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(54) Cutting method and cutting tool

(57) A method for cutting thixotropic material, comprising the phases of:

- providing an extended body (2) with a longitudinal (L) axis and an external surface (3), which develops around the longitudinal (L) axis;

- moving the extended body (2) forward over the thixotropic material along a cut (T) trajectory transversal to the longitudinal (L) axis, and rotating the external surface (3) of the extended body (2) around the longitudinal (L) axis, while the extended body (2) moves forward along the cut (T) trajectory.

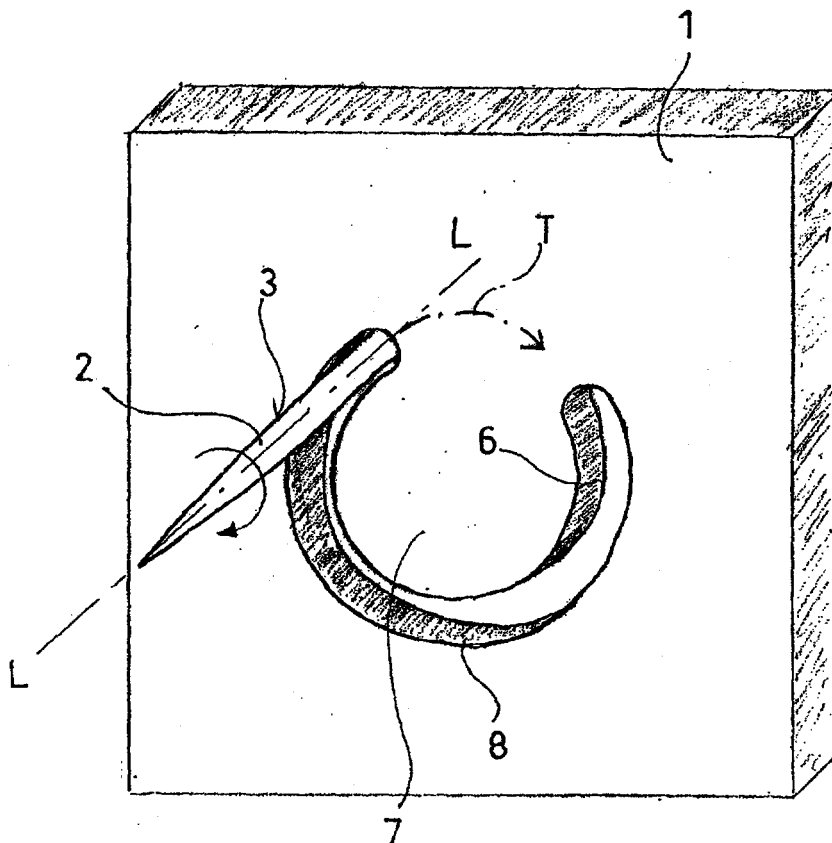


FIG. 7

Description

[0001] The present invention relates to a cutting method and cutting tool for cutting thixotropic materials, in particular moulded or preformed pieces in earth-like material, such as clay, kaolin or similar before they are cooked.

[0002] In the production of articles in ceramic material, in particular sanitary products, such as toilets, bidets, sinks and similar, the basic earth-like material, which is typically a mixture containing clay, kaolin, quartz and finely pulverised felspar and water, amongst other things, is preformed, for example by moulding. Because of the technological constraints, for example due to the complexity of the form of the moulded pieces, it is almost always impossible to make all of the openings provided in the final product during the moulding phase. Consequently, it is necessary to eliminate rather large pieces of material, after the moulding, to define its required three-dimensional shape before glazing and cooking the final piece.

[0003] The cutting of the semi-finished pieces in thixotropic, earth-like material, for example to make openings in sinks, bidets or toilets for draining and overfilling, is a rather delicate operation and therefore still carried out by man. In fact, because of the decrease in volume during cooking, any excess removal of material and any cracks that form when the semi-finished piece is cut, would inevitably lead to the final product breaking or, at least in a visible surface flaw.

[0004] A knife, for example made of steel, or a round shaped socket punch, is usually used to cut moulded pieces of clayey material that is still wet, and the operator, who performs the cutting must constantly check the edges of the cut and gauge the force, according to the local deformations and resistance of the material to cutting.

[0005] Moreover, the socket punch can only be round shaped, and so it is only possible to make round holes, since the use of the socket punch envisages rotating around its axis perpendicular to the surface to be punched.

[0006] Moreover, it is difficult to make radii of small cuts with the knife, since the thickness of the blade, although reduced, considerably complicates cutting with curvilinear paths.

[0007] When the knife or wire is moved forward without transversal movement, the edges of the cut tend to form cracks, which in turn lead to splitting in the next phase of drying the cut piece.

[0008] With the devices and processes for cutting thixotropic material of the prior art, the quality of the finished product and also the quantity of waste depend on the skill of the operator, and operation of cutting (particularly in the case of complex and precise cuts) cannot be automated.

[0009] Therefore, it is the object of the present invention to provide a process and tool for cutting pieces in earth-like/clayey, thixotropic material, with characteris-

tics to remedy the cited inconveniences, with reference to the prior art.

[0010] This object is achieved by means of a cutting process, according to claim 1 and a cutting tool, according to claim 12.

[0011] Some illustrative embodiments, which are not limiting, will be described below for a better understanding of the invention and to appreciate the advantages, with reference to the accompanying drawings, wherein:

[0012] figure 1 is a partial axial section view of a tool according to the invention;

[0013] figure 2 is an enlarged view of a detail in figure 1;

[0014] figures 3, 4, 5 are enlarged views of a detail of the tool, according to further embodiments of the invention;

[0015] figure 6 represents an example of a robot equipped with the tool according to the invention; and

[0016] figure 7 shows a schematic embodiment of the method, according to the invention.

[0017] With reference to figure 7, a moulded or preformed piece 1 of thixotropic earth-like/clayey material is cut by means of an extended body 2 with a longitudinal L axis and an external surface 3, which develops around the longitudinal L axis. The extended body 2 is moved forward over the thixotropic material of the moulded piece 1 along a cut T trajectory transversal to the longitudinal L axis, whilst the extended body 2 moves forward along the cut T trajectory, the external surface 3, which is preferably smooth, is rotated around the longitudinal L axis.

[0018] According to one embodiment, the longitudinal L axis of the extended part 2 is basically straight. To rotate the external surface 3, it is therefore sufficient to rotate the whole extended part 2 around the longitudinal L axis.

[0019] According to an alternative embodiment, the longitudinal L axis is curved or has a variable shape. Figures 4 and 5 represent extended bodies 2 that are curved, with a flexible, tubular external part 4, which forms the external surface 3 and a central part 5, where the external part 4 is rotated around the central part 5, which defines the longitudinal curved L axis.

[0020] In order to vary the shape of the cut edges when the extended part 2 moves forward along the cut T trajectory, it is possible to vary the form of the longitudinal L axis by deforming the central part 5 in a controlled manner.

[0021] According to an embodiment of the invention, the depositing of scrap material is controlled by controlling the direction of rotation of the external surface 3 around the longitudinal L axis. It has in fact been shown that the external surface 3 tends to deposit the scrap material on the cut edge in relation to which it 3 moves at a relative lower speed.

[0022] It is therefore advantageous to control the direction of rotation of the external surface 3 so that the relative speed between the external surface 3 and a first cut edge 6 (compare figure 7) of a waste part 7, to be separated from the product 1, is lower than the relative speed between the external surface 3 and a second cut

edge 8 of the product 1 itself. In this way, the scrap material advantageously deposits on the first cut edge 6 of the waste part 7.

[0023] In the example reported in figure 7, to obtain a hole, the extended part moves forward along an annular or circular path in a clockwise direction and rotates around the longitudinal axis in the same clock direction, with the result that the scrap material deposits on the inner cut edge.

[0024] According to an advantageous embodiment, the extended part 2, for example a pointed needle, such as a cobbler's needle, presents a sectioned axial-symmetrical circular form in relation to the longitudinal L axis and a diameter of between 0.5mm and 2.0mm inclusive, preferably between 0.7 mm and 1.0 mm, even more preferably, approximately 0.8mm.

[0025] To make the external surface 3 of the needle smoother, it is preferably chromed or nicked-plated.

[0026] It appears from a series of tests that the speed and quality of the cutting varies according to the rotation speed of the external surface 3. For the above reported examples of diameters of the extended part 2, good cutting results can be obtained with a rotational speed of between 5000 and 30000 turns a minute inclusive, and excellent results can be had with a rotational speed of about 20 000 turns a minute.

[0027] As will be better shown by the following description of figures 1 and 8, the cutting method described so far can be implemented to great advantage by means of a special cutting tool that can be coupled to a robot.

[0028] Figure 1 shows a tool 9 for cutting moulded or preformed pieces in earth material, such as clay, kaolin or similar before cooking.

[0029] The tool 9 comprises the previously described extended part 2 and a driving motor 10 suitable for rotating the whole extended part 2, or just its external surface 3 around the longitudinal L axis.

[0030] One embodiment (not shown in the figures) foresees that the tool 9 is fitted with suitable devices for deforming the central part 5 of an extended curved part to regulate the form of the longitudinal L axis of the extended curved part in a controlled manner.

[0031] The preferred embodiment, shown for example in figure 1, foresees the use of an extended part 2 in the shape of a straight needle with a pointed free end 2' to allow the initial penetration of the needle into the clayey material and an end for connecting 2'' with the driving motor 10, which is preferably a pneumatic motor or, alternatively an electric motor.

[0032] The tool 9 described so far can be fitted with a handle (not shown in the figures) to allow manual gripping for manual use of the tool.

[0033] Advantageously, the tool 9 is fitted with suitable connecting devices for connecting the tool to an automatic or semi-automatic handling device, such as a programmable tool machine, or a robot to perform the cutting operation in an automated manner, i.e. without the intervention of a human operator.

[0034] According to an embodiment, the tool 9 comprises a portion for coupling 11 to a programmable handling device to make the tool 9 follow a preset cut T trajectory.

5 **[0035]** The handling device is preferably a robot 12, for example an anthropomorphic robot (see figure 6), advantageously fitted with suitable devices for connecting and disconnecting the tool, to be able to substitute it automatically with other tools.

10 **[0036]** Advantageously, the robot 12 comprises devices for operating the tool, i.e. the driving motor 10, and control devices suitable for controlling and selecting the direction of rotation of the extended part 2 or its external surface 3, depending on the cut edge 6, 8 where the scrap material is to be deposited.

15 **[0037]** Advantageously, the control devices, for example a control unit (not shown in the figures), suitable for executing a digital program memorised on a memory connected to the control unit, sets or regulates the direction of rotation in reply to commands received from the digital program.

[0038] According to a further embodiment, the portion for coupling 11 also comprises a shaped plate 13 for resting the tool 9 in a relative deposit.

20 **[0039]** Advantageously, the robot 12 or tool 9 can comprise sensory devices, for example optical scanners suitable for monitoring the cut edges. These sensory devices are in data connection with the control unit, which sets the rotational speed and/or direction of rotation of the extended part 2 or its external surface 3 on the basis of the data provided by the sensory devices.

25 **[0040]** Advantageously, the control devices are suitable for setting the rotating direction of the external surface of the extended part 2 on the basis of the aforesaid digital program and/or on the basis of the data provided by the aforesaid sensors, so that when the extended part 2 moves forward along the cut T trajectory, the relative speed between the external surface 3 and a cut edge 6 of a waste part 7, to be separated from a product 1, is less than the relative speed between the external surface 3 and a cut edge 8 of the same product, so that the scrap material is deposited on the cut edge 6 of the waste part 7.

30 **[0041]** The cutting method and cutting tool according to the invention present numerous advantages. Thanks to the rotation of the external surface, which is preferably smooth, around an axis transversal to the cut path, it is possible to obtain an elevated advancing speed along the cut trajectory and a precise cut without surface flaws. It is also possible to influence the depositing of scrap material in a targeted way by making the appropriate choice of the direction of rotation, thus remedying subsequent operations of burring the cut edge.

35 **[0042]** Thanks to the elevated rotation speed, the thixotropic, clayey material along the cut trajectory is completely liquefied, but only locally, resolving the problem of having to gauge the advancing force according to the thickness of the piece to be cut. This allows partial or complete automation of the cutting process, also in the

case of complex geometries.

[0043] Since the liquefaction of the thixotropic material is limited to the area in direct contact with the external rotating surface, the result of the cut can be predicted, planned and reproduced, as with industrial series production.

[0044] Advantageously, the cutting of the preformed or moulded piece in clayey material is carried out by the same robot, which, for example, also performs the interlocking of the machine for the moulding of the piece.

Claims

1. Method for cutting thixotropic material, comprising the phases of:

- providing an extended body (2) with a longitudinal (L) axis and an external surface (3), which develops around the longitudinal (L) axis;
- making the extended body (L) move forward over said thixotropic material along a cut trajectory (T) that is transversal to the longitudinal (L) axis,
- rotating the external surface (3) of the extended body (2) around the longitudinal (L) axis, whilst the extended body (2) moves forward along said cut path (T).

2. Method according to claim 1, wherein the longitudinal (L) axis of the extended part (2) is basically straight, and wherein the whole extended part (2) is rotated around its longitudinal (L) axis.

3. Method according to claim 1 or 2, wherein the longitudinal (L) axis of the extended part (2) is curved, and wherein a flexible tubular part (4) that forms the external surface (3) is rotated around a central part (5), which defines the curved, longitudinal (L) axis.

4. Method according to claim 3, comprising the phase of varying the form of the longitudinal (L) axis by deforming the central part (5).

5. Method according to any one of the previous claims, comprising the phase of controlling the depositing of scrap material by controlling the rotating direction of the external surface (3) around the longitudinal (L) axis.

6. Method according to claim 5, comprising the phase of rotating the extended part (2) in such a direction that, when the extended part (2) moves forward along the cut (T) trajectory, the relative speed between the external surface (3) and cut edge (6) of a waste part (7), to be separated from a product (1), is less than the relative speed between the external surface (3) and cut edge (8) of the same product (1),

so that the scrap material deposits on the cut edge (6) of the waste part (7).

7. Method according to any one of the previous claims, comprising the phase of cutting an opening in a product (1), making the extended part (2) move forward along a basically annular cut (T) trajectory in an advancing direction, for example clockwise, and rotating the external surface (3) around the longitudinal (L) axis in the same advancing direction, for example, clockwise.

8. Method according to any one of the previous claims, comprising the phase of using a pointed needle as the extended part (2).

9. Method according to any one of the previous claims, comprising the phase of turning the extended part (2) around its longitudinal (L) axis at a rotational speed of between 5000 and 30000 turns a minute inclusive.

10. Method according to claim 10, wherein the rotational speed is about 20 000 turns a minute.

11. Method according to any one of the previous claims, wherein said method is performed by a robot (12).

12. Tool (9) for cutting thixotropic material, in particular, pieces (1) moulded or preformed in earth-like material, such as clay, kaolin or similar before they are cooked, comprising:

- an extended part (2) with a longitudinal (L) axis and an external surface (3), which is substantially smooth and that develops around the longitudinal (L) axis;
- a driving motor (10) suitable for rotating the external surface (3) around the longitudinal (L) axis.

13. Tool (9) according to claim 12, wherein said longitudinal (L) axis is basically straight.

14. Tool (9) according to claim 13, wherein said driving motor (10) is suitable for turning the whole extended part (2) around the longitudinal (L) axis.

15. Tool (9) according to claim 12, wherein said longitudinal (L) axis is curved.

16. Tool (9) according to claim 15, wherein said extended part (2) comprises a flexible tubular part (4) that forms the external surface (3), and a central part (5), which defines the longitudinal (L) curved axis and wherein the driving motor (10) is suitable for turning the flexible tubular part (4) around the central part (5).

17. Tool (9) according to claim 16, comprising devices for deforming the central part (5) so as to regulate the form of the longitudinal (L) axis.
18. Tool (9) according to any one of the claims from 12 to 17, wherein the extended part (2) is a needle with a pointed free end (2') and an end for connecting (2") with the driving motor (10). 5
19. Tool (9) according to any one of the claims from 12 to 18, wherein the external surface (3) is chromed or nickel-plated. 10
20. Tool (9) according to any one of the claims from 12 to 19, wherein the extended part (2) presents a sectioned axial-symmetrical circular form in relation to the longitudinal (L) axis, with a diameter of between 0.5mm and 2.0mm inclusive. 15
21. Tool (9) according to claim 20, wherein said diameter is between 0.7 mm and 1.0 mm inclusive. 20
22. Tool (9) according to claim 21, wherein said diameter is about 0.8mm. 25
23. Tool (9) according to any one of the claims from 11 to 22, wherein the driving motor (10) is a pneumatic motor. 25
24. Tool (9) according to any one of the claims from 11 to 22, comprising connecting devices (11) for connecting the tool (9) to an automatic or semi-automatic handling device (12) of the tool (9), such as a programmable tool machine or a robot, suitable for moving the extended part (2) along a cut (T) trajectory that is transversal to the longitudinal (L) axis. 30
35
25. Tool machine (12) for automatic or semi-automatic cutting of a piece (1) that is moulded or preformed in earth-like material, such as clay, kaolin or similar before cooking, said tool machine (12) comprising a tool (9) according to claim 24, and devices for operating the tool (9) and handling devices suitable for moving the extended part (2) along a cut (T) trajectory that is transversal to the longitudinal (L) axis. 40
45
26. Tool machine (12) according to claim 25, comprising devices for connecting and disconnecting the tool (9) with said handling devices and said automatic operating devices suitable for replacing the tool (9) automatically with other tools. 50
27. Tool machine (12) according to claim 25 or 26, comprising depositing devices for the tool when not in use. 55
28. Tool machine (12) according to claim 27, wherein said depositing devices comprise a shaped plate (13) for resting the tool (9) in a relative deposit.
29. Tool machine (12) according to any one of the claims from 25 to 28, wherein said tool machine (12) is a robot.
30. Tool machine (12) according to any one of the claims from 25 to 29, comprising control devices for controlling the rotating direction of the external surface (3) of the extended part (2) of the tool (9) to control the depositing of scrap material.
31. Tool machine (12) according to claim 29, wherein said control devices comprise a control unit suitable for executing a digital program memorised on a memory connected to the control unit.
32. Tool machine (12) according to claim 30 or 31, wherein said control devices are suitable for setting the rotating direction of the external surface (3) of the extended part (2), so that when the extended part (2) is moved forward along the cut (T) trajectory, the relative speed between the external surface (3) and cut edge (6) of a waste part (7), to be separated from a product (1), is less than the relative speed between the external surface (3) and cut edge (8) of the same product, so that the scrap material is deposited on the cut edge (6) of the scrap part (7).

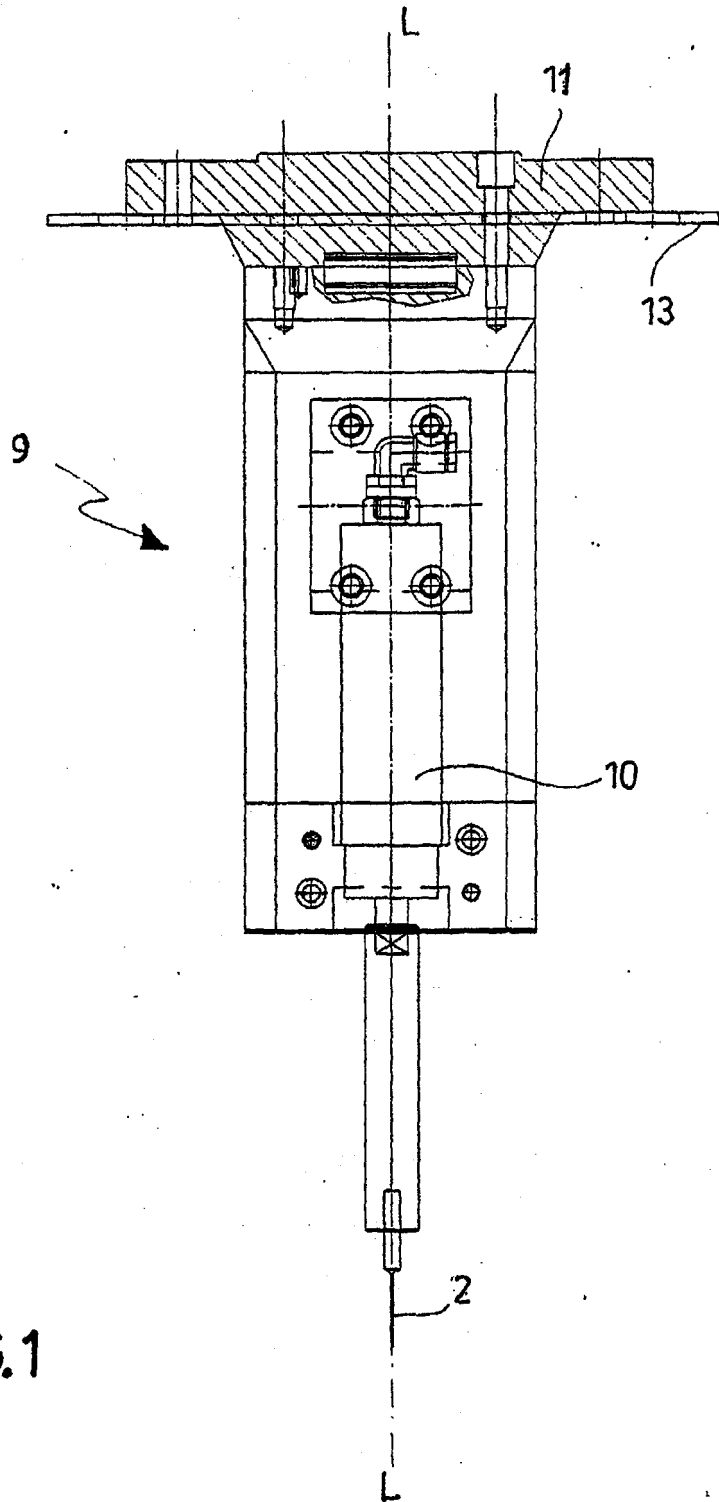


FIG.1

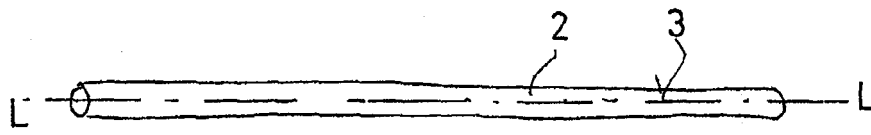


FIG. 3

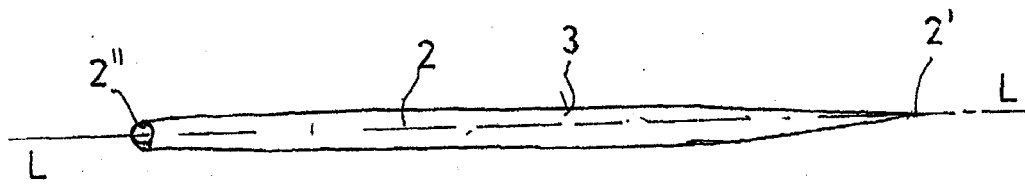


FIG. 2

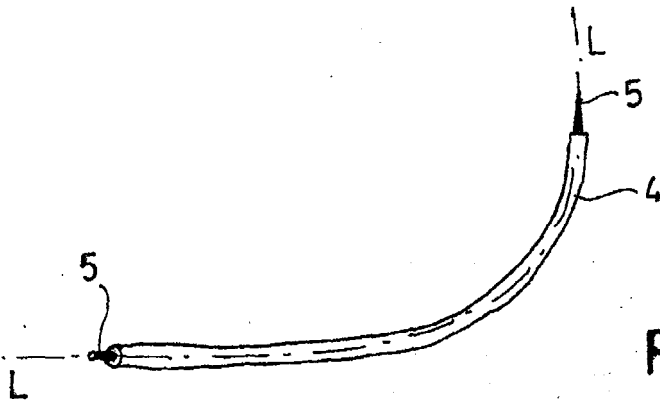


FIG. 4

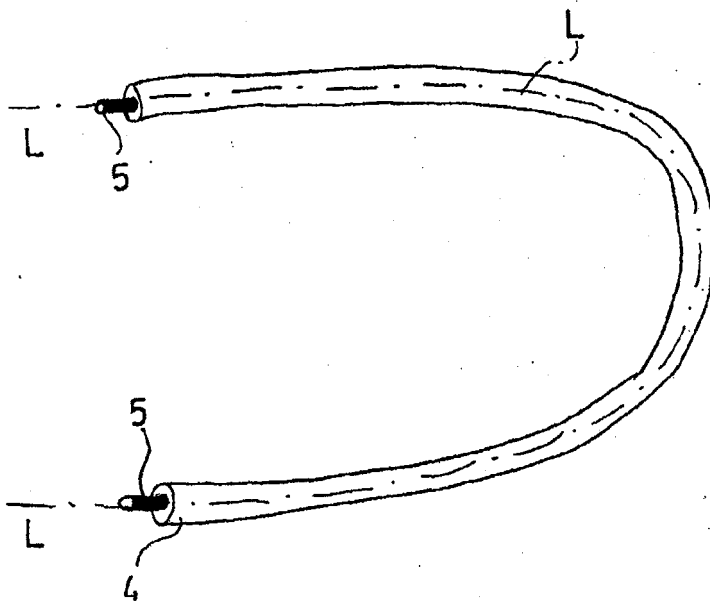


FIG. 5

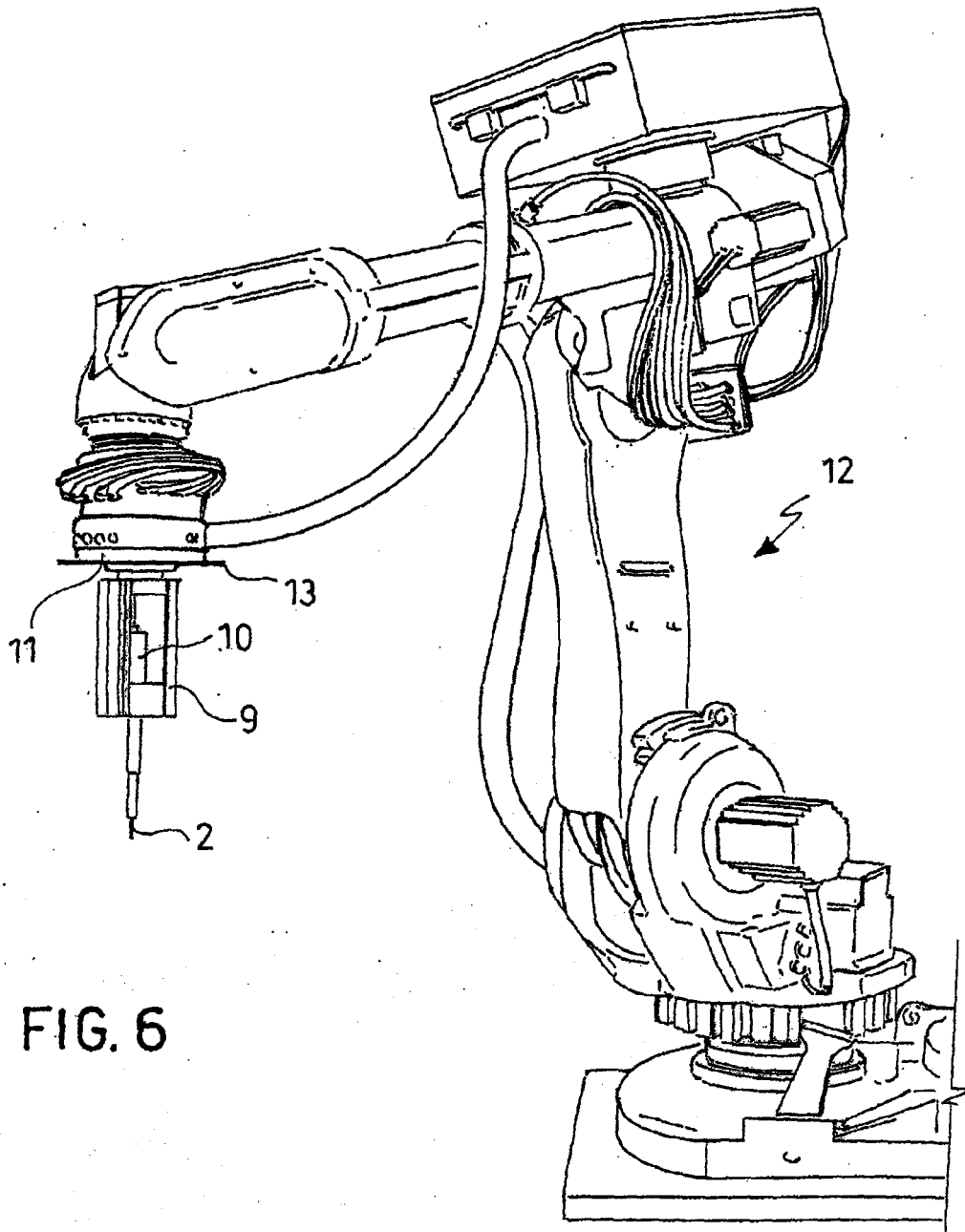


FIG. 6

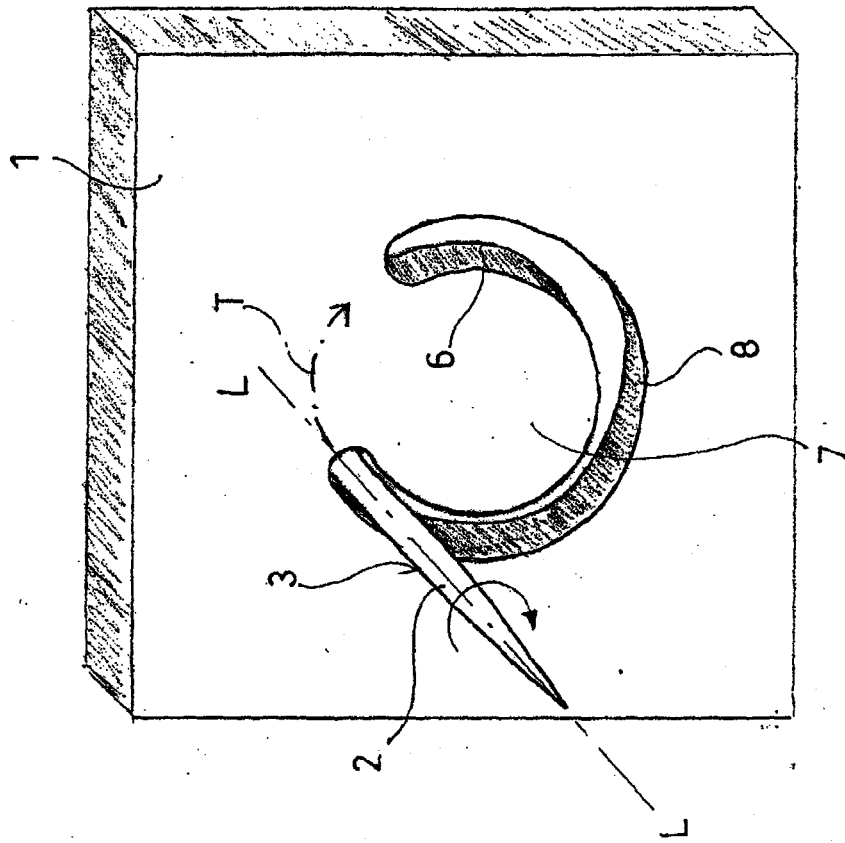


FIG. 7



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 42 5564

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	DE 34 07 278 A1 (TOTO LTD) 4 October 1984 (1984-10-04) * page 7, paragraph 2 - page 8, paragraph 1 *	12-14	B28B11/12 B28B1/48 B26D1/00
Y	* page 9, paragraph 3; figures 8-11 *	1,2,11	
Y	DE 37 14 580 C1 (BITTMAYER, HUGO, 8831 DOLLNSTEIN, DE) 24 November 1988 (1988-11-24) * the whole document *	1,2,11	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B28B
-The present search report has been drawn up for all claims-			
Place of search The Hague		Date of completion of the search 22 March 2005	Examiner Orij, J
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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</p> <p>& : member of the same patent family, corresponding document</p>			

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**CLAIMS INCURRING FEES**

The present European patent application comprised at the time of filing more than ten claims.

- Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-14



The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-14

method for cutting thixotropic material

2. claims: 15-32

tool

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

EP 04 42 5564

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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22-03-2005

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			JP 2031651 B	16-07-1990
			JP 59158213 A	07-09-1984

DE 3714580	C1	24-11-1988	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82