



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) **EP 1 329 270 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
23.07.2003 Bulletin 2003/30

(51) Int Cl.7: **B21J 15/10**

(21) Application number: **02009853.9**

(22) Date of filing: **02.05.2002**

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

(72) Inventor: **Bisiach, Bruno**
10078 Venaria (TO) (IT)

(74) Representative: **Robba, Pierpaolo et al**
INTERPATENT S.R.L.,
Via Caboto No.35
10129 Torino (IT)

(30) Priority: **11.01.2002 IT TO20020030**

(71) Applicant: **Bisiach, Bruno**
10078 Venaria (TO) (IT)

(54) **Device for riveting longitudinal reinforcing members onto aluminium panels**

(57) A device for riveting a longitudinal reinforcing member onto an aluminium panel includes a first robotised arm (2), equipped with a plurality of interchangeable tools (16,18,20), including one boring tool (16) and at least one riveting tool (18,20), and a second robotised arm (4), equipped with at least one backing tool (22).

The interchangeable tools (16,18,20) are mounted on a rotating table (14) that in turn is fastened to a first moving plate (32) of a powered double slide (10), whereas a second moving plate (30) of the same slide (10) houses a bearing foot (12) by which both parts to be riveted are kept together during working and tool change.

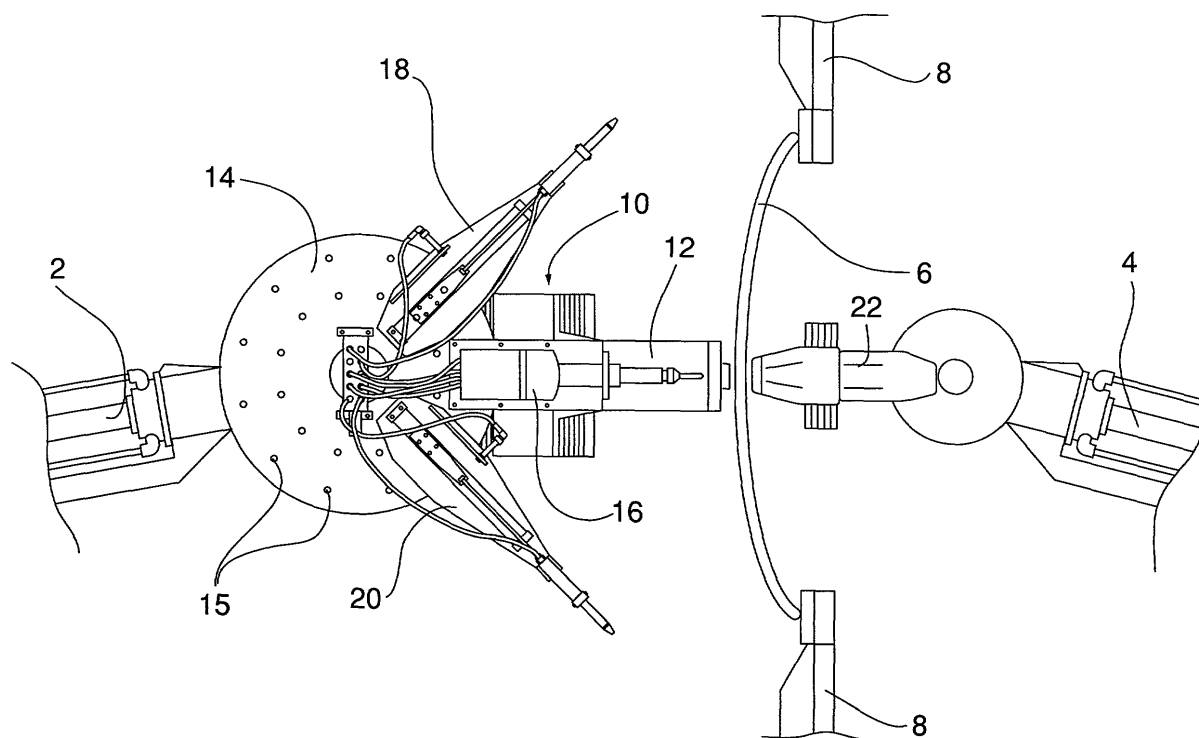


Fig. 1

Description

[0001] The present invention relates to a device for riveting longitudinal reinforcing members onto aluminium panels.

[0002] More particularly, the invention concerns a device for riveting the so-called "stringers" onto aluminium panels for preparing parts of aircraft fuselages or wings.

[0003] To construct aircraft fuselages or wings, use is made of very thin aluminium panels, to keep weight limited, which panels are strengthened with longitudinal reinforcing members, also of aluminium, called "stringers".

[0004] According to known techniques, the stringers, which may have different cross-sectional shapes, for instance the shape of a T or of an upset J, are secured to the aluminium panels either by riveting, if they have a suitable flap, or, according to more recent techniques, by laser welding.

[0005] Riveting is at present the preferred technique, since it exploits a widely tested technology, less critical than welding.

[0006] It is known that riveting of metal parts entails a sequence of simple operations, namely boring both parts to be joined, inserting a bonding agent into the hole and lastly inserting the rivet and clinching it. The above operations are generally performed in automatic manner, by moving the workpiece relative to the boring and riveting tools, which remain stationary.

[0007] A known device for automatically riveting panels, in particular for aircraft wings, is disclosed in US patent No. 4,762,261. The device disclosed therein uses two robotised arms, which are equipped each with a riveting tool and work in opposed relationship onto an aircraft wing, arranged in substantially vertical position. The robotised arms are movable in a vertical plane perpendicular to the longitudinal wing direction, and a moving system including a carriage slidable on rails is provided to allow displacing the wing during working.

[0008] The device disclosed in said patent, while allowing automatically riveting a whole panel, has however some limits. The system for longitudinally moving the panel has to support and displace with extreme accuracy even a whole wing: hence it is a complex, cumbersome and expensive system, since it must ensure the greatest stability during working and it can hardly ensure that no oscillation at all occurs.

[0009] The present invention therefore aims at solving the problem of how to simplify the process of riveting the stringers onto aluminium panels, while ensuring a high level of reliability and accuracy.

[0010] The above and other objects are achieved by the riveting device as claimed in the appended claims.

[0011] Advantageously, according to the invention, an automatic riveting system is provided that is capable of performing the whole of the operations included in the working cycle, from the boring to the final rivet clinching, in a quick manner and without requiring panel displace-

ment during working.

[0012] The above and other objects of the invention will become more apparent from the description of a preferred embodiment, with reference to the accompanying drawings, in which:

- Fig. 1 is a front view of a device, made in accordance with the present invention, for riveting longitudinal reinforcing members onto aluminium panels;
- Fig. 2 shows a powered double slide used in the riveting device shown in Fig. 1;
- Fig. 3 is a side view of the powered double slide shown in Fig. 2;
- Fig. 4 is a side view of a detail of a working arm of the device made in accordance with the present invention;
- Fig. 5 shows an enlarged detail of a bearing foot of the working arm shown in Fig. 4; and
- Figs. 6a to 6g show the operation sequence performed by the device during riveting.

[0013] Referring to Fig. 1, a device for the automatic riveting of a longitudinal reinforcing member, a so-called stringer, onto an aluminium panel comprises two robotised arms, namely a first arm 2 equipped with a multiple-tool head, and a second arm 4 equipped with a backing tool 22.

[0014] The riveting device is controlled by a numerical control system of known type that guides robotised arms 2 and 4 in pre-set movements in space according to a given working program. Thanks to the freedom of movement of robotised arms 2 and 4 in space, the system is generally capable of performing riveting operations onto an entire panel 7 without need for displacing or rotating the panel. Indeed, panel 6 being worked is secured to a stationary support 8, of which only two end portions are shown in Fig. 1, firmly supporting the panel in vertical position. The vertical panel position depends on the supporting structure of robotised arms 2 and 4, but in no way it affects the working cycle to be described hereinbelow.

[0015] Thus, it is possible to make an equivalent system in which the panel is horizontally or obliquely arranged, depending on the requirements.

[0016] Moreover, the size of the panel shown in Fig. 1 is merely indicative, and the actual panel size can change, as far as both the height and the width are concerned, compatibly with the range of reach of the robotised arms.

[0017] Robotised arm 2 bears a powered double slide 10, shown in detail in Figs. 2 and 3, which allows the independent displacement of two moving plates 30, 32 along a same axis. A bearing foot 12 and a rotating table 14, respectively, are secured to said plates.

[0018] As shown in detail in Fig. 2, both moving plates 30, 32 slide along the same guides 24, 26 and are coupled each with a threaded shaft 36, 34, which is rotated by a respective electric motor 40, 38 by means of a belt

45, 46. The rotation of each threaded shaft is therefore converted into a linear displacement of the associated plate. The stroke of each plate is therefore limited by the position taken by the other plate.

[0019] Moving plate 32 has a substantially square shape and it is provided with a plurality of bores 35 for securing rotating table 14. Rotating table 14 is internally equipped with a hydraulic or electric driving system for rotating it, also controlled by the numerical control system of the device, and is externally provided with bores 15 for securing a plurality of tools circumferentially distributed on its surface. Fig. 1 shows by way of example a mandrel 16, rotated into its working position, and two riveters 18, 20, arranged at 45° relative to the mandrel.

[0020] Thus, moving plate 32 allows longitudinally displacing the tool being used (mandrel 16 in the drawing), whereas the rotating table allows changing the tool, after having withdrawn the tool being used by moving back moving plate 32.

[0021] Table 14 is designed to house up to 8 tools. Yet generally it is sufficient to use a single mandrel, in which it is possible to automatically change the boring drills to make holes of different diameters, and one or two riveters for applying rivets of different sizes.

[0022] In order to perform both the panel boring and its riveting, it is necessary to have a backing tool 22, which is a well-known tool in automatic riveting, in opposite position to the boring or riveting tool.

[0023] Backing tool 22, coupled with robotised arm 4, follows the movements of the first arm 2 and therefore it can reach all panel points where riveting is performed.

[0024] Fig. 3 is a side view of the double slide 10. For sake of clarity, electric motor 40 has been removed in that Figure, to show the details said motor hides.

[0025] More particularly, the Figure shows means 42, 44 for coupling the slide to arm 2, moving plates 30, 32 and rubber bellows 37, 39, 41 protecting the internal slide members while allowing at the same time plates 30, 32 to displace longitudinally of the slide.

[0026] Fig. 4 shows instead in detail the lower end of slide 10, with bearing foot 12 secured to plate 30 thereof, and a device 48 for supplying a bonding agent in correspondence of the bore made by mandrel 16, before the riveting operation.

[0027] Bearing foot 12 forms, at its lower end, an internally hollow circular portion 12a, the internal cavity of which is connected with device 60 for aspirating boring chips (a flexible duct connected with a suitable aspirator). The internal diameter of input opening 12b giving access to hollow circular portion 12a of the foot slightly exceeds the external diameter of chuck 17 of mandrel 16: thus, during boring, an air-tight sealed chamber is formed that favours chip aspiration by chip aspirating device 60.

[0028] Device 48 for supplying a bonding agent is coupled with bearing foot 12 through an actuating system, such as an oil-pressure piston, allowing its reciprocation for moving close to and away from the hole.

Fig. 4 shows the device in its lowered position.

[0029] Advantageously, device 48 for supplying a bonding agent is moved close to and away from the hole during a rotation phase of rotating table 14, whereby the dead times during tool change are exploited.

[0030] Fig. 5 shows in greater detail hollow circular portion 12a of bearing foot 12, which presses panel 5 against stringer 6a, and the lower end of device 48 for supplying a bonding agent in its lowered position, when it is brought in correspondence with hole 52.

[0031] A channel 50 through which the bonding agent passes is provided inside device 48. Channel 50, in its end portion, is divided into two or more oblique channels 50a, 50b, preferably three channels arranged at 120° relative to each other, favouring a homogeneous distribution of the bonding agent onto the internal hole walls. The tip of device 48, i. e. the portion where oblique channels 50a, 50b are provided, is so shaped that it becomes positioned onto hole 52 as if it would arrive in axial alignment therewith, notwithstanding the oblique approaching movement.

[0032] The operation cycle of the riveting device according to the invention will now be described with reference to Figs. 6a to 6g.

[0033] The riveting of a stringer 6a to a panel 6 take place as follows:

- the reaction group consisting of backing tool 22 supported by robotised arm 4 is brought against panel 6, on the side of stringer 6a, in the position set by the program for the boring (Fig. 6a);
- working arm 2 is brought in front of panel 6 and, through a translation of the first plate 30, its bearing foot 12 reaches the point set by the program of the numerical control system controlling working (Fig. 6b),
- bearing foot 12 is pressed against panel 6 until it exerts a programmable force of about 20 to 60 Kg, preferably 30 Kg, onto panel 6, so as to press panel 6 and stringer 6a against backing member 22; such pressure, that is opposed by backing member 22, is substantially maintained during the whole riveting operation (Fig. 6c);
- the working control program detects the actual quote reached by bearing foot 12 and actuates the second plate 32 of slide 10 (by moving it closer and farther depending on the error between the actual and theoretical positions), so as to bring mandrel 16 to the correct position of boring/countersinking start; by moving plate 32 closer, the hole and the corresponding countersink are made by means of drill 16a mounted on mandrel 16 (Fig. 6d);
- mandrel 16 is moved away by moving back plate 32 and, while table 14 is being rotated for tool change, the bonding agent is injected by device 48 (Fig. 6e);
- once the rotation of table 14 is over, riveter 18 or 20 is lowered and it introduces rivet 51 into the countersunk hole; at the same time, a reaction mass 23

is moved close to stringer 6a in correspondence of the hole, with a force of about 10 Kg (Fig. 6f);

- rivet 51 is introduced into the hole and riveting is carried out, preferably in a single blow (Fig. 6g);
- arms 2 and 4 are moved away for repeating the riveting cycle at another point of panel 6.

[0034] Advantageously, thanks to the device according to the invention, a hole and a countersink can be obtained with minimum errors relative to the required specifications. It is important that especially the countersink has minimum tolerance, since the head of rivet 51, at the riveting end, must be at the same level as the external surface of panel 6. The depths of the hole and the countersink are kept constant in that mandrel 16, before starting boring, is positioned again, thereby recovering possible errors with respect to the theoretical zero, based on the actual point where foot 12 is located when it is pressed against panel 6.

Claims

1. A device for riveting a longitudinal reinforcing member (6a) onto an aluminium panel (6), the device being of a kind including a first robotised arm (2), equipped with at least one riveting tool (18, 20), and a second robotised arm (4), equipped with at least one backing tool (22), the device being **characterised in that** it comprises a powered double slide (10) coupled with said first robotised arm (2), said powered double slide (10) being equipped with a first moving plate (30) onto which a bearing foot (12) is mounted, which foot is arranged to exert a programmable pressure, contrasted by said second robotised arm (4), to keep said panel and said longitudinal reinforcing member (6a) together, and with a second moving plate (30) onto which a rotating table (14) is mounted, which table houses a plurality of tools (16, 18, 20) that are interchangeable by rotating said table (14), said first (30) and second (32) moving plates being independently operable.
2. A device according to claim 1, wherein the first (30) and second (32) moving plates slide on common guides (24, 26).
3. A device according to claim 2, wherein each moving plate (30, 32) is coupled with a threaded shaft (36, 34), which is driven by means of a respective electric motor (40, 38).
4. A device according to claim 3, wherein each threaded shaft (36, 34) is coupled with the associated electric motor (40, 38) by means of a belt (45, 46).
5. A device according to claim 4, wherein said rotating table (14) houses a mandrel (16) arranged to make a hole (52) in said panel (6) and in said longitudinal reinforcing member (6a), and at least one riveter (18) arranged to introduce and thereafter to clinch a rivet into said hole (52).
6. A device according to claim 5, wherein said rotating table (14) houses a second riveter (20) arranged to introduce and to clinch rivets with different diameter with respect to said first riveter (18).
7. A device according to claim 6, wherein said mandrel (16) is equipped with a chuck (17) arranged to house automatically interchangeable drills of different diameters.
8. A device according to claim 1, wherein said bearing foot (12) forms, at its end, an internally hollow circular portion (12a), of which the internal cavity is connected with a device (50) for aspirating boring chips.
9. A device according to claim 8, wherein said mandrel (16) is equipped with a chuck (17) and wherein the internal diameter of the input opening (12b) of said hollow circular portion (12a) slightly exceeds the external diameter of said chuck (17) whereby, during boring, an air-tight sealed chamber is formed in said hollow, favouring chip aspiration by said aspirating device (50).
10. A device according to claim 1, and further comprising a device (48) for supplying a bonding agent at the hole (52) bored by the mandrel (16), said device (48) being coupled with said bearing foot (12) through an actuating system (46), allowing its reciprocation for moving close to and away from said hole (52).
11. A device according to claim 10, wherein said device (48) for supplying a bonding agent is brought close to said hole during a rotation phase of said rotating table (14) for tool change.
12. A device according to any preceding claim, wherein, when said bearing foot (12) exerts the programmed pressure against said panel (6), said second moving plate (32) is displaced to bring said tools (16, 18, 20) back to the programmed relative distance with respect to the bearing foot (12).

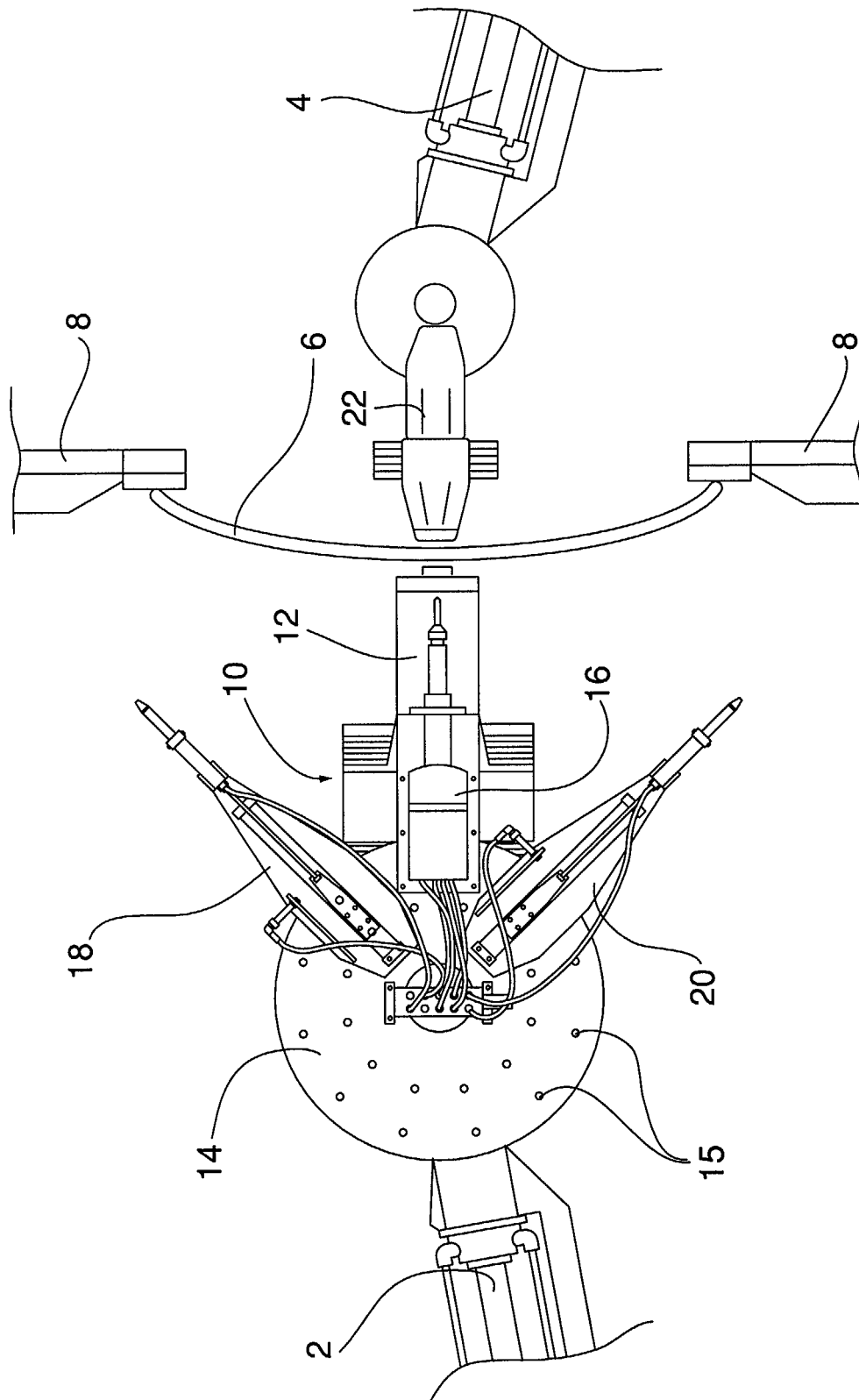


Fig. 1

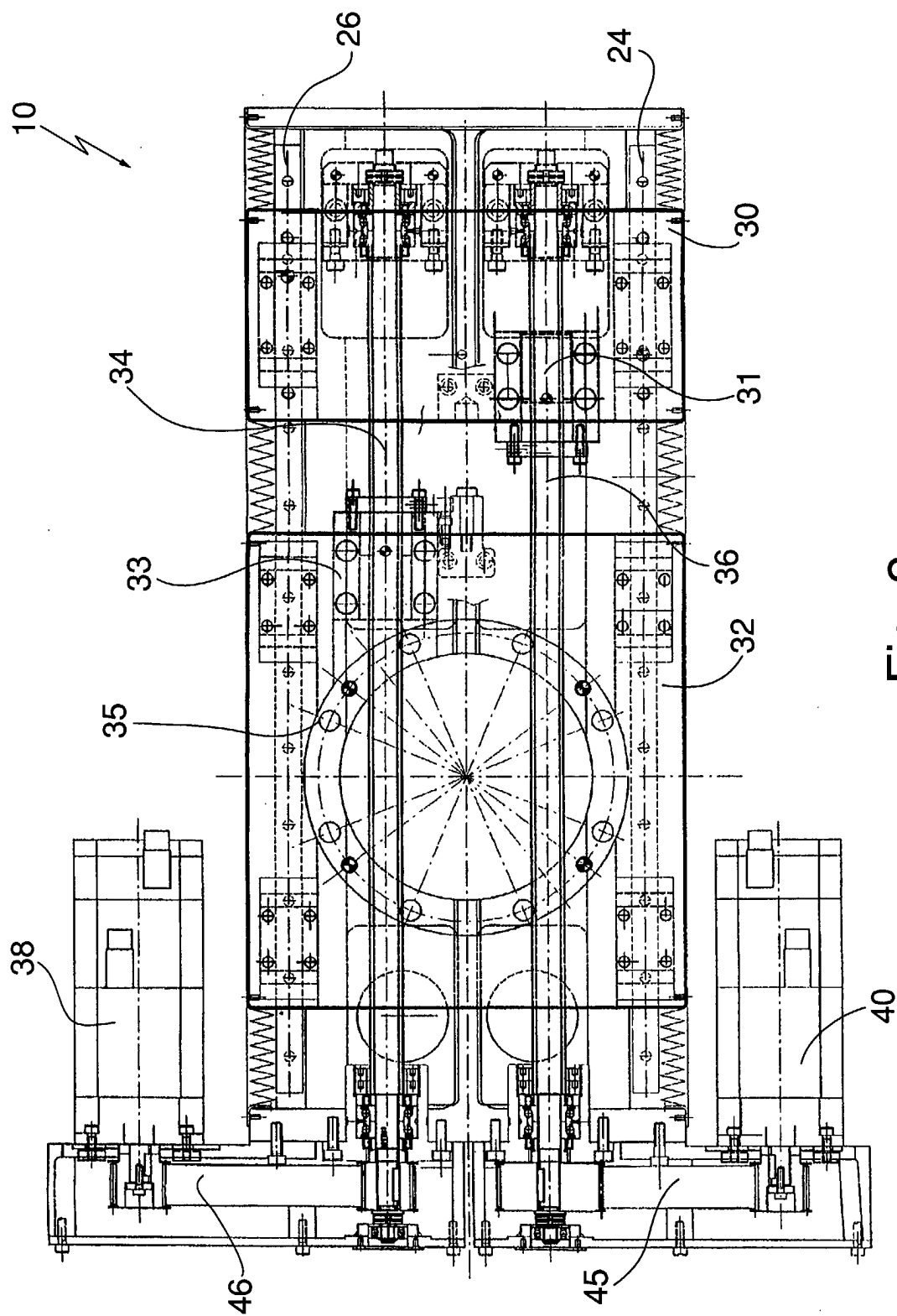


Fig. 2

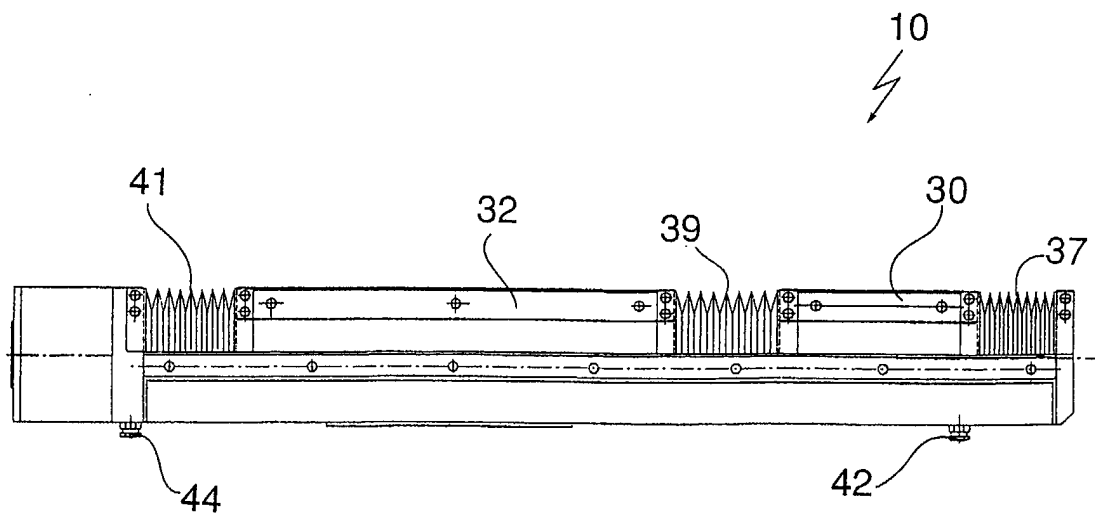


Fig. 3

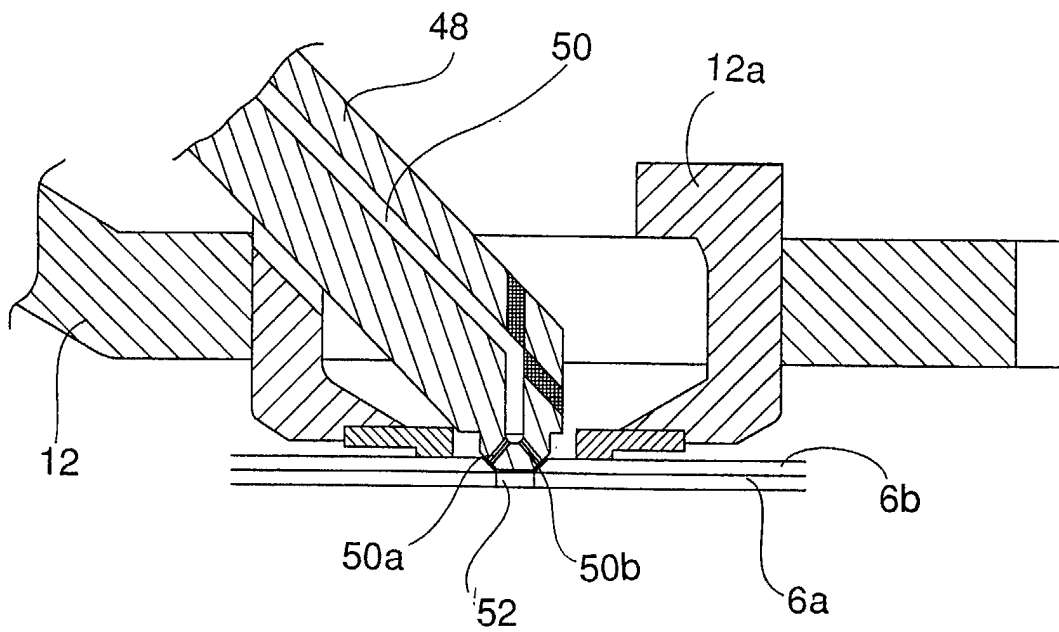


Fig. 5

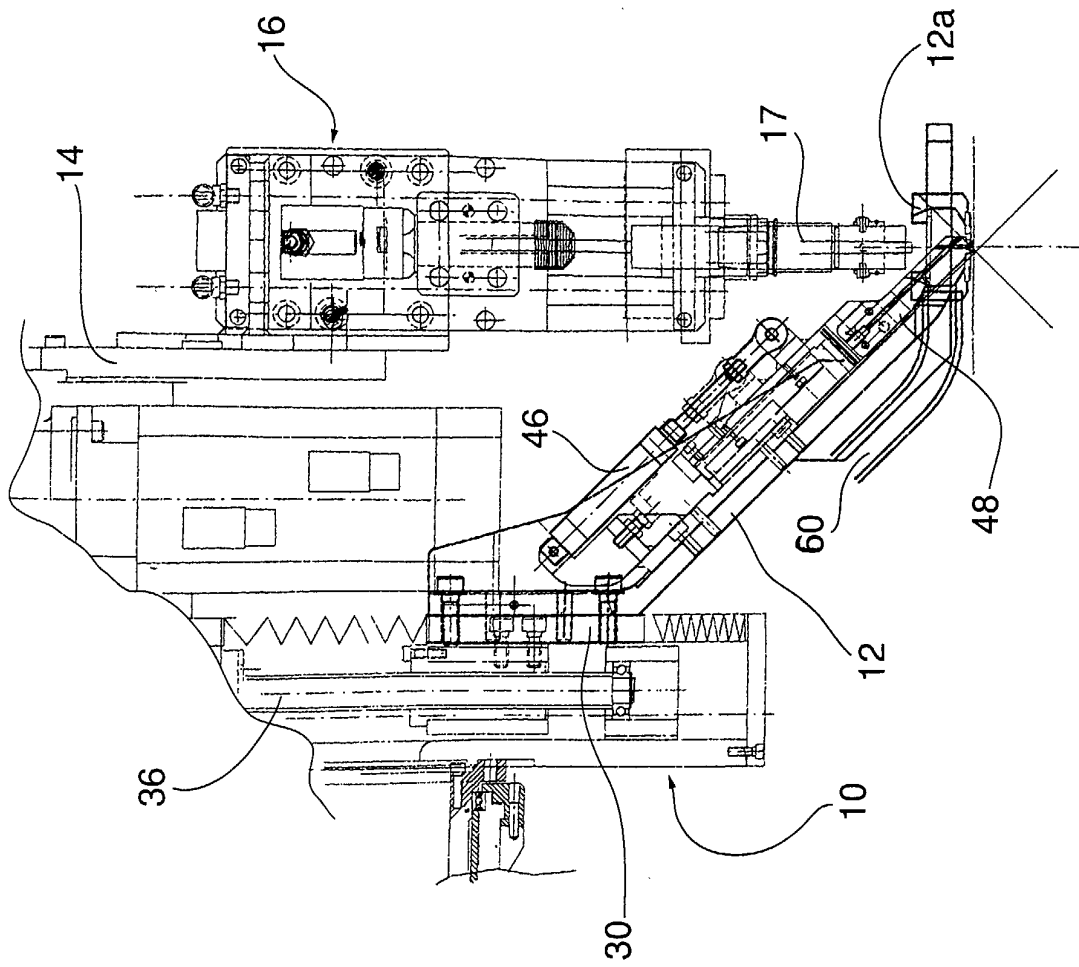


Fig. 4

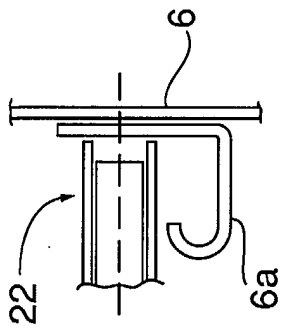


Fig. 6a

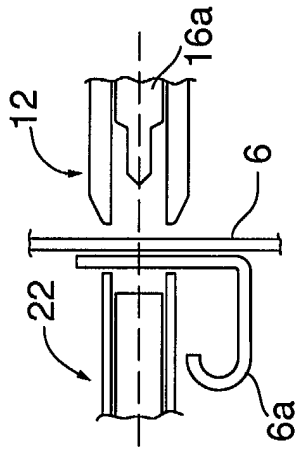


Fig. 6b

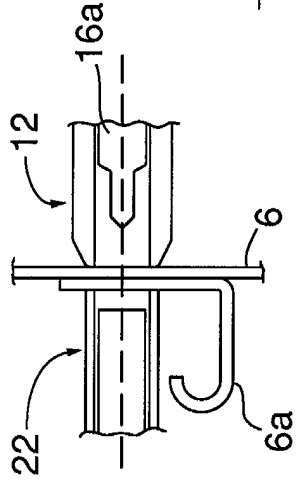


Fig. 6c

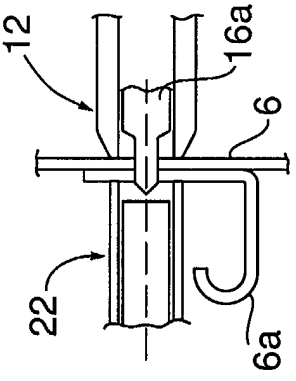


Fig. 6d

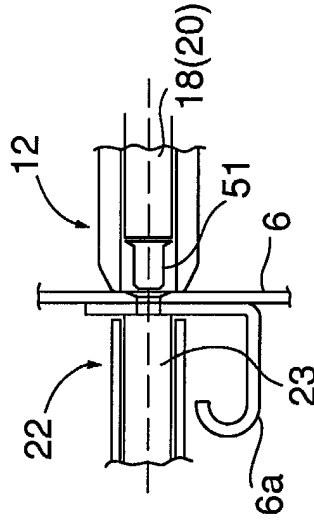


Fig. 6f

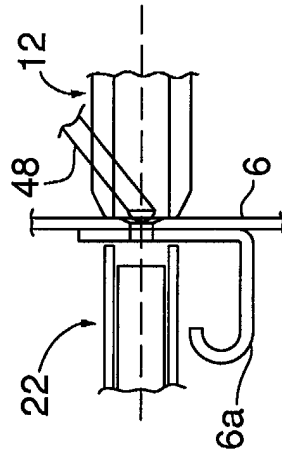


Fig. 6e

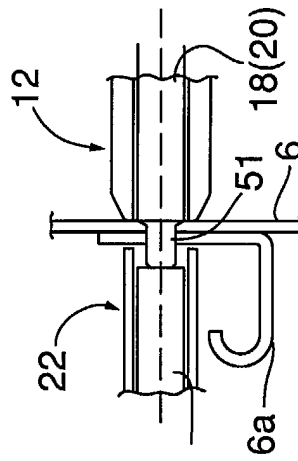


Fig. 6g



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 00 9853

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)
A,D	US 4 762 261 A (HAWLY RUDOLF ET AL) 9 August 1988 (1988-08-09) * column 5, line 27-44 * * column 6, line 18-34; figures 1-3 * ---	1	B21J15/10
A	US 4 854 491 A (STOEWER UDO-HENNING) 8 August 1989 (1989-08-08) * column 3, line 5 - column 4, line 21; figure 2 * ---	1	
A	US 4 919 321 A (RYDSTROEM SVEN-OLOF ET AL) 24 April 1990 (1990-04-24) * column 2, line 52,53 * * column 3, line 29-64; figures 1-4 * ---	1	
A	WO 00 15373 A (GEN ELECTRO MECH CORP) 23 March 2000 (2000-03-23) * page 4, line 12-34; figures 1,2 * -----	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B21J B25J B23K
Place of search	Date of completion of the search	Examiner	
MUNICH	11 March 2003	Augé, M	
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document 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	

EPO FORM 1503 03 82 (P04C01)

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

EP 02 00 9853

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-03-2003

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 4762261	A	09-08-1988	DE	3535761 C1	26-03-1987

US 4854491	A	08-08-1989	DE	3715927 A1	01-12-1988
			JP	63290645 A	28-11-1988

US 4919321	A	24-04-1990	SE	454956 B	13-06-1988
			DE	3769153 D1	08-05-1991
			EP	0318523 A1	07-06-1989
			SE	8604361 A	16-04-1988
			WO	8802673 A1	21-04-1988

WO 0015373	A	23-03-2000	AU	6034299 A	03-04-2000
			EP	1112131 A1	04-07-2001
			US	2002083567 A1	04-07-2002
			WO	0015373 A1	23-03-2000
			US	6237212 B1	29-05-2001
			US	2001016973 A1	30-08-2001
