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(54) **SYSTEM AND METHOD FOR TESTING OR CALIBRATING IN A PRESSURIZED AND/OR WET ENVIRONMENT**

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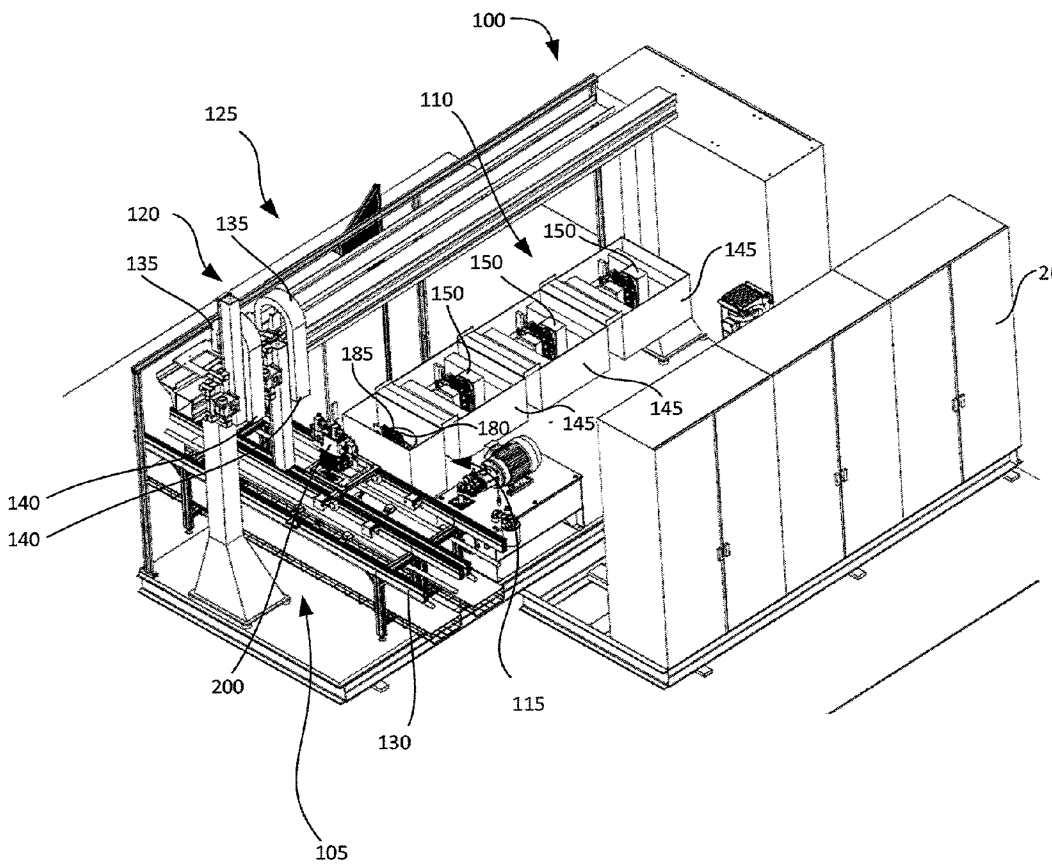
(57) **ABSTRACT**

A system for testing or calibrating a part, the system including: a plurality of test stations, each test station including a container and a clamping mechanism, wherein the clamping mechanism includes: a clamp frame including: two clamp plates; a plurality of clamp bars configured to securely hold the clamp plates at a distance relative to each other; a seal manifold provided on one of the two clamp plates; and a clamping module, located opposite the seal manifold on another of the two clamp plates, wherein the clamping module includes: a plurality of pistons to hold the part against the seal manifold for the test operation; and at least one cleaning station comprising a spin mechanism for spinning the part to remove excess fluid; and a robotic system for moving individual parts to and from the plurality of test stations and to and from the at least one cleaning station.



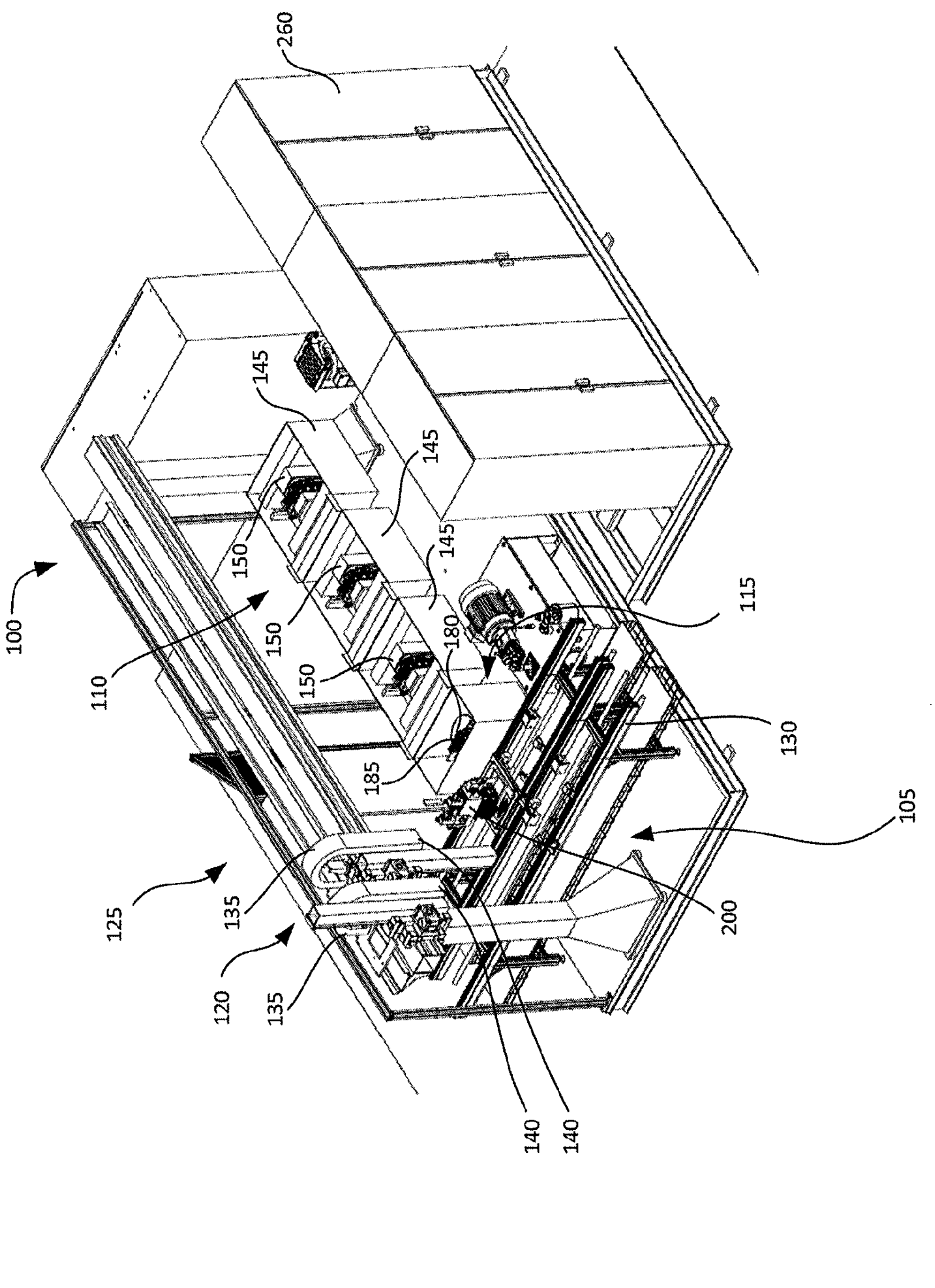

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Figure 1

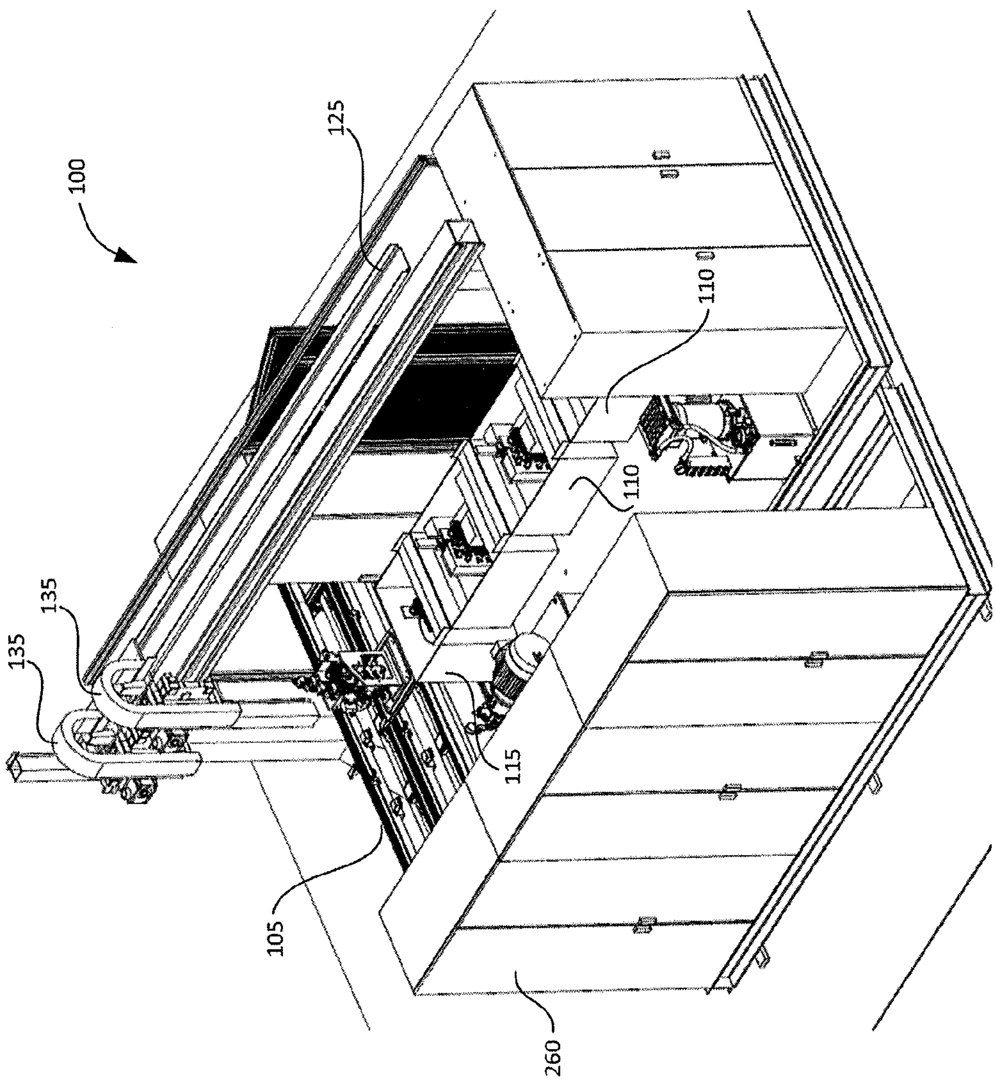

Figure 2

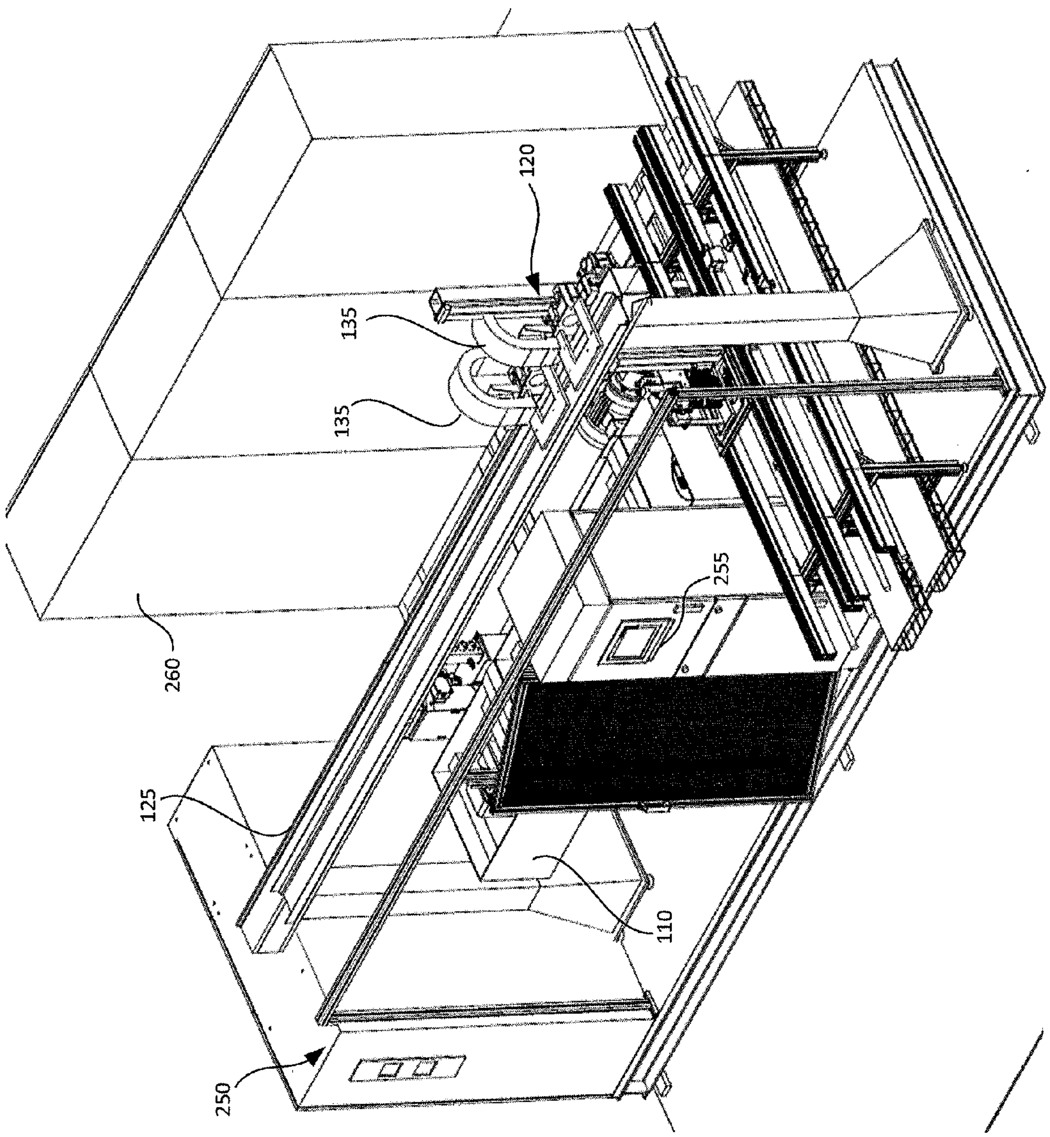

Figure 3

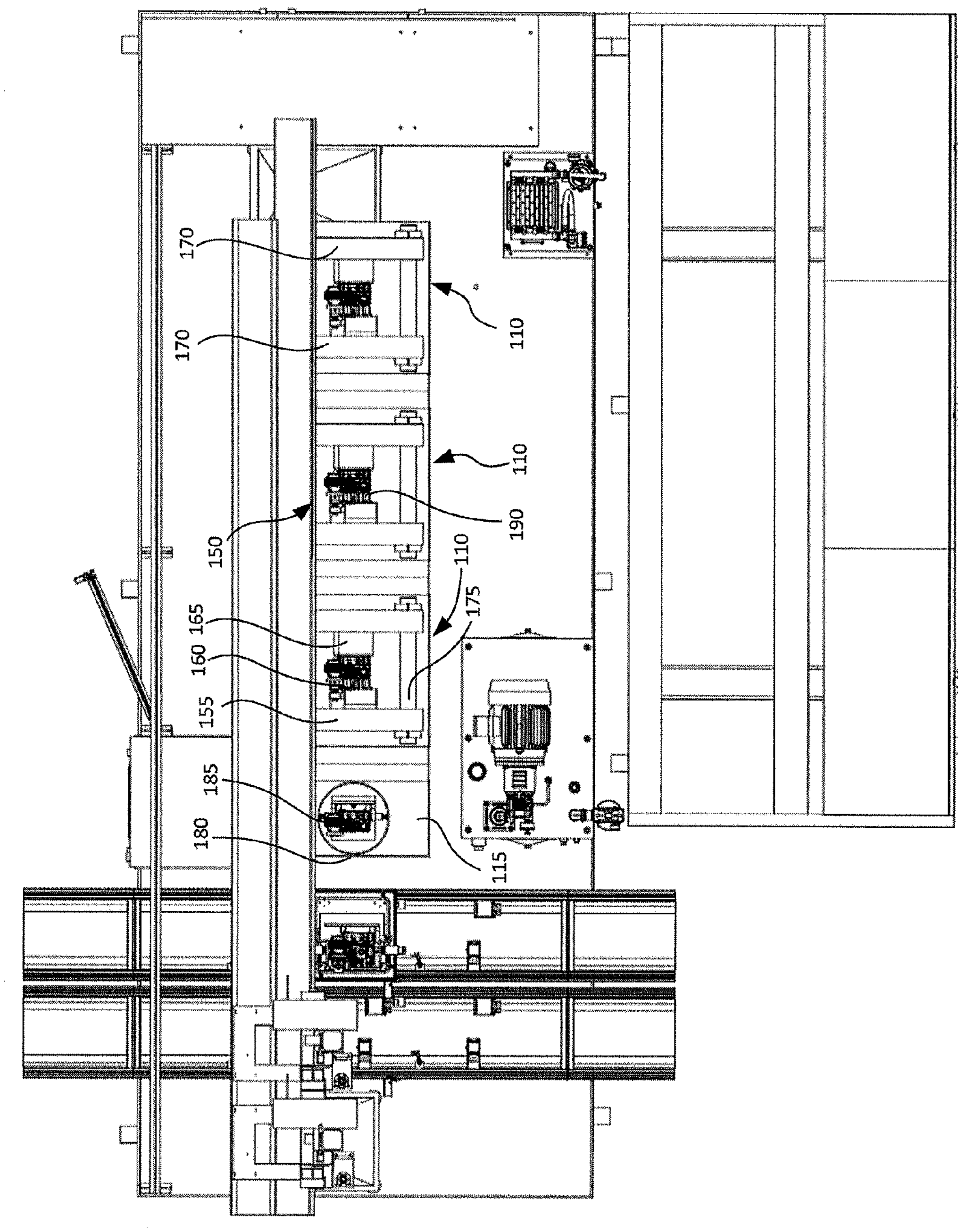

Figure 4

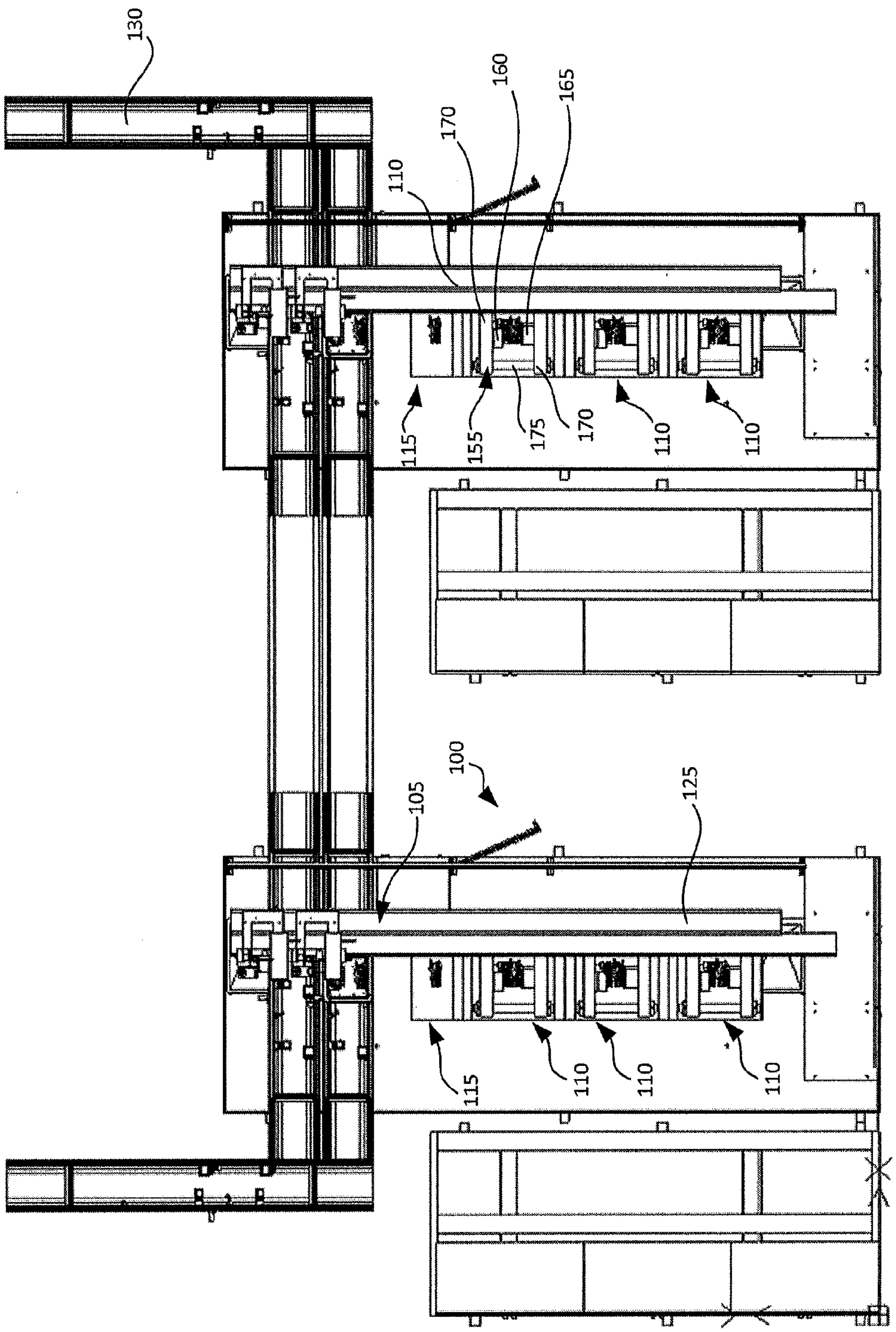
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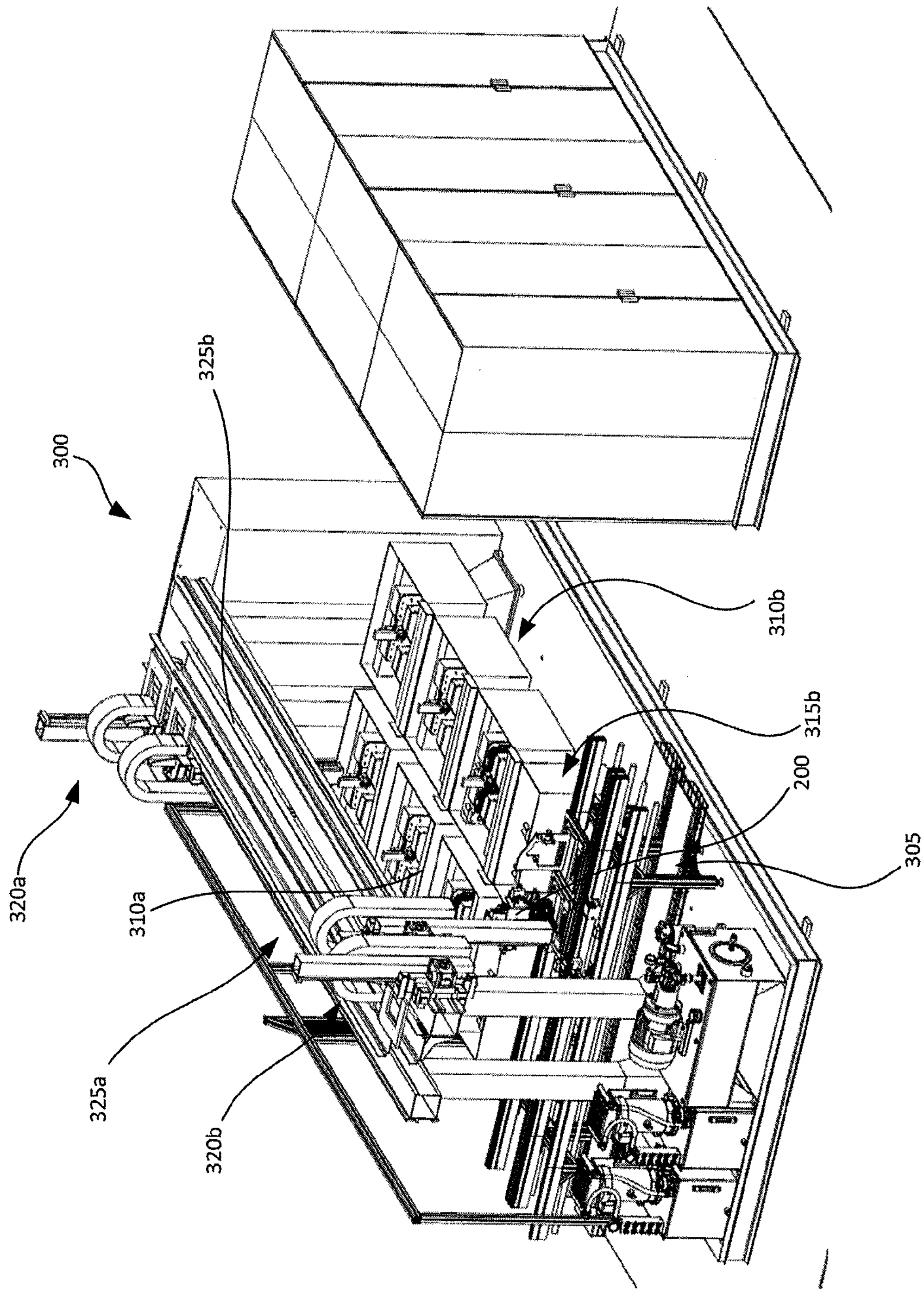
Figure 5



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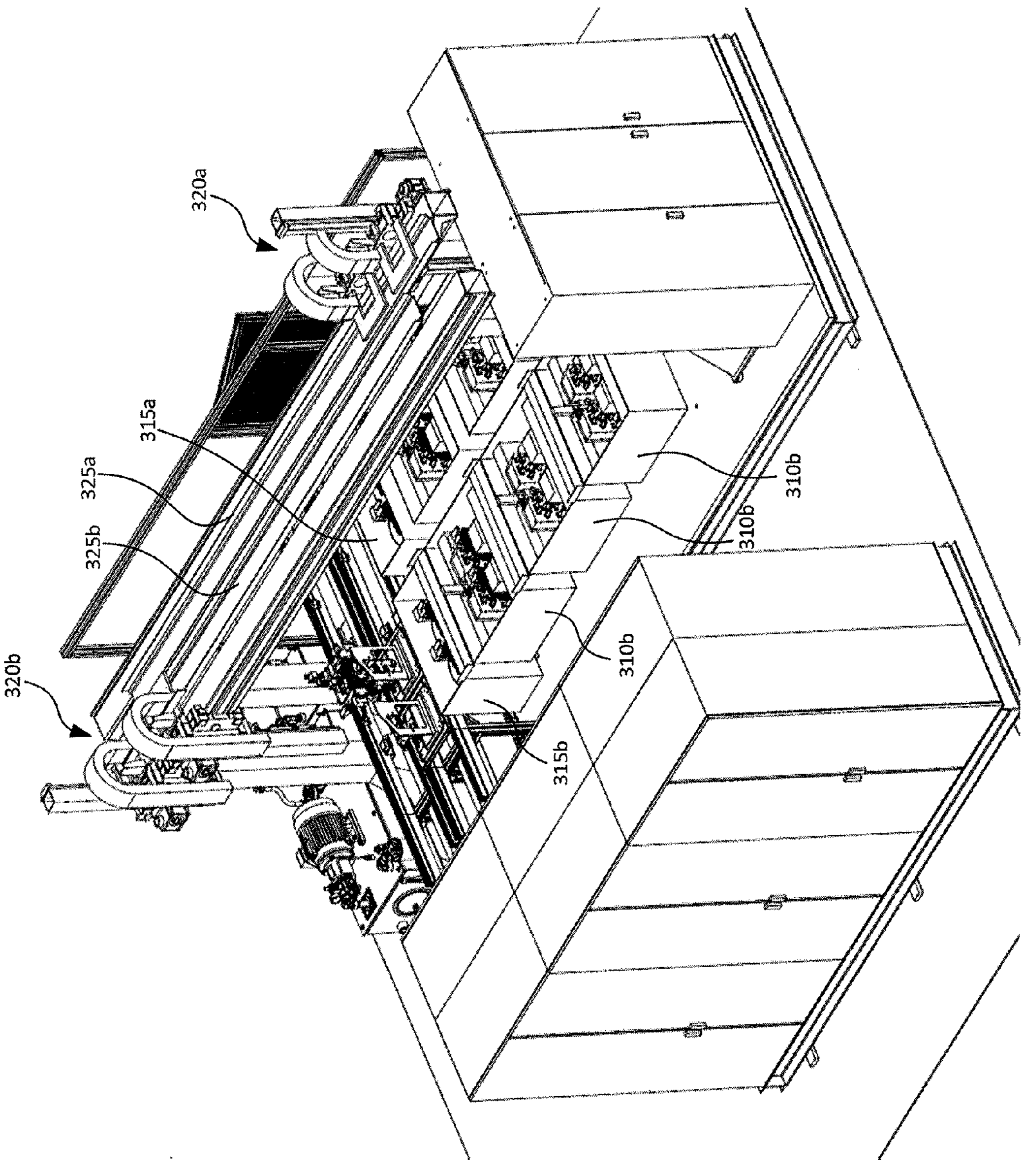

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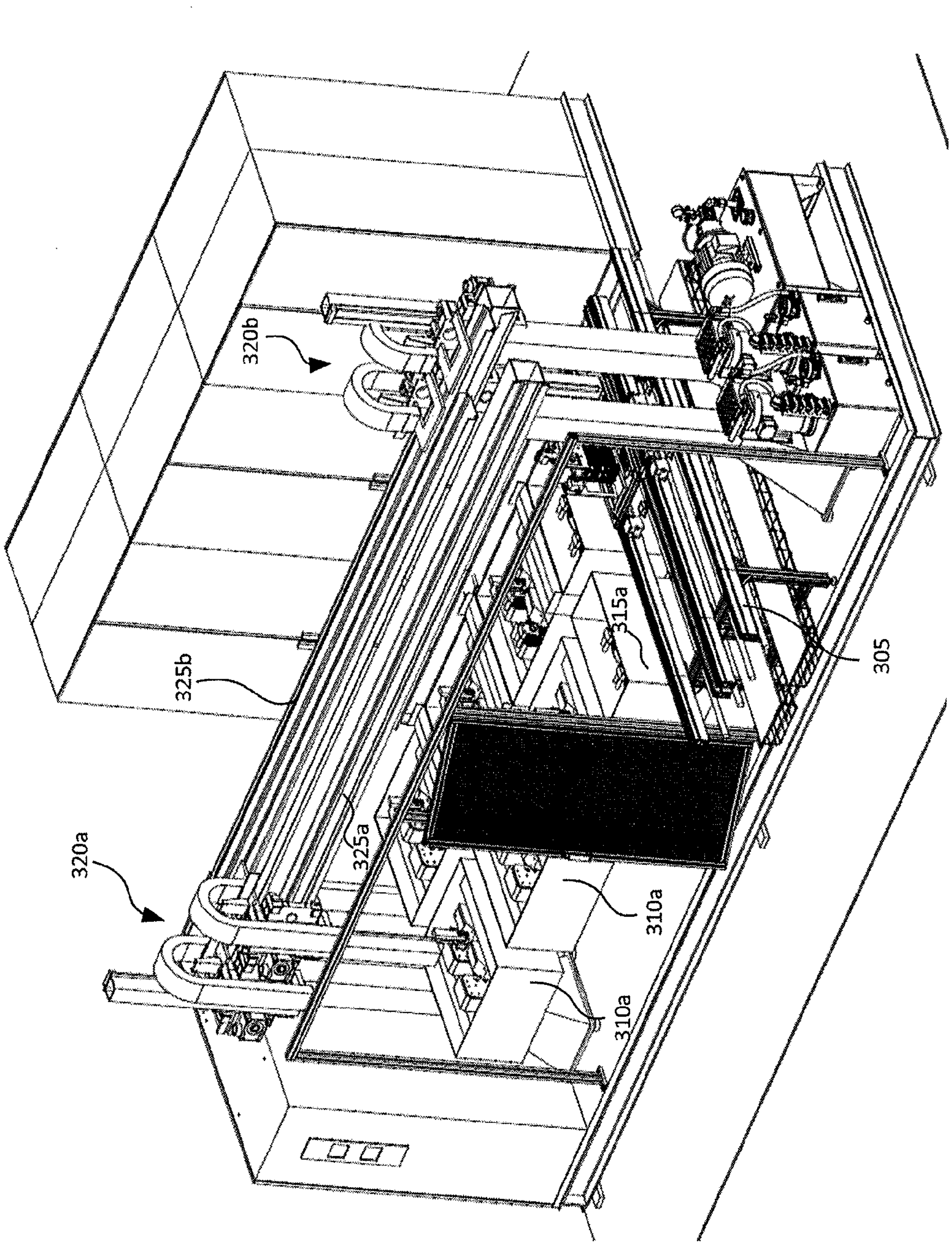

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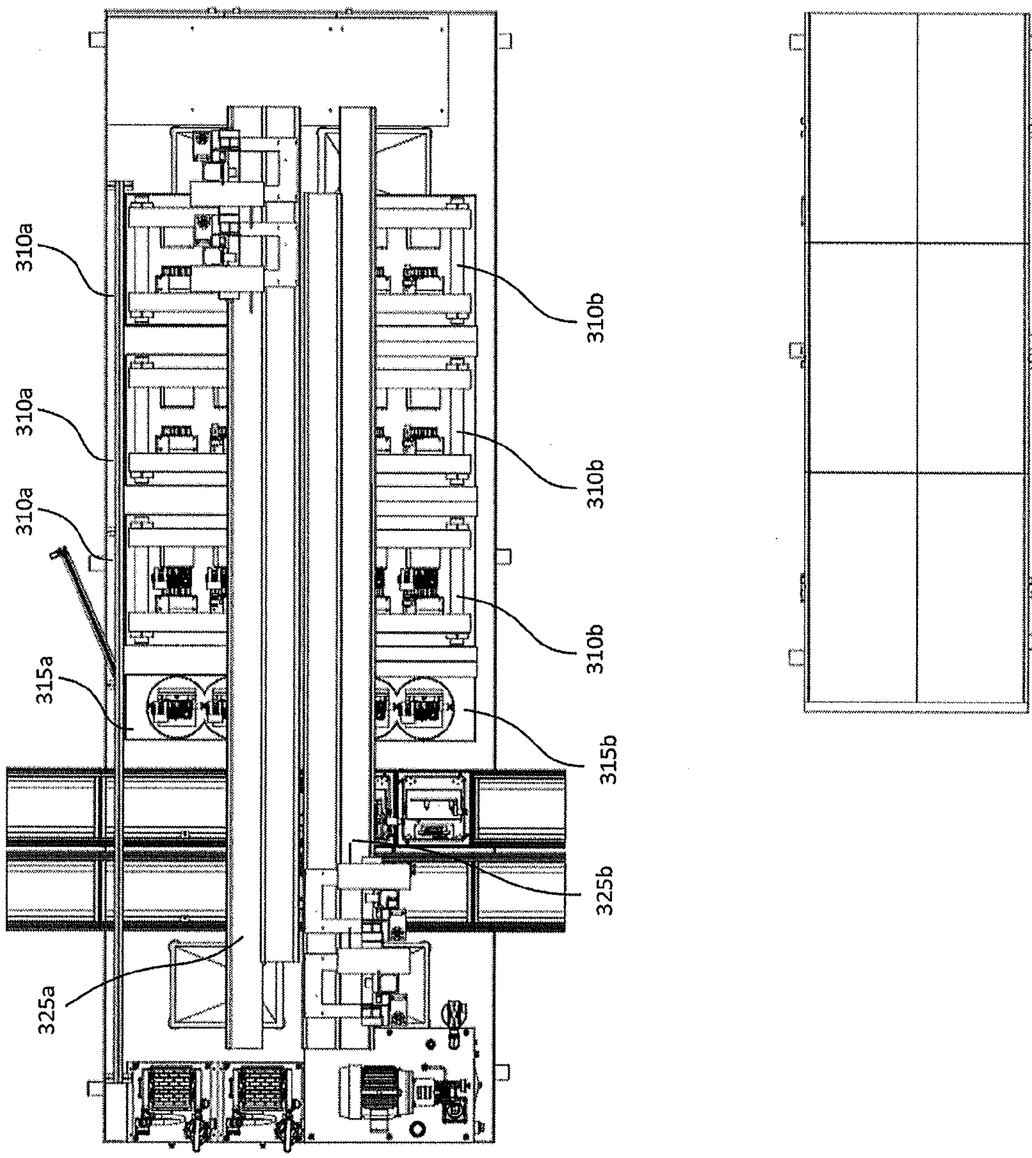

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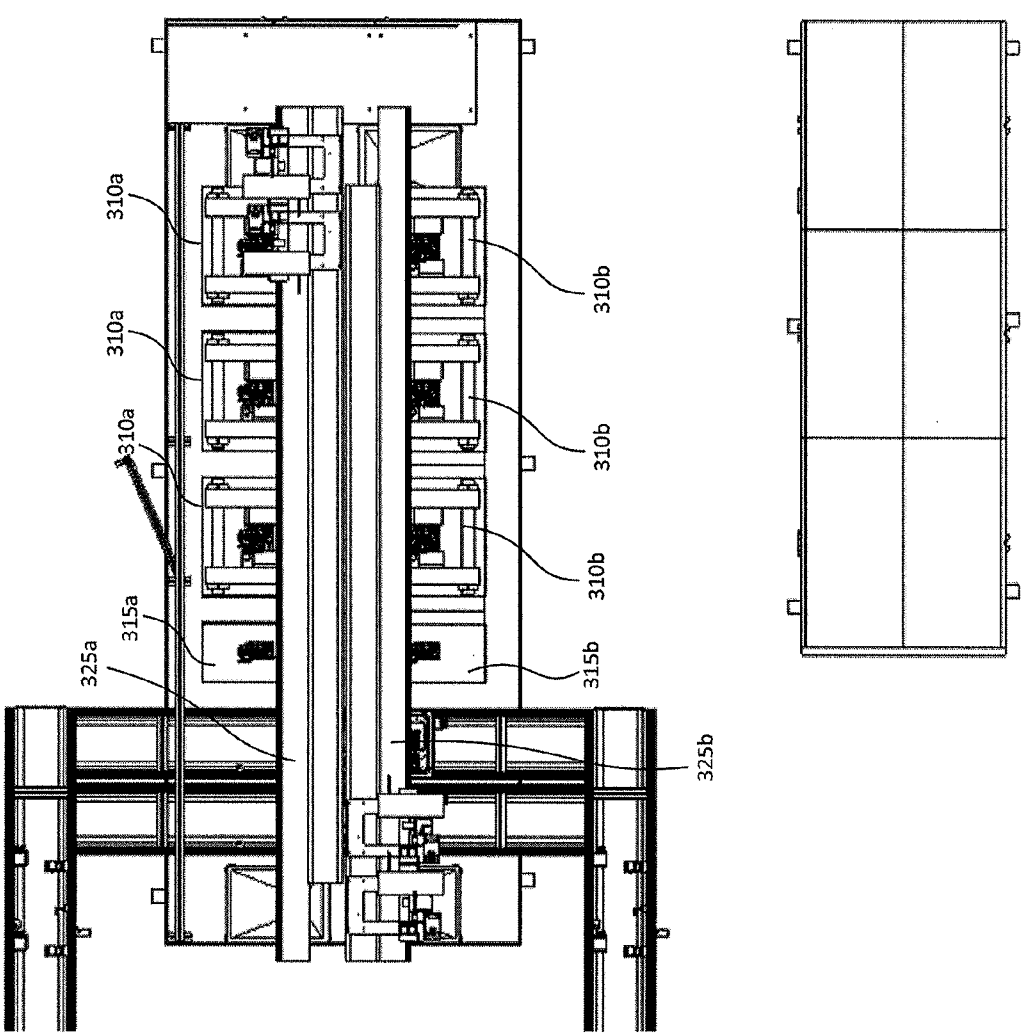

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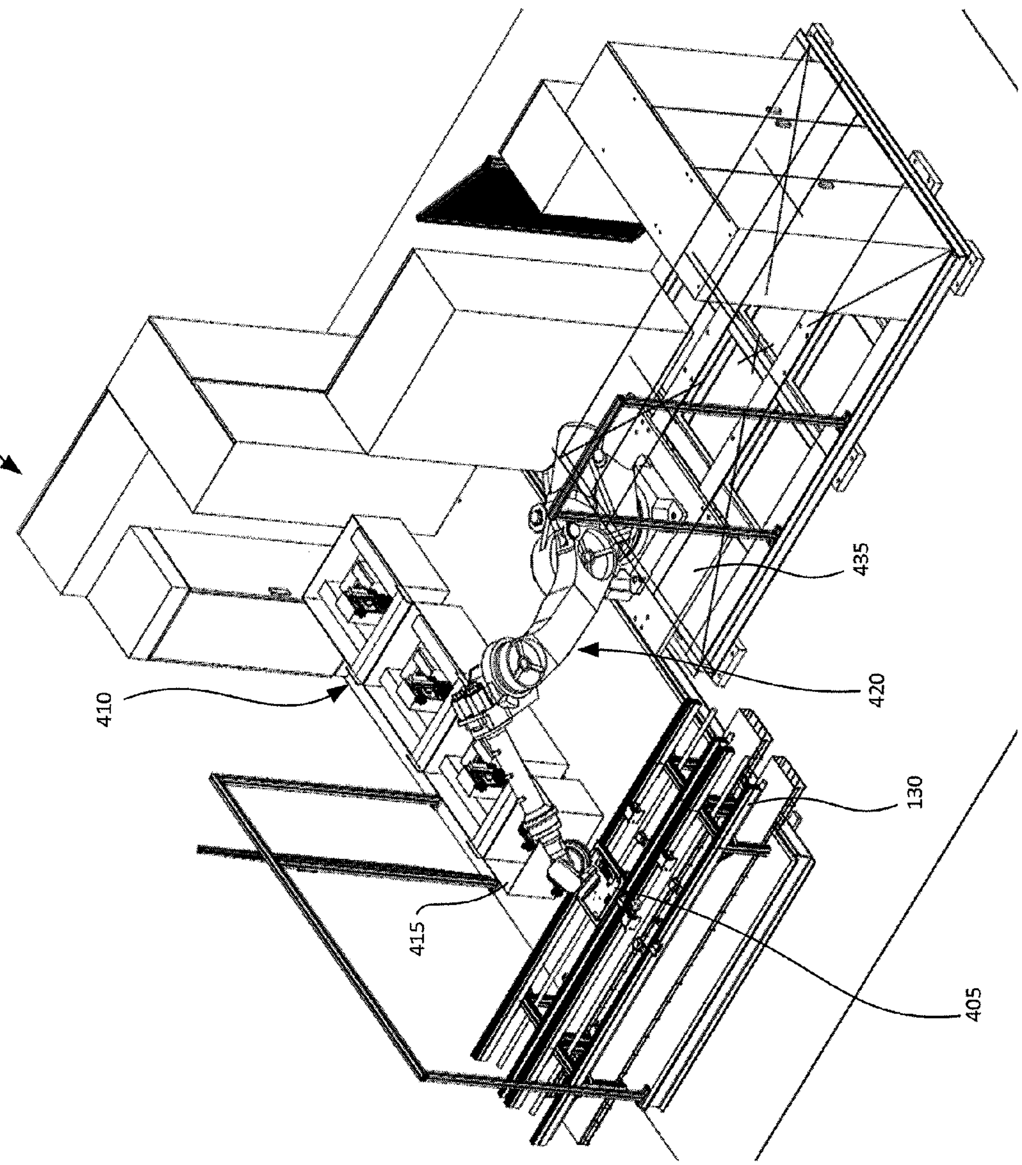

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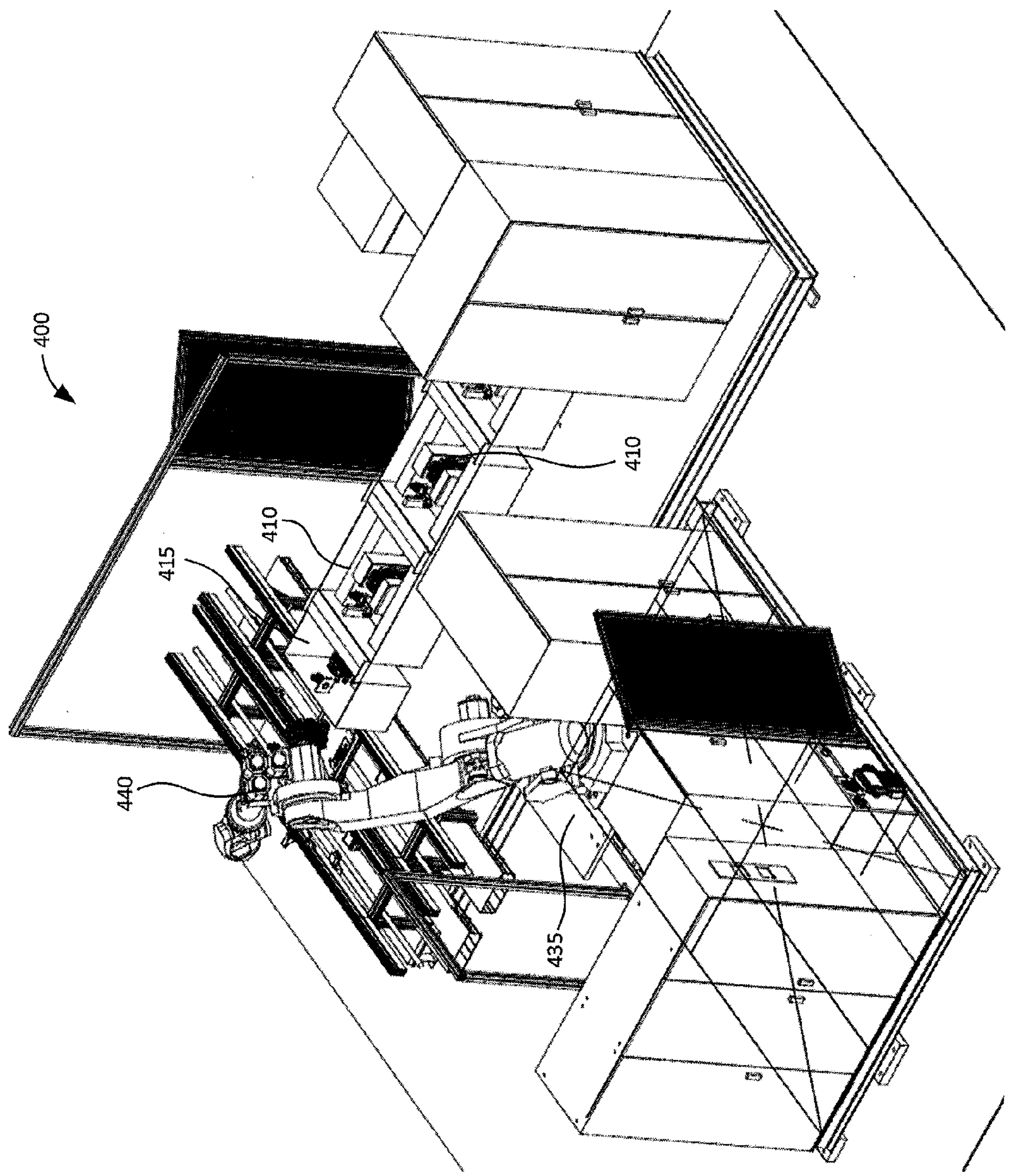

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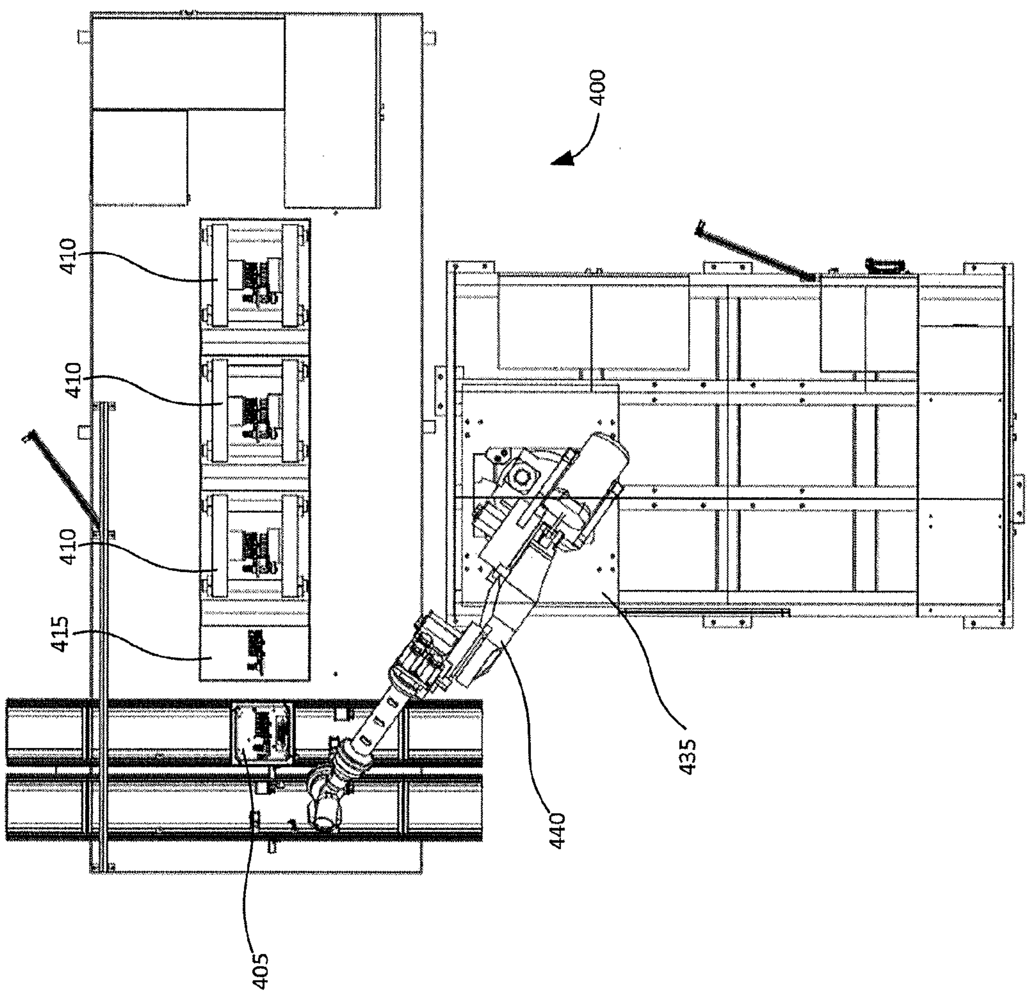

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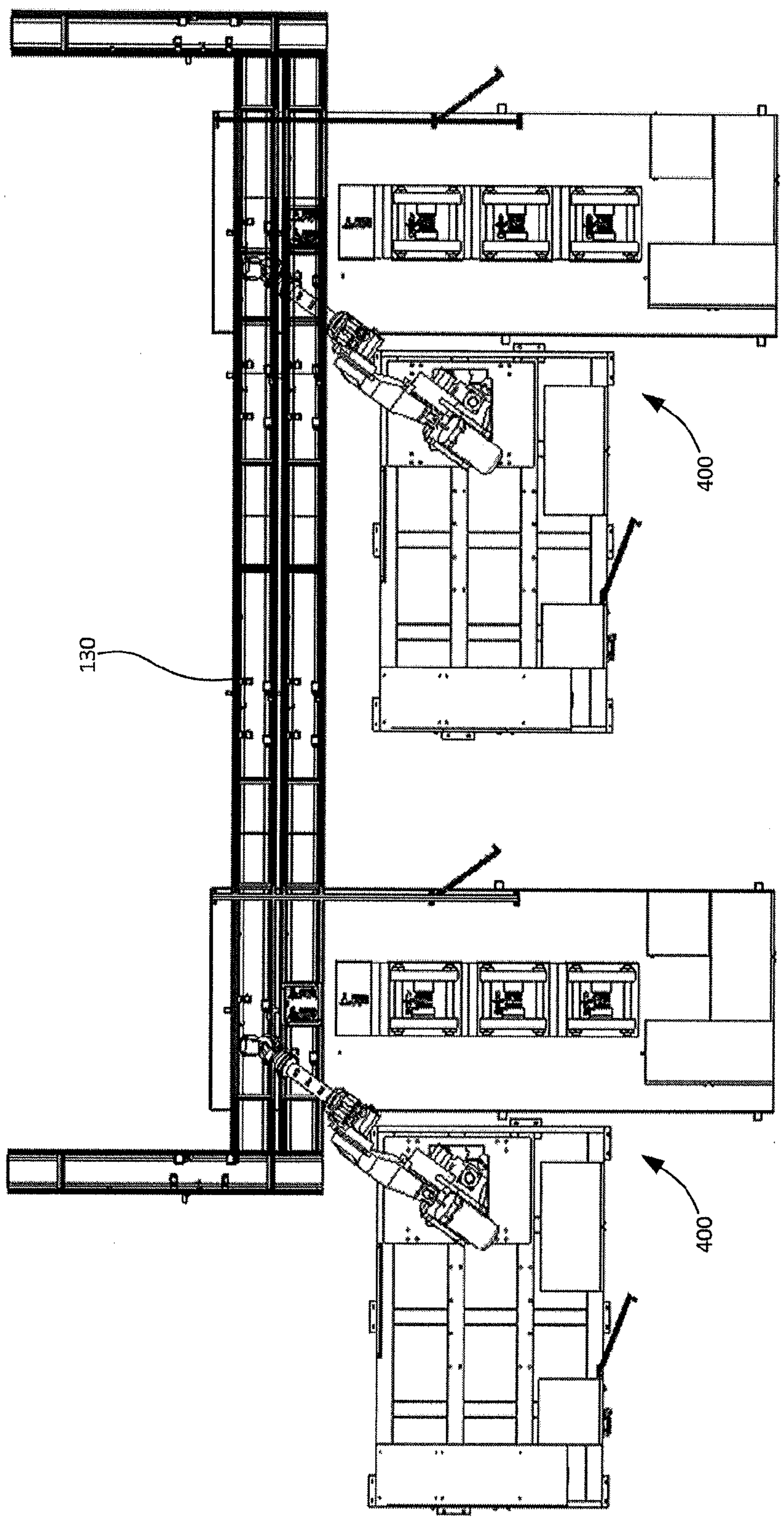

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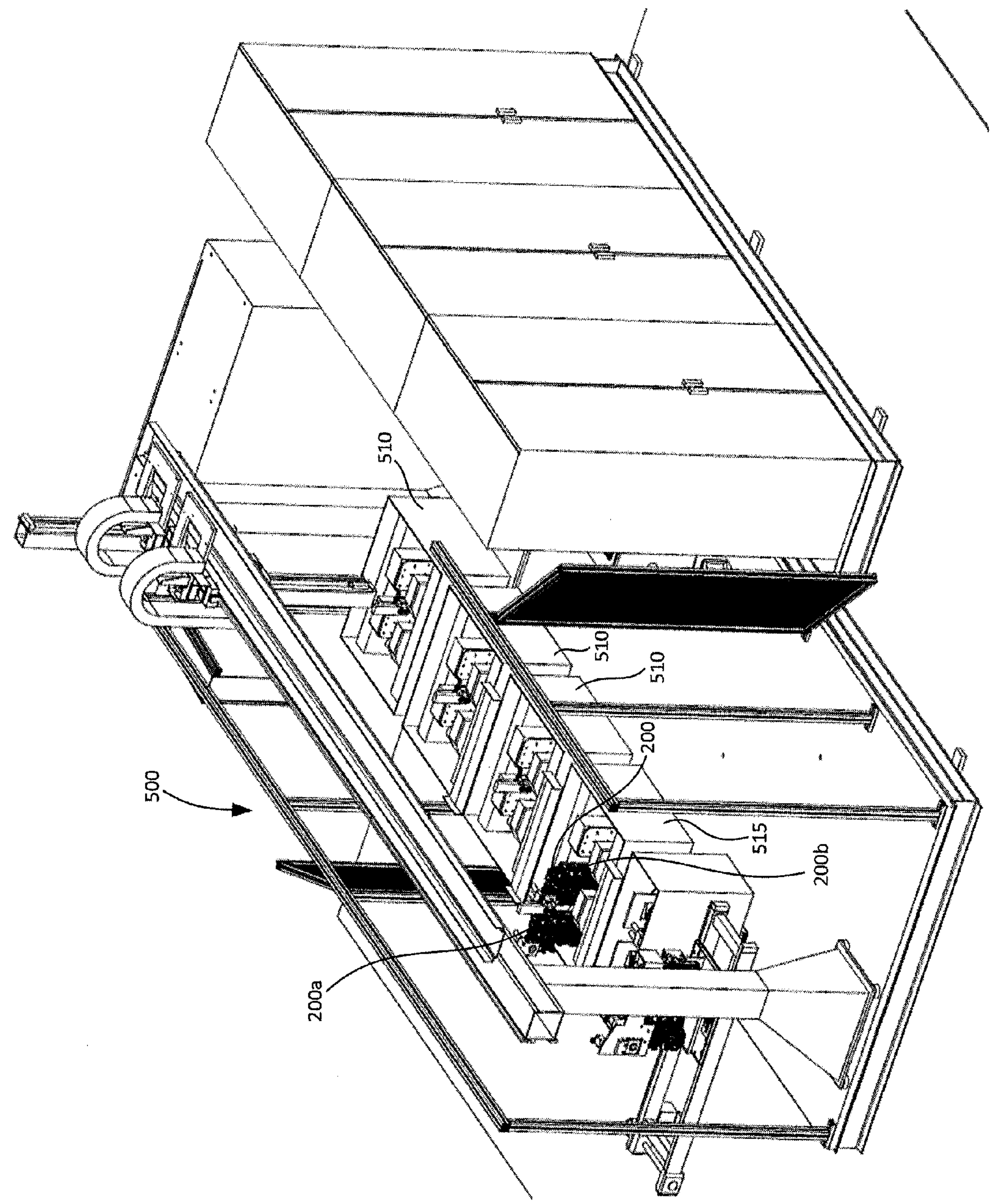

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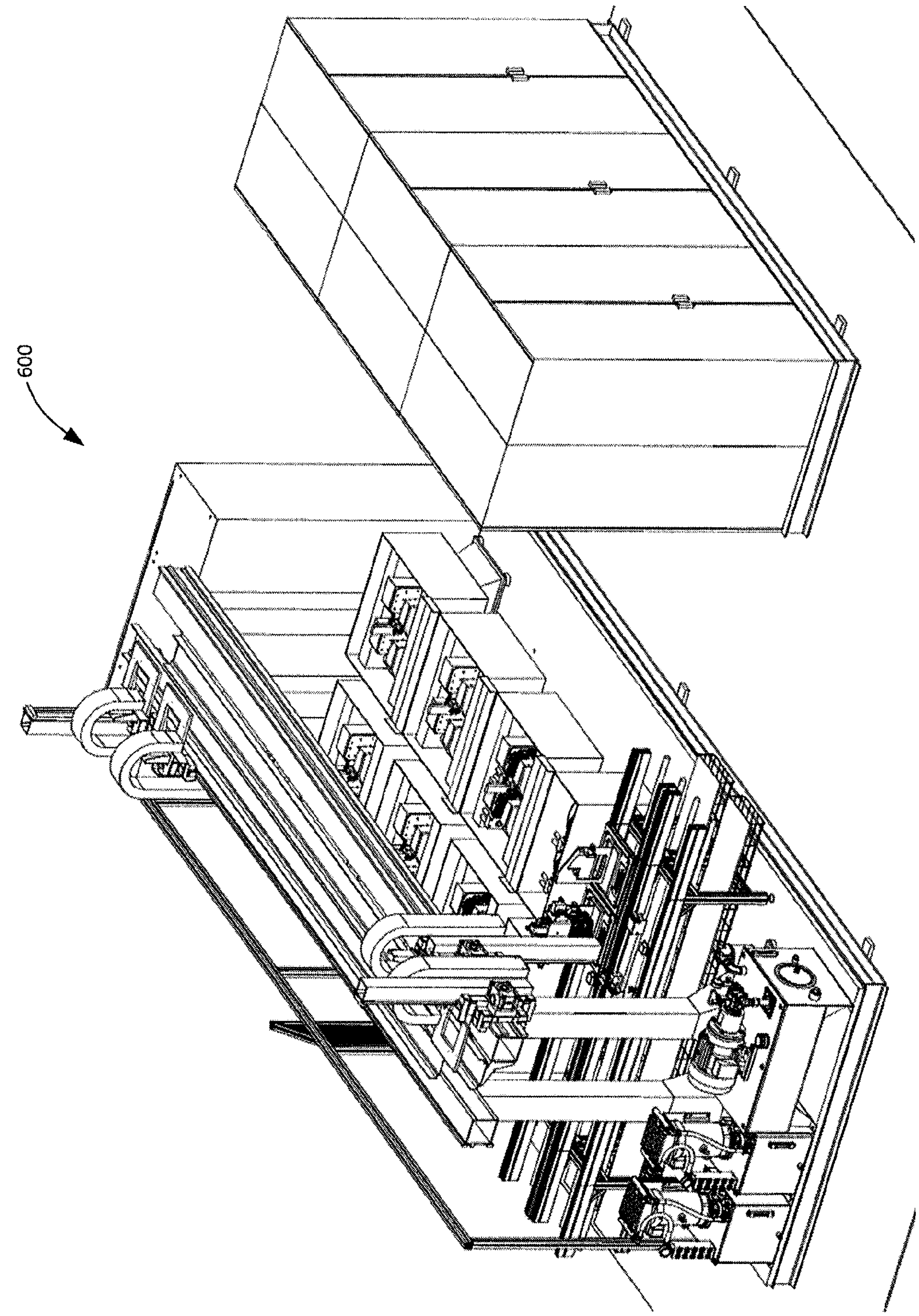

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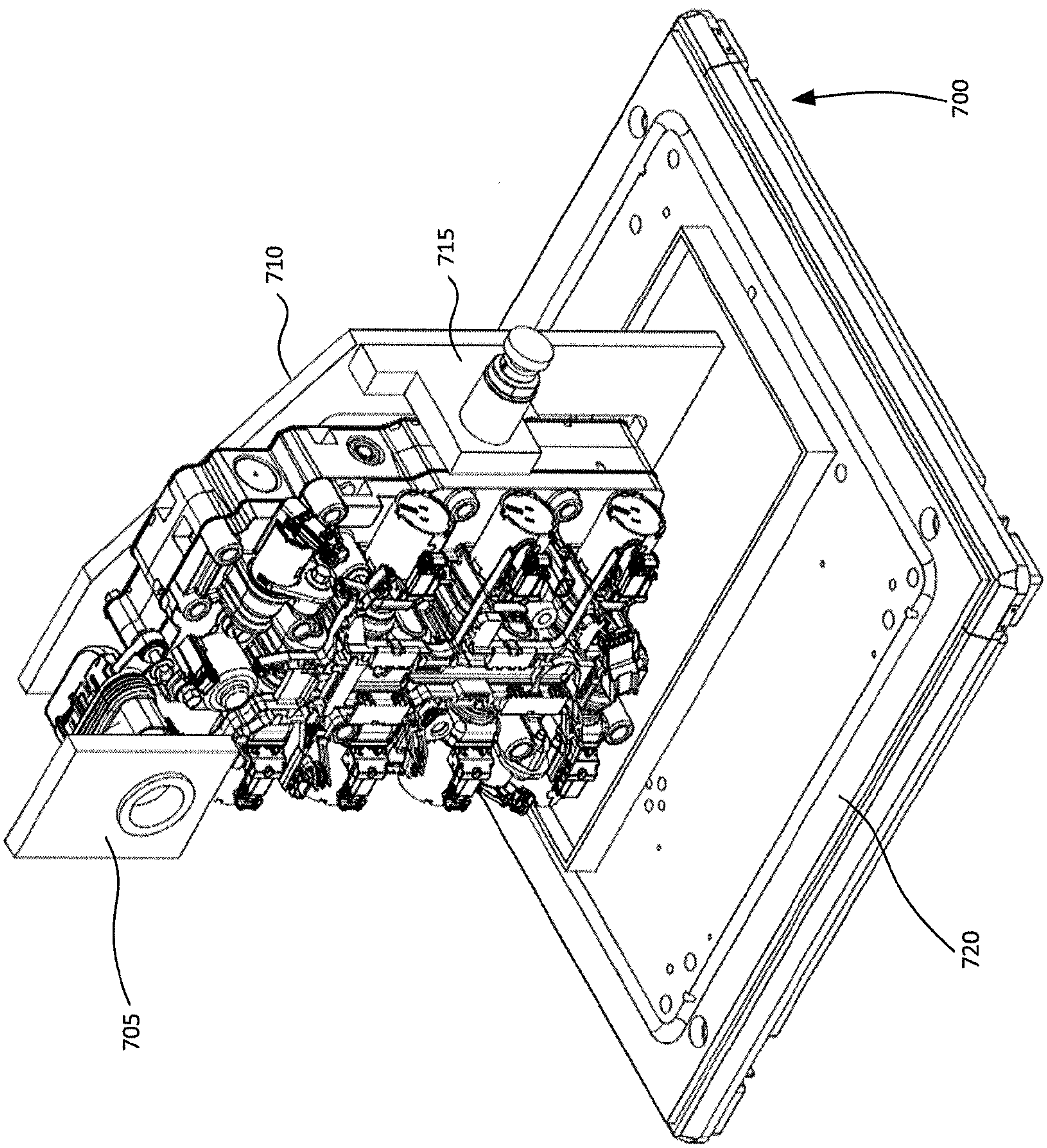

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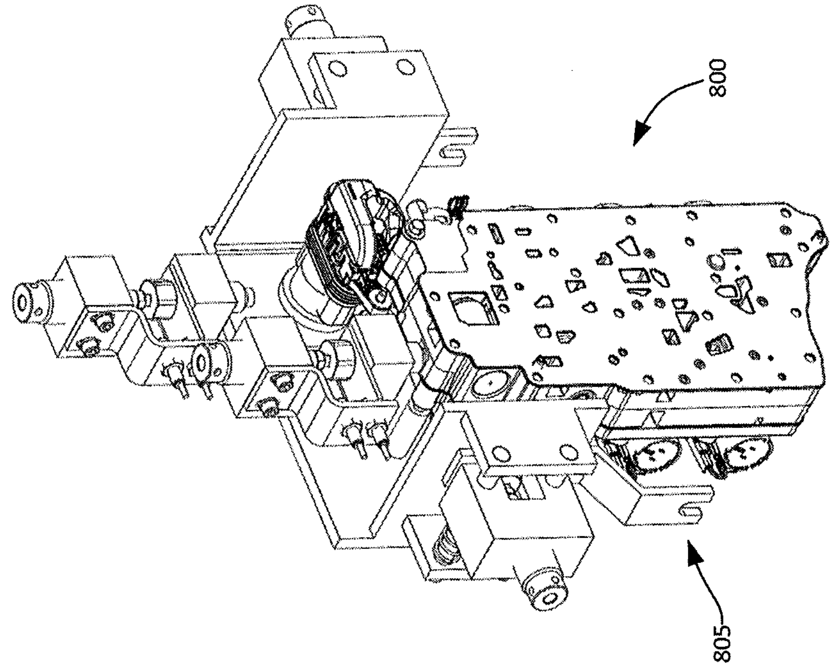


Figure 18B

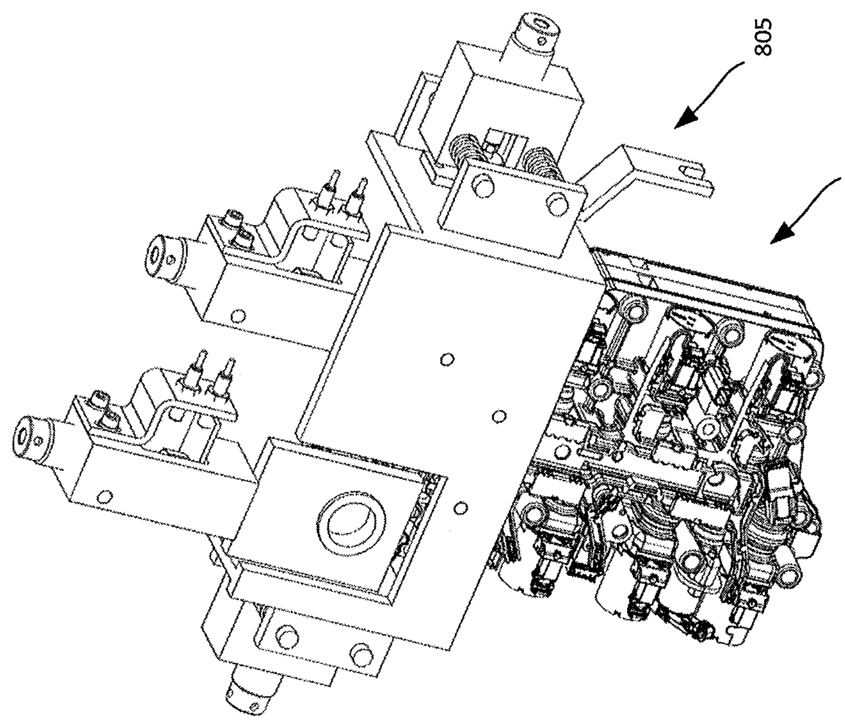
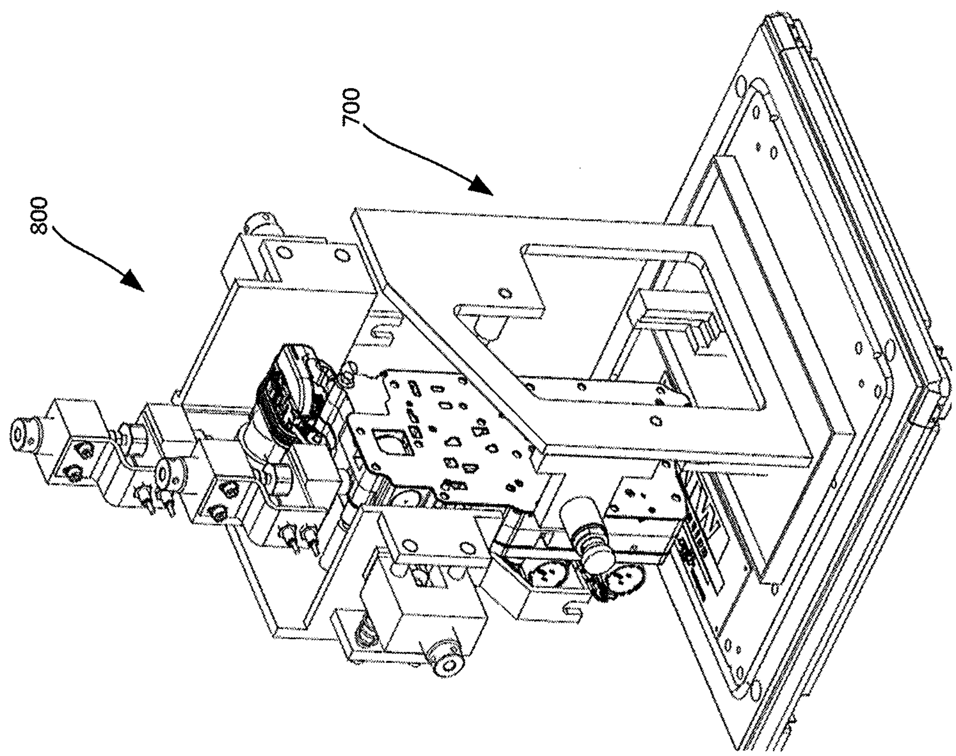


Figure 18A



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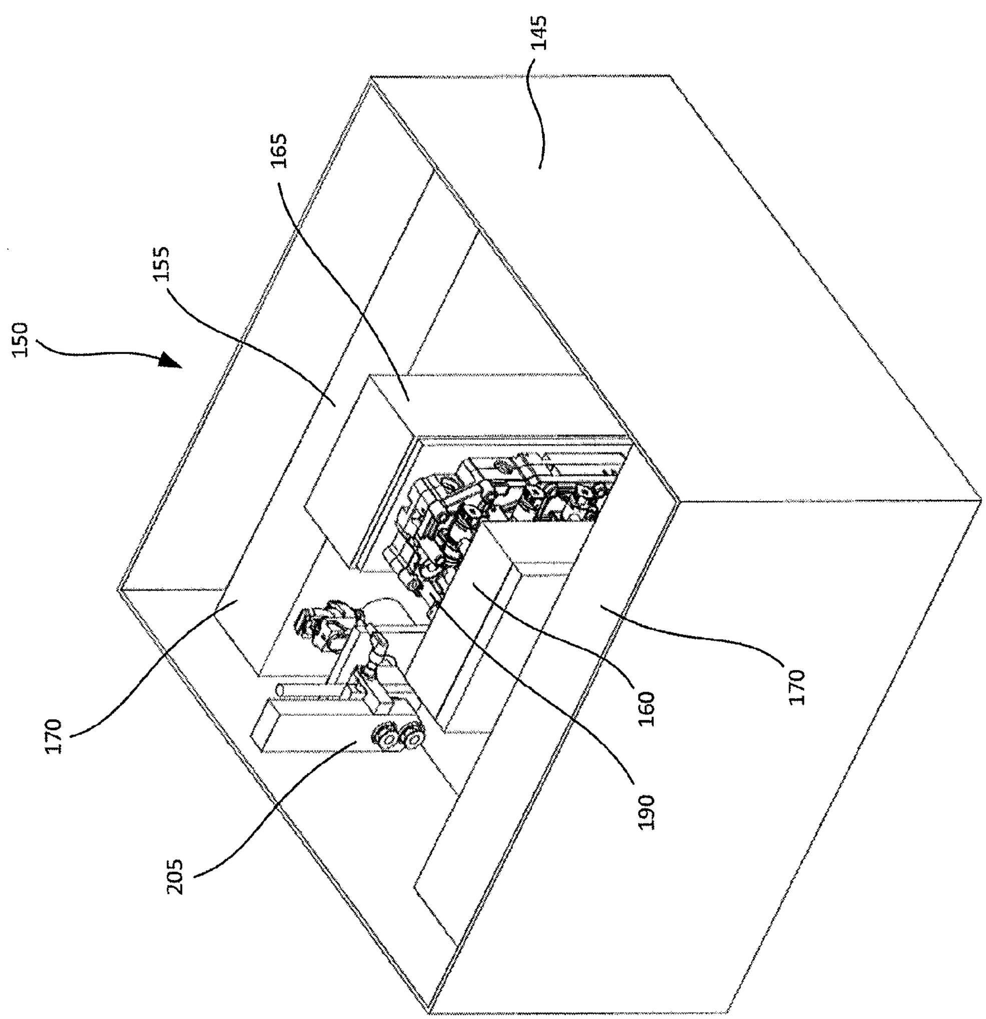

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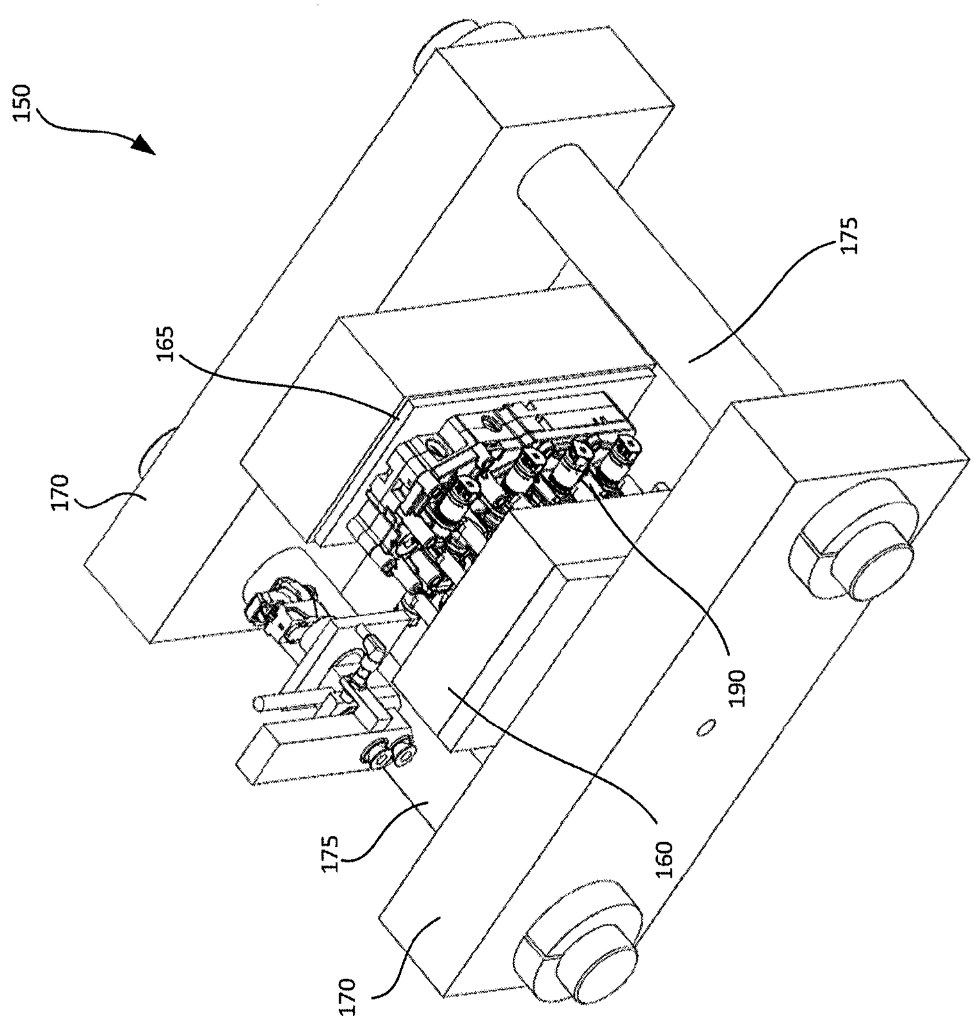

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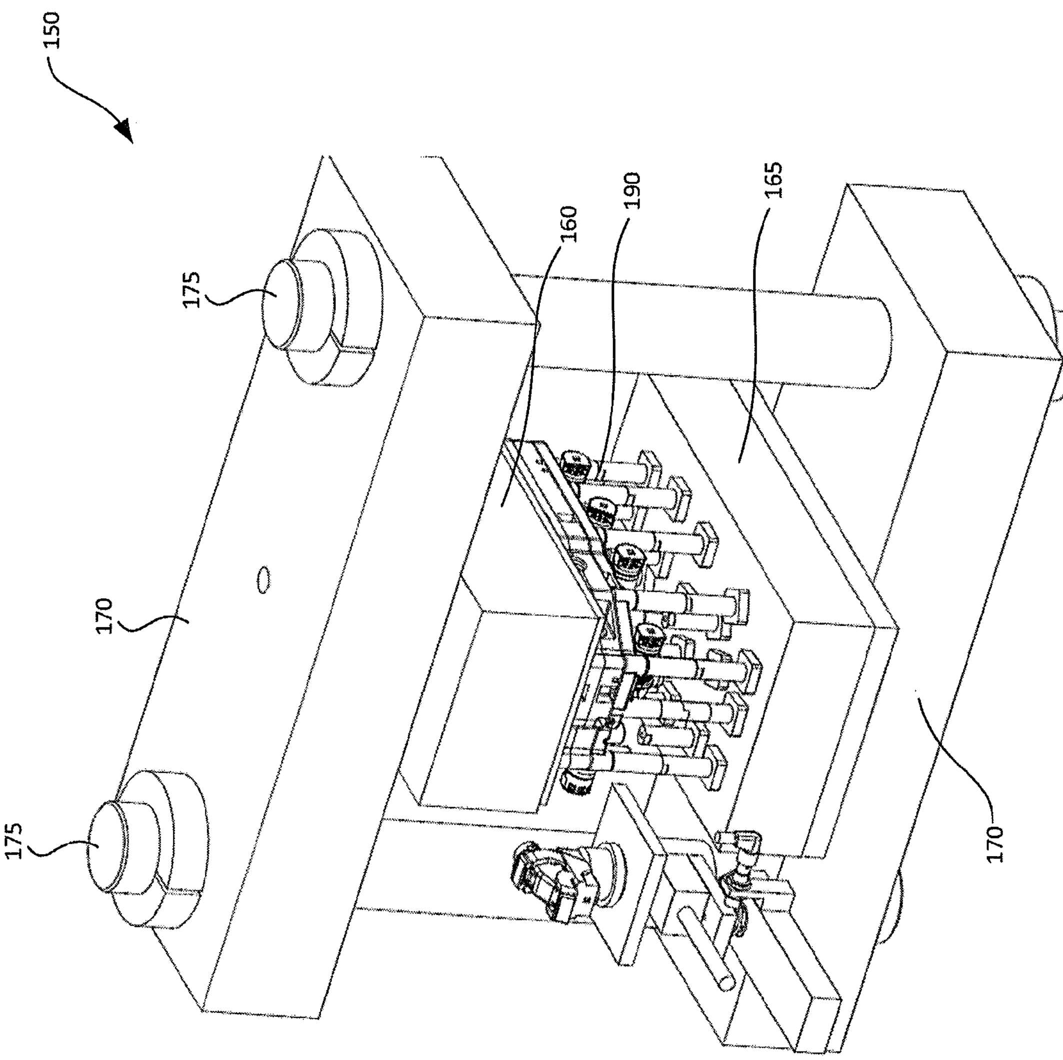
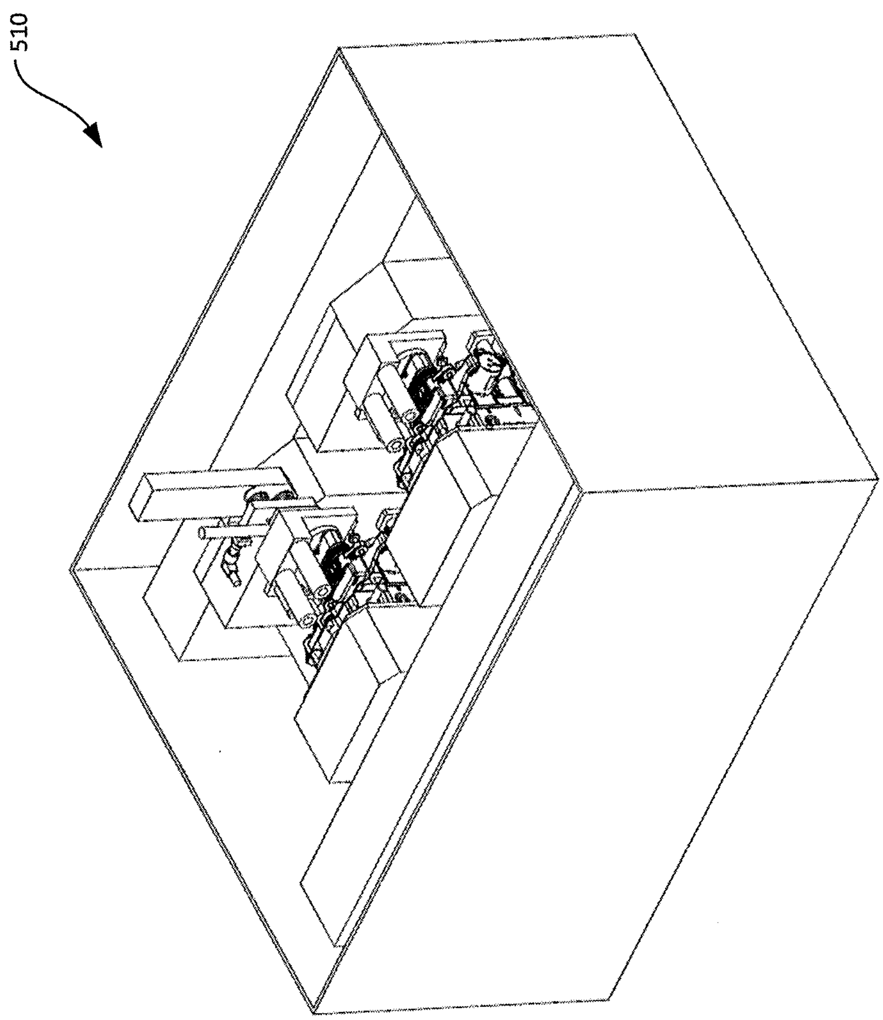


Figure 22



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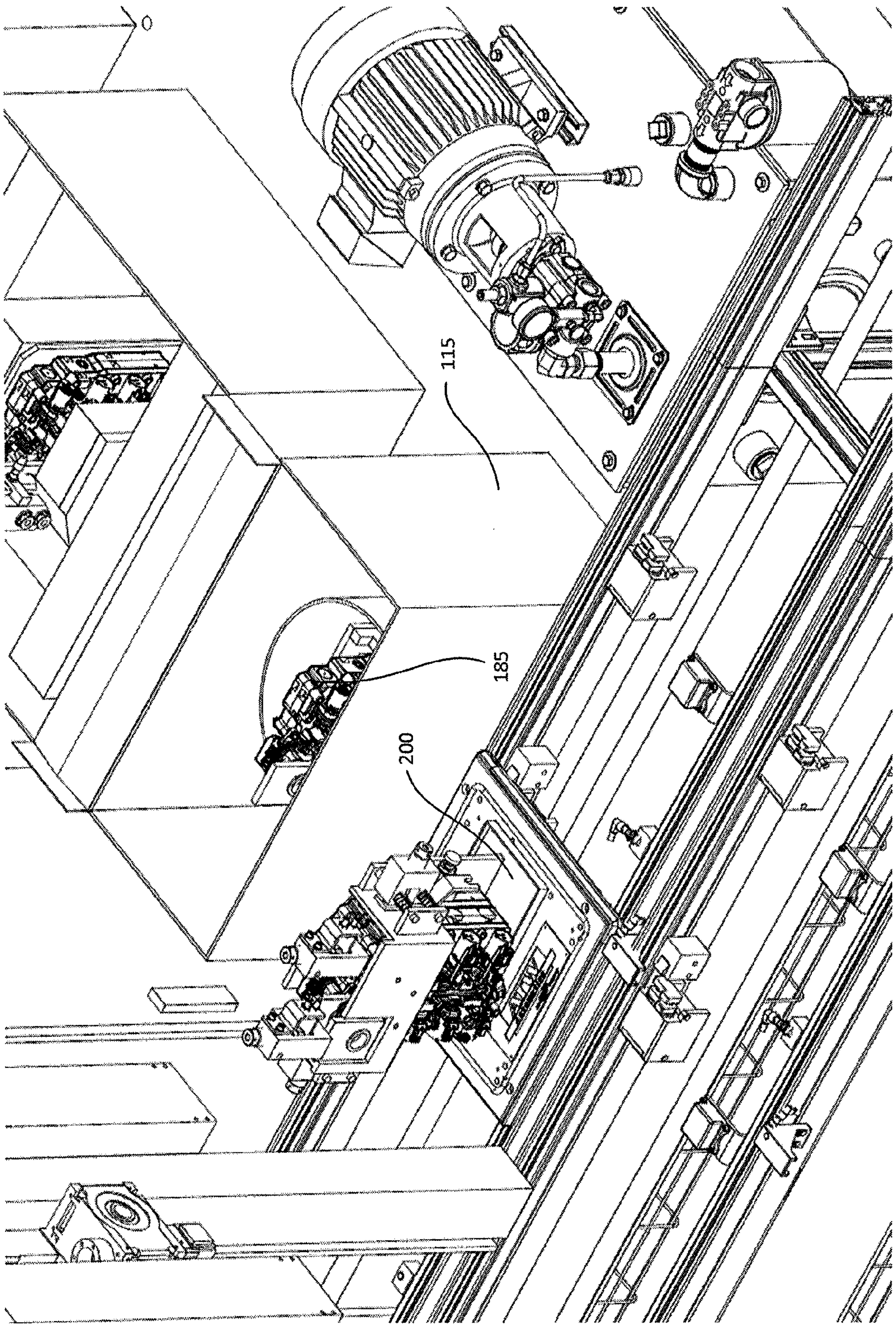

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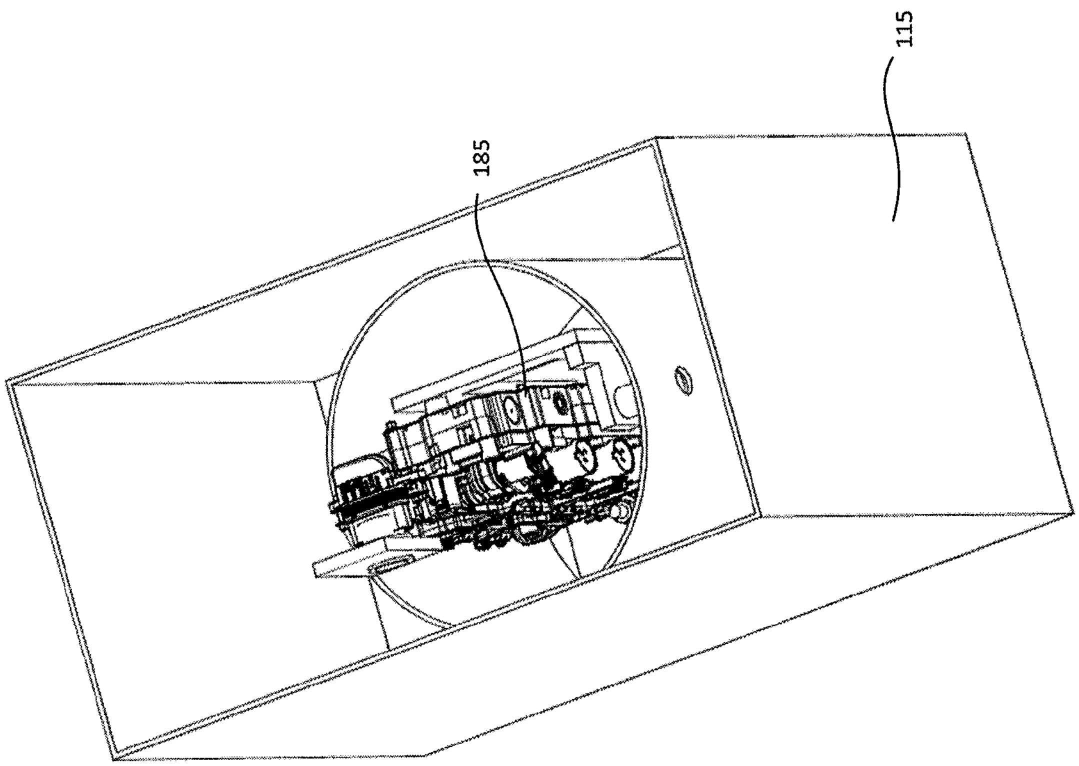

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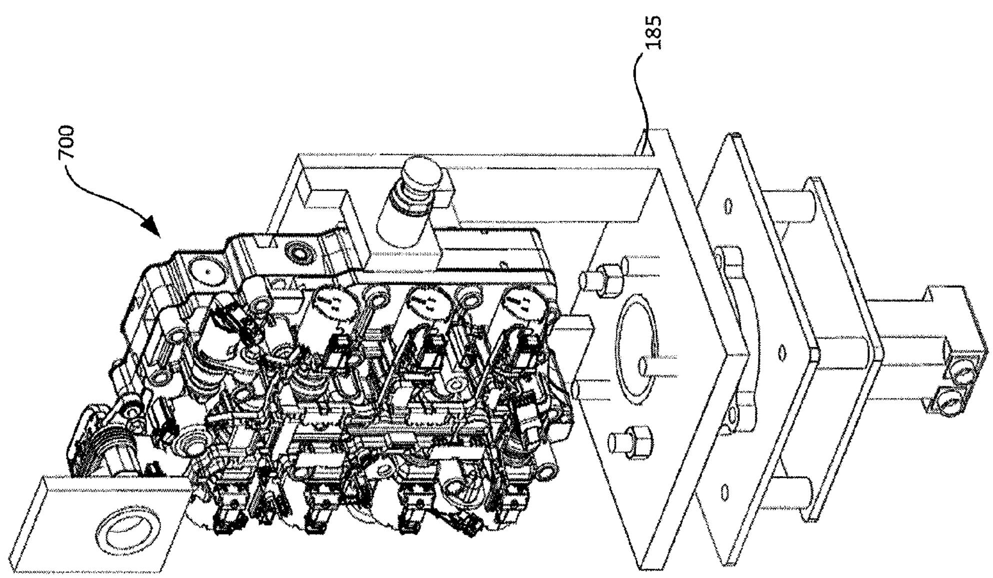

Figure 26A

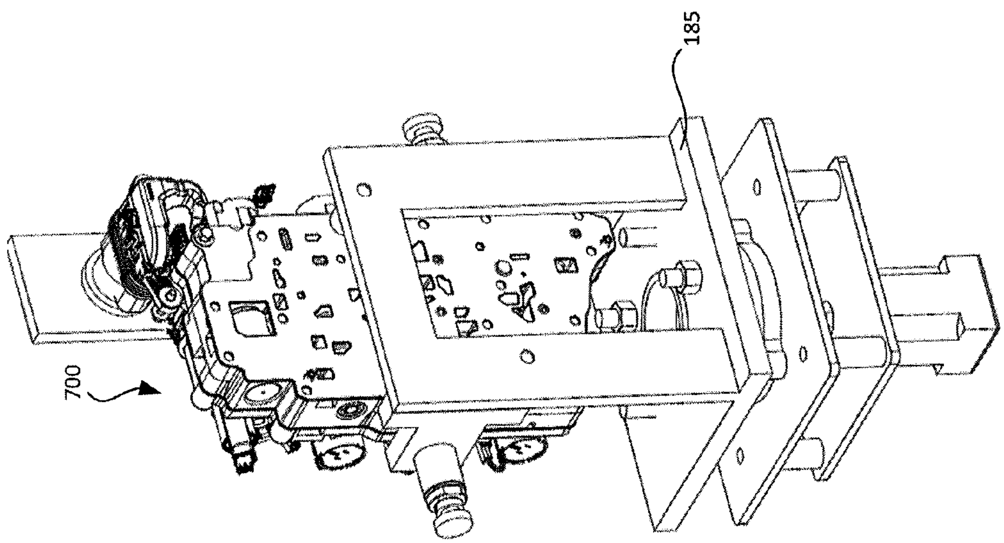

Figure 26B

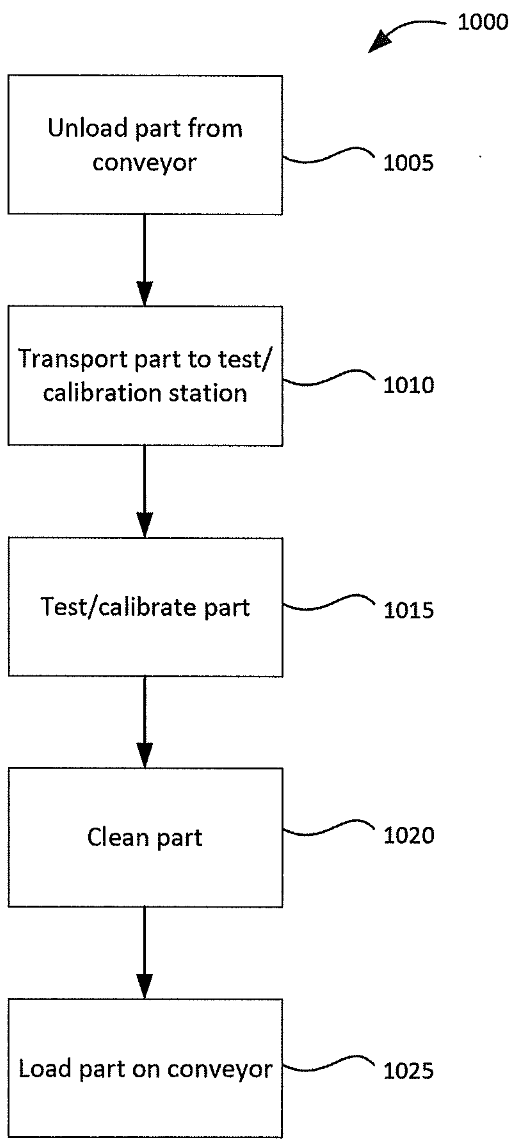
1000
Unload part from conveyor
1005
Transport part to test/ calibration station
1010
Test/calibrate part
1015
Clean part
1020
Load part on conveyor
1025

Figure 27

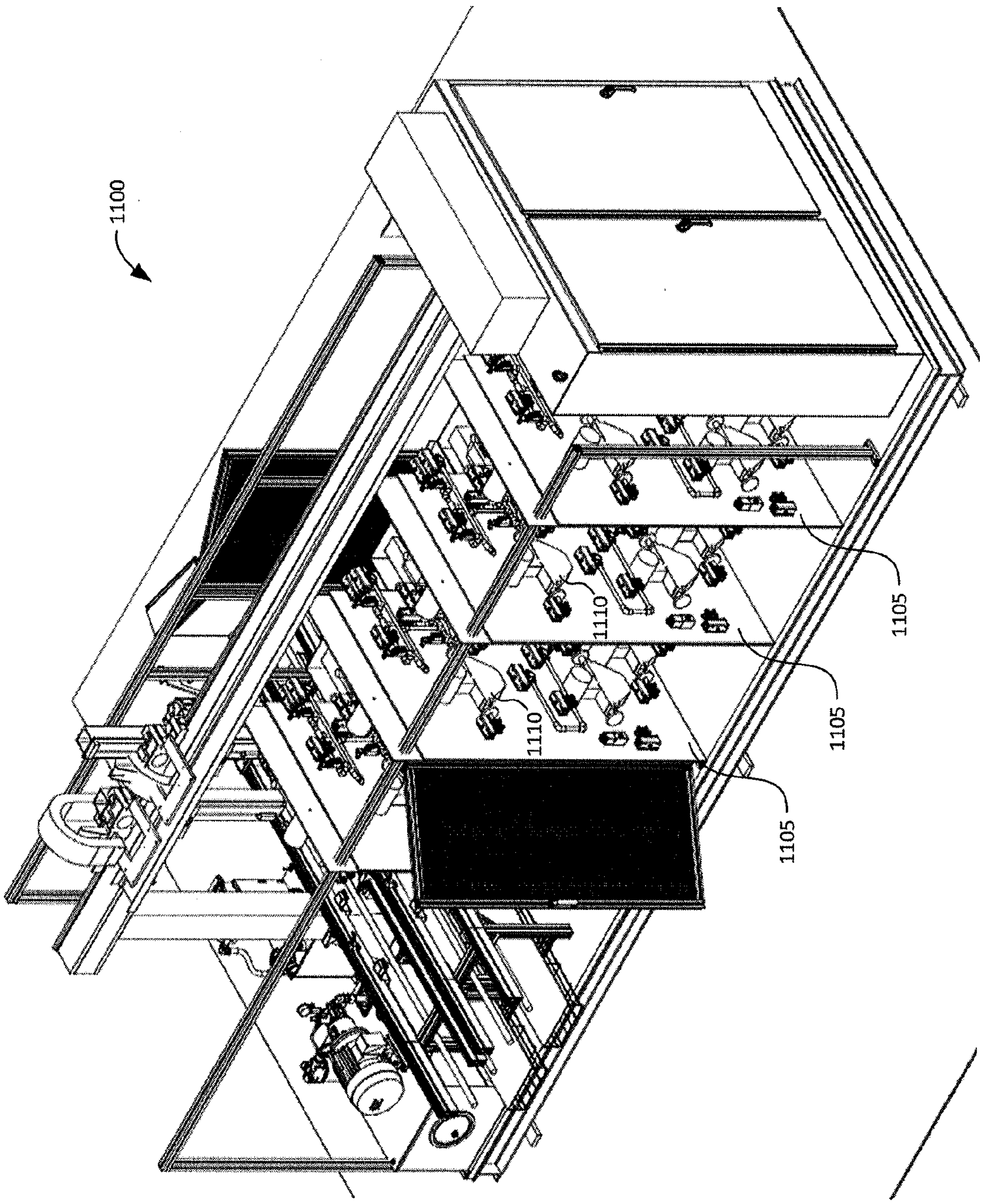

Figure 28

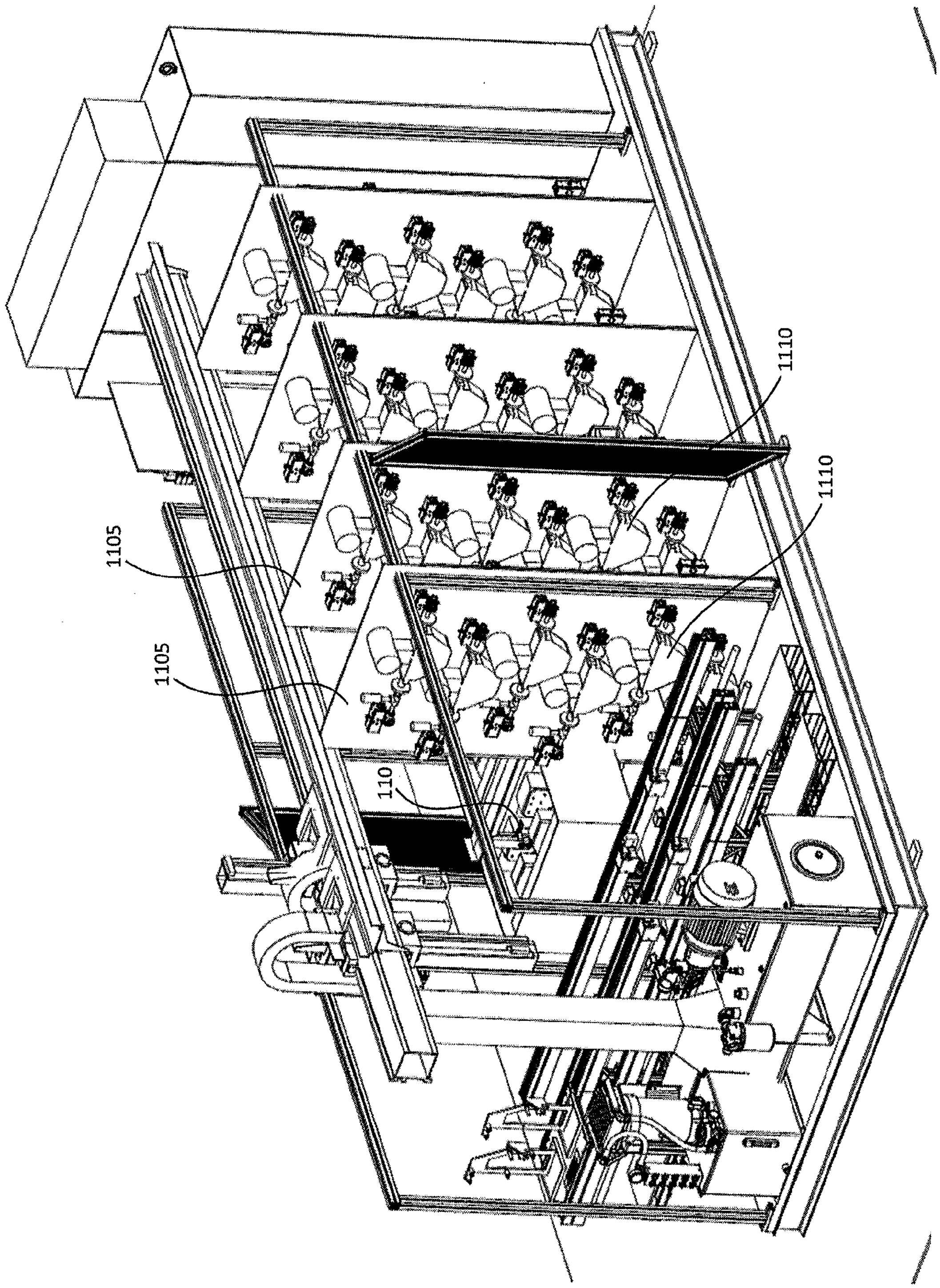

Figure 29

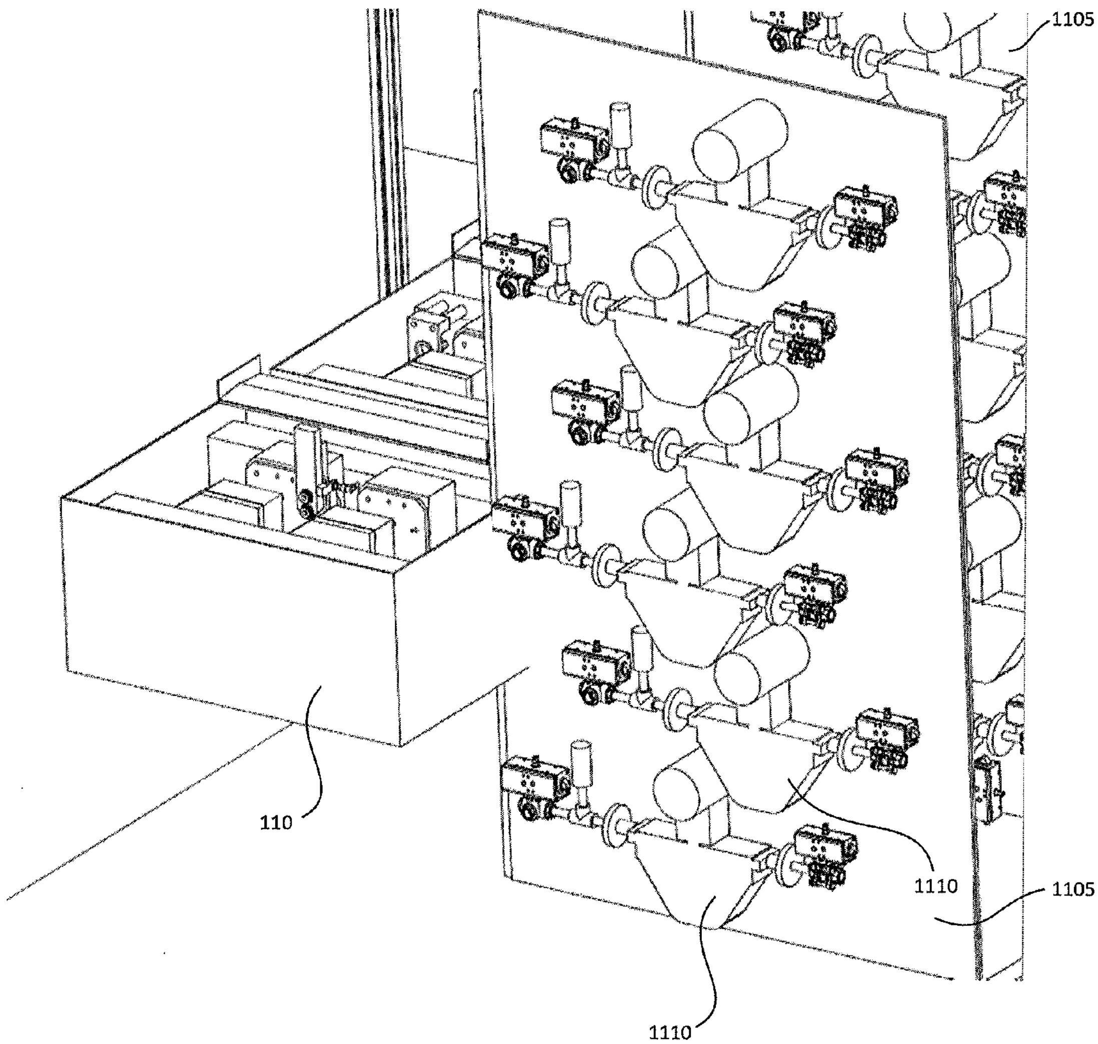

Figure 30

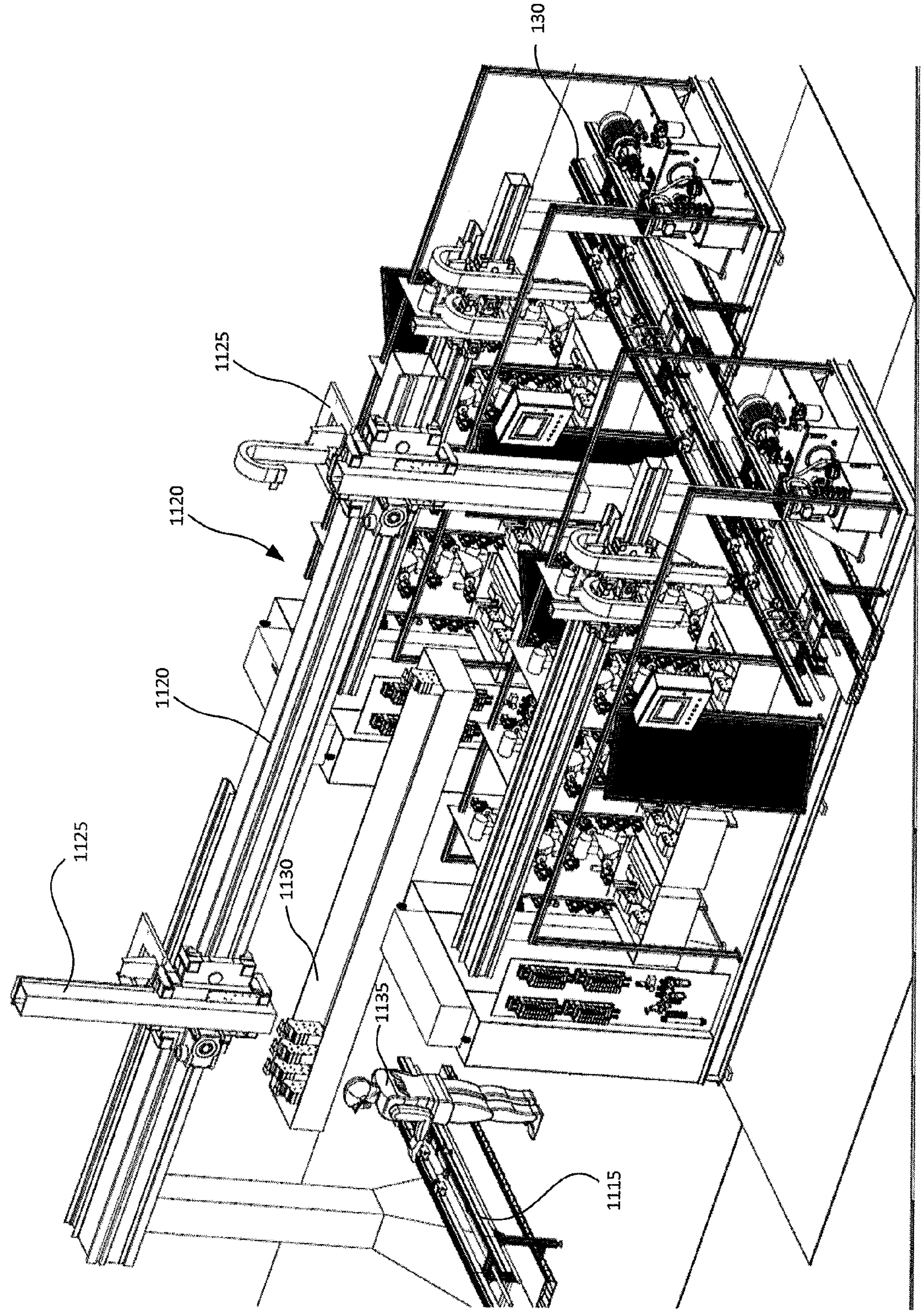

Figure 31

SYSTEM AND METHOD FOR TESTING OR CALIBRATING IN A PRESSURIZED AND/OR WET ENVIRONMENT

RELATED APPLICATIONS

[0001] This patent disclosure claims the benefit of U.S. Provisional Patent No. 62/111,767 filed Feb. 4, 2015, the content of which is hereby incorporated herein by reference.

FIELD

[0002] The present document relates to a system and method for testing and/or calibration in a pressurized and/or wet environment, particularly for parts that must be tested using fluids and pressure is needed on the part for the testing and/or calibration, or the like.

BACKGROUND

[0003] Existing systems for testing or calibrating use various techniques to allow for the testing or calibration depending on the nature of the parts. Two instances where testing and calibration become more complex include: (1) those where some element of the part to be tested needs to be placed under pressure during testing; and (2) those where the testing or calibration process makes use of a liquid and the liquid is ideally removed prior to moving the part to another processing operation. One example of where these two conditions apply is the testing and calibration of a transmission control apparatus. In this process, a part is submerged in oil and requires a predetermined amount of pressure to be placed on bolt locations where the part would be attached when in use.

[0004] Current systems and methods for testing and calibration can be complex and costly in order to meet these requirements. For example, when testing a transmission control apparatus, a large press is conventionally used to provide the necessary pressure to the transmission control apparatus. As another example, in some "wet" testing/calibration processes, the part may be air-dried following the testing. However, air drying can release mist which may require a complex mist collection mechanism to prevent spread of the mist into other areas. A mist can be particularly problematic when it is formed from an oil that was used in the process.

[0005] There is a need for an improved system and method for testing and/or calibration in a pressurized and/or wet environment.

SUMMARY

[0006] In a first aspect, the present disclosure provides a system for testing or calibrating a part, the system including: a plurality of test stations, each test station comprising a container and a clamping mechanism, wherein the container is configured to hold a fluid and the clamping mechanism is configured to receive the part in a vertical orientation and clamp the part horizontally with sufficient force to withstand a predetermined pressure to be placed on the part while submerged in the fluid, wherein the clamping mechanism includes: a clamp frame including: two clamp plates; a plurality of clamp bars configured to securely hold the clamp plates at a distance relative to each other; a seal manifold provided on one of the two clamp plates; and a clamping module, located opposite the seal manifold on another of the two clamp plates, wherein the clamping module includes: a plurality of pistons to hold the part against the seal manifold for the test operation; and at least one cleaning station comprising a spin mechanism for spinning the part to remove excess fluid; and a robotic system for moving individual parts to and from the plurality of test stations and to and from the at least one cleaning station.

[0007] In a particular case, the robotic system may include: a gantry located above the plurality of test stations; a robotic module comprising: at least one moving mechanism configured to move along the gantry; and a robot gripper attached to each moving mechanism and configured to grip and transport the part.

[0008] In another particular case, the robot gripper may be configured to maintain the vertical orientation of the part.

[0009] In still another particular case, the system may include a pallet for carrying the part and wherein the robot gripper includes a lock/release mechanism configured to interact with the pallet.

[0010] In yet another particular case, the robotic system may include: a floor mount; and a robotic arm attached to the floor mount, wherein the robotic arm moves the part to and from the plurality of test stations.

[0011] In a particular case, the spinning mechanism may maintain the part in a vertical orientation.

[0012] In another particular case, the system may include: a plurality of test panels, wherein each of the plurality of test panels engage with one of the plurality of test stations such that each of the engaged test panels and test stations can be slidably removed from the system.

[0013] In another aspect, there is provided a method for testing or calibrating a part, the method including: receiving the part from a conveyor; transporting the part to a test station while orienting the part in a vertical orientation; inserting the part in a clamping mechanism in the test station while maintaining the part in a vertical orientation; applying pressure to the part via the clamping mechanism, wherein the pressure is applied in a horizontal direction; testing the part, while maintaining the part in a vertical orientation and while under pressure; releasing the pressure and removing the part from the clamping mechanism; and returning the part to the conveyor.

[0014] In a particular case, the test station includes a fluid and the part is tested in a fluid, the method further comprising cleaning the part at a cleaning station by spinning the part to remove excess fluid.

[0015] In still yet another aspect, there is provided a system for testing or calibrating parts under pressure, the system including: a plurality of test stations, each test station comprising: a clamping mechanism configured to receive the part in a vertical orientation and clamp the part horizontally with sufficient force to withstand a predetermined pressure to be placed on the part; and a robotic system for moving individual parts to and from the plurality of test stations.

[0016] In a particular case, the clamping mechanism may include: a clamp frame including: two clamp plates; a plurality of clamp bars configured to securely hold the clamp plates at a distance relative to each other; a seal manifold provided on one of the two clamp plates; and a clamping module, located opposite the seal manifold on another of the two clamp plates, wherein the clamping module includes: a plurality of pistons to hold the part against the seal manifold for the test operation.

[0017] In still another particular case, the robotic system may include: a gantry located above the plurality of test stations; a robotic module including: at least one moving mechanism configured to move along the gantry; and a robot gripper attached to each moving mechanism and configured to grip and transport the part.

[0018] In yet another particular case, the robot gripper may be configured to maintain the vertical orientation of the part.

[0019] In still yet another particular case, the system may include a pallet for carrying the part and wherein the robot gripper includes a lock/release mechanism configured to interact with the pallet.

[0020] In a particular case, the robotic system may include: a floor mount; and a robotic arm attached to the floor mount, wherein the robotic arm moves the part to and from the plurality of test stations.

[0021] In another particular case, the system may include at least one cleaning station comprising a spin mechanism for spinning.

[0022] In still another particular case, the spinning mechanism maintains the part in a vertical orientation.

[0023] In still yet another particular case, the system may further include: a plurality of test panels, wherein each of the plurality of test panels engage with one of the plurality of test stations such that each of the engaged test panels and test stations can be slidably removed from the system.

[0024] Other aspects and features of the present disclosure will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Embodiments of the present disclosure will now be described, by way of example only, with reference to the attached Figures.

[0026] FIG. **1** illustrates a front right perspective view of an embodiment of a system for testing and calibration;

[0027] FIG. **2** illustrates a rear perspective view of the embodiment of the system in FIG. **1**;

[0028] FIG. **3** illustrates a front left perspective view of the embodiment of the system in FIG. **1**;

[0029] FIG. **4** illustrates a top view of the embodiment of the system in FIG. **1**;

[0030] FIG. **5** illustrates a top view of an embodiment having a plurality of systems similar to those illustrated in FIG. **1**;

[0031] FIG. **6** illustrates a front right perspective view of another embodiment of the system for testing and calibration;

[0032] FIG. **7** illustrates a rear perspective view of the embodiment of the system in FIG. **6**;

[0033] FIG. **8** illustrates a front left perspective view of the embodiment of the system in FIG. **6**;

[0034] FIG. **9** illustrates a top view of the embodiment of the system in FIG. **6**;

[0035] FIG. **10** illustrates a top view of a variation of the embodiment of the system in FIG. **6**;

[0036] FIG. **11** illustrates a front right perspective view of yet another embodiment of a system for testing and calibration;

[0037] FIG. **12** illustrates a rear perspective view of the embodiment of the system in FIG. **11**;

[0038] FIG. **13** illustrates a top view of the embodiment of the system in FIG. **11**;

[0039] FIG. **14** illustrates a top view of an embodiment having a plurality of systems similar to those in FIG. **11**;

[0040] FIG. **15** illustrates still another embodiment of a system for testing and calibration in which the system is configured to work on two parts simultaneously;

[0041] FIG. **16** illustrates still yet another embodiment of a system that is similarly configured to that of FIG. **15**;

[0042] FIG. **17** illustrates a pallet according to an embodiment herein for carrying a part for loading into the system;

[0043] FIGS. **18**A and **18**B illustrate a gripper according to an embodiment of the system for testing/calibration;

[0044] FIG. **19** illustrates the interaction of the gripper and the pallet while loading/unloading a part;

[0045] FIG. **20** illustrate a test station according to an embodiment;

[0046] FIG. **21** illustrates a clamping mechanism of the test station of FIG. **20**;

[0047] FIG. **22** illustrates a side view of the clamping mechanism of FIG. **21**;

[0048] FIG. **23** illustrates another embodiment of the test station;

[0049] FIG. **24** illustrates an embodiment of the cleaning station;

[0050] FIG. **25** illustrates a top perspective view of the cleaning station shown in FIG. **24**;

[0051] FIGS. **26**A and **26**B illustrate an embodiment of a spinner in the cleaning station with attached part;

[0052] FIG. **27** is a flow chart illustrating an embodiment of a method for testing and calibration;

[0053] FIG. **28** illustrates a rear perspective view of a further embodiment of a system for testing and calibration;

[0054] FIG. **29** illustrates a front right perspective view of the embodiment of the system of FIG. **28**;

[0055] FIG. **30** illustrates a combined test panel and a test station; and

[0056] FIG. **31** illustrates an embodiment of a system for testing and calibration as included in an assembly line.

DETAILED DESCRIPTION

[0057] Generally the present disclosure relates to a system and method for testing in a pressurized and/or calibration in a pressurized and/or wet environment. In the following, the system and method are referred to as a system and method for testing but it will be understood that calibration may also be performed in appropriate embodiments/situations. Further, although the embodiments focus on a system and method for testing and calibration of a transmission control assembly, it will be appreciated that the principles and concepts disclosed can be used for testing and/or calibration of other parts, particularly parts that are tested or calibrated using the same or similar parameters as those in the embodiments shown and described herein.

[0058] The embodiments of the system and method described herein may allow for a more efficient, lower cost, lower floor space alternative to conventional systems and methods. In some embodiments, the cost reduction may be provided by replacing multiple conventional machines with one or two machines or systems that can operate on more parts at the same time. This may allow for a smaller number of duplicated sub-components and a more compact system.

[0059] Some embodiments of the system include a plurality of test stations configured to receive parts to be tested under pressure and, in some cases, in a wet environment under pressure. As noted above, the test stations may alternatively or also be calibration stations. In some cases, embodiments of the system include a cleaning station configured to clean the part after the part has been tested and/or calibrated in a wet environment and prior to loading the part on a conveyor or the like for further processing.

[0060] Further, some embodiments of the system and method for testing involve processing of a part in a generally vertical, upright orientation or position. Conventional systems typically process the part in a flat, horizontal or plane orientation or position because pressure clamping is typically performed using vertical presses. The use of a generally vertical orientation may enable a more compact footprint, an easier material handling robot, or fewer motions in the part handling and the test positions. This approach may provide lower costs and a compact machine. The vertical orientation may also allow the part to be put into the test clamp position somewhat like putting bread into a toaster and may reduce or eliminate extra motions, cycle time and the like that may be required in order to "lay flat" (i.e. make horizontal) a part inside a test clamp.

[0061] The system and method for testing may include a manifold with individual integrated piston clamp motions for the "test clamp". Conventional systems typically use a large press type mechanism. The use of individual piston motion may enable a compact test clamp mechanism, and less motion. This may result in a compact packaging of multiple "test clamps" and may enable multiple clamps (or test stations) in a single machine, having fewer motions to control, and reducing or eliminating the need for multiple machines with single or double controlled test clamps. The use of individual piston motion may also allows for quick change of fixtures and fixtures may be tested off-line for different parts.

[0062] The system and method for testing may also include the use of a cleaning mechanism, for example, a spin mechanism or the like. This may provide a method to remove post-test residual oil, or other testing fluid, from the part. Using a spin mechanism may allow for a compact foot-print such that this spinning process can be performed in-line by the same system as the testing, which may provide more efficient and compact handling.

[0063] FIGS. **1** to **4** illustrate an embodiment of a system for testing **100**. The system includes a loading/unloading station **105**, a plurality of test stations **110** (sometimes referred to as test fixtures or cells). In this embodiment, three test stations **110** are shown. The system **100** may optionally include a cleaning station **115**. Parts **200** are moved among the test stations **100** and cleaning station **115** by a gantry robotic module **120** provided to a gantry **125** above the stations.

[0064] The loading/unloading station **105** is positioned to receive a conveyor **130** for moving parts **200** to and from the system **100**. The gantry robotic module **120** provided to the gantry **125** moves a part **200** from the conveyor **130** to one of the plurality of test stations **110**. As noted above, the test stations **110** may perform calibration processes as well as testing processes on the part **200**. The embodiment shown in FIGS. **1** to **4** shows the gantry robotic module **120** with two moving mechanisms **135** and robotic grippers **140**. In this way, the gantry robotic module **120** can more efficiently both load and unload the parts **200** from the test stations **110** as the gantry robotic module **120** moves along the gantry **125**. For example, one moving mechanism **135** removes a part **200** while the other moving mechanism **135** places a part **200** in the test station **110**.

[0065] Each test station **110** includes a container **145**. The container **145** also contains a clamping mechanism **150**, as illustrated in greater detail in FIG. **4** and also described further herein. In some embodiments, the container **145** may be configured to be filled with fluid, for example, oil.

[0066] With reference to FIG. **4**, the clamping mechanism **150** includes a clamp frame **155**, a clamping module **160** (sometimes referred to as a manifold), and a seal manifold **165** (sometimes referred to as a base). The clamp frame includes two clamp plates **170** that are connected by a plurality of clamp bars **175**. The clamp bars **175** securely hold the clamp plates **170** at a distance relative to each other with sufficient force to hold against the pressure generated in the test.

[0067] The clamping module **160** and seal manifold **165** are provided on the inner surfaces of the clamp plates **170**, opposite from each. This can allow the part **200** to be positioned between the manifold **160** and the seal manifold **165**. The clamping module **160** includes a plurality of hydraulic high pressure pistons **190**. The pistons **190** can be activated to provide pressure and hold the part **200** in place against the seal manifold **165** for the test operation. In this particular embodiment, the plurality of pistons are configured to match with bolt locations on the part **200**. The clamping module **160** and seal manifold **165** may be removably attached to the clamp plates **170**. Removability may allow for ease of maintenance or changing of test operations. Further, in some embodiments, the clamp plates **170** may be incorporated into the container **145**.

[0068] Each test station **110** is configured in a modular way so that test stations **110** can be added/removed from a system **100** depending on the part throughput required. In the embodiment of FIGS. **1** to **4**, three test stations **110** are provided but, depending on the test or calibration requirements, the system **100** could be adapted for fewer or more test stations **110** and/or could be designed for a larger number than are actually in use initially to allow for larger volumes in the future.

[0069] When testing or calibrating in a wet environment, following a test/calibration operation, the part **200** may be coated with excess liquid, for example, oil. In this case, the part **200** can be moved by the gantry robotic module **120** to the cleaning station **115** to remove excess liquid. The cleaning station **115** includes a container **180** and, in this embodiment, a spinning mechanism **185** in the container **180**. The container **180** may include a lid (not shown) that can be closed during operation. The spinning mechanism **185** is configured to receive and hold the part **200** following test/calibration. The spinning mechanism **185** rotates at an appropriate rate for an appropriate time to remove excess oil that remains on the part **200** following test/calibration. The use of a cleaning station **115** may help to reduce oil dripping from the part **200** following the test/calibration. In some embodiments, the part **200** may have some residue after being cleaned (e.g. depending on the subsequent processing). As with the test station **110**, the cleaning station **115** may be designed in a modular fashion. This may help with maintenance and interchangeability with cleaning stations in other systems. In some embodiments, other methods of removing/reducing excess liquid may be used depending on the application, including, for example, air drying, shaking, or the like.

[0070] Following either testing, calibration or cleaning (as appropriate), the part **200** is moved by the robotic module **120** from the cleaning station **115** to the conveyor **130**, where the part will be advanced for separate processing.

[0071] FIG. **3** illustrates a power station **250**, for example an electronic control panel configured to provide power to the test stations **110** and the cleaning station **115**, and a control station **255**, for example a data acquisition panel, for the system **100**. FIG. **3** further illustrates test panels **260**, which house test circuits for each of the test stations **110**. The test panels are at the side of the system **100** and may be at some distance from the actual test stations **110**. When a test station **110** requires a change or a repair, the test station **110** may be removed from the system. To remove the test station **110**, lines (not shown but may include electrical and hydraulic connections or the like) connecting the test station **110** and the test panels **260** will generally need to be disconnected, which may take additional time and effort. Further, the new or repaired test station **110** will not be able to be operated until it is reconnected to the test panel **260**.

[0072] As shown in FIG. **5**, a plurality of the systems **100** may be operated in parallel. In some embodiments, the plurality of systems may use the same conveyors **130** for providing parts to the systems.

[0073] FIGS. **6** to **9** illustrate another embodiment of a system **300** for testing and calibration. The system **300** may include a load and unload station **305** configured to receive parts **200** from a conveyor **330**. The system **300** includes a first and a second gantry **325***a* and **325***b* and a first and second row of test stations **310***a* and **310***b*. The first and second gantry **325***a* and **325***b* are placed in-line with the test stations **310***a* and **310***b*. Generally speaking, there may also be a first and second cleaning station **315***a* and **315***b* provided as well. Although not shown, embodiments of the system such as shown in FIGS. **6** to **10** may also be arranged with other similar systems and having appropriate feeder conveyors to allow greater throughput of parts. In some cases, the first gantry **325***a* may take parts from a first lane of the conveyor **130** and the second gantry **325***b* may take parts from the second lane of the conveyor **130**. Overall, the system **300** of FIGS. **6** to **9** is similar to the system **100** of FIGS. **1** to **4** but with two lanes of test stations **310***a* and **310***b*. FIG. **10** illustrates a variation of the system **300** of FIGS. **6** to **9** with an alternate feeding mechanism.

[0074] FIGS. **11** to **13** illustrate still another embodiment of a system **400** for testing. This embodiment provides for the movement of the parts **200** in the system **400** to be performed by a robotic module **420** that includes a floor mount **435** and a robotic arm **440**, rather than a gantry, moving mechanism and gripper, to move the parts among a load/unload station **405**, at least one test station **410**, and at least one cleaning station **415**.

[0075] FIG. **14** illustrates a top view of an embodiment having a plurality of systems similar to those in FIG. **11** operating in parallel.

[0076] FIG. **15** illustrates an embodiment of a system **500** for testing that is somewhat similar to that of the system **100** of FIGS. **1** to **4**. One difference is that the system **500** has been modified such that each test station **510** can contain multiple parts **200**, in this case, two parts, for example a part "A" **200**A and a part "B" **200**B, at the same time. This may allow for either simultaneous testing or for alternating testing or the like. In this embodiment, depending on the configuration, the test station **510** may be loaded with either different types of parts (in order to allow flexibility in manufacturing operations) or the same type of parts (for higher throughput of the same type of part). It will be understood that it may be useful to also modify a cleaning station **515** to be able to handle multiple parts in a similar manner.

[0077] FIG. **16** illustrates another embodiment of a system **600** with a similar modification to that of FIG. **15** but based on the system **300** of FIGS. **6** to **9**.

[0078] FIG. **17** illustrates an embodiment of a pallet system **700** for carrying a part for loading into an embodiment of a system, such as that of FIG. **1**. In particular, the part **200** is loaded having a vertical orientation or upright position. The pallet system **700** includes an adapter **705** to be connected during the test/calibration. The adapter **705** may be picked up with the part **200** by the robotic module. A fixture **710** on the pallet **700** includes a lock/release mechanism **715** that allows the robotic gripper to grip the part and maintain its orientation during gripping and movement. In some cases, the lock/release mechanism **715** may be a hook mechanism configured to allow the robotic gripper to connect to and lock with the hook. In other cases, the lock/release mechanism **715** may be configured to provide for a magnetic lock, or a friction fit with the robotic gripper. In still other cases, the lock/release mechanism may have retractable pins configured to engage the robotic gripper. The base **720** of the pallet system **100** may remain on the conveyor **130** during processing of the part **200**.

[0079] FIGS. **18**A and **18**B illustrate an embodiment of a gripper **800** for gripping the part **200** and moving the part **200** among the stations in the system. The gripper **800** is configured to maintain the orientation of the part **200** and adapter **705** during movement and is also provided with a gripper lock/release mechanism **805** that interacts with the pallet lock/release mechanism **715** such that control of the part **200** is maintained. In some cases, the gripper lock/release mechanism **805** may be configured to lock to a hook, or may include a magnetic lock or friction fit in order to engage the lock/release mechanism **715**. In other cases, the gripper lock/release mechanism **805** may include retractable pins configured to engage the lock/release mechanism **715**. In this manner, the gripper **800** may take the part to be tested into the test station and the pallet may remain on the conveyor **130**.

[0080] FIG. **19** illustrates the interaction of the gripper **800** and the pallet **700** while loading/unloading the part **200**.

[0081] FIGS. **20** to **22** illustrate further detail for an embodiment of the test station **110**. Each test station **110** includes a container **145** and at least one clamping mechanism **150**. FIGS. **21** and **22** illustrate the clamping mechanism **150** removed from the container **145**. As noted above, the clamp plates **170** (sometimes referred to as fixture plates) are held in fixed orientation while the part **200** is loaded between the clamping module **160** and the seal manifold **165** (sometimes referred to as a seal plate). The clamping module **160** is then activated such that pistons **190** move forward to hold the part against the seal manifold **165** with appropriate force placed in the correct positions to hold the part in place during testing. The hydraulic force for the pistons **190** is provided by hydraulic cables or piping (not shown) that enter the clamping module **160** and drive the pistons **190**. In other embodiments, the pistons **190** may be driven by another power source such as pneumatic or electrically driven pistons or the like.

[0082] It is intended for the part **200** to be loaded in a vertical position, similar to a "toaster" type insertion into the clamping mechanism **150**. A connector slide **205** advances making electrical connection. In some cases, the clamping module **160** and seal manifold **165** are configured to be removable from the clamping frame **155** and quickly replaced.

[0083] FIG. **23** illustrates an embodiment of the test station **510** that is configured to hold two parts **200** (same type or different type). The part **200** may be held at either the same time or as required based on manufacturing need. This type of test station **510** could be used with the systems **500** and **600** described above.

[0084] FIGS. **24** to **26**B illustrate further detail of an embodiment of the cleaning station **115**. In particular, FIGS. **25** and **26**A and **26**B illustrate a spinning mechanism **185** configured to receive, hold and spin a part to remove excess liquid. In some cases, the spinning mechanism may be drum that is spun by a motor. Similar to the pallet having a lock/release mechanism, the spinning mechanism **185** also includes a lock/release mechanism and interacts with the gripper to maintain part orientation and control.

[0085] FIG. **27** illustrates a method **1000** for testing. At **1005**, the part **200**, for example a transmission control assembly or other part to be tested or calibrated arrives at the load/unload station of the system.

[0086] At **1010**, the robotic module removes the part from the load/unload station and transports the part to the test station while maintaining or orienting the part in a generally vertical or upright orientation. The robotic module may include at least one moving mechanism with a gripper that grips the part to transport the part **200** to the test station.

[0087] At **1015**, the part **200** is tested in the test station. The part **200** is placed into a clamping mechanism of the test station in a vertical orientation. The clamping mechanism is then operated to apply pressure to the part **200** during testing (e.g. pressure may be applied horizontally, on a generally horizontal plane). In cases where the part is tested in a wet environment, for example, when submerged in oil, the test station may already contain oil or be filled with oil in order to carry out the test, which may include calibration. Once the test and/or calibration is complete, the part is removed by the robotic module.

[0088] At **1020**, the part **200** may be cleaned at a cleaning station. In cases where the part **200** was tested in a wet environment, for example, when submerged in oil, the part **200** may be cleaned at the cleaning station to remove excess liquid from the part **200**. In some cases, the part **200** may be cleaned by a spinning mechanism housed within the cleaning station.

[0089] At **1025**, the part **200** is transported by the robotic mechanism to the load/unload station in order to be returned to the conveyor.

[0090] FIGS. **28** and **29** illustrate yet another embodiment of a system **1100** for testing and calibration of a part **200**. In this embodiment, the system **1100** is generally similar to the system **600** of FIG. **15**. One difference is that the plurality of test panels **1105** are configured to connect with the test stations, for example test stations **110**. In particular, a test valve **1110** can be configured to connect to the test station **110**. The test panels **1105** may be located proximate to the test stations which may reduce the required floor space around the system **100**. The test panels **1105** may be removed together with the test stations when a repair or replacement is needed. In particular, the test station and test panel can be slidably removed, which may allow for a replacement unit to be inserted more quickly and efficiently. The test station remains engaged with the test panel and a new part or repair can be completed outside the system while allowing the remaining test stations to continue production. As shown in FIG. **30**, the test panels **1105** may include a plurality of test valves **1110**, which may be mounted to either or both sides of the test panel. This may allow easier changeover during repair replacement and/or provide greater throughput.

[0091] FIG. **31** illustrates the system **1100** as included as a component in an assembly line **1115**. After processing by the system **1100**, the part **200** is unloaded onto an unload conveyor **130**. A transfer gantry **1120** is able to retrieve the part **200** and transfer it to the assembly line **1115**. The transfer gantry **1120** includes a "Z" axis picker **1125** which may pick the part off the pallet and transfer the part **200** to a buffering area **1130**. The buffering area **1130** may allow for further drying time for the part **200** (e.g. if the part **200** was processed in fluid). The "Z" axis picker **1125** may then pick parts **200** out of the buffering area and present the part directly in front of an assembly line operator **1135** and the assembly line operator **1135** to place the part **200** on the assembly line **1115**. In some cases, there may be at least two "Z" axis pickers **1125**, for example, one to move the part **200** from the unload conveyor **130** to the buffering area **1130** and a second to move the part **200** from the buffering area **1130** to the assembly line **1115**. In some cases, the "Z" axis picker **1125** may move the part directly to the assembly line **1115**.

[0092] In the preceding description, for purposes of explanation, numerous details are set forth in order to provide a thorough understanding of the embodiments. However, it will be apparent to one skilled in the art that these specific details are not required. In other instances, well-known electrical structures and circuits are shown in block diagram form in order not to obscure the understanding. For example, specific details are not provided as to whether the embodiments described herein are implemented as a software routine, hardware circuit, firmware, or a combination thereof.

[0093] Embodiments of the disclosure can be represented as a computer program product stored in a machine-readable medium (also referred to as a computer-readable medium, a processor-readable medium, or a computer usable medium having a computer-readable program code embodied therein). The machine-readable medium can be any suitable tangible, non-transitory medium, including magnetic, optical, or electrical storage medium including a diskette, compact disk read only memory (CD-ROM), memory device (volatile or non-volatile), or similar storage mechanism. The machine-readable medium can contain various sets of instructions, code sequences, configuration information, or other data, which, when executed, cause a processor to perform steps in a method according to an embodiment of the disclosure. Those of ordinary skill in the art will appreciate that other instructions and operations necessary to implement the described implementations can also be stored on the machine-readable medium. The instructions stored on the machine-readable medium can be executed by a processor or other suitable processing device, and can interface with circuitry to perform the described tasks.

[0094] The above-described embodiments are intended to be examples only. Alterations, modifications and variations can be effected to the particular embodiments by those of skill in the art without departing from the scope, which is defined solely by the claims appended hereto.

1. A system for testing or calibrating a part, the system comprising:
   - a plurality of test stations, each test station comprising a container and a clamping mechanism, wherein the container is configured to hold a fluid and the clamping mechanism is configured to receive the part in a vertical orientation and clamp the part horizontally with sufficient force to withstand a predetermined pressure to be placed on the part while submerged in the fluid, wherein the clamping mechanism comprises:
     - a clamp frame comprising:
       - two clamp plates;
       - a plurality of clamp bars configured to securely hold the clamp plates at a distance relative to each other;
     - a seal manifold provided on one of the two clamp plates; and
     - a clamping module, located opposite the seal manifold on another of the two clamp plates, wherein the clamping module comprises:
       - a plurality of pistons to hold the part against the seal manifold for the test operation; and
   - at least one cleaning station comprising a spin mechanism for spinning the part to remove excess fluid; and
   - a robotic system for moving individual parts to and from the plurality of test stations and to and from the at least one cleaning station.

2. A system according to claim **1**, wherein the robotic system comprises:
   - a gantry located above the plurality of test stations;
   - a robotic module comprising:
     - at least one moving mechanism configured to move along the gantry; and
     - a robot gripper attached to each moving mechanism and configured to grip and transport the part.

3. A system according to claim **2**, wherein the robot gripper is configured to maintain the vertical orientation of the part.

4. A system according to claim **2**, further comprising a pallet for carrying the part and wherein the robot gripper comprises a lock/release mechanism configured to interact with the pallet.

5. A system according to claim **1**, wherein the robotic system comprises:
   - a floor mount; and
   - a robotic arm attached to the floor mount, wherein the robotic arm moves the part to and from the plurality of test stations.

6. A system according to claim **1**, wherein the spinning mechanism maintains the part in a vertical orientation.

7. A system according to claim **1** further comprising:
   - a plurality of test panels, wherein each of the plurality of test panels engage with one of the plurality of test stations such that each of the engaged test panels and test stations can be slidably removed from the system.

8. A method for testing or calibrating a part, the method comprising:
   - receiving the part from a conveyor;
   - transporting the part to a test station while orienting the part in a vertical orientation;
   - inserting the part in a clamping mechanism in the test station while maintaining the part in a vertical orientation;
   - applying pressure to the part via the clamping mechanism, wherein the pressure is applied in a horizontal direction;
   - testing or calibrating the part, while maintaining the part in a vertical orientation and while under pressure;
   - releasing the pressure and removing the part from the clamping mechanism; and
   - returning the part to the conveyor.

9. A method according to claim **8**, wherein the test station comprises a fluid and the part is tested in a fluid, the method further comprising cleaning the part at a cleaning station by spinning the part to remove excess fluid.

10. A system for testing or calibrating parts under pressure, the system comprising:
    - a plurality of test stations, each test station comprising:
      - a clamping mechanism configured to receive the part in a vertical orientation and clamp the part horizontally with sufficient force to withstand a predetermined pressure to be placed on the part; and
    - a robotic system for moving individual parts to and from the plurality of test stations.

11. A system according to claim **10**, wherein the clamping mechanism comprises:
    - a clamp frame comprising:
      - two clamp plates;
      - a plurality of clamp bars configured to securely hold the clamp plates at a distance relative to each other;
    - a seal manifold provided on one of the two clamp plates; and
    - a clamping module, located opposite the seal manifold on another of the two clamp plates, wherein the clamping module comprises:
      - a plurality of pistons to hold the part against the seal manifold for the test operation.

12. A system according to claim **10**, wherein the robotic system comprises:
    - a gantry located above the plurality of test stations;
    - a robotic module comprising:
      - at least one moving mechanism configured to move along the gantry; and
      - a robot gripper attached to each moving mechanism and configured to grip and transport the part.

13. A system according to claim **12**, wherein the robot gripper is configured to maintain the vertical orientation of the part.

14. A system according to claim **12**, further comprising a pallet for carrying the part and wherein the robot gripper comprises a lock/release mechanism configured to interact with the pallet.

15. A system according to claim **10**, wherein the robotic system comprises:
    - a floor mount; and
    - a robotic arm attached to the floor mount, wherein the robotic arm moves the part to and from the plurality of test stations.

16. A system according to claim **10**, further comprising at least one cleaning station comprising a spin mechanism for spinning.

17. A system according to claim **16**, wherein the spinning mechanism maintains the part in a vertical orientation.

18. A system according to claim **10** further comprising:

a plurality of test panels, wherein each of the plurality of test panels engage with one of the plurality of test stations such that each of the engaged test panels and test/calibration stations can be slidably removed from the system.

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