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(11)

EP 1 621 308 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
01.02.2006 Bulletin 2006/05

(51) Int Cl.:
B28B 11/18 (2006.01)

(21) Application number: **04425566.9**

(22) Date of filing: **27.07.2004**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PL PT RO SE SI SK TR**
Designated Extension States:
AL HR LT LV MK

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(54) **Finishing tool**

(57) The invention relates to a finishing tool, in particular for removing joint burrs of moulded pieces, comprising at least one scraper element (13) which extends between two opposite end portions (13'), where said end portions are fixed to respective support means (14,15) and actuator devices (16), suitable for moving said support means in a controlled manner in relation to each other to regulate the tension of said scraper element.

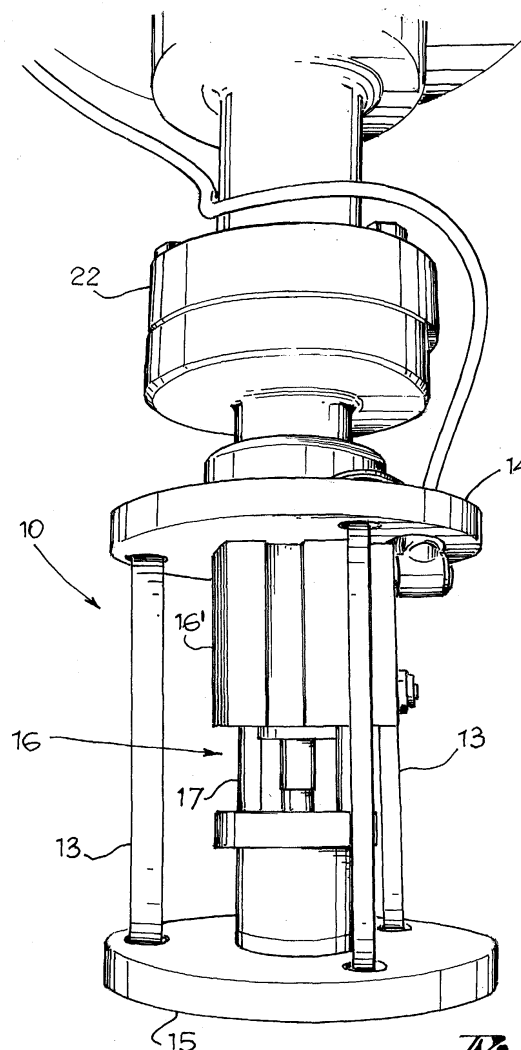


Fig. 1

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Description

[0001] The present invention relates to a finishing tool for moulded pieces, in particular for removing joint burrs. The tool proposed here is particularly suitable for use in the sector of producing ceramic products, for example sanitary items, such as toilets.

[0002] The finishing of a moulded piece in ceramic material can be carried out as soon as the piece is demoulded from the mould, before it is dried (piece still wet or "raw"), or after it has been dried (dry).

[0003] Making the finishing of a piece when dry does not pose any particular problems, and can be done in an automated way, for example by means of a robot with a suitable tool. However, when the piece is dry, the finishing does not allow the same level of precision as is possible with a raw piece, since the material has solidified.

[0004] Furthermore, to accomplish the finishing of the piece when dry in an automated manner, a special robot must be used at the end of the drying line of the pieces. If the finishing is performed by the robot used to carry out the glazing phase of the dried pieces, said phase is slowed down considerably with a drop in productivity.

[0005] In any case, each handling suffered by a piece for being transferred from one station to another may be a source of errors during the positioning in relation to the robot that is programmed to interact with said piece.

[0006] Therefore, it would be much more advantageous to be able to use, for the finishing operations, the same robot that controls the demoulding phases of the pieces and possible gluing operations between them, since this robot is currently not exploited to its maximum potential, which would thus limit the handling of the pieces.

[0007] In other words, there is a particularly strong need to be able to carry out in an automated manner the finishing of the raw piece, that has just come out of the mould

[0008] However, the finishing of the raw piece is much more delicate and is currently still carried out by man. In fact, the ceramic material, when is just cast, is a thixotropic material, that is, if it suffers mechanical stress, it loses its consistency and becomes deformed. In other words, it is necessary to gauge the pressure to be impressed by the finishing tool on the surface to be worked suitably, so as not to penetrate the material and cause irreparable damage to the piece. Furthermore, the optimum working pressure of the tool varies according to the piece or part of the piece to be finished.

[0009] However, if the robot is equipped with a traditional tool, such as a spatula or scraper, it runs the risk, for example, as a result of inaccuracies during the relative positioning between the tool and the piece to be finished, of applying excessive pressure on the tool, which would damage the piece, or insufficient pressure, which would not achieve the finishing in the required fashion, since the robot has to follow a fixed path and is bound by mechanical constraints.

[0010] The problem at the origin of the present invention is to satisfy the above stated need to perform the finishing of the moulded pieces in an automated way and before the material is dry, thus resolving the above problems at the same time.

[0011] This problem is resolved with a tool, a robot and a finishing system according to the following claims.

[0012] The idea of the solution at the origin of the present invention is to regulate the tension or flexibility of the part that comes into contact with the surface of the piece to be finished, and therefore its incisiveness on this surface at an equal distance from it, in order to compensate for any shifts in optimum pressure that said part should apply on the piece and the pressure actually applied.

[0013] Further features and advantages of the tool according to the present invention will be appreciated from the description below of an example of embodiment, given by way of example, which is not limiting, with reference to the accompanying drawings, wherein:

[0014] figure 1 is an elevation view of the tool according to the invention;

[0015] figure 2 is a view of the tool from above;

[0016] figure 3 shows a partial axial section of the tool;

[0017] figure 4 shows the tool in a configuration suitable for self-cleaning;

[0018] figure 5 represents a detail of a scraper element of the tool in a twisted configuration to aid the lateral evacuation of the material removed;

[0019] figure 6 represents an example of a robot equipped with the tool according to the invention; and

[0020] figure 7 represents a block diagram of an example of a control system of the finishing operation carried out using the tool of the invention.

[0021] With reference to the figures, with reference numeral 10a is globally indicated a finishing tool for moulded pieces, in particular to remove joint burrs between the parts that form the piece.

[0022] The tool 10 is particularly suitable for being applied to a handling or manipulating device to accomplish the finishing in an automated manner, or without the intervention of an operator. In particular, the tool proposed here is configured to be applied to the wrist 11 of a robot 12, as will be described in further detail later on.

[0023] The tool 10 also presents structural and functional characteristics, which make it particularly suitable for carrying out the finishing on ceramic products, for example sanitary items, as soon as they have been demoulded from the mould, before drying.

[0024] In a more general embodiment, the tool 10 comprises at least one scraper element 13, which is suitable for sliding over a surface of the item to be finished. Said scraper element 13 extends between two opposite end portions 13'.

[0025] The scraper element preferably extends along a main X axis.

[0026] According to a preferred embodiment, the scraper element 13 is in the shape of a strap or thin sheet,

for example of metal. The form of the scraper element is particularly suitable for removing the burr on ceramic material that is still raw. In fact, the scraper element comes into contact with the surface to be finished by means of a flat surface part, without penetrating the material, which is still soft.

[0027] Alternatively, for example, it is possible to use a reed for the scraper element made of abrasive material, or simply a wire.

[0028] In any case, both the thin thickness of the strap or reed and the wire structure give the scraper element a certain flexibility.

[0029] According to the invention, the end portions 13' of the scraper element 13 are fixed to relative support means 14, 15, which can be moved by actuator devices 16 in relation to each other in a controlled manner to allow the tension of the scraper element to be regulated.

[0030] This regulation of the tension or flexibility of the scraper element 13 is necessary so that this element applies the correct pressure on the surface to be finished, depending on the piece or part of the piece to be worked. In other words, by calibrating the flexibility of the scraper element it is possible to compensate for any inaccuracies in positioning the scraping element in relation to the surface to be finished, inaccuracies that might result in the scraper element being too incisive and irreparably damaging the piece or not being incisive enough, for example not removing the joint burr.

[0031] This option to carry out adjustments is particularly important in the case of a tool handled by a manipulation device, for example a robot, and in the case of the finishing of a piece that is still raw and therefore susceptible to irreparable damage.

[0032] The support means 14, 15 of the end portions 13' of the scraper element 13 can preferably be moved along a direction that is parallel to the direction of the X axis of said part.

[0033] According to a preferred embodiment, the actuator devices 16 of the tool comprise an actuator cylinder. The support means 14, 15 are fixed to the body 16' and stem 17 of the piston of said cylinder, respectively. Advantageously, said cylinder is an anti-rotation, pneumatic cylinder.

[0034] The movements of the cylinder piston, and therefore the regulation of the flexibility of the scraper element 13, are preferably controlled by a proportional valve (indicated schematically by block 26 in the diagram in figure 7).

[0035] The support means 14, 15 comprise, for example, a fixed flange 14 that is integral with the bottom of the body 16 of the pneumatic cylinder and a mobile flange 15 that is integral with the stem 17 of said cylinder.

[0036] According to a preferred embodiment, devices 18 for regulating the angular position of strap 13 are associated to the support means 14, 15 of the end portions of said strap 13. In particular, said devices 18 allow the angle of incidence of the strap to be regulated in relation to the surface of the piece to be finished. In order to avoid

the strap penetrating the raw ceramic material, said angle of incidence is nonetheless preferably negative. In other words, the strap 13 forms an acute angle with the part to be finished, whilst it runs over the surface of the piece.

[0037] Also advantageously, the devices 18 for regulating the angular position of the strap 13 can be adjusted independently of each other. In other words, the end portions 13' of the strap 13 can be rotated differently from each other. This allows said end portions 13' to be rotated slightly in the opposite direction, for example, to give the strap 13 a slightly twisted course to aid the lateral evacuation of the material removed during the finishing operation (figure 5).

[0038] According to an embodiment, each end portion 13' of the scraper element 13 is integral with a small plate 19 sliding angularly on a relative support flange 14, 15. A curved slot 20 is made in each small plate 19 to pass a screw 20' to fasten the small plate 19 to the flange. A shaped locking pin 21, with a semi-cylindrical shape, for example, extends from each small plate 19, and a relative end portion 13' of the scraper element 13 is fixed to the pin, for example, by screwing. Advantageously, each locking pin 21 is housed in a respective cavity that is provided in the relative support flange 14, 15.

[0039] In practice, the curved slot 20 allows each small plate 19 to be mounted in a required angular position.

[0040] According to a preferred embodiment, the tool 10 is equipped with a plurality, for example, of three, scraper elements 13. The support flanges 14, 15 of said parts present an axis of symmetry coinciding with the axis of the actuator cylinder 16. The scraper elements 13 are fixed to the support flanges 14, 15 around the main axis of the cylinder.

[0041] According to an embodiment, the tool 10 comprises a portion 22 for coupling to a handling device that is programmed to make the tool follow a set path. Said handling device is preferably a robot 12, for example an anthropomorphic robot.

[0042] Advantageously, the coupling part 22 also comprises a shaped plate 23 for resting the tool in a relative deposit.

[0043] According to another feature of the invention, the tool 10 is part of a system for automated realisation of the finishing operation, which also comprises transducer devices 24 suitable for recording a quantity correlated to the finishing operation, besides the tool itself, the handling device 12 onto which it is mounted and the control devices 26 of the actuator devices 16 of the support means of the scraper element. This quantity can be used to set the correct value of flexibility that must be possessed by the scraper element.

[0044] Advantageously, the transducer devices 24 are connected in a closed ring to a control unit 25 that is planned to control the proportional valve 26.

[0045] For example, if P_o is the optimum pressure value for the finishing operation on a certain part of a piece, the transducer devices advantageously comprise a pressure transducer 24, suitable for recording the pressure

P applied by the scraper element on the surface of the piece to be finished. If the pressure recorded is greater than the optimum pressure, for example because of the tool being drawn too close to the piece to be finished, the control unit 25 will command the proportional valve 26 to make the piston return back into the cylinder 16 by a Δx quantity to reduce the tension of the scraper element. This will translate into a ΔP decrease in the pressure exerted by the scraper element 13 on the surface. Vice versa, if the recorded pressure P is less than the optimum pressure, the control unit will command the proportional valve to make the piston come out of the cylinder and increase the tension of the scraper element, thus making the scraper element more incisive in relation to the surface to be worked.

[0046] Alternatively, a feeler pin device, for example, which is suitable for recording discontinuity on the surface to be finished can be used as transducer devices, or viewing devices.

[0047] Finally, it must be pointed out that using a pneumatic cylinder to adjust the flexibility of the scraper element also allows ceramic material to be removed from the element itself automatically at the end of the finishing operation. In fact, it is sufficient to command the cylinder to cause a substantial flexion of the scraper element (figure 4) and then make the piston advance rapidly, for example under the action of a spring inside the cylinder, if the cylinder is a simple effect type.

[0048] Obviously, a person skilled in the art can make further modifications and variations to the finishing tool according to the present invention to satisfy specific and contingent needs, all of which are nevertheless included in the scope of protection of the invention, as defined by the following claims.

Claims

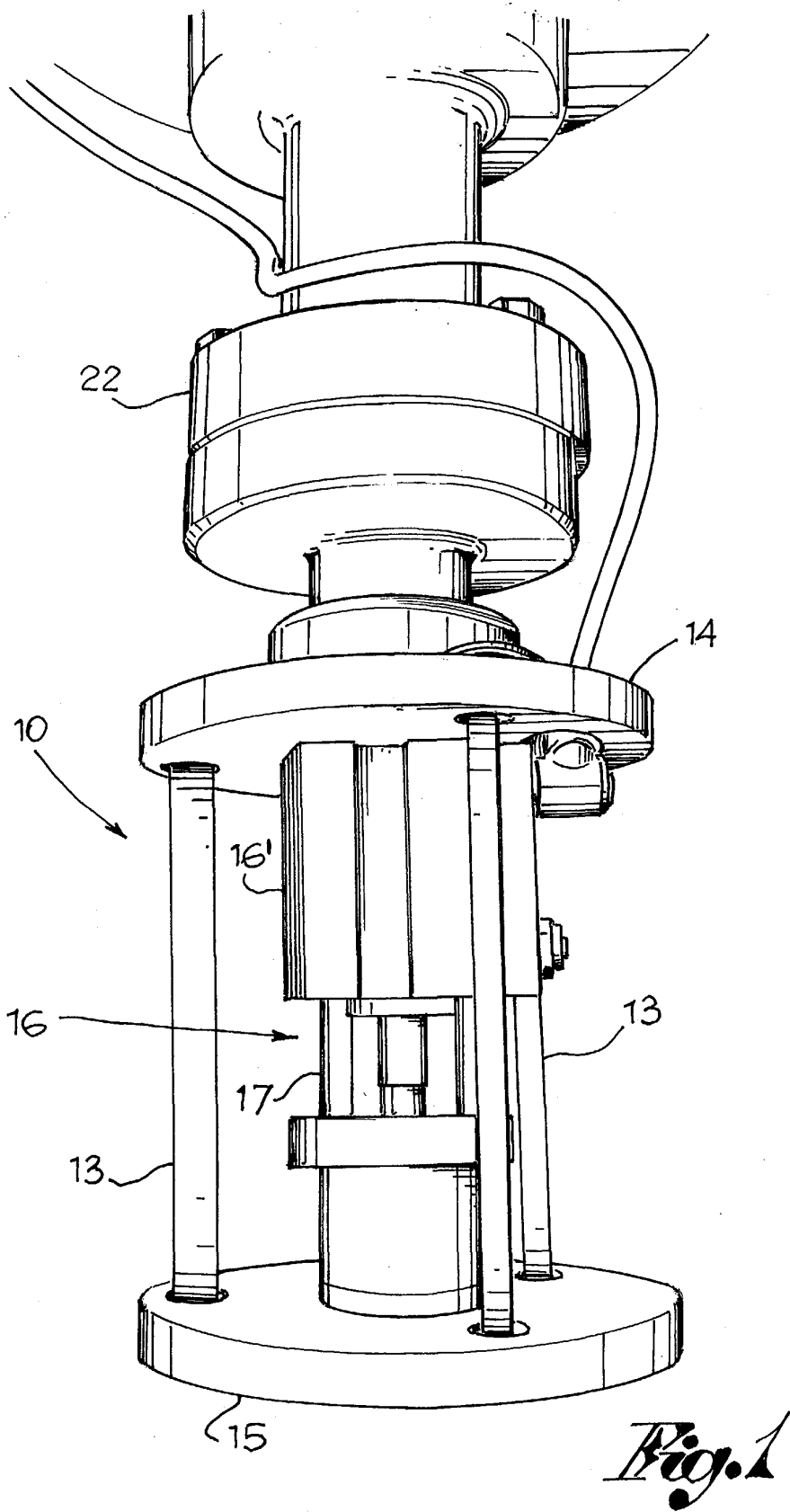
1. Finishing tool, in particular for removing joint burrs of moulded pieces, comprising at least one scraper element (13) which extends between two opposite end portions (13'), where said end portions are fixed to respective support means (14, 15), **characterised in that** it comprises actuator devices (16) suitable for moving said support means in a controlled manner in relation to each other to regulate the tension of said scraper element.
2. Tool according to claim 1, wherein said at least one scraper element extends longitudinally along a main axis (X).
3. Tool according to claim 2, wherein said actuator devices are suitable for moving the support means along a direction that is parallel to the direction of the axis of the scraper element.
4. Tool according to claim 2, wherein said scraper element is a strap.
5. Tool according to claim 2, wherein said scraper element is a reed made of abrasive material.
6. Tool according to claim 2, wherein said scraper element is a wire.
7. Tool according to any one of the previous claims, wherein said actuator devices comprise an actuator cylinder, the support means of the end portions of the scraper element being fixed to the body (16') and stem (17) of the piston of said actuator cylinder, respectively.
8. Tool according to claim 7, wherein said cylinder is an anti-rotation pneumatic cylinder.
9. Tool according to claim 8, wherein said cylinder is commanded by a proportional valve.
10. Tool according to any one of the previous claims, wherein the end portions of the scraper element are fixed respectively to a fixed flange (14) that is integral with the bottom of the actuator cylinder (16) and to a moving flange (15) that is integral with the stem of said cylinder.
11. Tool according to any one of the previous claims, wherein devices (18) for regulating the angular position of the scraper element are associated to the support means of the end portions of said scraper element to regulate its angle of incidence in relation to the surface of the piece to be finished.
12. Tool according to claim 11, wherein a device is associated to each of the end portions of the scraper element for regulating the angular position, each device being adjustable independently from the other one.
13. Tool according to claim 12, wherein each end portion of the scraper element is integral with a small plate (19) sliding angularly on the support means of said end portion.
14. Tool according to claim 13, wherein a curved slot (20) is made in each small plate (19) for passing a screw (20') to fasten said small plate to the relative support device.
15. Tool according to claim 14, wherein from each small plate (19) a shaped locking pin (21) extends for locking a respective end portion (13') of the scraper element (13).
16. Tool according to claim 15, wherein each locking pin (21) is housed in a respective cavity that is provided

in the relative support device.

17. Tool according to any one of the previous claims, comprising a plurality of scraper elements (13) arranged parallel to each other. 5
18. Tool according to claim 17, comprising an actuator cylinder, two support flanges fixed to the body and stem of said cylinder respectively, said flanges having an axis of symmetry coinciding with the axis of the cylinder, and a plurality of scraper elements which extend between said support flanges around said axis of symmetry. 10
19. Tool according to any one of the previous claims, comprising a portion (22) for connecting to a handling device programmed to make the tool follow a set path. 15
20. Tool according to claim 19, wherein said handling device is a robot. 20
21. Tool according to any one of the previous claims, wherein said portion for connecting to the handling device comprises a shaped plate (23) for resting the tool in a relative deposit. 25
22. Robot to perform a finishing operation of a piece in an automated manner, in particular for removing joint burrs of a moulded piece, **characterised in that** it comprises an arm equipped with a tool according to any one of the previous claims. 30
23. System for automated accomplishment of a finishing operation of a piece, in particular to remove joint burrs of a moulded piece, comprising a tool (10) according to any one of the previous claims from 1 to 21, an automated device for handling said tool, control devices (26) of the actuator devices (16) of the tool and transducer devices (24) suitable for recording a quantity correlated to the finishing operation. 35 40
24. System according to claim 23, wherein said transducer devices are connected, in a closed ring, to a control unit (25) to control the control devices (26) of the actuator devices (16) of the tool. 45
25. System according to claim 24, wherein said transducer devices comprise a pressure transducer, suitable for recording the pressure exerted by the scraper element on the surface of the piece to be finished. 50
26. System according to claim 24, wherein said transducer devices comprise a feeler pin device suitable for recording discontinuity of the surface of the piece to be finished. 55
27. System, in accordance with claim 24, wherein said

transducer devices comprise viewing devices.

28. Method for finishing an article of ceramic material made by moulding, **characterised in that** it is carried out by a robot in accordance with claim 21, before the ceramic material is dried.
29. Process for producing an article in ceramic material, wherein said article is made by moulding, **characterised in that** it comprises a finishing method, in accordance with claim 28.



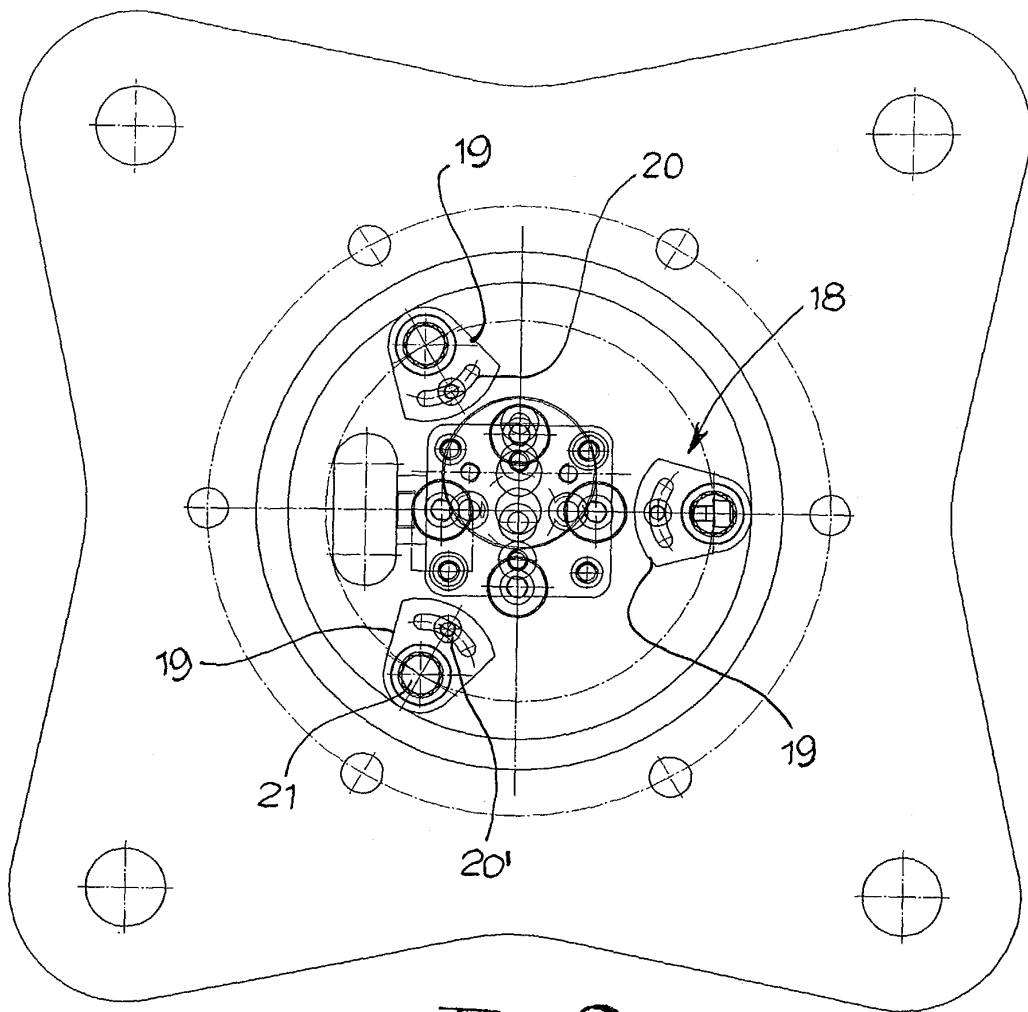


Fig. 2

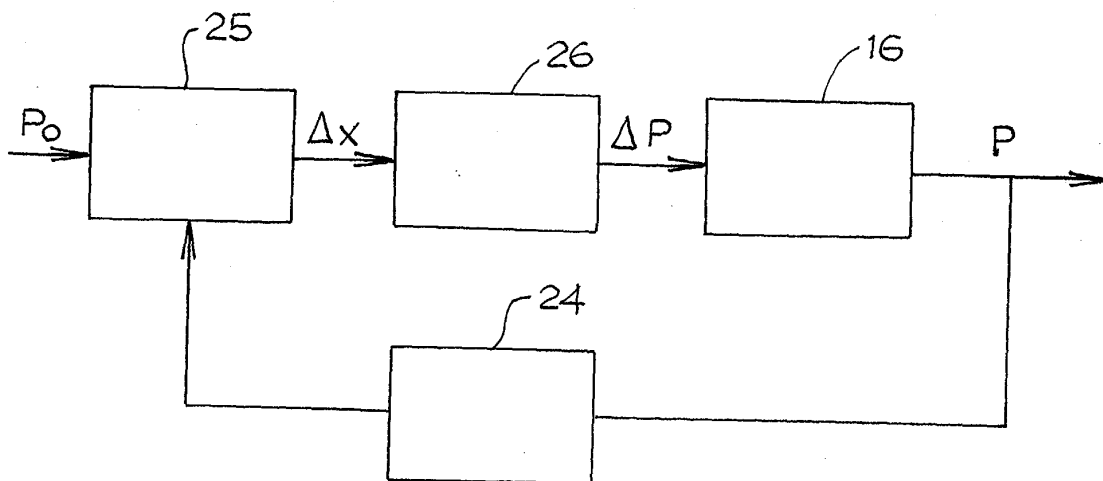
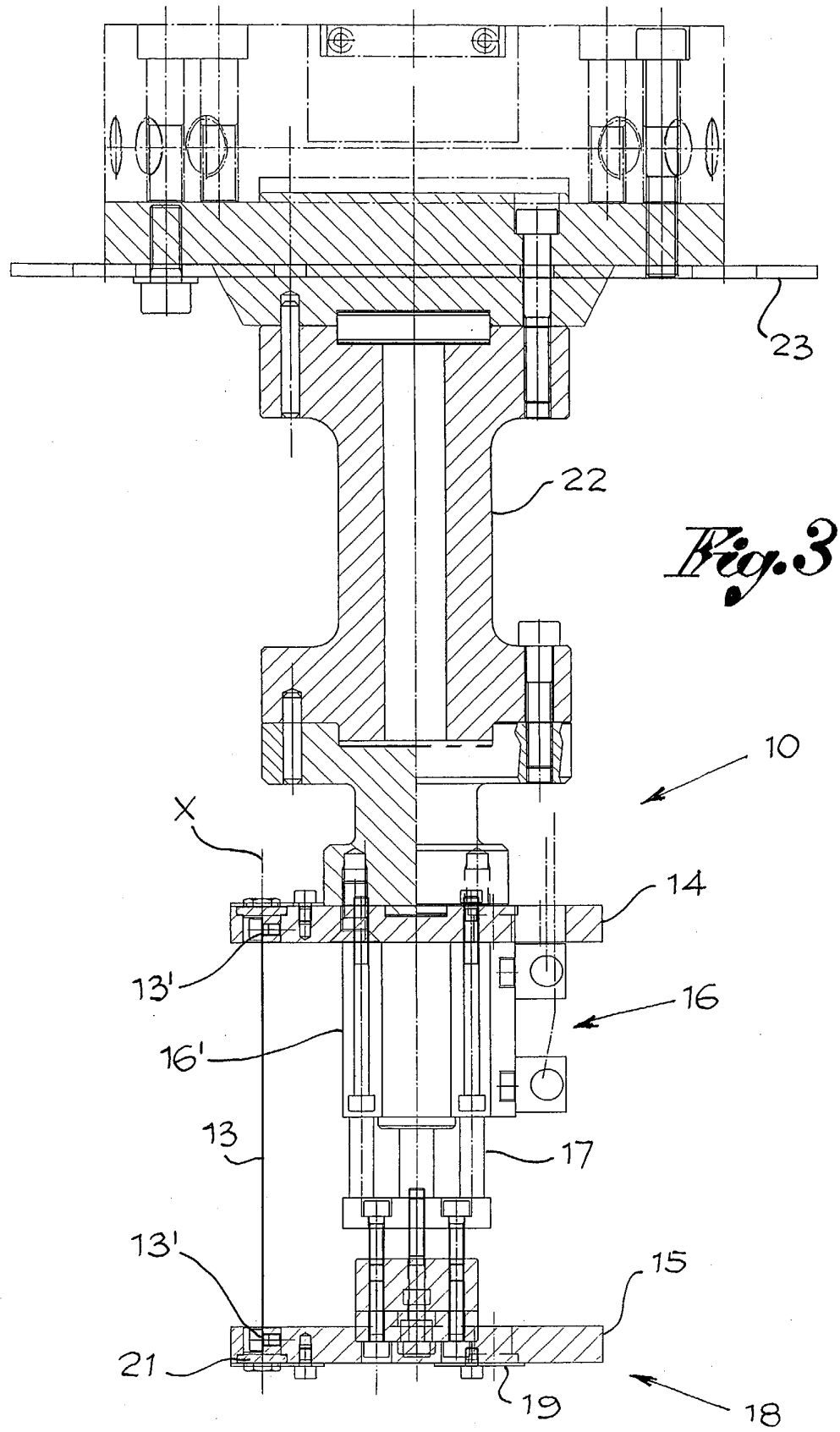


Fig. 7



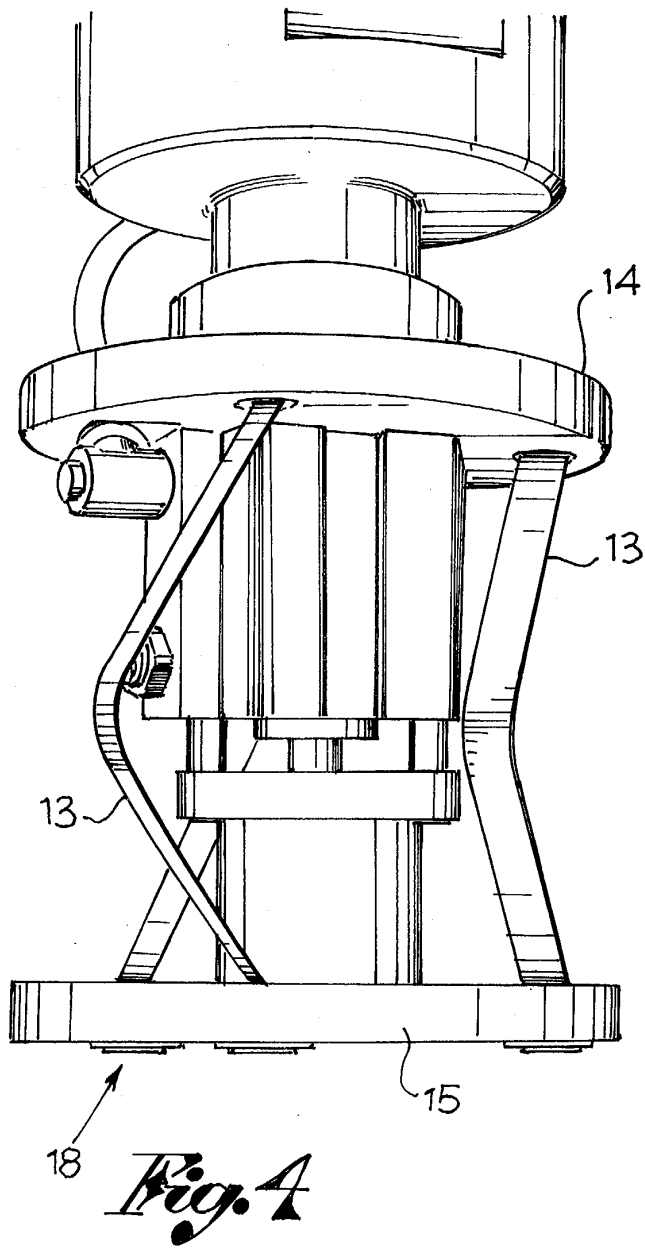
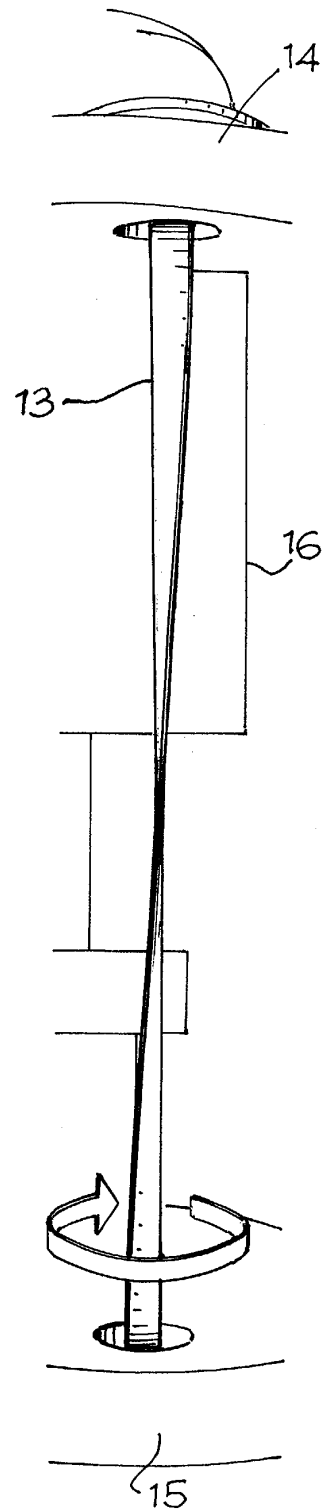


Fig. 5



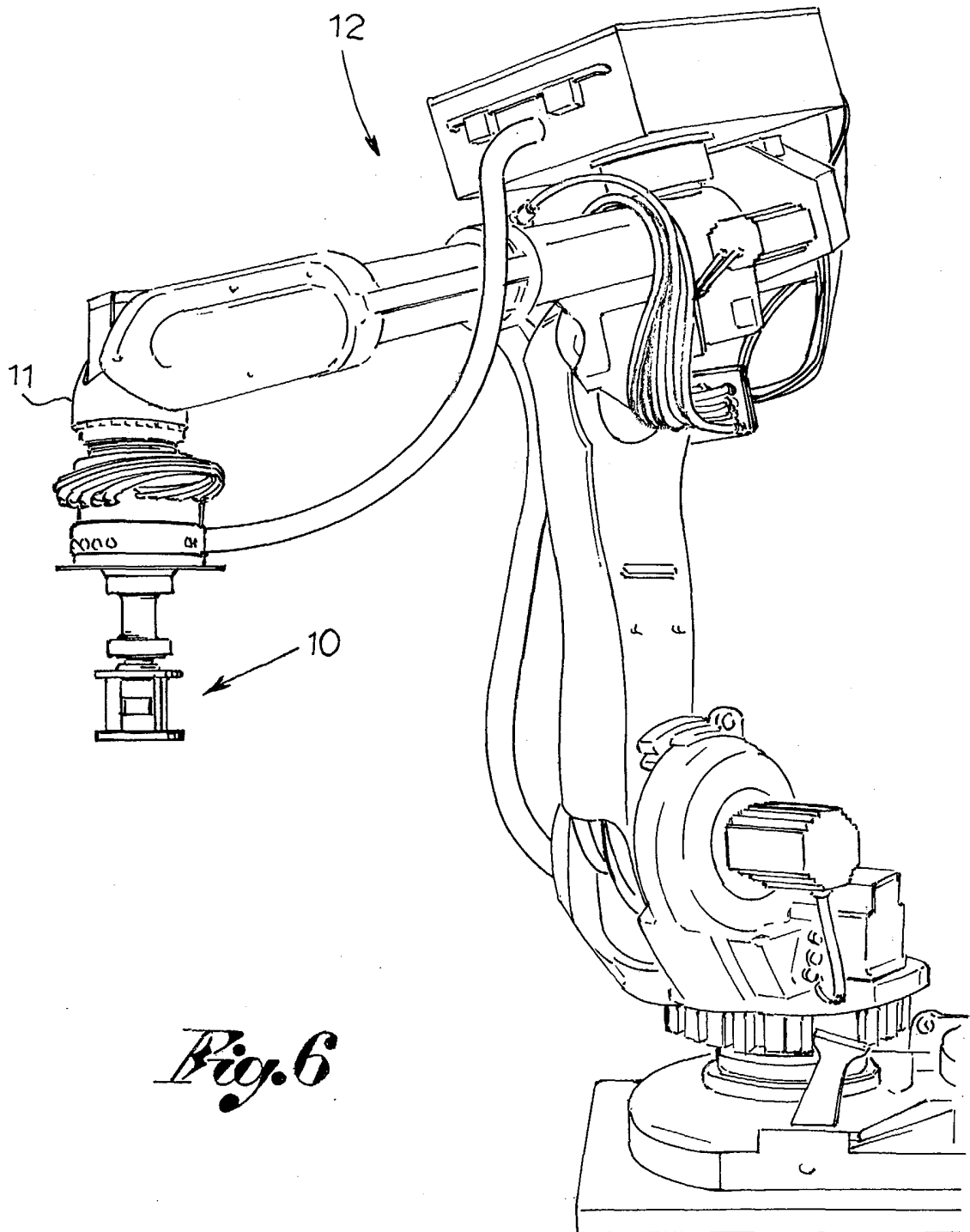


Fig. 6



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 04 42 5566

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15 December 2004	Examiner Roberts, P
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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