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(54) **Grinding machine for bearing rings and method for moving a bearing ring in such a machine**

(57) This grinding (2) machine for bearing rings (500) includes a frame (4), a rotating grinding wheel (6) movable in rotation around a first rotation axis (X6), a working station (14) where a bearing ring (500) stands during a grinding operation (R6) of one of its surfaces. This grinding machine also includes holding means for holding a bearing ring in the working station and transfer means (100, 200) for transferring bearing rings (500) to and from the working station (14). The transfer means include at least a multi-axis robot (100) and a ring moving arm (200) provided with gripping means for temporarily gripping a bearing ring, this ring moving arm being rotatable around a second rotation axis (X200), parallel to the first rotation axis (X6), and movable in translation along this second rotation axis.

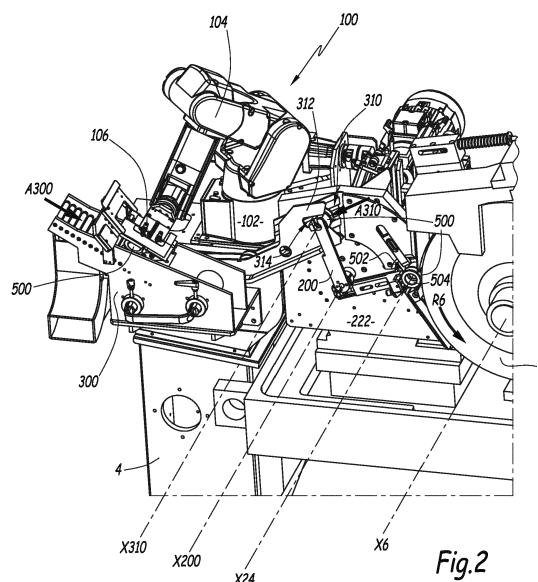


Fig.2

Description

TECHNICAL FIELD OF THE INVENTION

[0001] This invention relates to a grinding machine which can be used for grinding of bearing rings. This invention also relates to a method for moving a bearing ring between a loading station and an unloading station in such a grinding machine.

BACKGROUND OF THE INVENTION

[0002] In the field of bearings manufacturing, it is known, e.g. from WO-A-2008/082140, to use a grinding machine provided with a rotating grinding wheel movable in rotation around an axis. This machine includes a working station where bearing rings to be processed are successively fed through a vertical guiding rail whose dimensions depend on the external diameter and axial length of the bearing rings. A magnetic clamp is used to keep each magnetic ring in position within the working station.

[0003] A bearing manufacturer generally offers a range of bearings whose inner rings have different dimensions. Thus, bearing rings with different dimensions usually have to be successively processed on a grinding machine. When it is needed to switch the machine from a configuration where it grinds a first type of ring to a configuration where it grinds a second type of ring, the transfer means have to be disassembled from the machine and new transfer means have to be mounted on the machine. This is time consuming and implies that specific tools must be manufactured and stored for each type of bearing ring to be processed. This is expensive and requires a highly qualified manpower.

SUMMARY OF THE INVENTION

[0004] This invention aims at solving these problems with a new grinding machine which is adapted for an easy and fast change of configuration when the bearing rings to be processed change from one type to another.

[0005] To this end, the invention concerns a grinding machine for bearing rings, this machine including a frame, a rotating grinding wheel movable in rotation around a first rotation axis and a working station where a bearing ring stands during a grinding operation of one of its surfaces. This grinding machine also includes holding means for holding a bearing ring in the working station and transfer means for transferring bearing rings to and from the working station. According to the invention, the transfer means include at least a multi-axis robot and a ring moving arm provided with gripping means for temporarily gripping a bearing ring, this moving arm being rotatable around a second rotation axis, parallel to the first rotation axis, and movable in translation along this second rotation axis.

[0006] Thanks to the invention, the multi-axis robot and the moving arm, which is both rotatable and axially mov-

able, allow feeding the working station with different types of bearing rings. Thus, when one switches from the manufacturing of one type of bearing ring to the manufacturing of another type of bearing ring, it is not necessary to change the transfer means, since the multi-axis robot and the moving arm can be used for different types of bearing rings.

[0007] According to further aspects of the invention, which are advantageous but not compulsory, the grinding machine might incorporate one or several of the following features taken in any admissible configuration:

- The grinding machine includes driving means for automatically driving the moving arm in rotation around and in translation along the second rotation axis.
- The driving means include a first pneumatic jack dedicated to driving the moving arm in rotation and a second pneumatic jack dedicated to driving the moving arm in translation along the second rotation axis.
- The first pneumatic cylinder is rotatable around a third rotation axis parallel to the first rotation axis.
- The grinding machine includes a releaser for separating from the gripping means a ring born by the moving arm, via a translation movement of the moving arm parallel to the second rotation axis.
- The grinding machine includes a loading station and an unloading station, whereas the multi-axis robot is configured to carry a bearing ring from the loading station to the working station and the moving arm is configured and driven to carry a bearing ring from the working station to the unloading station.
- The unloading station includes an outlet chute whose width is adjustable, depending on the axial thickness of the bearing rings.
- The gripping means include a nose part adapted to be engaged into or taken out of a central bore of a bearing ring, depending on an axial position of the moving arm along the second rotation axis.
- The grinding machine includes sensor means for sensing the angular position of the moving arm around the second rotation axis.
- The grinding machine includes several proximity sensors adapted to detect a part fast in rotation, around the second rotation axis, with the moving arm.
- Actuation of the driving means to drive the moving arm in translation along the second rotation axis depends on an output signal of the sensor means.
- The moving arm is movable in rotation around the second rotation axis between a first position where the gripping means are aligned, along a fourth axis parallel to the first rotation axis, with an unloading station of bearing rings and a second position where the gripping means are aligned, along a fifth axis parallel to the first rotation axis, with the working station,
- The second pneumatic jack is operable to drive the moving arm in translation along the second rotation

axis only when the sensor means detect that the moving arm is in its first angular position or in its second angular position.

- The holding means include a magnetic clutch and the multi-axis robot is configured to introduce a bearing ring in the working station via a translation along an axis parallel to the first rotation axis.

[0008] The invention also relates to a method for moving a bearing ring between a loading station and an unloading station in a grinding machine as mentioned hereabove, this method being characterized in that it includes at least the following steps consisting in:

- a) picking the bearing ring with a multi-axis robot,
- b) moving the bearing ring with the multi-axis robot into a working station of the grinding machine,
- c) actuating holding means for holding the bearing ring in the working station during grinding of a surface of the bearing ring,
- d) gripping the bearing ring in the working station via gripping means provided on a moving arm, thanks to a translation movement of the arm along a second rotation axis parallel to the first rotation axis,
- e) deactivate the holding means,
- f) rotate the moving arm around the second rotation axis in a direction which brings the bearing ring close to the unloading station,
- g) translate the moving arm along the second axis of rotation in a direction which frees the bearing ring from the gripping means.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention will be better understood on the basis of the following description which is given in correspondence with the annexed figures and as an illustrative example, without restricting the object of the invention. In the annexed figures:

- figure 1 is a front view of a grinding machine according to the invention,
- figure 2 is a partial perspective view corresponding to detail II on figure 1,
- figure 3 is a partial perspective view of the machine from another direction,
- figure 4 is an enlarged view of detail IV on figure 1,
- figure 5 is a perspective view of a moving arm and its driving means which belong to the machine of figures 1 to 4, the moving arm being in a first position and
- figures 6 to 8 are perspective views similar to figure 5 when the moving arm is respectively in a second, a third and a fourth position.

DETAILED DESCRIPTION OF SOME EMBODIMENTS

[0010] The grinding machine 2 represented on figures

1 to 8 includes a frame 4 and a rotating grinding wheel 6 which rotates around a first rotation axis X6. An electric motor 8 is used to drive wheel 6 in rotation around axis X6. D6 denotes the outer diameter of grinding wheel 6.

[0011] Grinding wheel 6 and motor 8 are supported by an auxiliary frame 9 which is movable with respect to frame 4 in two opposite directions perpendicular to axis X6, as shown by double arrow A9 on figure 1. Axis X6 is fixed with respect to auxiliary frame 9.

[0012] The outer peripheral surface 10 of grinding wheel 6 is shaped by a knurl 12 when needed and is used to grind the outer surface of an inner ring 500 of a non-further represented bearing. Knurl 12, which is sometimes called "diamant roller", is also supported by auxiliary frame 9. In the example of the figures, outer surface 10 has a central bump, so that it is used to grind the outer radial surface 502 of ring 500 with a concave groove.

[0013] Grinding machine 2 is provided with a working station or zone 14 where each ring 500 is successively held in position with respect to grinding wheel 6 during a grinding operation.

[0014] Working station 14 includes two support shoes 16 and 18, each provided with a fitting 20, respectively 22. Fitting 20 is adapted to lie against the outer radial surface of a magnetic clamp 24, whereas fitting 22 is made of two parts and adapted to lie against the outer peripheral surface 502 of ring 500. Each support shoe 16 and 18 is mounted on a slider 26, respectively 28. Another slide 30 is used to avoid the escape of the ring 500.

[0015] When it is loaded in working station 14, as shown on figures 1, 2 and 4, each ring 500 is centered around a central axis X24 of magnetic clamp 24 parallel or substantially parallel to axis X6. In this configuration, the central bore 504 of ring 500 is empty and, because of the friction between surfaces 10 and 502, ring 500 is driven in rotation around axis X24 by the rotation movement of grinding wheel 6 around axis X6. On figure 4, arrow R6 represents the rotation of grinding wheel 6 and arrow R500 represents the rotation of ring 500.

[0016] Two types of equipment are used to feed working station 14 with rings 500 and to evacuate the rings from this working station, once they have been processed. In this description, a ring which is not yet processed is called a "black ring", whereas a ring which has been processed by grinding wheel 6 is called a "ground ring".

[0017] A multi-axis robot 100, with 6 degrees of freedom, belongs to the transfer means. It is mounted by its base 102 on the frame 4 of grinding machine 2 and includes a multi-articulated arm 104 whose free end is equipped with a clamp 106 adapted to grasp or grip different types of rings 500, via a proper programming of robot 100.

[0018] A moving arm 200 also belongs to the transfer means. This moving arm is rotatable around an axis X200 which is fixed with respect to frame 4 and parallel to axis

X6. Near its free end 204 opposite to axis X200, moving arm 200 is provided with a gripper 206 in the form of a block having a nose 208 suitable to enter the central bore 504 of a ring 500 to be moved away from working station 14. This gripper 206 allows temporally gripping a ring 500.

[0019] Grinding machine 2 includes an inlet chute 300 where black rings 500 move by gravity in the direction of arrow A300. For the sake of simplicity, only one ring 500 is represented in inlet chute 300 on figure 2. Inlet chute 300 is close to robot 100 which can pick-up a ring 500 present in inlet chute 300 when needed.

[0020] On the other hand, grinding machine 2 also includes an outlet chute 310 where ground rings 500 are dumped, one after the other. In outlet chute 310, ground rings 500 move by gravity, in the direction of arrow A310. On its side oriented towards arm 200, outlet chute 310 is equipped with a releaser 312 provided with a notch 314 of a size sufficient to accommodate the gripper 206 of moving arm 200 but with a transverse dimension, measured between two lateral edges of this notch, smaller than the outer diameter of the rings 500.

[0021] The width of outlet chute 310 is adjustable, depending on the axial thickness of the rings 500. This allows keeping the rings 500 with their central axis substantially horizontal when they are in the chute, while allowing them to roll in the direction of arrow A310.

[0022] Moving arm 200 is driven in rotation around axis X200 by a first pneumatic jack 210 whose stem 212 is connected to a bracket 214 integral in rotation with moving arm 200. The body 216 of pneumatic jack 210 is articulated on a second bracket 218, around an articulation axis X210 which is fixed with respect to frame 4 and parallel to axis X200. As shown on figure 3, bracket 218 is rigidly mounted on a support member 220 which is mounted on a support plate 222 fixed with respect to frame 4. Bracket 214 is integral with a pin 224 which extends from bracket 214, along a direction parallel to axis X200.

[0023] Three proximity sensors 226A, 226B and 226C are distributed around axis X200 in order to detect the angular position of pin 224 around this axis. Since pin 224 is integral in rotation with moving arm 200, sensors 226A, 226B and 226C allow detecting the angular position of moving arm 200 around axis X200. S_{226A} , S_{226B} and S_{226C} respectively denote the output signals of sensors 226A, 226B and 226C.

[0024] The position of moving arm 200 along axis X200 is controlled by a second pneumatic jack 230. More precisely, moving arm 200 is integral, in rotation and in translation with respect to axis X200, with a shaft 240 engaged through a bushing 242 which crosses support plate 222. Moving arm 200 is movable along axis X200 between a first position represented on figures 5 and 8, where it is relatively close to support plate 222, and a second position represented on figures 6 and 7, where it is relatively distant from support plate 222 and where shaft 240 protrudes outward of bushing 242.

[0025] Figure 5 schematically represents a transparent

bearing ring 500 mounted on gripper 206 of moving arm 200 and an electronic control unit or ECU 250 which receives signals S_{226A} , S_{226B} and S_{226C} and which controls feeding of pneumatic jacks 210 and 230 with air. Two sensors 236A and 236B are mounted on a frame 238 and deliver to ECU 250 signals S_{236A} and S_{236B} representative of the axial position of moving arm 200 along axis X200. For the sake of simplicity, ECU 250 and its connections to sensors and jacks are schematically represented on figure 5 only.

[0026] Thanks to first pneumatic jack 210, moving arm 200 can be moved, in rotation around axis X200, between a first angular position, where pin 224 is aligned with sensor 226A, as shown on figures 5 and 6, and a second angular position, where pin 224 is aligned with sensor 226C, as shown on figures 7 and 8. In the first angular position, gripper 206 is aligned with slot 314 of inlet chute 310, along an axis X310 parallel to axis X6. In the second angular position, gripper 206 is aligned with magnetic clamp 24 and working station 14 along axis X24.

[0027] Electronic control unit 250 can be programmed to actuate pneumatic jack 230 only when sensors 226A to 226C detect that the angular position of moving arm 200 around axis X200 is its first position or its second position. In other words, an axial movement of arm 200 along axis X200 is only possible when this arm is oriented, with respect to axis 200 as shown on figures 5 and 6 or as shown on figure 7.

[0028] One now describes how grinding machine 2 works with respect to the feeding of bearing rings 500 to the working station 14. Figures 1 to 5 represent a first step 1001 where multi-axis robot 100 picks-up a black bearing ring 500 in inlet chute 300. In this step, nose 208 of moving arm 200 is engaged inside the central bore 204 of a ground bearing ring 500 and moving arm 200 is in its first axial position, close to support plate 222, and in its first angular position, so that its gripper 206 is engaged within notch 314. During this step 1001, a third bearing ring 500 is being processed by grinding wheel 6 which rotates, as shown by arrow R6.

[0029] In a second step 1002, moving arm 200 is pushed in translation along axis X200, in the direction of arrow T1 on figure 5. This brings it to the position of figure 6. The result is that releaser 312 takes the second bearing ring 500 away from gripper 206 and the ground ring falls within outlet chute 310.

[0030] In a third step 1003, moving arm 200, whose gripper 208 has been drawn out of notch 314, is rotated by pneumatic jack 310 in the direction of arrow R1 on figure 6 up to the position of figure 7 where its nose 208 is aligned, along axis X24 with the central bore 504 of the third bearing ring 500 which is being processed in working station 14.

[0031] In a fourth step 1004, pneumatic jack 230 is actuated in order to move arm 200 axially along axis X200, as shown by arrow T2 on figure 7, in a direction which brings this arm closer to support plate 222. The result is that nose 208 is engaged inside the central bore

504 of the bearing ring 500. This takes place while grinding wheel 6 and the third ring 500 rotate, respectively around axis X6 and X24, which is possible since nose 208 does not contact ring 500.

[0032] In steps 1002 to 1004, multi-axis robot 100 keeps the position of step 1001.

[0033] In a fifth step 1005, multi-axis robot 100 transfers the first black bearing ring 500 from inlet chute 300 towards working station 14.

[0034] In a sixth step 1006, multi-axis robot 100 holds the first black bearing ring 500 in front of working station 14 with this ring aligned on axis X24, at an axial distance, along axis X24, of arm 200.

[0035] In steps 1005 and 1006, arm 200 remains in the position reached at the end of step 1004, that is in the position of figure 8.

[0036] In a seventh step 1007, magnetic clamp 24 is deactivated, in order to free the third ring, now a ground ring, from working station 14 and moving arm 200 is rotated around axis X200 by first pneumatic jack 210 in the direction of arrow R2 on figure 8, which brings this arm back to the position of figure 5, so that its gripper 206 is engaged within notch 314 as in step 1001.

[0037] In an eight step 1008, multi-axis robot 100 introduces the first black bearing ring 500 within working station 14 and its clamp 106 is actuated in order to free the first black bearing ring 500 which bears against fittings 20 and 22. Then, the magnetic clamp 24 is actuated in order to hold this bearing ring 500 within working station 14.

[0038] Then, multi-axis robot goes back to its position of step 1001 and step 1001 can be implemented once again.

[0039] Steps 1001 to 1008 are automatically implemented after proper programming of multi-axis robot 100. In particular, items 210, 230 and 250 automatically drive moving arm 200, as a function of the grinding process of each ring 500.

[0040] Thanks to steps 1001 to 1008, a full automatic loading and a loading of bearing rings 500 to working station 14 and out of this working station can be implemented. A change of manufacturing process, from one type of bearing ring 500 to another, is very easy and does not need to change or modify many specific components, as in the prior art. As compared to the prior art, the resetting time needed to change the manufacturing parameters between two different types of bearing rings 500 has been reduced by 3 and the presetting time has been reduced by 10. Moreover, the load carried for each resetting operation has been reduced from about 125 kg to about 5 kg and the tooling cost per reference has been reduced by 5.

[0041] As compared to prior art machines, the following elements do not need to be changed anymore when changing from one type of ring 500 to another: a support plate, the grinding wheel 6 and the inlet and outlet chutes 300 and when changing from one type of ring 500 to another

[0042] Let us consider the bearing ring moved by machine 2 from inlet chute 300 to outlet chute 310. In a first step a), multi-axis robot 100 picks-up this bearing ring in the inlet chute. In a second step b), the bearing ring is moved by the multi-axis robot into the working station 14. In a third step c), the magnetic clamp 24, which forms holding means, is actuated and this actuation remains for the whole grinding operation of the outer surface 502 of this ring 500.

[0043] Thereafter, in a fourth step d), the bearing ring 500 is temporarily gripped in the working station via gripper 206 provided on moving arm 200 because of the translation represented by arrow T2 on figure 7. At the end of the grinding operation, the magnetic clamp is deactivated in a further step e). In a sixth step f), the moving arm 200 is rotated as shown by arrow R2 on figure 8 which brings the bearing ring behind releaser 312 on figure 2.

[0044] Thereafter, in a further step g), the moving arm 200 is translated along axis X200, as shown by arrow T1 on figure 5, which induces that the ring 500 which is still mounted on nose 208 is taken out of this gripper and falls within outlet chute 310, where it moves by gravity, in the direction of arrow A310.

[0045] According to a non represented embodiment of the invention, multi-axis robot 100 can have less than 6 degrees of freedom. The invention requires a robot with at least two degrees of freedom.

Claims

1. Grinding (2) machine for bearing rings (500), this machine including:

- a frame (4),
- a rotating grinding wheel (6) movable in rotation around a first rotation axis (X6),
- a working station (14) where a bearing ring stands during a grinding operation (R6, R500) of one of its surfaces (502),
- holding means (24) for holding a bearing ring in the working station,
- transfer means (100, 200) for transferring bearing rings (500) to and from the working station (14),

characterized in that the transfer means include at least

- a multi-axis robot (100) and
- a ring moving arm (200) provided with gripping means (206) for temporarily gripping a bearing ring, this ring moving arm being rotatable (R1, R2) around a second rotation axis (X200), parallel to the first rotation axis (X6), and movable in translation (T1, T2) along this second rotation axis.

2. A grinding machine according to claim 1, **character-**

ized in that it includes driving means (210, 230, 250) for automatically driving the moving arm (200) in rotation around and in translation along the second rotation axis (X200).

3. A grinding machine according to claim 2, **characterized in that** the driving means include a first pneumatic jack (210) dedicated to driving the moving arm (200) in rotation (R1, R2) and a second pneumatic jack (210) dedicated to driving the moving arm in translation (T1, T2) along the second rotation axis (X200).
4. A grinding machine according to claim 3, **characterized in that** the first pneumatic cylinder (210) is rotatable around a third rotation axis (X210) parallel to the first rotation axis (X6).
5. A grinding machine according to any preceding claim, **characterized in that** it includes a releaser (312) for separating from the gripping means (206) a ring (500) born by the moving arm (200), via a translation movement (T1) of the moving arm parallel to the second rotation axis (X200).
6. A grinding machine according to any preceding claim, **characterized in that**
 - it includes a loading station (300) and an unloading station (310),
 - the multi-axis robot (100) is configured to carry a bearing ring (500) from the loading station (300) to the working station (14),
 - the moving arm (200) is configured and driven to carry a bearing ring from the working station (14) to the unloading station (310).
7. A grinding machine according to claim 6, **characterized in that** the unloading station includes an outlet chute (310) whose width is adjustable, depending on the axial thickness of the bearing rings (500).
8. A grinding machine according to any preceding claim, **characterized in that** the gripping means include a nose part (208) adapted to be engaged into or taken out of a central bore (504) of a bearing ring (500), depending on an axial position (T1, T2) of the moving arm (200) along the second rotation axis (X200).
9. A grinding machine according to any preceding claim, **characterized in that** it includes sensor means (226A, 226B, 226C) for sensing the angular position of the moving arm (200) around the second rotation axis (X200).
10. A grinding machine according to claim 9, **characterized in that** it includes several proximity sensors

(226A, 226B, 226C) adapted to detect a part (224) fast in rotation, around the second rotation axis (X200), with the moving arm (200).

11. A grinding machine according to claim 2 and one of claims 9 and 10, **characterized in that** actuation of the driving means (230) to drive the moving arm in translation (T1, T2) along the second rotation axis (X200) depends on an output signal (S_{226A}, S_{226B}, S_{226C}) of the sensor means.
12. A grinding machine according to any preceding claim, **characterized in that** the moving arm (200) is movable in rotation around the second rotation axis (X200) between
 - a first position (fig. 5, 6) where the gripping means (206) are aligned, along a fourth axis (X310) parallel to the first rotation axis (X6), with an unloading station (310) of bearing rings (500),
 - a second position where the gripping means are aligned, along a fifth axis (X24) parallel to the first rotation axis, with the working station (14),
13. A grinding machine according to claims 3, 11 and 12, **characterized in that** the second pneumatic jack (230) is operable to drive the moving arm (200) in translation along the second rotation axis (X200) only when the sensor means (226A, 226B, 226C) detect that the moving arm is in its first angular position or in its second angular position.
14. A grinding machine according to any preceding claim, **characterized in that** the holding means include a magnetic clutch (24) and the multi-axis robot (100) is configured to introduce a bearing ring (500) in the working station (14) via a translation along an axis (X24) parallel to the first rotation axis (X6).
15. Method for moving a bearing ring (500) between a loading station (300) and an unloading station (310) in a grinding machine provided with a grinding wheel (6) rotatable around a first rotation axis, **characterized in that** it includes at least the following steps consisting in:
 - a) picking (1001) the bearing ring with a multi-axis robot (100),
 - b) moving (1005, 1008) the bearing ring with the multi-axis robot into a working station (14) of the grinding machine,
 - c) actuating (1008) holding means (24) for holding the bearing ring in the working station during grinding of a surface (502) of the bearing ring,
 - d) gripping (1004) the bearing ring in the working station via gripping means (206) provided on a moving arm (200), thanks to a translation

movement (T2) of the arm along a second rotation axis (X206) parallel to the first rotation axis,
- e) deactivate (1007) the holding means,
- f) rotate (1007) the moving arm around the second rotation axis in a direction (R2) which brings the bearing ring close to the unloading station,
- g) translate (1001) the moving arm along the second axis of rotation in a direction (T1) which frees the bearing ring from the gripping means.

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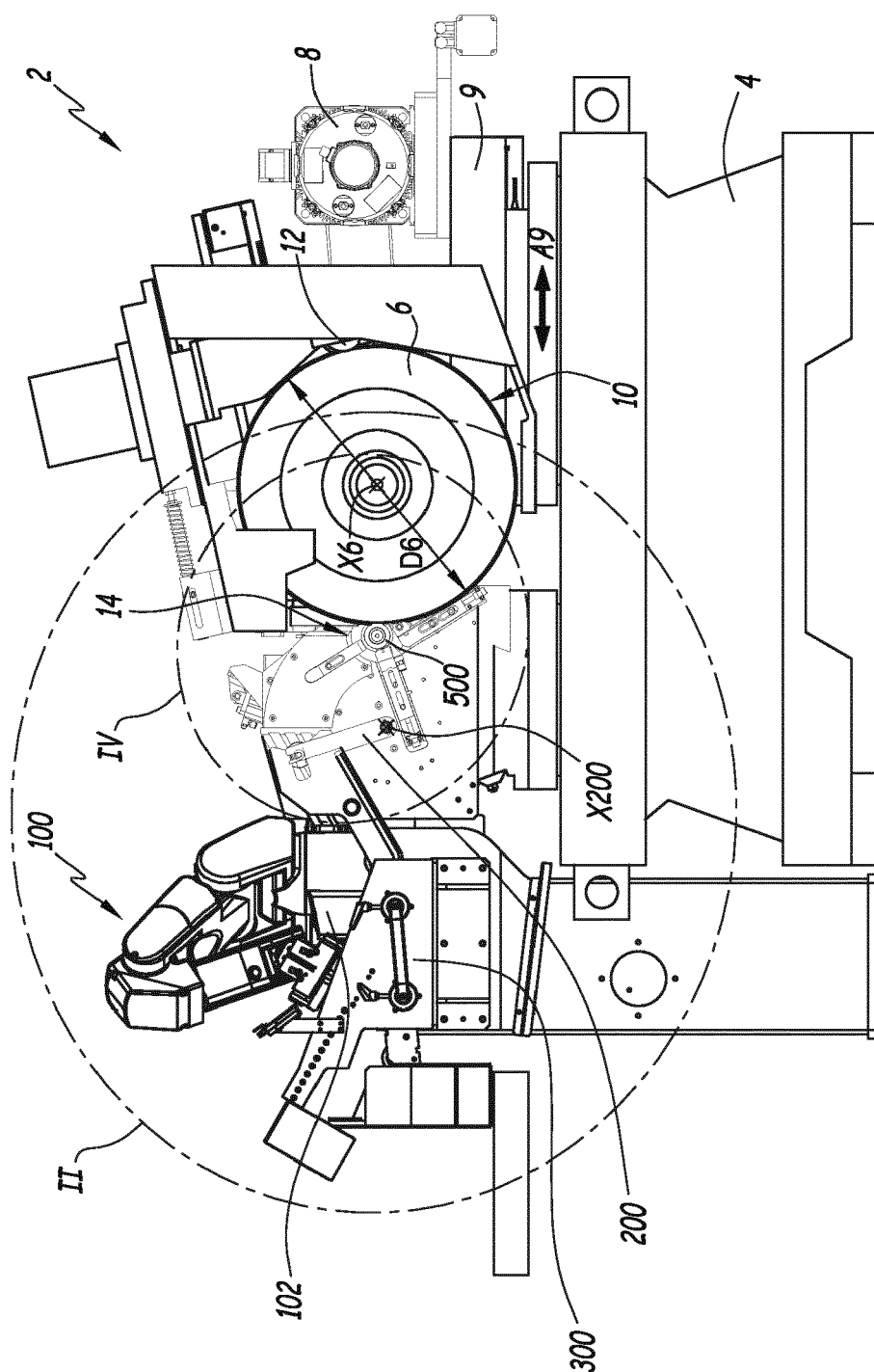
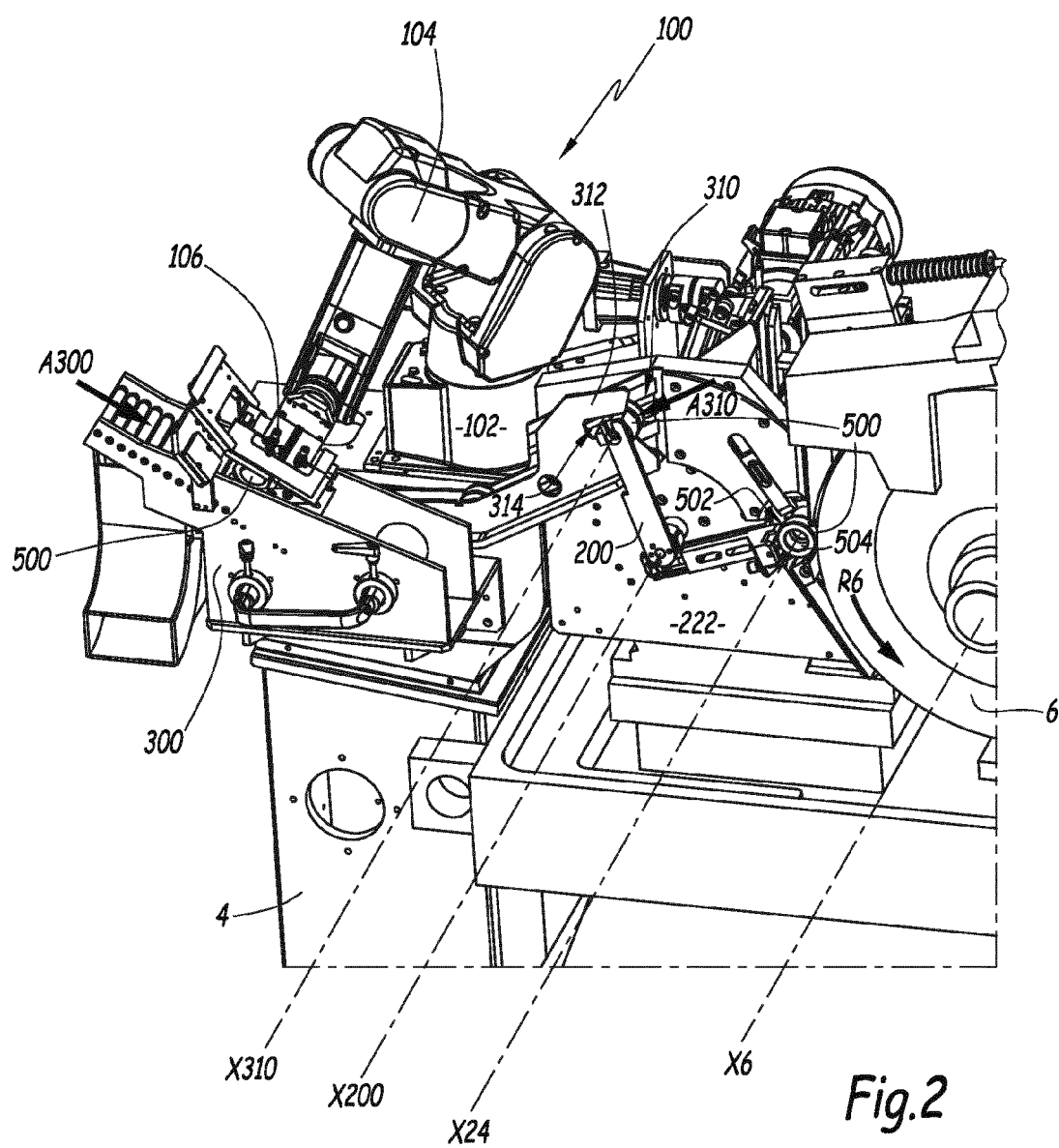


Fig.1



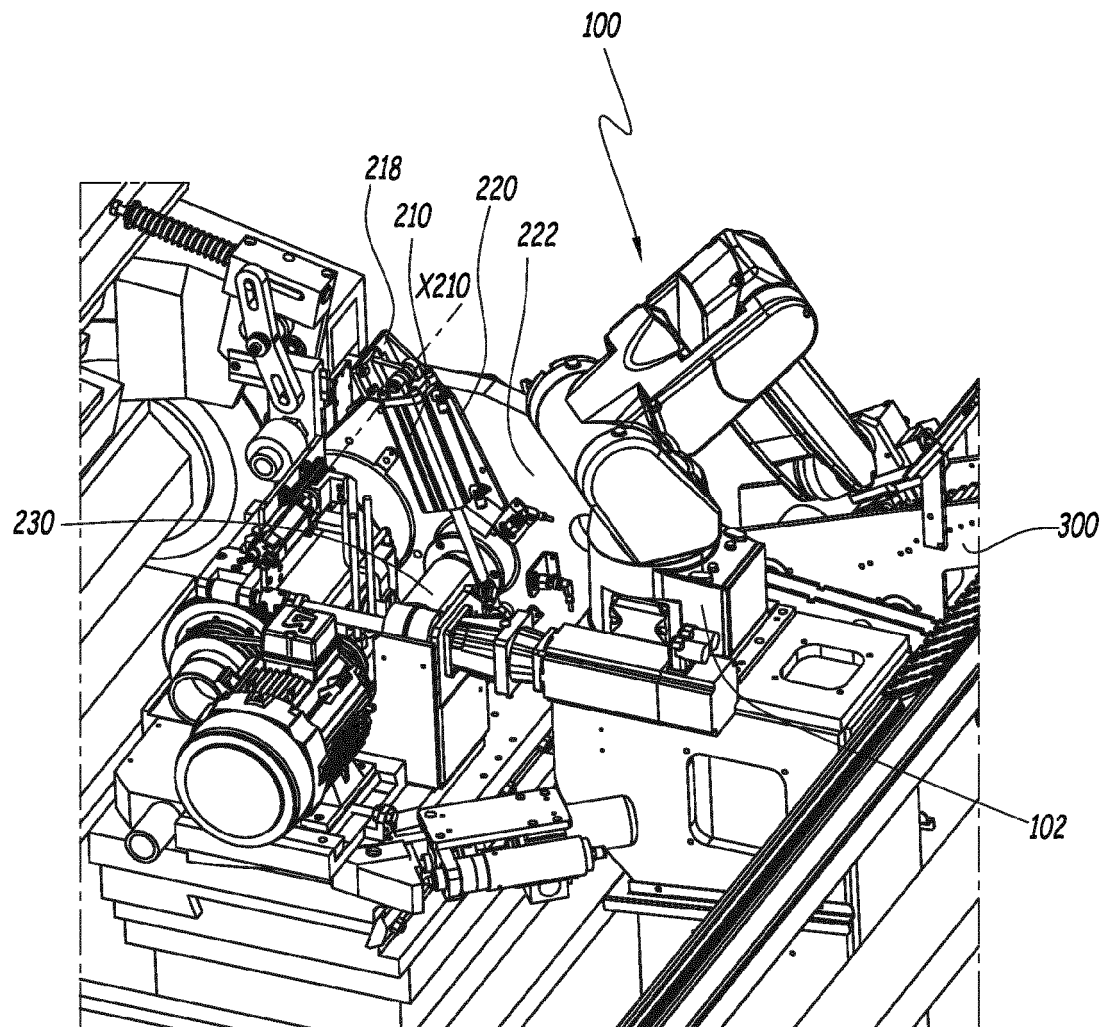
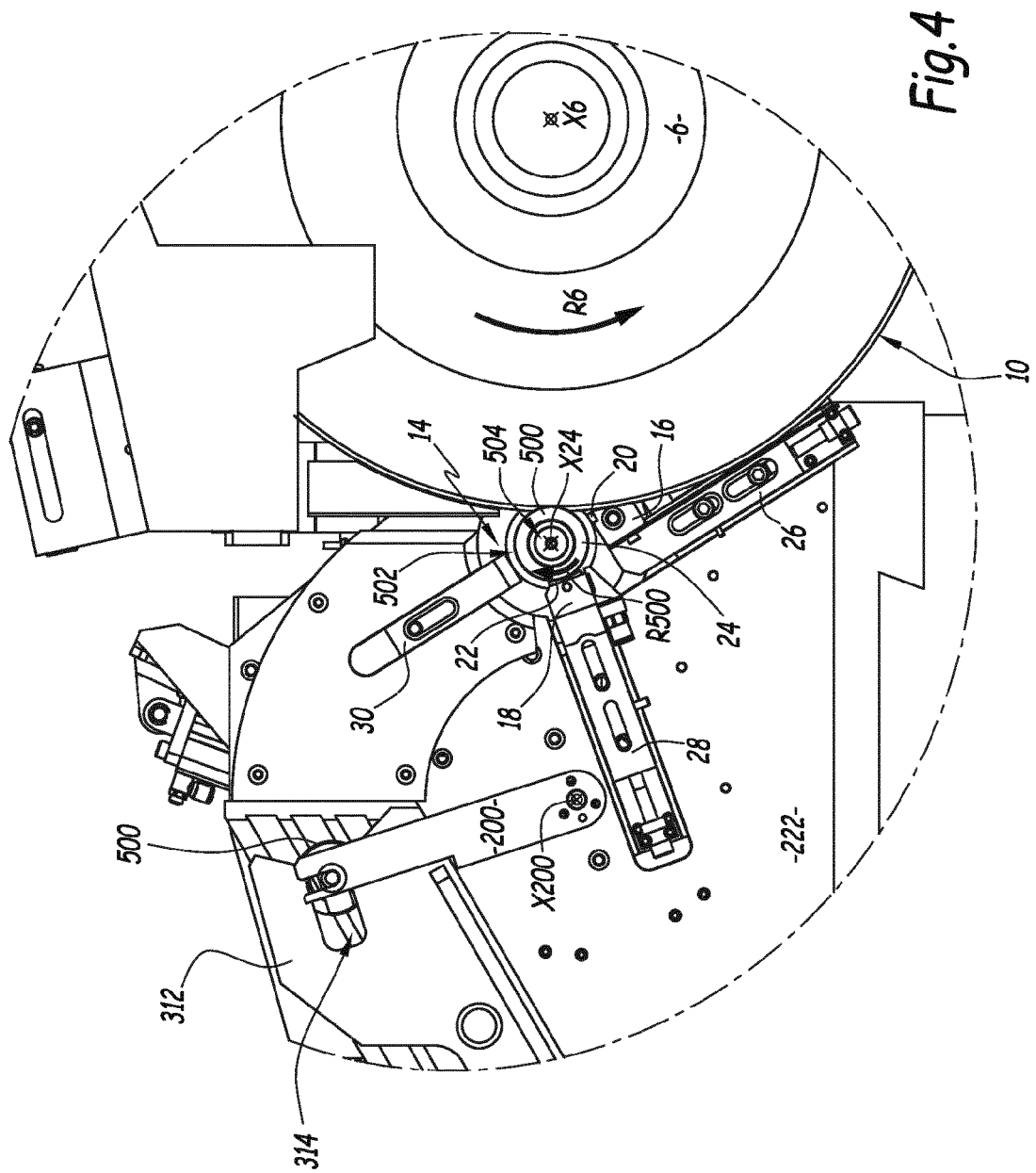
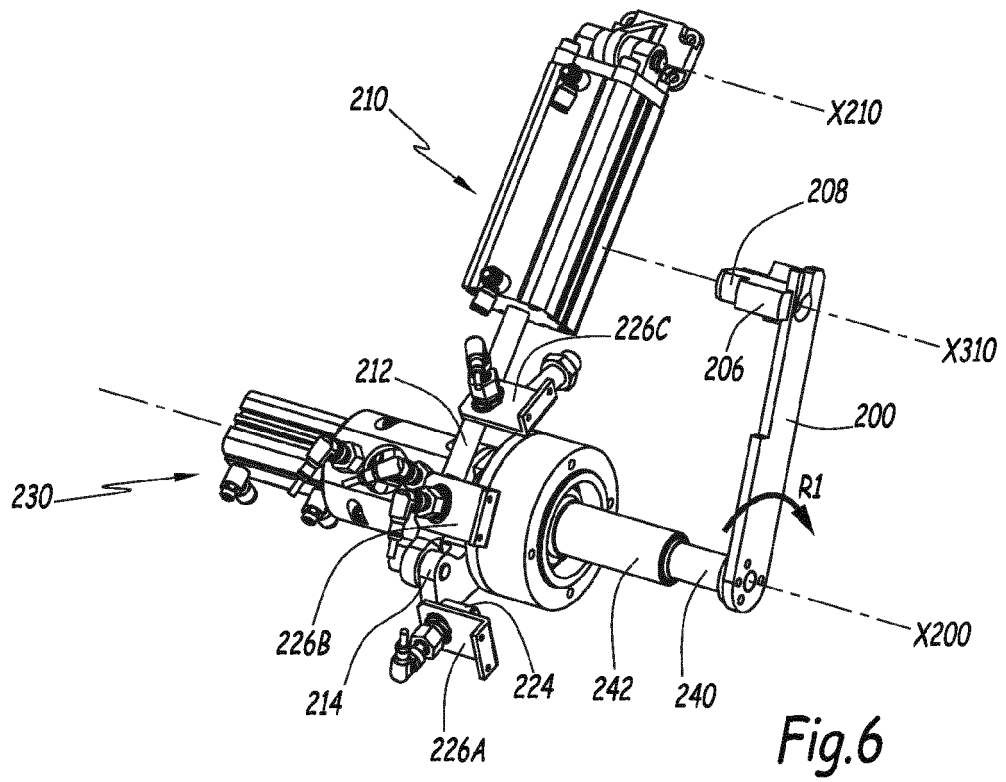
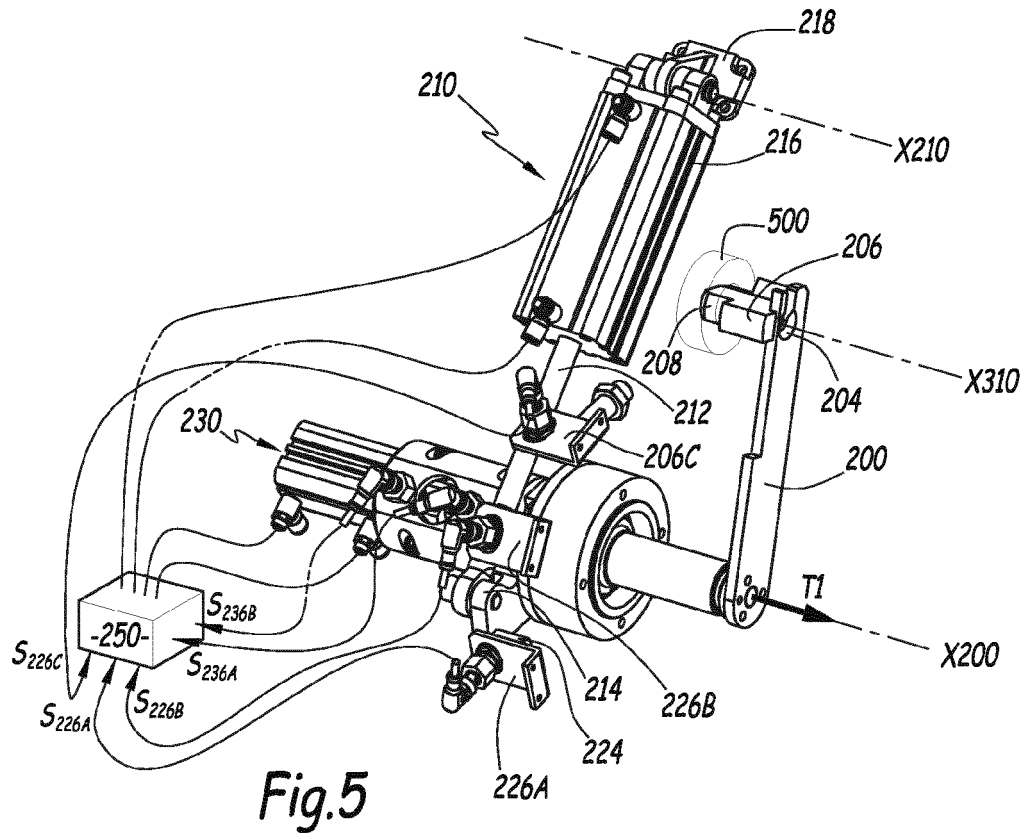
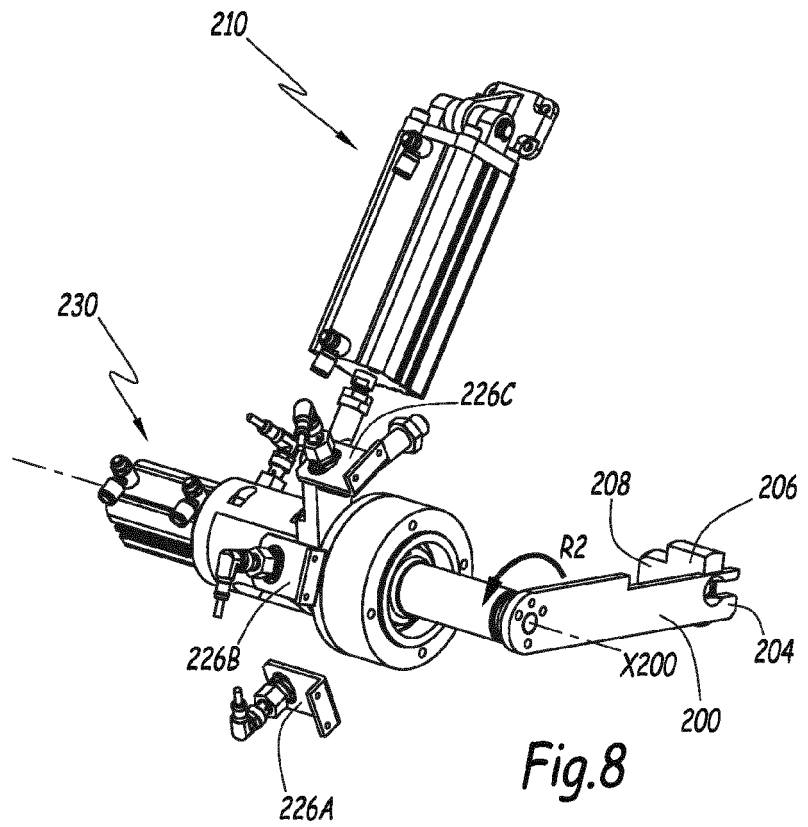
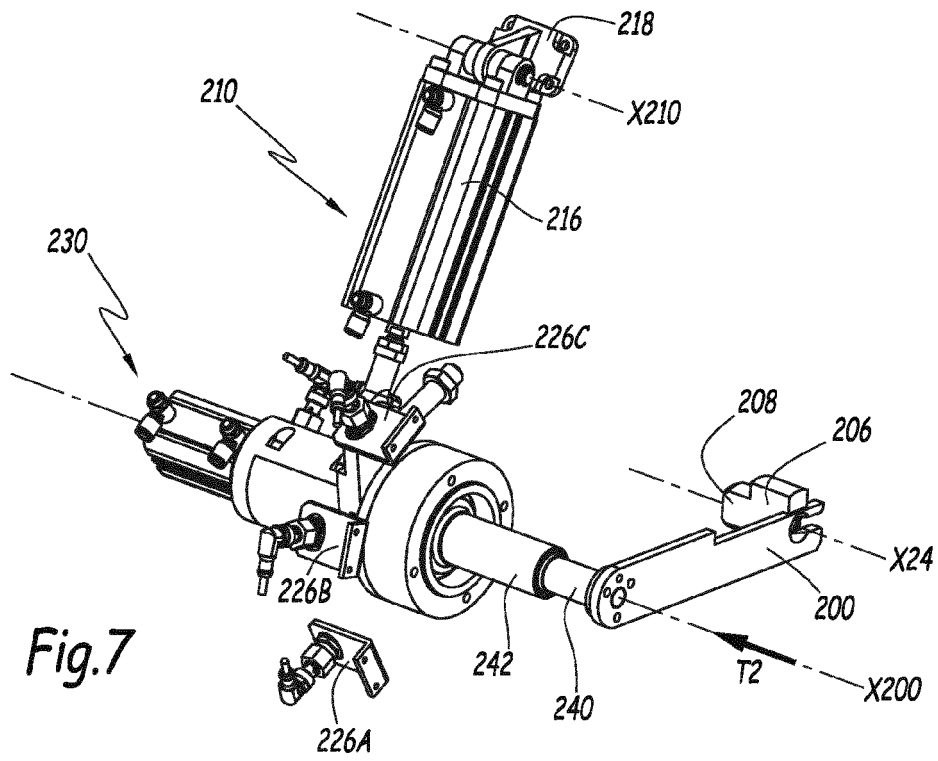


Fig.3









EUROPEAN SEARCH REPORT

Application Number
EP 14 30 5616

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 1 July 2014	Examiner Eder, Raimund
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 14 30 5616

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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