance system.

44. The system according to claim 40, wherein the cutting system is selected from the group consisting of high-speed fluid jets, high-speed water jets, laser beams, knives, and saws.

45. The system according to claim 40, wherein the control system processor is operable to control the cutting system to cut the food item; and then control one or both the unloading system and the conveyance system to pick up the cut portions of the food item from the conveyance system before the cut portions travel beyond the range of the unloading system.

46. In a system for cutting portions from a workpiece based on desired physical specifications of the cut portions resulting in one or more cut portions and remaining trim, an unloading system for unloading the cut portions from a conveyance system, comprising:

(a) a scanning system for scanning the workpiece and generating data pertaining to physical specifications of the workpiece and to the location of the workpiece on the conveyance system;

(b) at least one powered unloading system operable to lift the cut portions off the conveyance system to deposit the cut portions at desired locations; and

(c) wherein the at least one powered unloading system comprises a suction head connectable in suction flow communication with a source of suction, said suction

head having an inlet of a minimum width large enough to enable entry of the cut portions through the suction head;

(d) a control system processor operable to:

(i) process the scanning data and the desired physical specifications of the portions; and

(ii) direct the at least one powered unloading system to pick up the cut portions from locations on the conveyance system as determined by the scanning data and deposit the cut portions at desired locations.

47. The system according to claim 46, wherein the control system controls the unloading system for moving the suction head upward and downward relative to the conveyor system.

48. A system for cutting portions from a workpiece based on desired physical specifications of the cut portions resulting in one or more cut portions and trim, and then unloading the trim from a conveyance system, comprising:

(a) a scanning system for scanning the workpiece and generating data pertaining to physical specifications of the workpiece and to the location of the workpiece on the conveyance system;

(b) a cutting system for cutting one or more portions from the workpiece;

(c) at least one carrier system for supporting and moving the cutting system to cut the workpiece into portions per desired physical specifications;

(d) at least one powered unloading system operatively associated with the at least one carrier system, said unloading system operable to lift the trim off the conveyance system to deposit the trim at desired locations; and

(e) wherein the at least one powered unloading system comprises a suction head connectable in suction flow communication with a source of suction, said suction head having an inlet of a minimum width large enough to enable entry of the trim through the suction head;

(f) a control system processor operable to:

(i) process the scanning data and the desired physical specifications of the portions to determine the cutting paths required to cut the workpiece to achieve the desired physical specifications for the portions;

(ii) direct the at least one powered unloading system to pick up the trim from locations on the conveyance system as determined by the scanning data and deposit the trim at desired locations.

49. The system according to claim 48, wherein the carrier system comprises an automated, multi-directional actuator system capable of moving at least along, across, and diagonally relative to the conveyance system.

50. The system according to claim 49, wherein the multi-directional actuator system is also capable of moving upward and downward relative to the conveyance system.

51. The system according to claim 48, wherein the control system processor is operable to control the cutting system to cut the food item; and then control one or both the unloading system and the conveyance system to pick up the trim of the food item from the conveyance system before the trim travels beyond the range of the unloading system.

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