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- **Giraud, Pascal**
37540 Saint Cyr sur Loire (FR)
- **Kaelin, Alexandre**
41000 Blois (FR)
- **Pellat, Guillaume**
37000 Tours (FR)
- **Rimbault, Gérard**
37360 Semblancay (FR)

(71) Applicant: **Aktiebolaget SKF**
415 50 Göteborg (SE)

(74) Representative: **Myon, Gérard Jean-Pierre et al**
Cabinet Lavoix
62, rue de Bonnel
69003 Lyon (FR)

(72) Inventors:
• **Allin, Eric**
37230 Pernay (FR)

(54) **Grinding machine with liquid coolant injection nozzle**

(57) This grinding machine (2) for bearing rings includes a frame, a rotating grinding wheel (6) movable in rotation around a first rotation axis and a nozzle (150) adapted to inject (A2) a liquid coolant on a peripheral portion (10) of the grinding wheel. The nozzle (150) is mounted on a first slide (152) movable in translation along

a second axis (Y154) perpendicular to the first rotation axis (X6) and the position of the slide along the second axis is controlled by a mechanical linkage (152, 172, 190, 202, 204) connected to a movable part (170) of the machine whose position depends on the outer diameter of the grinding wheel (6).

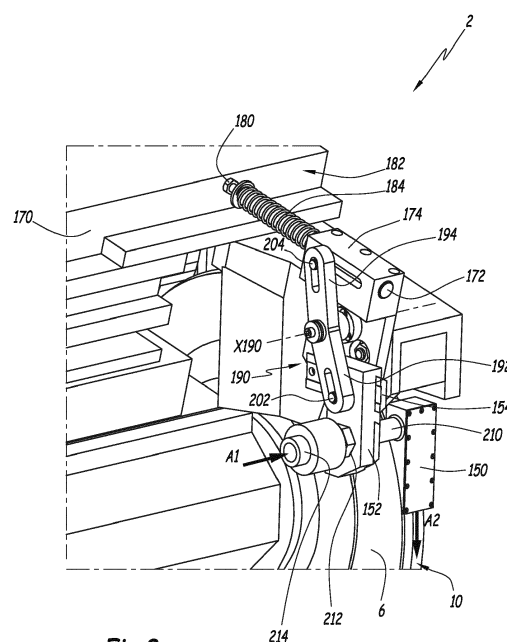


Fig.3

Description

TECHNICAL FIELD OF THE INVENTION

[0001] This invention relates to a grinding machine which can be used for the grinding of bearing rings and which includes, amongst others, a nozzle to inject a liquid coolant on a peripheral portion of a grinding wheel.

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. In that kind of a machine, it is known that a contact zone between the grinding wheel and the bearing ring being processed needs to be cooled, in order to avoid overheating of the bearing ring and to facilitate the grinding operation. Thus, it is known to use a nozzle in order to flush the contact area between the grinding wheel and the bearing ring. The location of the nozzle has to take into account that the diameter of the grinding wheel changes during its lifetime, typically from about 610 mm to about 480 mm. Under such circumstances, it is known to move a liquid coolant injection nozzle of a grinding machine according to the diameter of a grinding wheel with an external actuator, such as a pneumatic or hydraulic cylinder or an electric motor. Such an actuator requires a dedicated power supply and some control means. This is rather complicated and expensive, whereas the reliability of the grinding machine might be decreased by such an equipment. According to another approach, it is possible to use an injection nozzle which is dedicated to each type of workpiece to be processed on the grinding machine, that is to each type of bearing ring. Such a dedicated nozzle must be changed each time one changes the type of bearing ring processed on the grinding machine. This is both complicated and expensive.

SUMMARY OF THE INVENTION

[0003] This invention aims at solving these problems with a new grinding machine which is adapted to efficiently cool a peripheral portion of its grinding wheel, without needing dedicated nozzles or the use of complicated actuators.

[0004] 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 nozzle adapted to inject a liquid coolant on a peripheral portion of the grinding wheel. According to the invention, the nozzle is mounted on a first slide movable in translation along a second axis perpendicular to the first rotation axis and the position of the slide along the second axis is controlled by a mechanical linkage connected to a movable part of the machine whose position depends on the outer diameter of

the grinding wheel.

[0005] Thanks to the invention, the mechanical linkage adjusts the position of the slide along the guide rail depending on the actual outer diameter of the grinding wheel. This allows taking into account the actual outer diameter of the grinding wheel, without having to use an external actuator, such as a jack or an electric motor, and external sensors and control means.

[0006] 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 movable part of the machine moves in translation, along an axis perpendicular to the first rotation axis, depending on the outer diameter of the grinding wheel.
- The movable part is a dressing slide of the machine which is integral in translation with a tool for shaping the peripheral portion of the grinding wheel.
- The mechanical linkage includes a lever movable in rotation around a second rotation axis parallel to the first rotation axis, whereas the lever includes a first arm articulated on the first slide and a second arm articulated on a member driven in translation by the movable part of the machine.
- The member is a rod with an end in contact with the movable part of the machine and the rod is movable in translation when it is driven by the movable part.
- A first distance, measured radially with respect to the second rotation axis, between this axis and an articulation point between the first arm and the first slide, equals second distance, measured radially with respect to the second rotation axis, between this axis and an articulation point between the second arm and the driven member.
- The articulation between the first arm and the first slide occurs via a first pin mounted on the slide or on the first arm and engaged in a first receiving hole provided in the first arm or in the slide, whereas the articulation between the second arm and the driven member occurs via a second pin mounted on the driven member or on the second arm and engaged in a second receiving hole provided in the second arm or in the slide and whereas the first and second pins extend each along an axis parallel to the first rotation axis.
- The first and second pins are respectively mounted on the first slide and on the driven member and the first and second receiving holes are oblong slots provided respectively in the first and second arms, with their longitudinal directions extending radially with respect to the second rotation axis.
- The grinding machine includes elastic means for pushing the nozzle away from the grinding wheel.
- The elastic means include a spring mounted around the rod, between a collar of the rod and a part fixed with respect to the frame.

- The mechanical connection between the nozzle and the first slide includes a tube where the liquid coolant flows to feed the nozzle and the slide is connected to a coolant inlet tube.
- The first slide includes an internal channel which connects the tube to a fitting for connection of the coolant inlet tube.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] 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 using a new grinding wheel,
- figure 2 is a perspective view corresponding to detail II on figure 1,
- figure 3 is a partial perspective view of the machine of figures 1 and 2 in another direction,
- figure 4 is a detailed view corresponding to detail IV on figure 1,
- figure 5 is a back cut view, at a slightly larger scale, of the center of the portion of the machine represented on figure 5,
- figure 6 is a detailed view similar to figure 4 when the grinding wheel is almost worn out, and
- figure 7 is a back cut view similar to figure 5 when the machine is in the configuration of figure 6.

DETAILED DESCRIPTION OF SOME EMBODIMENTS

[0008] The grinding machine 2 represented on figures 1 to 7 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.

[0009] 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.

[0010] 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.

[0011] 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.

[0012] 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 slider 30 is used to avoid escape of the ring 500.

[0013] When it is loaded in working station 14, as shown on figures 1, 2, 4 and 6, 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.

[0014] 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".

[0015] 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.

[0016] A moving arm 200 also belongs to the transfer means. This moving arm 200 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 means for gripping a ring 500 to be moved away from working station 14.

[0017] 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.

[0018] 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 gripping means 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.

[0019] In the configuration of figures 1 to 5, a new grinding wheel 6 is used and its diameter D6 is about 610 mm.

[0020] A nozzle 150 is used to inject a given quantity of liquid coolant, such as water, at the interface between surfaces 10 and 502, that is in the contact area between

grinding wheel 6 and bearing ring 500 located in working station 14.

[0021] When grinding wheel 6 has its maximum diameter as shown on figures 1 to 5, nozzle 150 must be at a distance of axis X6 which is large enough to avoid a contact between items 6 and 150. On the other hand, when grinding wheel 6 is almost worn out, as shown on figures 6 and 7, nozzle 150 must be close enough to outer surface 10 in order to efficiently cool its interaction zone with surface 502 of a ring 500.

[0022] In order to adjust the radial distance between axis X6 and nozzle 150, this nozzle is connected to a slide 152 which is movable along an axis Y154 perpendicular to axis X6 and defined by a guide rail 154 mounted on a support structure formed of two support plates 156 and 158. These two support plates move together with auxiliary frame 7 which supports grinding wheel 6.

[0023] On the other hand, knurl 12 is supported by a support structure which includes a bracket 162, a support plate 164 and a spacer 166. This support structure hangs down from a dressing slide 170 which is mounted on support plate 158 with a possibility of translation along an axis Y170 perpendicular to axis X6. Since knurl 12 lies against outer surface 10 of grinding wheel 6 when it is used to shape this surface, the position of dressing slide along axis Y170 is automatically adjusted, as a function of the diameter D6 of grinding wheel 6.

[0024] On the other hand, a rod 172 is slidably mounted within a parallelepipedal housing 174 fixed on plate 156. One end 176 of rod 172 is provided with a screw 178 whose head 180 lies against a front surface 182 of dressing slide 170, this front surface 182 being perpendicular to axis Y170. A spring 184 is mounted around rod 172 and compressed between housing 174 and a washer 186 rigidly mounted at end 176. Thanks to this construction, a movement of dressing slide 170 to the left of figures 1 and 2, which corresponds to a decrease in the value of diameter D6, is transmitted to rod 172 which slides within housing 174, because front surface 82 pushes head 180. On the other hand, in case dressing slide 170 is moved to the right of figures 1 and 2, in particular upon replacement of a worn-out grinding wheel 6 with a new one, spring 184 pushes washer 186 and rod 172 towards front surface 182. In other words, spring 184 guarantees a permanent contact between head 180 and front surface 182.

[0025] A lever 190 is articulated on support plate 156 around an axis X190 parallel to axis X6. This lever is formed of two arms 192 and 194 which extend along two radial directions with respect to axis X190.

[0026] A first longitudinal slot 196 is provided in first arm 192 and a second longitudinal slot 198 is provided in second arm 194. Each slot has its longitudinal direction parallel to the longitudinal direction of the arm in which it is machined, that is radial with respect to axis X190.

[0027] A pin 202 mounted on slide 152 is engaged within first slot 196. Thus, first arm 192 is articulated on first slide 152 around the longitudinal axis X202 of pin 202.

[0028] On the other hand, a pin 204 crosses rod 172 and two longitudinal slots 174A and 174B formed on either side of housing 174 and parallel to axis Y170. Pin 204 is also engaged into second slot 198, so that second arm 194 is articulated on rod 172 around the central axis X204 of pin 204 which is also parallel to axis X6.

[0029] d1 denotes the distance, measured radially with respect to axis X190, between axes X190 and X202. On the other hand, d2 denotes the distance, measured radially with respect to axis X190, between axes X190 and X204. Distances d1 and d2 are equal. Thus, in case of rotation of lever 190 around axis X190, the axial displacement of pin 202 along axis Y154 has the same amplitude as the axial displacement of pin 204 along axis Y170.

[0030] As more clearly visible on figure 3, a hollow tube 210 connects slide 152 to nozzle 150. This tube 210 supports nozzle 150 in cantilever manner with respect to slide 152. This allows feeding nozzle 150 with water under a pressure of about 3 bars via hollow tube 210. On its side opposite to nozzle 150, slide 152 is provided with a fitting 212 for the connection of a coolant inlet tube 214 where water under pressure circulates, as shown by arrow A1 on figure 3. A non represented channel, internal to slide 152, connects fitting 212 to tube 210. The flow rate of water within tubes 214 and 210 and the internal channel of slide 152 can be chosen so that water coming out of nozzle 150, as shown by arrow A2, has a velocity of about 80 m/s. This velocity is constant, irrespective of the dimension of grinding wheel 6, because the outlet orifice of nozzle 150 is not modified since no direct contact takes place between items 6 and 150.

[0031] When one loads a new grinding wheel 6 on grinding machine 2, knurl 12 must be moved away from working station 14, which induces a translation movement of dressing slide 170 in the direction of arrow A3 on figure 4. Thus, dressing slide 170 moves away from housing 174. This movement induces that washer 186 is pushed by spring 184 away from housing 174, which brings lever 190 in the configuration of figures 3 and 5 where pin 204 is close to a first end 174B1 of slot 174B, oriented towards dressing slide 170, and slide 152 is pushed in a position relatively away from axis X6.

[0032] Upon use of grinding machine 2, grinding wheel 6 must regularly be reshaped via knurl 12, which induces that its diameter diminishes. Thus, knurl 12 moves closer to axis X6, which induces a translation movement of dressing slide 170 in the direction of arrow A4, along axis Y170. This translation movement induces that rod 172 is pushed within housing 174 and that pin 204 moves away from the first end 174B1 of slot 174B. This axial movement of pin 204 along axis Y170 induces a rotational movement of lever 190 around axis X190, in the direction of arrow R1 on figure 5. During this rotational movement of lever 190, pins 202 and 204 move towards axis X190 within slots 196 and 198 and then backwards. When ring 6 is almost completely worn out, one reaches the configuration of figures 6 and 7 where axis X204 is close to the second end 174B2 of slot 174B, away from dressing slide

170 and where slide 152 has been moved closer to axis X6 along axis Y154.

[0033] Therefore, thanks to the mechanical linkage formed by items 152, 172, 190, 202 and 204 between dressing slide 170 and nozzle 150, in particular thanks to the use of lever 190, the position of nozzle 150 is automatically adjusted, as a function of the outer diameter D6 of grinding wheel 6. One does not need any external actuator to move nozzle 150 and the resetting time and presetting time of nozzle 150 has been cancelled insofar as it is automatically correctly positioned where knurl 12 is moved to a position away from axis X6 when machine 2 is loaded with a new grinding wheel 6.

[0034] The elastic effort of spring 184 acts on washer 186 in a direction towards dressing slide 170, which tends to move lever 190 towards the configuration of figures 1 to 5 and to keep nozzle 150 away from grinding wheel 6.

[0035] According to a non-represented embodiment of the invention, the articulation mechanism between lever 190, slide 152 and rod 174 can be inverted. The pins can be provided on the lever and corresponding slots can be provided on items 152 and 174.

Claims

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

- a frame (4),
- a rotating grinding wheel (6) movable in rotation around a first rotation axis (X6)
- a nozzle (150) adapted to inject (A2) a liquid coolant on a peripheral portion (10) of the grinding wheel.

characterized in that the nozzle (150) is mounted on a first slide (152) movable in translation along a second axis (Y154) perpendicular to the first rotation axis (X6) and **in that** the position of the slide along the second axis is controlled by a mechanical linkage (152, 172, 190, 202, 204) connected to a movable part (170) of the machine whose position (A3, A4) depends on the outer diameter (D6) of the grinding wheel (6).

2. A grinding machine according to claim 1, **characterized in that** the movable part (170) of the machine moves in translation (A3, A4), along an axis (Y170) perpendicular to the first rotation axis (X6), depending on the outer diameter (D6) of the grinding wheel.

3. A grinding machine according to any of the preceding claim, **characterized in that** the movable part is a dressing slide (170) of the machine which is integral in translation with a tool (12) for shaping the peripheral portion (10) of the grinding wheel (6).

4. A grinding machine according to any of the preceding claim, **characterized in that** the mechanical linkage includes a lever (190) movable in rotation around a second rotation axis (X190) parallel to the first rotation axis (X6) and **in that** the lever includes a first arm (192) articulated on the first slide (152) and a second arm (194) articulated on a member (172) driven in translation by the movable part (170) of the machine.

5. A grinding machine according to claim 4, **characterized in that** the member is a rod (172) with an end (176) in contact with the movable part (170) of the machine and the rod is movable in translation when it is driven by the movable part.

6. A grinding machine according to one of claims 4 and 5, **characterized in that** a first distance (d1), measured radially with respect to the second rotation axis (X190), between this axis and an articulation point (X202) between the first arm (192) and the first slide (152), equals a second distance (d2), measured radially with respect to the second rotation axis, between this axis and an articulation point (X204) between the second arm (194) and the driven member (172).

7. A grinding machine according to one of claims 4 to 6, **characterized in that**

- the articulation between the first arm (192) and the first slide (152) occurs via a first pin (202) mounted on the slide or on the first arm and engaged in a first receiving hole (196) provided in the first arm or in the slide,
- the articulation between the second arm (194) and the driven member (172) occurs via a second pin (204) mounted on the driven member or on the second arm and engaged in a second receiving hole (198) provided in the second arm or in the slide and
- the first and second pins (202, 204) extend each along an axis (X202, X204) parallel to the first rotation axis (X6).

8. A grinding machine according to claim 7, **characterized in that** the first and second pins (202, 204) are respectively mounted on the first slide (152) and on the driven member (172) and the first and second receiving holes are oblong slots (196, 198) provided respectively in the first and second arms (192, 194), with their longitudinal directions extending radially with respect to the second rotation axis (X190).

9. A grinding machine according to any of the preceding claim, **characterized in that** it includes elastic means (184) for pushing the nozzle (150) away from the grinding wheel (X6).

10. A grinding machine according to claims 5 and 9, **characterized in that** the elastic means include a spring (184) mounted around the rod (172), between a collar (186) of the rod and a part (174) fixed with respect to the frame (6). 5
11. A grinding machine according to any of the preceding claim, **characterized in that** the mechanical connection between the nozzle (150) and the first slide (152) includes a tube (210) where the liquid coolant flows to feed the nozzle and **in that** the slide is connected to a coolant inlet tube (214). 10
12. A grinding machine according to claim 11, **characterized in that** the first slide (152) includes an external channel which connects the tube (210) to a fitting (212) for connection of the coolant inlet tube (214). 15

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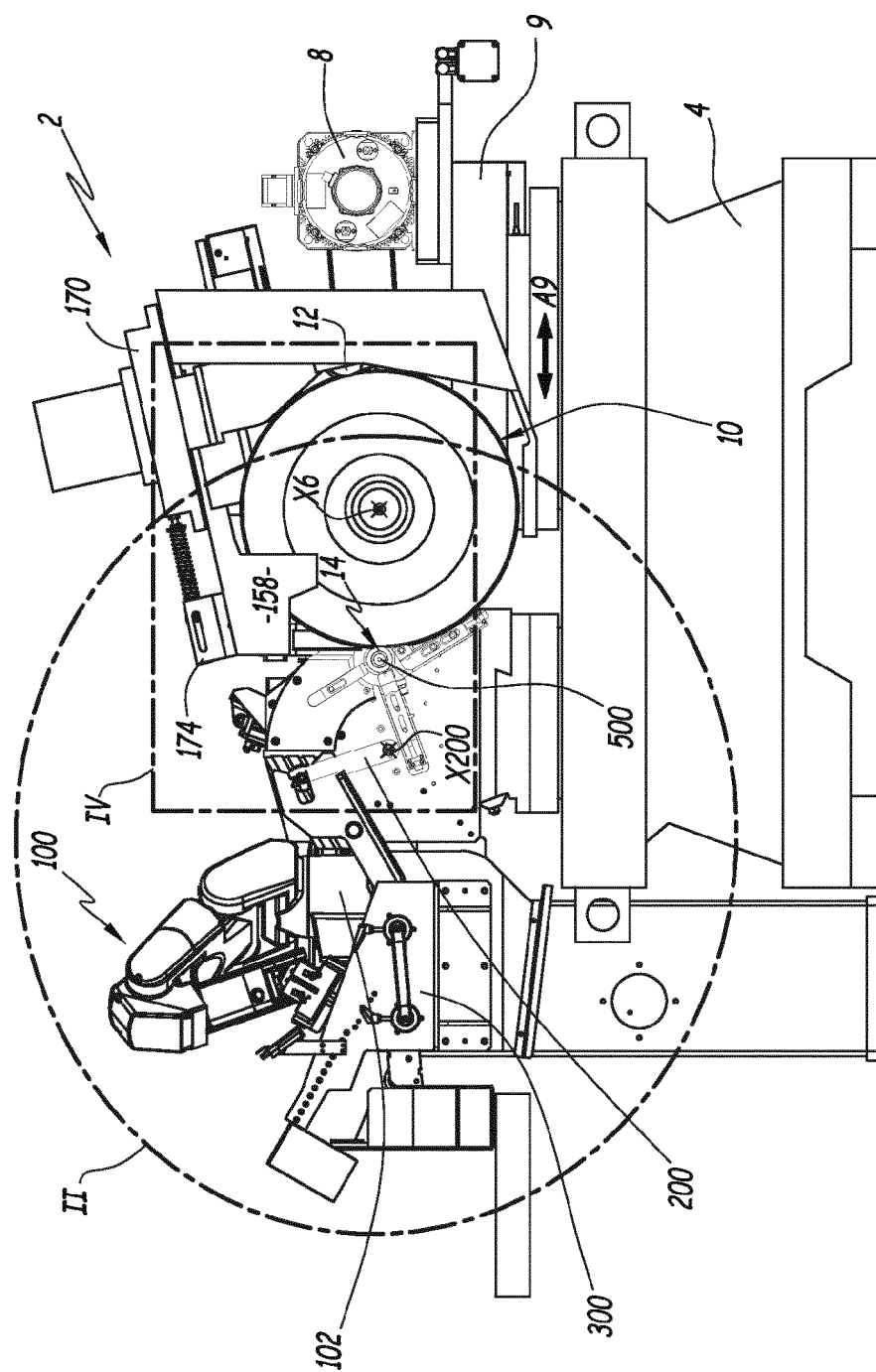
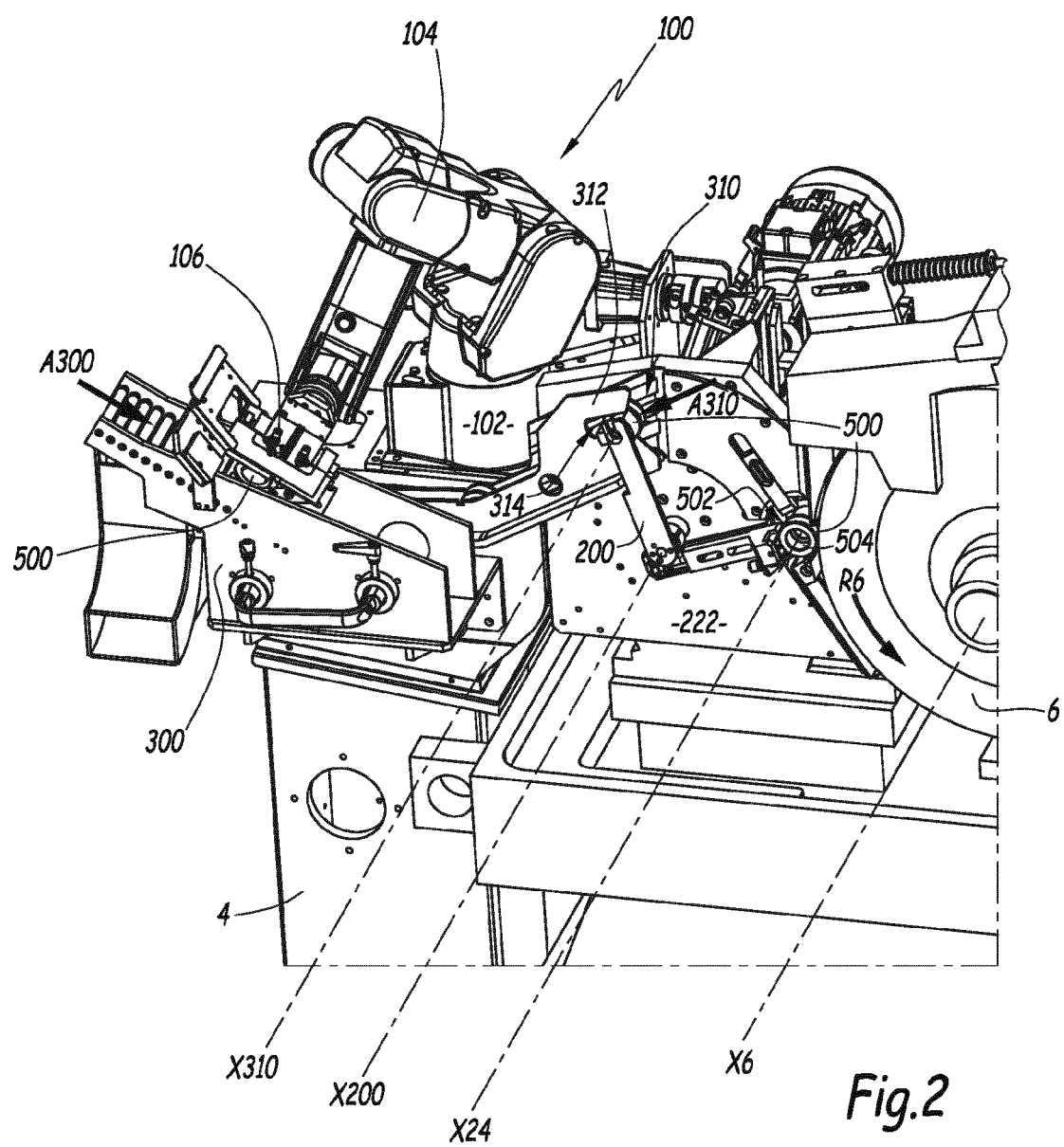


Fig. 1



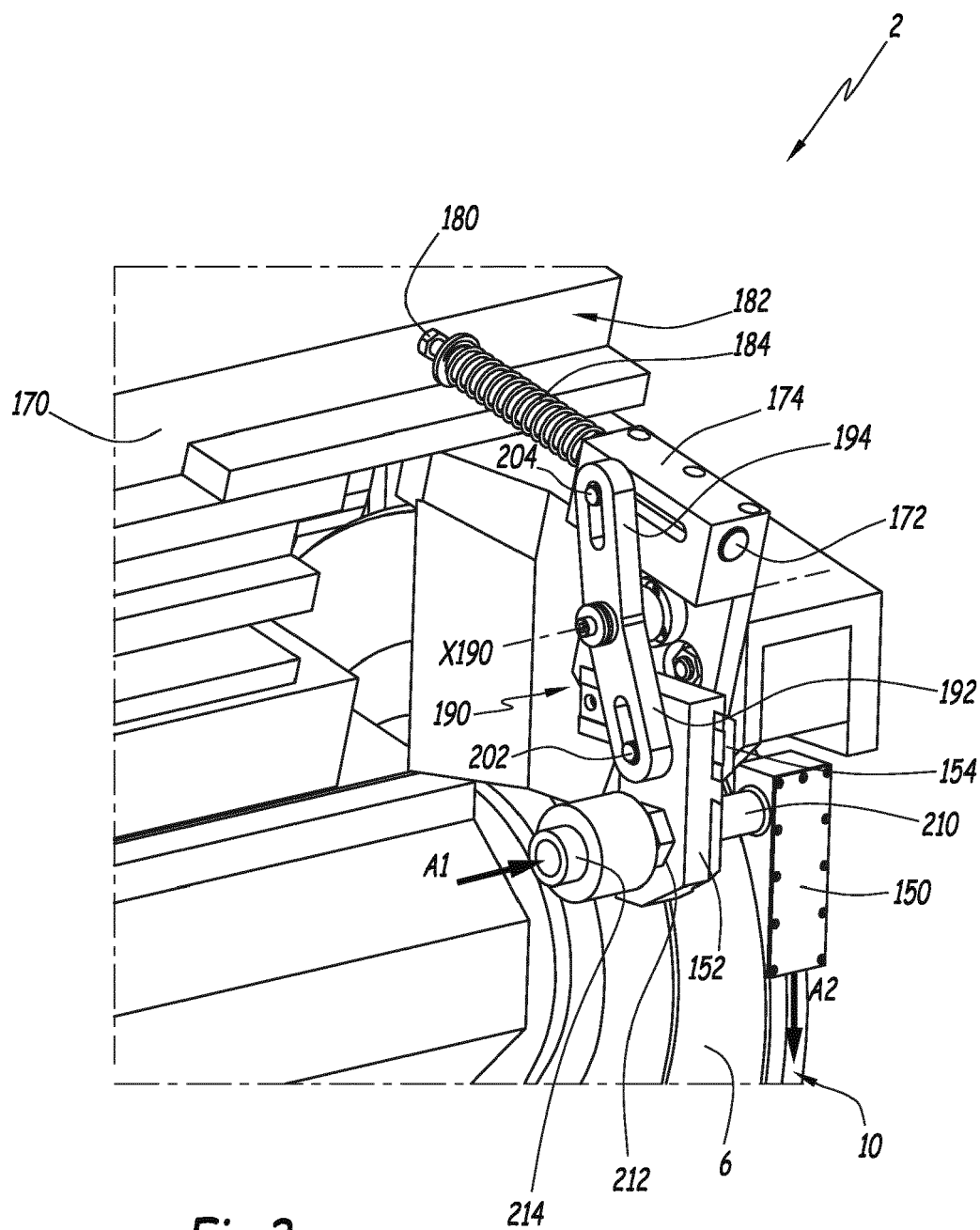


Fig.3

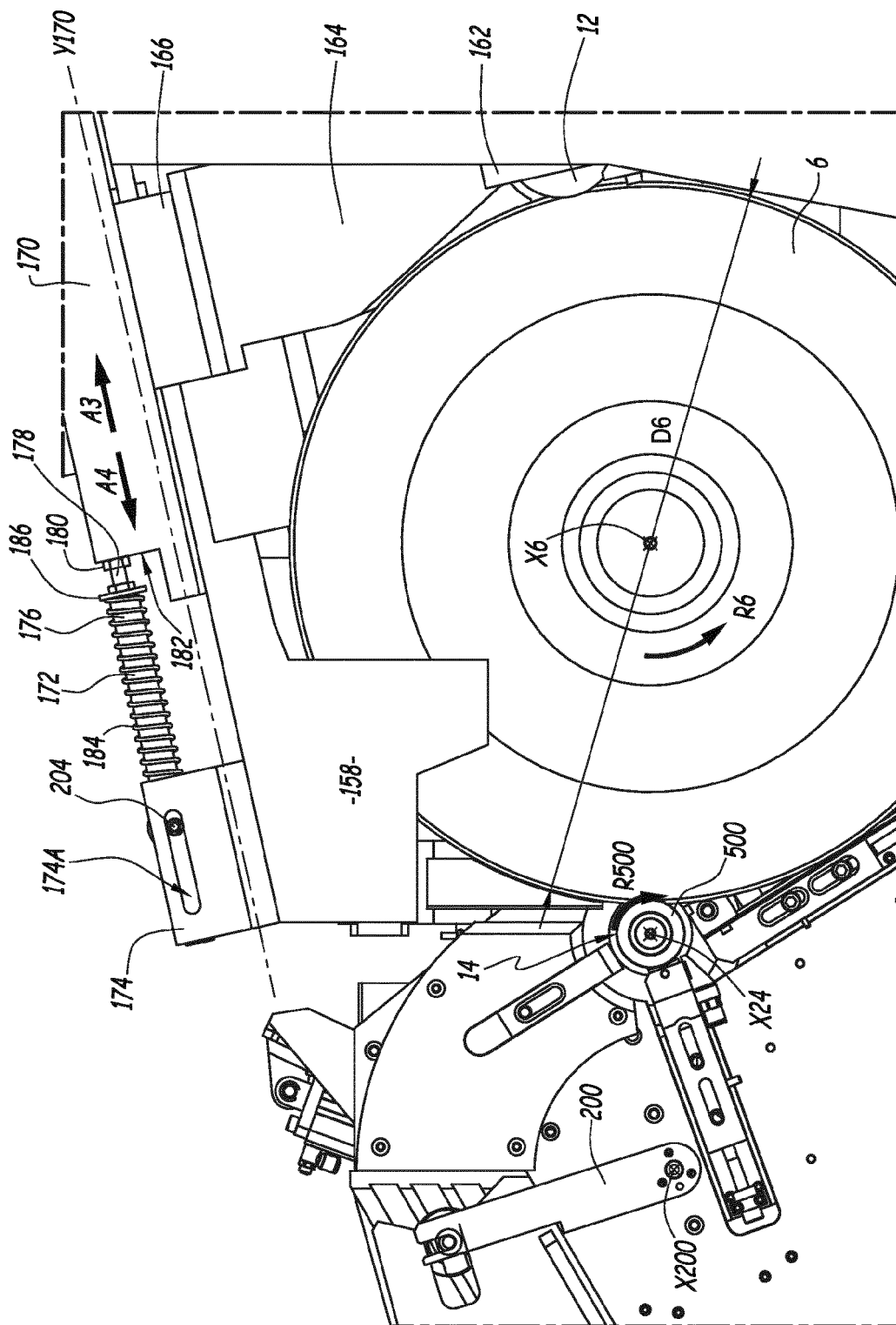


Fig.4

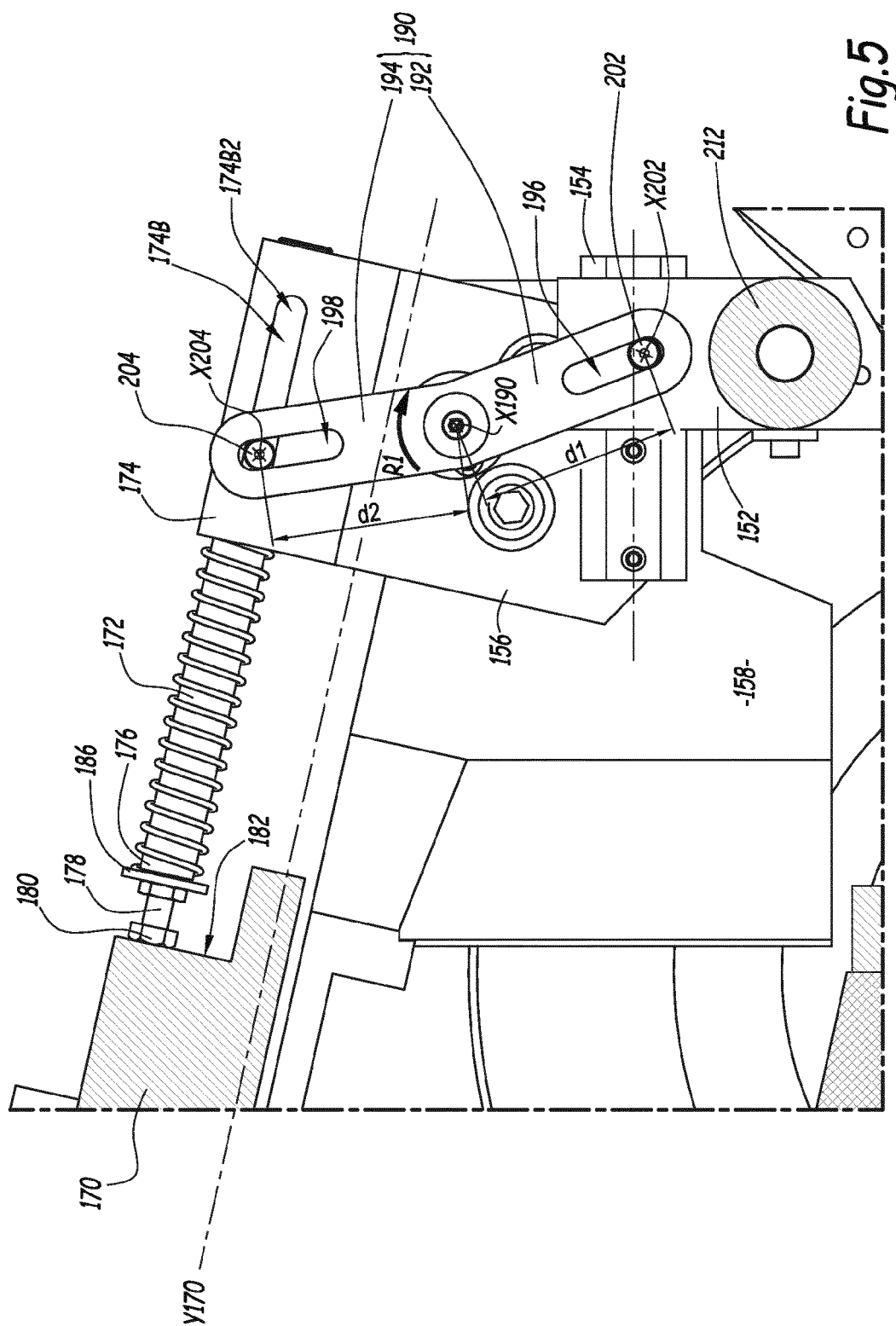


Fig. 5

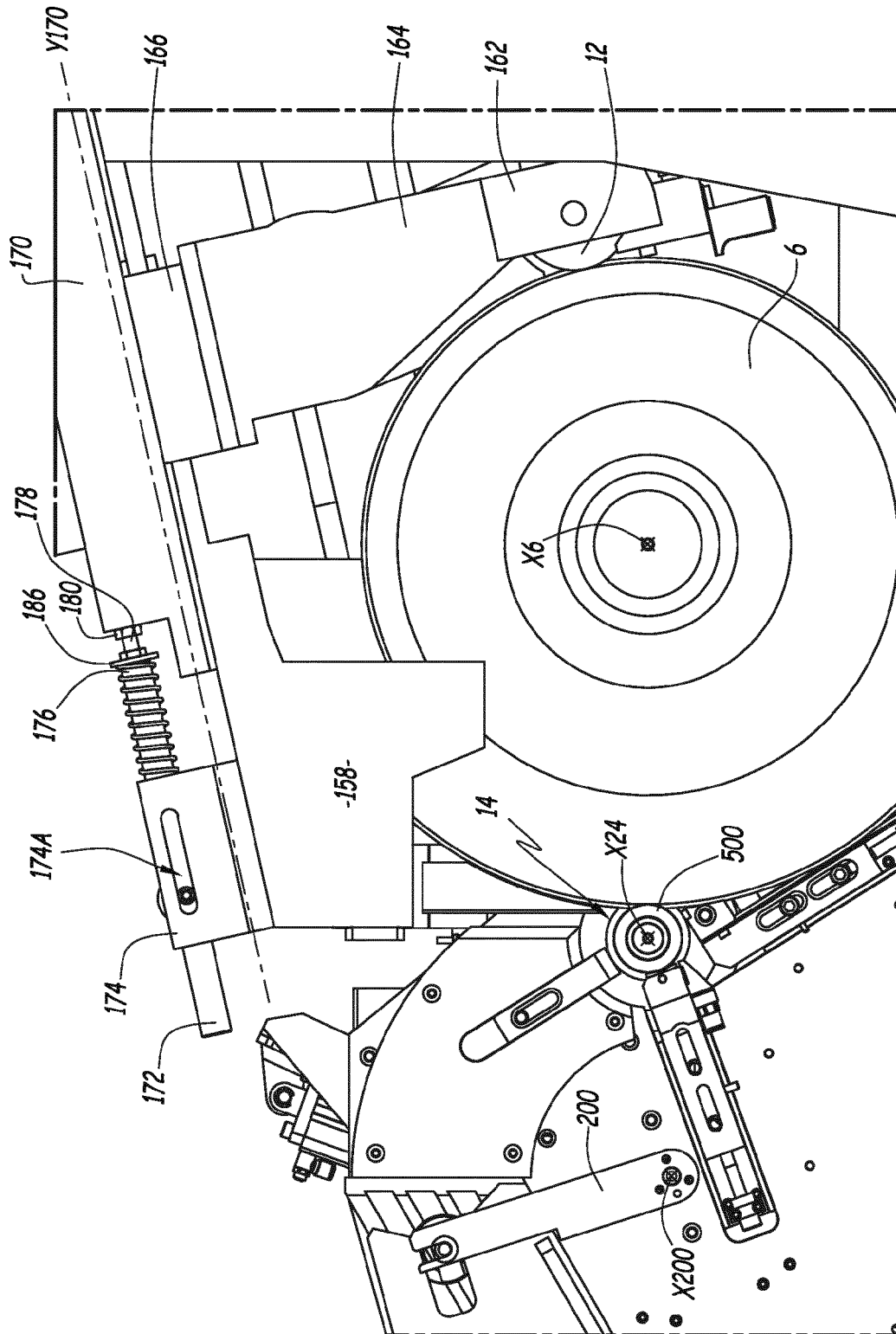


Fig.6

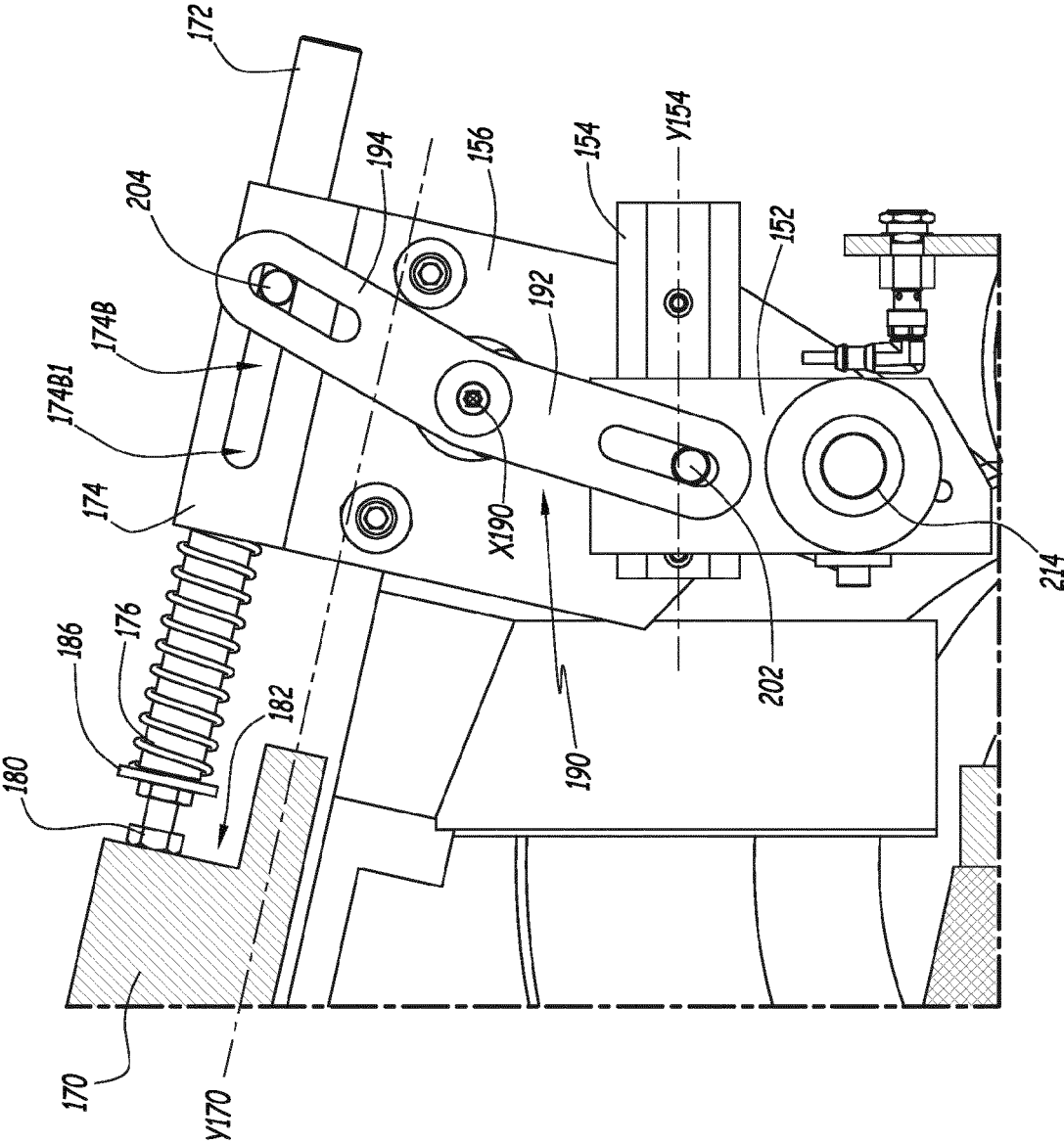


Fig.7



EUROPEAN SEARCH REPORT

 Application Number
 EP 14 30 5617

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
			B24B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 September 2014	Examiner Eder, Raimund
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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