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(71) Applicant *(for all designated States except US)*: **PRO FORM S.R.L.** [IT/IT]; Viale Europa Unita 37, I-24043 Caravaggio (IT).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **SPAIRANI, Roberto** [IT/IT]; Via De Amicis, 27, I-27036 Mortara (IT). **SPAIRANI, Secondo** [IT/IT]; Via De Amicis, 27, I-27036 Mortara (IT).

(74) Agent: **VALENTINI, Giuliano**; Marietti, Gislon e Trupiano S.r.l., Via Larga, 16, I-20122 Milan (IT).

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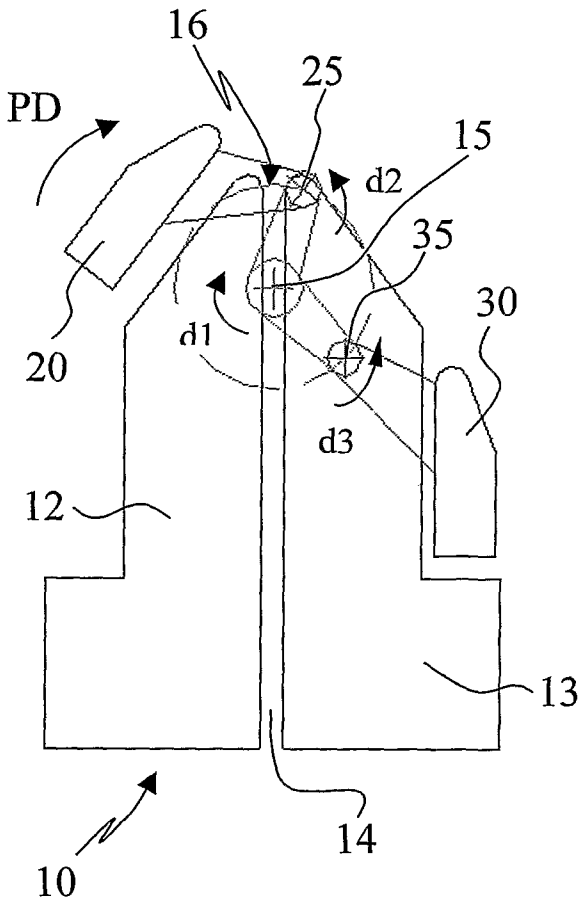
(54) Title: DEVICE AND METHOD FOR BENDING A METALLIC STRIP



(57) Abstract: A device and method for bending a metallic strip (1) are described, particularly for manufacturing die cutting blades, wherein the bending tools (20,30) are capable of being rotated about a common axis (15) and wherein each tool (20,30) is further capable of being rotated about its own axis (25,35) of rotation which is different from the others (15,25,35) .

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"DEVICE AND METHOD FOR BENDING A METALLIC STRIP"

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Field of the Invention

The present invention relates to a device and method for bending a metallic strip, and particularly a device and method for manufacturing die cutting blades starting from a continuous metallic strip which is shaped by means of subsequent bending steps and subjected to a final shearing step.

Technical Background of the Invention

The metallic strip bending devices known in the art, particularly those intended for the manufacture of die cutting blades, generally comprise a system for feeding the continuous metallic strip through a guide opening, near which one or more bending tools are arranged. Most commonly, two bending tools are provided, the one for providing the strip with the right (or for example upwards) bends and the other for providing the strip with the left (or for example downwards) bends.

The strip is advanced through the guide opening and temporarily stopped when a bend has to be performed. The bending tool, which is arranged near the guide opening, is then rotated to provide the strip with the right (or left) deformation for a predetermined angle, as desired.

A double-tool bending system is described, for example, in the United States Patent n. US-5870919, in which the bending tools are engaged in suitable seats of co-axial holders that are arranged opposite the guide opening, and caused to rotate about their common axis. The bending tools can be retractable, and thus can be used in a mutually exclusive manner, i.e. a tool is held in the working position while the other is held in the rest position.

Another example of a double-tool bending system is described in the United States Patent n. US-6629442, in which each tool is held by a pair of co-axial holders rotating about their common axis. The holders of a pair are arranged alternating with those of the other pair, and consequently, at least two of them are required to have an engaging seat for the bending tool being held, as well as a groove for allowing the other to move.

One of the problems involved with the known bending systems is that, during the bending step, the tool that is carrying out the bending moves away from the bending point while rotating, thereby a relative sliding movement is caused between the tool contacting the strip and the strip itself. This entails considerable wear of the bending tools, and thus the tools need to be replaced quite frequently in order to ensure the required process accuracy.

As the bending tools are very complex systems from a mechanical point of view, they may require a very long time for replacement, which may affect productivity.

In addition, it should also be noted that a tool is subjected to a stress that increases proportionally to the bending angle to be obtained. The wear effects on the tool are thus considerable, when manufacturing products with particularly sharp bending angles.

The task of the present invention is to provide a device and method for bending metallic strips, which allow to overcome the drawbacks of the prior art.

Within this task, an object of the present invention is to provide a method and device of the above-mentioned type, which allow to avoid the relative sliding motion between the bending tools and the metallic strip during the bending steps.

Another object of the present invention is to provide a method and device of the above-mentioned type which allow to hold the tool always in the most effective position, regardless of the bending angle to be obtained.

A further object of the present invention is to provide a method and device of the type mentioned above, which however allow to provide very close bends, also in the opposite directions, and also for high bending angles.

Summary of the Invention

These objects are achieved according to the invention thanks to a device for bending a metallic strip, comprising at least one feeding section for carrying the strip through a guide opening, at least one pair of bending tools arranged near the guide opening, the bending tools being rotatable about at least one

common axis of rotation, and means for rotatably driving the bending tools about the at least one common axis of rotation, characterized in that each of the bending tools can be rotatably driven about its own axis, which differs from the common axis of rotation and the axis of rotation of the other of the tools.

Particularly, each of the bending tools comprises rotary driving means separate from the rotary driving means of the other bending tool and from the rotary driving means of both bending tools about the common axis of rotation.

As compared with the prior art, an additional degree of freedom is thus added to the tools, thereby optimizing the position of the axis of rotation around which each tool provides the bend.

The solution proposed according to the present invention provides a number of advantages. Particularly, the tool that carries out the bend is always perpendicular to the strip to be bent, regardless of the bending angle to be obtained, thereby a considerable effectiveness is achieved in the bending step.

Another advantage is that the axis of rotation of the bending tool can always be placed in the optimum position, where the tool abutment point on the strip to be bent is maintained fixed while the bending is being carried out, contrary to what occurs with the prior art bending systems. This dramatically reduces the tool wear and allows to provide very close bends even when they have high bending angles and opposite directions (such as a 90° right bend immediately followed by a 90° left bend).

The invention further relates to a machine for manufacturing die cutting blades according to claim 12 or 13, as well as a bending method according to claim 14. Specific characteristics of devices, machines and methods as indicated above are set forth in the respective dependent claims.

Brief Description of the Drawings

Further characteristics and advantages of the present invention will be better understood from the following description, which is given by way of example

with reference to the annexed drawings, in which:

- Fig. 1 is a schematic plan view illustrating several elements of a bending device according to the present invention;

- Fig. 2 is a schematic plan view of the bending device as depicted in Fig. 1, with the tools positioned to carry out a right bending;

- Fig. 3 is a schematic plan view of the bending device as depicted in Fig. 1, with the tools positioned to carry out a left bending;

- Figs. 4A-4D schematically illustrate the left-bending steps on a metallic strip;

- Fig. 5 is a perspective view illustrating a possible embodiment of a bending device according to the present invention, with some elements not being shown for clarity;

- Fig. 6 is a perspective view illustrating some elements of the bending device as depicted in Fig. 5;

- Fig. 7 illustrates an enlarged perspective view of a detail of the device from Fig. 5;

- Fig. 8 is a front view of some elements composing a bending device according to the embodiment from Fig. 5;

- Fig. 9 is a perspective view of a bending device according to the embodiment from Fig. 5, in which the rotary driving systems of the bending tools about the respective axes thereof are evidenced; and

- Fig. 10 is a perspective view of a bending device according to the embodiment from Fig. 5, in which the rotary driving systems of the bending tools about the respective axes thereof are evidenced.

Modes for Carrying out the Invention

In Fig. 1 there is illustrated a schematic and simplified version of a device for bending a metallic strip according to the present invention. The schematic view essentially reproduces a feeding section, of which a guide assembly 10, a tool 20 for carrying out the right bends on the metallic strip and a tool 30 for carrying out the left bends are represented.

The metallic strip to be bent, not shown in Fig. 1-3 for clarity, is fed through a

passageway 14 comprised between the blocks 12 and 13 of the guide assembly 10, which ends with a guide opening 16.

In the representation of Fig. 1 the axes are evidenced about which the rotation of the bending tools 20 and 30 is carried out, i.e. a common axis of rotation 15, an axis of rotation 25 of the tool 20 and an axis of rotation 35 of the tool 30.

In Fig. 2, there are shown the positions of the tools for preparing a right bending of the strip. Assuming that the initial position of the tools is as shown in Fig. 1, the tools 20 and 30 are rotated clockwise about the common axis 15 (arrow d1), and simultaneously about the respective axes 25 and 35 with such rotation directions (arrows d2 and d3) that the tools move to the position illustrated in Fig. 2, i.e. the tool 30 being in the backward position and the tool 20, which is intended to carry out the right bending on the strip, having its own axis of rotation 25 passing at the end portion of the block 13. Starting from this position, the right bending is carried out by rotating only the tool 20 about its own axis 25 (arrow PD) by a certain predetermined angle in order to obtain the desired bending angle on the strip.

Accordingly, in the device according to the present invention, two types of movement can be essentially seen, i.e. a "positioning movement" of the tools which implies rotating the tools 20 and 30 about the common axis 15 and about the respective axes 25 and 35, and a "bending movement" which implies rotating the tool intended to carry out the bending only about its own axis.

On the other hand, in Fig. 3 there is shown the position of the tools for preparing a left bending of the strip. In this case, again, assuming that the initial position of the tools is as shown in Fig. 1, the tools 20 and 30 are rotated counter-clockwise about the common axis 15 (arrow s1), and simultaneously about the respective axes 25 and 35 with such rotation directions (arrows s2 and s3) that the tools move to the backward position and the tool 30, which is intended to carry out the left bending of the strip, having its own axis of rotation 35 at the end portion of the block 12. Starting

from this position, the left bending is carried out by rotating only the tool 30 about its own axis 35 (arrow PS) by a certain predetermined angle in order to obtain the desired bending angle on the strip.

It may be appreciated that the further degrees of freedom as determined by the rotation of the tools 20 and 30 about the respective axes 25 and 35, in addition to the common axis 15, allow bringing the tools in the most effective and advantageous condition for carrying out the bending. In other words, when the tool intended to carry out the bending, such as for instance the tool 20 (or 30) is arranged with its own axis of rotation 25 (or 35) at the end of the "opposite" block 13 (or 12), i.e. the end of the block being on the bending side, the actuated bending tool is ensured to remain always substantially perpendicular to the strip throughout the bending step.

For clarity purposes, Figs. 4A-4D illustrate some steps of the method for left-bending a strip 1, assuming that the initial position of the tools 20 and 30 is as depicted in Fig. 3.

In Fig. 4A, the feeding of the strip 1 has been stopped and the latter is held in position between the two blocks 12 and 13. The tool 30 has already started the left-bending step on the strip 1 by carrying out a rotation in the direction indicated by the arrow PS about its own axis 35.

The rotation of the tool 30 continues along a predetermined arc, until the desired bend is obtained, such as illustrated in Fig. 4B. From a comparison between Fig. 4A and 4B, it is observed that the bending tool 30 remains in contact with the strip 1 by remaining substantially perpendicular to the strip 1 throughout the bending step.

At the end of the bending step, the tool 30 is moved away from the strip 1 (Fig. 4C) and brought back to its initial position by means of a rotary movement about its own axis 35 in the direction indicated by the arrow RP.

When the bending tool 30 has returned to the initial position (Fig. 4D), the strip 1 can be advanced in the direction indicated by the arrow A. The tools 20 and 30 can be maintained in the position indicated in Fig. 4D if also the subsequent bending has to be carried out leftwards, or can be "exchanged"

(Fig. 2) in the case where a right bending has to be subsequently carried out. It is understood that the same steps as represented in Figs. 4A-4D are carried out during the right-bending of the strip 1, it should be considered however that in this case the bending tool 30 will be held in the backward position, while the bending tool 20, for example starting from the position as indicated in Fig. 2, will carry out the required bending rotations in the opposite directions with respect to the tool 30 in each step.

A possible embodiment of the present invention is represented in Fig. 5, and in the enlarged view of Fig. 6. The bending tools 20 and 30 are driven by two moving units 40 and 50, which are arranged opposite the guide opening 16 of the strip 1. The moving unit 40 in Fig. 5 is illustrated with some parts thereof being removed, in order to better highlight several constructive characteristics which will be described below in greater detail. The device has a guide opening 16 oriented in the horizontal direction, with a bending tool 20 arranged above and a bending tool 30 arranged below the guide opening 16.

Regardless of the vertical/horizontal orientation of the guide opening 16, the same considerations apply for the steps of moving the bending tools 20 and 30 as set forth above for the schematic drawings of Figs. 1-3 and 4A-4D, but in this case it should be considered that the bends carried out by the tool 20 are directed downwards rather than rightwards, whereas the bends carried out by the tool 30 are directed upwards rather than leftwards. In any case, a device according to the present invention can be arranged with the guide opening 16 either horizontal or vertical in a machine for manufacturing die cutting blades.

In Fig. 7, which represents an enlarged view of a part of the device as represented in Fig. 5, there is illustrated in detail the moving unit 40 comprising a main shaft 41 capable of rotating about an axis coincident with the axis of rotation 15 in common with both tools. On the shaft 41 there are provided eccentric cylindrical portions 42 and 43 with parallel and staggered axes relative to the common axis of rotation 15. The eccentric cylindrical

portions 42 and 43 allow rotating the tools 20 and 30 about the respective axes of rotation 25 and 35 (not shown). An identical shaft 51 (Fig. 5) is provided in the moving unit 50 and is provided with corresponding eccentric cylindrical portions 52 and 53, of which only the eccentric portions 52 can be partially (Fig. 7) or fully (Fig. 5) seen.

Referring now to the view in Fig. 8, the moving units 40 and 50 comprise each an upper bracket 60 having a supporting portion 61 to which an end of the bending tool 20 is removably attached and a connecting portion 62 connecting the bracket 60 to the means for rotary driving the bending tool 20 about its own axis of rotation 25. The moving units 40 and 50 further comprise each a lower bracket 70 having a supporting portion 71 to which an end of the bending tool 30 is removably attached and a connecting portion 72 connecting the bracket 70 to the respective means for rotary driving the bending tool 30 about its own axis of rotation 35. The two moving units 40 and 50 are thus mechanically connected to each other at least via the bending tools 20 and 30.

In Fig. 8 there are further represented some connection members 46 and 56 connecting the brackets 60 of the two moving units 40 and 50 to the respective eccentric cylindrical portions 42 and 52 having the axis 25 coincident with the axis of rotation of the tool 20. In the same way, the connection members 47 and 57 connect the brackets 70 of the two moving units 40 and 50 to the respective eccentric cylindrical portions 43 and 53 having the axis 35 coincident with the axis of rotation of the tool 30.

The connection members 46 and 56 of the two moving units 40 and 50 are further rotatably mounted on the respective eccentric cylindrical portions 42 and 52, as well as the connection members 47 and 57 of the two moving units 40 and 50 are rotatably mounted on the respective eccentric cylindrical portions 43 and 53.

According to the present invention, each of the bending tools must be capable of rotating about its own axis of rotation independently from the other, and however both must be capable of rotating also about a common

axis of rotation. A respective motor has to be provided for each axis of rotation, three in this case, such as an electric motor that can be controlled separately from the other two.

The system for rotary driving the tools about their axes is illustrated in Fig. 9, in which a first motor 82 for rotating the tool 20 about its own axis 25 is evidenced. The motor 82 is connected to the arms 65 of both moving units 40 and 50 through rotary motion driving means that can comprise, for example, chains and geared wheels, or belts and timing belt pulleys, or gearings. The arms 65 can be rotated about the common axis of rotation 15 through respective hubs (not shown) co-axial to the main shafts 41 and 51 of each moving unit and can be separately rotated with respect to the main shafts. The free ends of the arms 65 comprise slots 67 in which respective pins 68 integral with the respective ends of the brackets 60 are slidingly engaged.

The same configuration is repeated for the rotation of the other tool 30 about its own axis 35, which is obtained by means of a second separate motor 83, which transmits the rotary motion to arms 75, which can be also rotated about the common axis of rotation 15 in a separate manner with respect to the rotation of the main shafts 41 and 51 of each moving unit. The arms 75 also have slots 77 in which pins 78 integral with the respective ends of the brackets 70 are slidingly engaged.

The rotation of the tool 20 (or 30) about its own axis 25 (or 35) is thus imparted by the arms 65 (or 75) to the brackets 60 (or 70). Thereby, the latter, by being integral with the connection members 56 (or 57), rotate about the axis of the eccentric cylindrical portions 42 (or 43), which have axes coincident with the axis of rotation 25 (or 35) of the tool 20 (or 30), thus forcing the tool 20 (or 30) to rotate about its own axis 25 (or 35).

As shown in Fig. 10, a third motor 81 has to be further provided, which can be separately controlled with respect to the other two motors 82 and 83, in order to drive the main shafts 41 and 51 rotatably about the common axis of rotation 15. Also in this case, the rotary motion driving means can comprise

chains and geared wheels, or timing belt pulleys, or gearings and the like.

CLAIMS

1. A device for bending a metallic strip, comprising at least one feeding section for carrying said strip through a guide opening, at least one pair of bending tools arranged near said guide opening, said bending tools being rotatable about at least one common axis of rotation, and means for rotatably driving the bending tools about said at least one common axis of rotation, characterized in that each of said bending tools can be rotatably driven about its own axis, which is different from said common axis of rotation and from the axis of rotation of the other of said tools.

2. The device according to claim 1, wherein each of said bending tools comprises rotary driving means independent from the rotary driving means of the other of said bending tools and from the rotary driving means of both bending tools about said common axis of rotation.

3. The device according to claim 1, wherein at least two moving units are provided for said tools, said moving units being arranged on opposite sides relative to said guide opening and mechanically connected to each other at least through said tools.

4. The device according to claim 3, wherein each of said moving units comprises at least one main shaft with the axis coincident with said common axis of rotation, said main shaft comprising cylindrical portions having parallel and staggered axes relative to said common axis of rotation.

5. The device according to claim 4, wherein each of said moving units comprises at least one first bracket having at least one supporting portion, to which there is removably attached an end of a first of said bending tools, and at least one connecting portion to first rotary driving means about its own rotation axis of said first bending tool, and wherein there is provided at least one connection element having an end fastened to said first bracket and another end rotatably mounted to at least a first one of said cylindrical portions with parallel and staggered axis relative to the axis of rotation of said main shaft.

6. The device according to claim 5, wherein said rotary driving means

about its own axis of rotation of said first bending tool comprise at least one first motor and means for transmitting the rotary motion to at least one first arm that can be rotated about said common axis of rotation passing through an end thereof, the other end of said arm comprising a slot in which there is slidably engaged a pin integral with the end of the connecting portion of said first bracket.

7. The device according to claim 6, wherein said first motor is connected to the first brackets of both said moving units through said means for driving the rotary motion about its own axis of rotation of said first bending tool.

8. The device according to claim 4, wherein each of said moving units comprises at least one second bracket having at least one supporting portion, to which there is removably attached an end of a second of said bending tools, and at least one connecting portion to second rotary driving means about its own axis of rotation of said second bending tool, and wherein there is provided at least one connection member having an end fastened to said second bracket and another end rotatably mounted to at least a second one of said cylindrical portions with parallel and staggered axis relative to the axis of rotation of said main shaft.

9. The device according to claim 8, wherein said rotary driving means about its own axis of rotation of said second bending tool comprise at least one second motor and means for transmitting the rotary motion to at least one second arm that can be rotated about said common axis of rotation passing through an end thereof, the other end of said arm comprising a slot in which there is slidably engaged a pin integral with the end of the connecting portion of said second bracket.

10. The device according to claim 9, wherein said second motor is connected to the second brackets of both said moving units through said means for driving the rotary motion about its own axis of rotation of said second bending tool.

11. The device according to claim 4, wherein a third motor is provided for rotary driving said main shaft about said common axis of rotation.

12. A machine for manufacturing die cutting blades from a continuous metallic strip which is shaped by means of subsequent bending steps and subjected to a final shearing step, characterized by comprising a device according to any of claims 1 to 11 and wherein said guide opening in said feeding section is oriented in the horizontal direction.

13. A machine for manufacturing die cutting blades from a continuous metallic strip which is shaped by means of subsequent bending steps and subjected to a final shearing step, characterized by comprising a device according to any of claims 1 to 11 and wherein said guide opening in said feeding section is oriented in the vertical direction.

14. A method for performing the bending on a metallic strip, wherein said strip is carried through a feeding section to a guide opening; and wherein said strip is bent by at least one pair of bending tools that are arranged near said guide opening and can be rotatably driven about at least one common axis of rotation, characterized in that each of said bending tools can be rotary driven about its own axis of rotation which is different from said common axis of rotation and from the axis of rotation of the other of said tools.

15. The method according to claim 14, wherein each of said bending tools is rotary driven separately from the rotary driving of the other of said bending tools and from the rotary driving of both the bending tools about said common axis of rotation.

16. The method according to claim 14, wherein said common axis of rotation and said their own axes of rotation of said tools are parallel to each other.

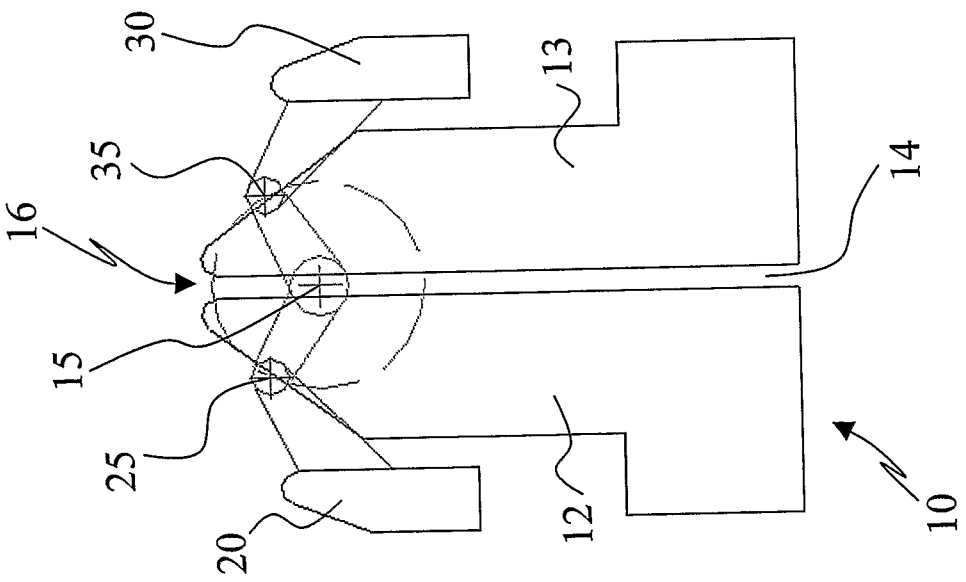

Fig. 1

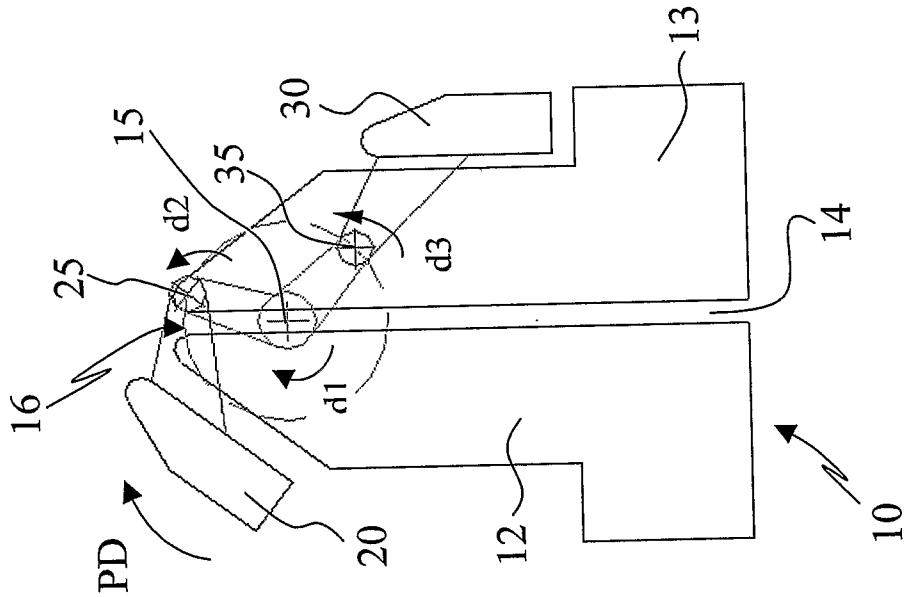

Fig. 2

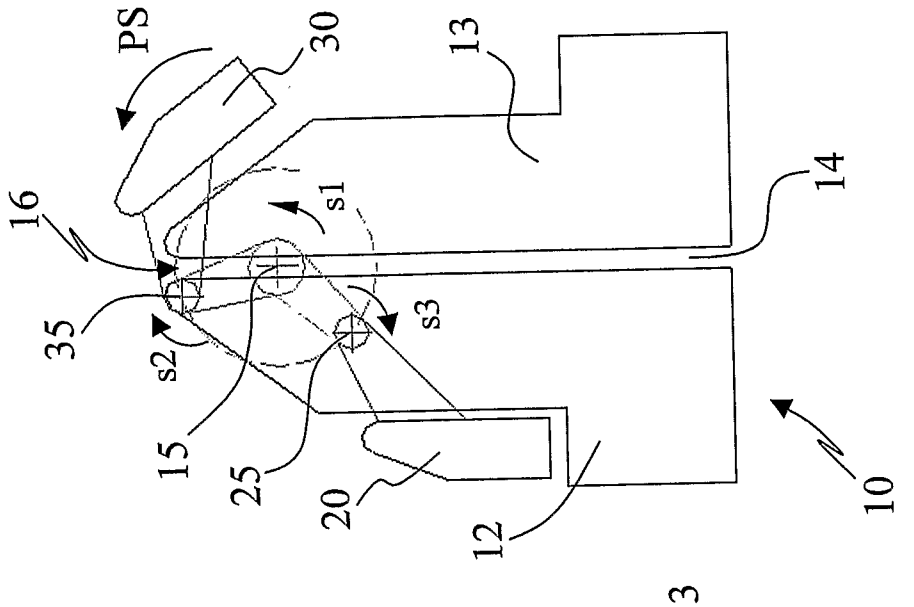

Fig. 3

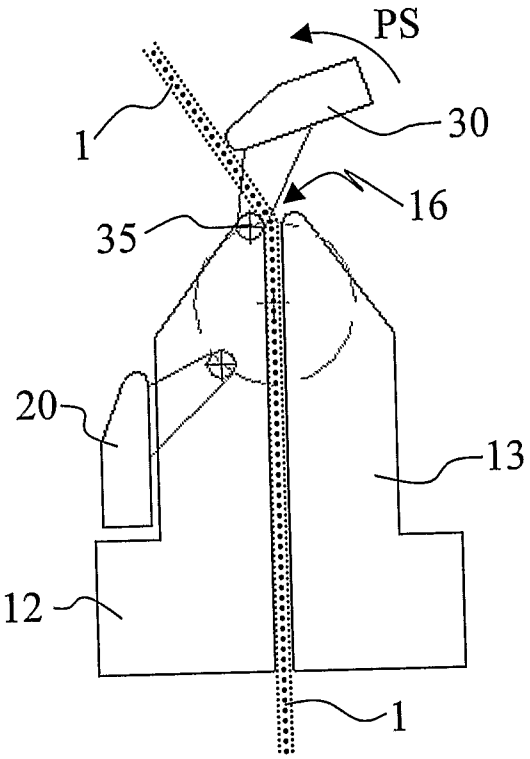

Fig. 4A

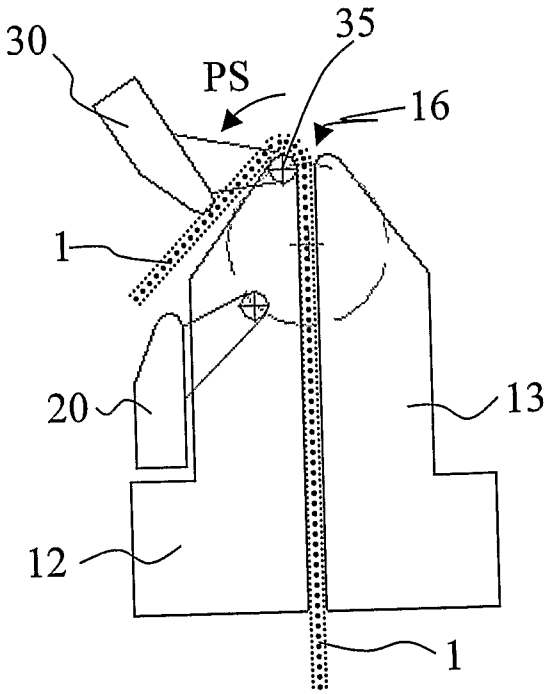

Fig. 4B

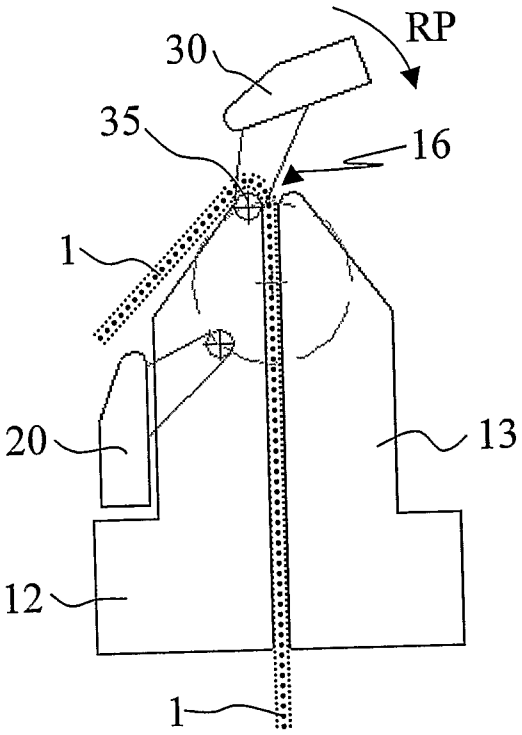

Fig. 4C

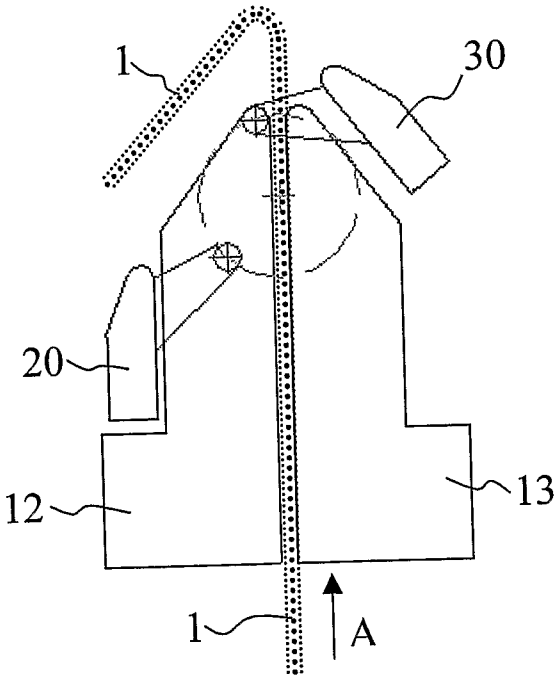

Fig. 4D

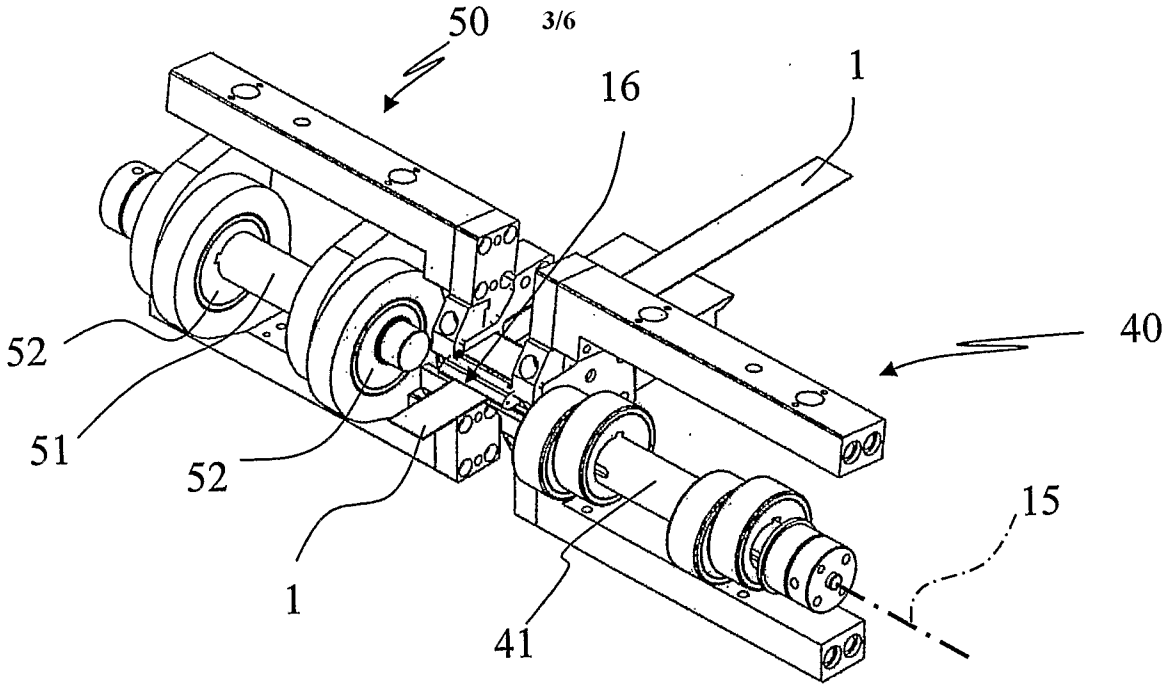

Fig. 5

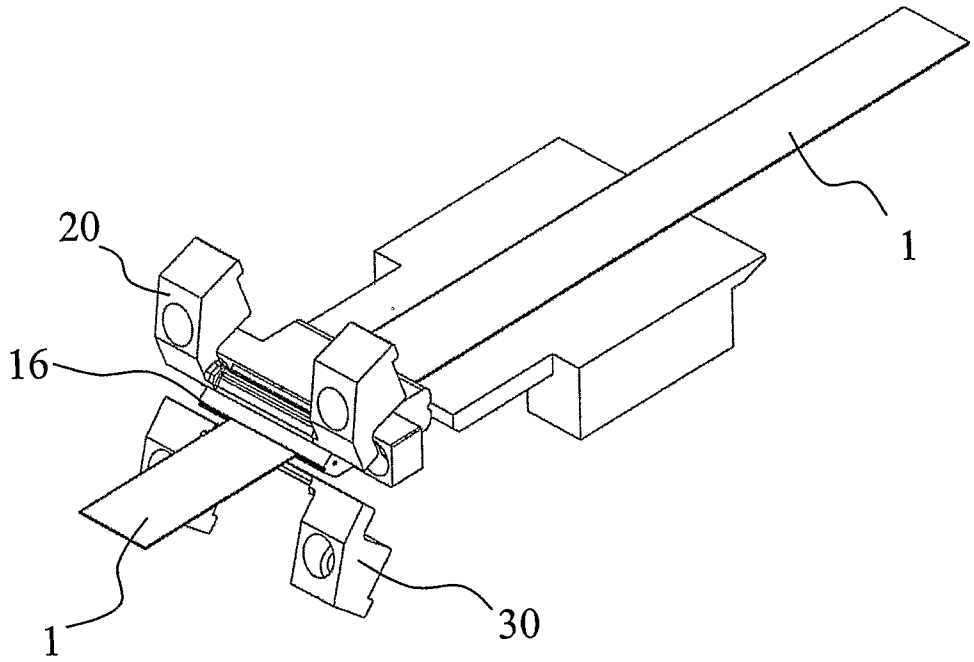

Fig. 6

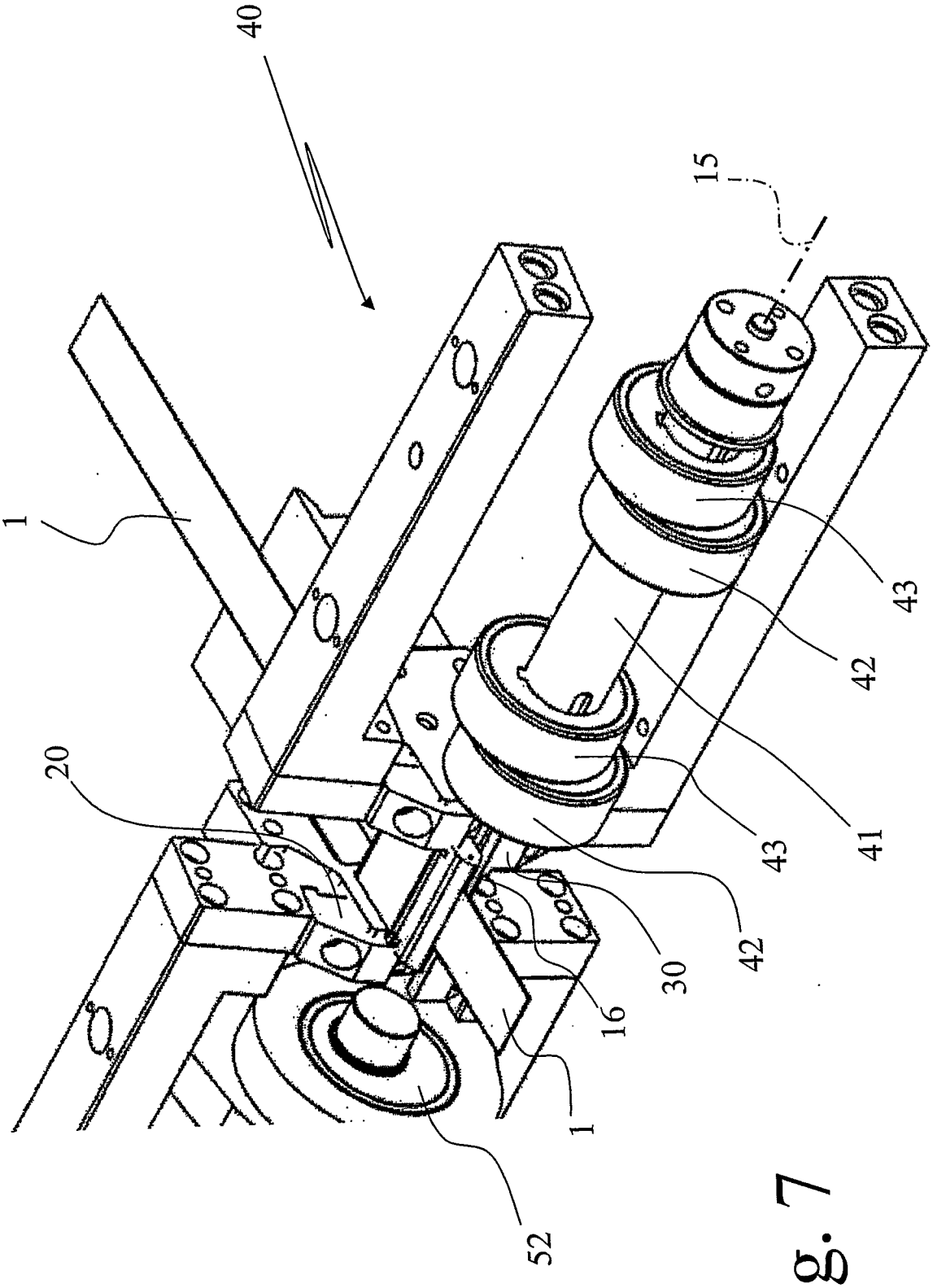

Fig. 7

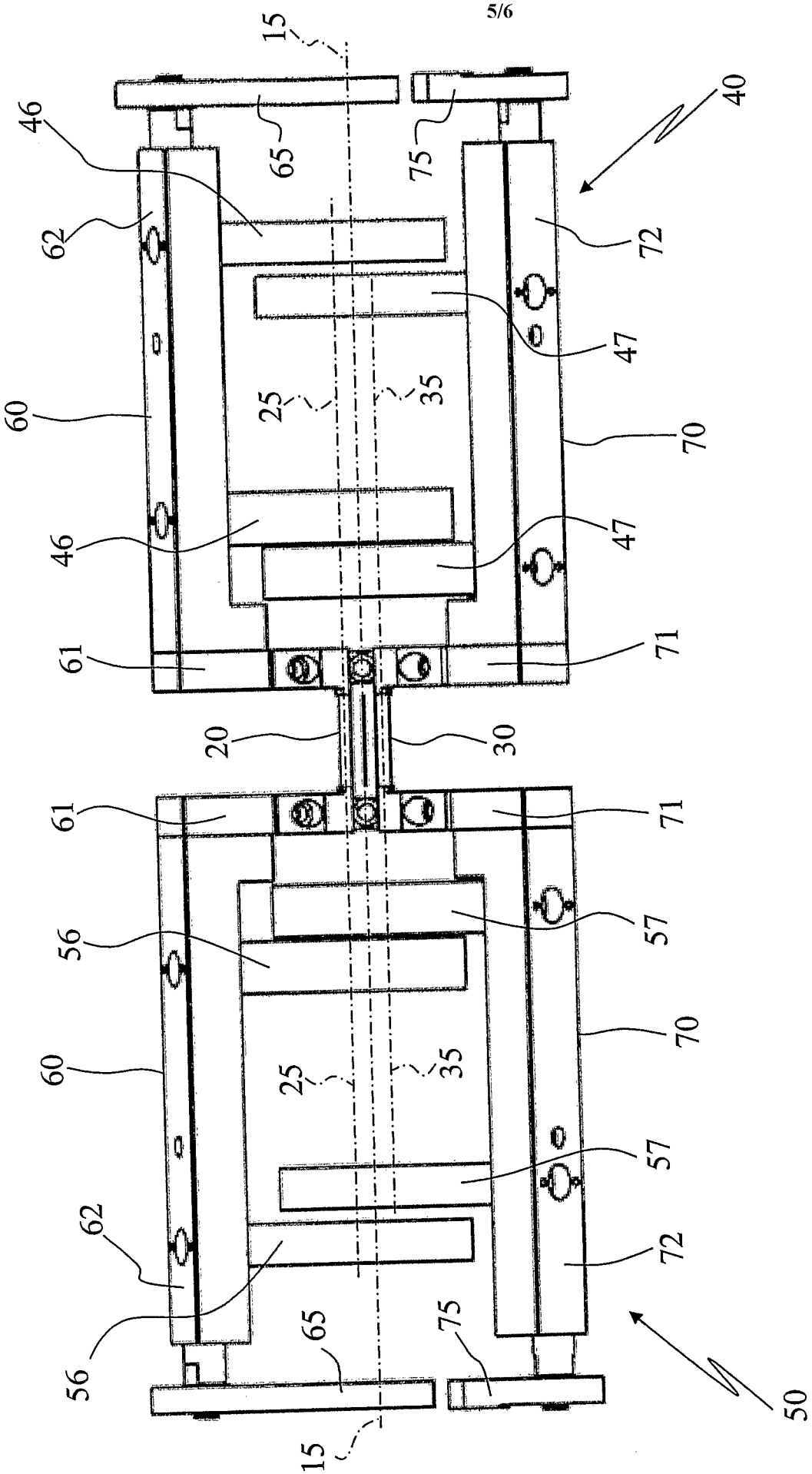
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Fig. 8

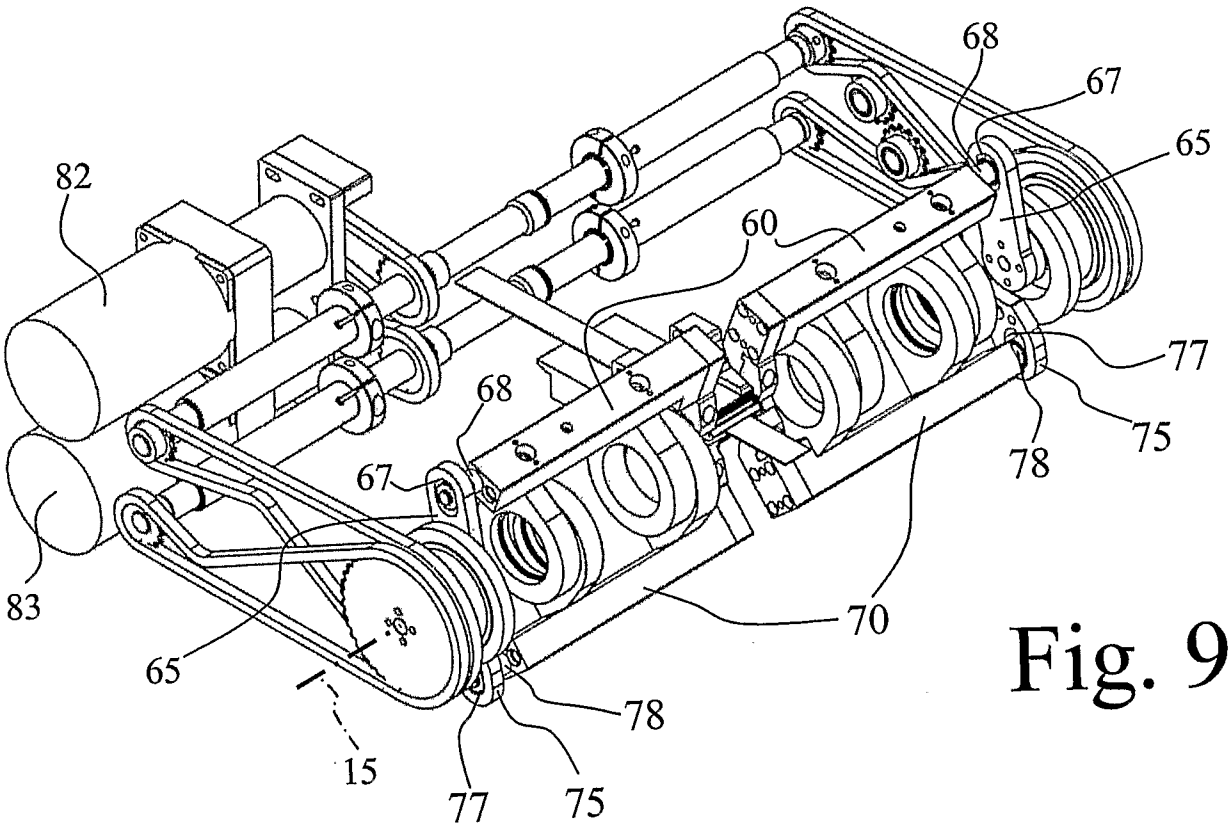

Fig. 9

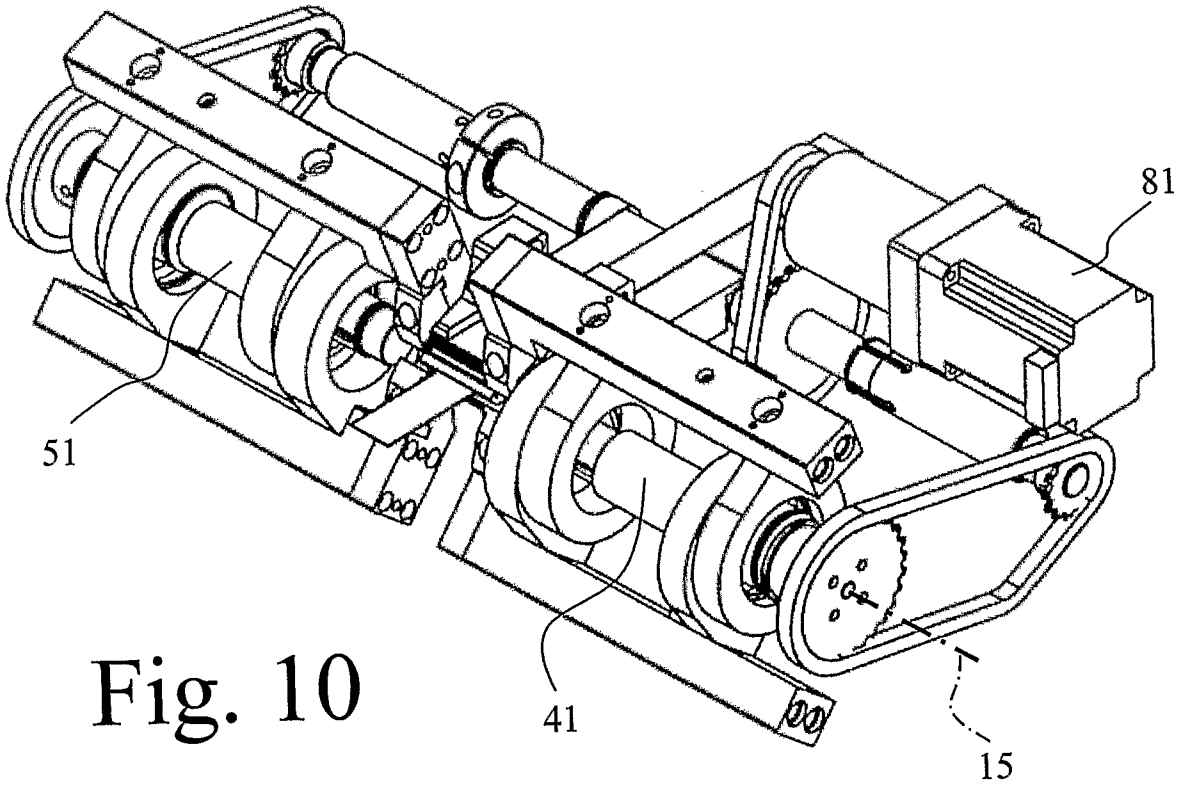

Fig. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2006/000136

A. CLASSIFICATION OF SUBJECT MATTER
INV. B21D37/20 B21D11/10 B21D53/64 B21D7/022

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B21D B26F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 870 919 A (SONG BYUNG-JUN [KR]) 16 February 1999 (1999-02-16) cited in the application the whole document	1-16
A	US 6 629 442 B2 (PARK HONG-SOON [KR]) 7 October 2003 (2003-10-07) cited in the application the whole document	1-16
A	JP 08 215761 A (MIZUKAWA SUEHIRO) 27 August 1996 (1996-08-27) figures 1-6,8	1-16
A	EP 0 699 488 A1 (ITAMI IND CO LTD [JP]) 6 March 1996 (1996-03-06) figures 7-14	1-16

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2006	05/12/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Vinci, Vincenzo

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2006/000136

C(Continuation). * DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 226 167 A2 (DISCHLER HELMUT) 24 June 1987 (1987-06-24) figures 1-5a	1-16

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Information on patent family members

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