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CA 2561922 C 2012/05/22

(11)(21) 2 561 922

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2005/03/22
(87) Date publication PCT/PCT Publication Date: 2005/10/20
(45) Date de délivrance/Issue Date: 2012/05/22
(85) Entrée phase nationale/National Entry: 2006/10/02
(86) N° demande PCT/PCT Application No.: EP 2005/003048
(87) N° publication PCT/PCT Publication No.: 2005/097383
(30) Priorité/Priority: 2004/04/03 (DE20 2004 005 321.7)

(51) Cl.Int./Int.Cl. *B23B 31/30* (2006.01)

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(54) Titre : MANDRIN DE SERRAGE HYDRAULIQUE EXPANSIBLE
(54) Title: HYDRAULIC EXPANSION CHUCK

(57) Abrégé/Abstract:
The invention relates to a hydraulic expansion chuck (1) which has a particularly advantageous long, narrow design. The tool end (3) of the expansion chuck (1) is equipped with an expansion bushing (1) that is surrounded by a pressure chamber (12) which can be radially deformed in order to clamp a tool by means of a hydraulic fluid (F) that is contained in said pressure chamber (12). A pressure generation unit (14) is situated at an axial distance from the expansion bushing (10) and a pressure conduction system (13) is provided to transfer pressure from the pressure generation unit (14) to the pressure chamber (12), said pressure conduction system being formed by an annular gap (11) that is concentric with the chuck axis (2).

Abstract of the invention

Hydraulic expansion chuck

The invention relates to a hydraulic expansion chuck (1) which has a particularly advantageous long, narrow design. The tool end (3) of the expansion chuck (1) is equipped with an expansion bushing (1) that is surrounded by a pressure chamber (12) which can be radially deformed in order to clamp a tool by means of a hydraulic fluid (F) that is contained in said pressure chamber (12). A pressure generation unit (14) is situated at an axial distance from the expansion bushing (10) and a pressure conduction system (13) is provided to transfer pressure from the pressure generation unit (14) to the pressure chamber (12), said pressure conduction system being formed by an annular gap (11) that is concentric with the chuck axis (2).

Hydraulic expansion chuck

This invention relates to a hydraulic expansion chuck for chucking a tool, in particular a boring tool or milling cutter.

An expansion chuck is used to connect a tool that is driven in rotation with the drive spindle of a machine tool. For this purpose an expansion chuck has a pronounced expansion chuck axis around which the expansion chuck and the tool clamped in it are driven in rotation. In the direction of this expansion chuck axis, an expansion chuck always has a tool-side end which is provided to hold the tool, and a machine-side end, which is realized so that it forms a connection between the expansion chuck and the drive spindle of the machine tool. Hydraulic expansion chucks form a genre of expansion chucks that is described in the prior art. On an expansion chuck of this type, the receptacle for the tool is formed by a thin-walled expansion bushing. The expansion bushing is surrounded by a pressure chamber which is filled with a pressure fluid, such as an oil, for example. The expansion chuck is then realized so that when pressure is applied to the pressure fluid, the expansion bushing is elastically deformed radially and thereby chucks the tool that is being used in place. One of the advantages of a hydraulic expansion chuck is that in operation, it damps any vibrations and impacts that occur. This property makes it possible to achieve a particularly high surface quality during the machining and a long useful life of the tool.

WO 03/095132 A1 describes a hydraulic expansion chuck of this type. On this expansion chuck of the prior art, the pressure chamber is realized between an expansion bushing which is realized in one piece with a base body and a chucking ring which is screwed onto the base body. By screwing or unscrewing the chucking ring with respect to the base body, the volume of the pressure chamber can thereby be reduced or increased, and the pressure fluid can thereby be pressurized or depressurized.

In contrast to the chuck described above, on an expansion chuck there is frequently a pressure generating unit, e.g. on that is realized in the form of a piston-cylinder unit, which is axially offset

toward the tool-side end with respect to the pressure chamber and the expansion bushing. An expansion chuck of this type is described in WO 98/39123 A1, for example. For the transmission of the pressure from the pressure generating device into the pressure chamber, on this expansion chuck an oil conducting system is provided, which consists of narrow connecting borings that are introduced into the material of which the expansion chuck is made.

An expansion chuck which is pushed onto a drive shaft with an expansion bushing that can chuck both radially outward and radially inward is also known from DE 743 530 C.

In particular in mold and die construction, very long and narrow expansion chucks are required. Conventional expansion chucks, however, can no longer be constructed in such long and narrow designs or only with considerable expense and at considerable effort. For example, on a particularly narrow expansion chuck a movable chucking ring, e.g. of the type described in WO 03/095132 A1, can no longer be installed for space reasons. Likewise a connecting boring, e.g. of the type described in WO 98/39123 A1 to transmit the pressure, can no longer be used on account of the thin walls of a narrow expansion chuck or can only be realized with a great deal of effort. As the length of the expansion chuck increases, the technical effort required to introduce a correspondingly longer connecting boring also increases drastically. An additional problem results from the fact that, when pressure is applied, stresses are introduced into the material of the expansion chuck also in the vicinity of each connecting boring, which can lead to a significant bending of the expansion chuck and thus have an adverse effect on the true or concentric running of the tool.

One object of an aspect of the invention is therefore to indicate a hydraulic expanding clutch which can be realized with comparatively little effort and expense in a long and narrow shape, and is also characterized by advantageous properties in operation.

According to one aspect, on the tool-side end of the expanding clutch, an expansion bushing is provided to hold and chuck a tool. To generate a pressure that

hydraulically deforms this expansion bushing, the expansion chuck has a pressure generating unit which is offset axially with respect to the expansion bushing and the pressure chamber that surrounds it. To transmit the applied pressure over the axial distance between the pressure chamber and the pressure generating unit, the expansion chuck has a pressure conducting system, which the invention teaches is realized in the form of a closed, ring-shaped gap or channel which is concentric with the axis of the expansion chuck. The pressure chamber is thereby extended by or through the pressure conducting system, in particularly continuously axially toward the pressure generating unit.

Compared to the use of a conventional boring as the pressure conduction system, an annular gap with a comparable cross section surface area has a radial dimension that is generally significantly smaller. An annular gap with a cross section surface area that is sufficient to transmit the pressure can therefore be located in a space-saving manner even in an extremely narrow expansion chuck. When pressure is applied into the material of the expansion chuck, the stresses that are introduced in the vicinity of the annular pressure conduction system are also always rotationally symmetrical with reference to the axis of the expansion chuck, so that no asymmetrical deformation of the expansion chuck can occur and thus the true or concentric running of the expansion chuck is not adversely affected in operation.

A ring-shaped and concentric pressure conduction system can be realized particularly easily by a two-part construction of the expansion chuck. In one preferred realization of the invention, the expansion chuck comprises a central base body which carries on its tool-side end the expansion chuck, and on the tool-side end a chucking sleeve which is drawn onto the base body. As a result of the coordinated sizing of the inside diameter of the chucking sleeve and the outside diameter of the base body, an annular gap is thereby formed between the base body and the chucking sleeve which forms the pressure chamber and the pressure conduction system that is axially adjacent to it. For purposes of a simple and stable construction, the invention teaches that the base body and the chucking sleeve are preferably connected to each other in a manner that is rigid and pressure-tight, in particular by hard soldering.

A geometry of the expansion chuck that is advantageous in terms of a space-saving design is achieved by locating the pressure generating unit in the chucking sleeve. A pressure generating

unit with a piston/cylinder system is advantageous both with regard to ease of manufacture as well as with regard to ease of handling of the expansion chuck. This piston/cylinder system comprises a compression piston which is guided in a cylinder bore or in a sleeve that can optionally be inserted into a cylinder bore. A simple filling of the pressure chamber, of the pressure conduction system and of the pressure generating system with the pressure fluid is achieved by a filling boring that is bent at an angle with respect to the cylinder bore and connects the cylinder bore with the pressure conduction system. In one particularly simple and effective realization, the compression piston can be actuated by means of a tightening screw.

In one form of the expansion chuck that is advantageous in particular for the construction of molds and dies, the chucking sleeve transitions on the tool side into a long, narrow neck region, the axial length of which is at least four times its outside diameter. The length of this neck area is in particular at least 100 mm.

One particular advantage of the expansion chuck according to an aspect of the invention is that it becomes possible with comparatively little effort and expense to achieve a very narrow tool holder, which is defined by the inside diameter of the expansion bushing. For example, the inside diameter of the expansion bushing is preferably 12 mm, although it can also be significantly smaller or larger. To chuck such thin tools on conventional expansion chucks, it is frequently necessary to use a reducer piece for the tool that can be inserted into the receptacle of the expansion chuck. The use of this reducing piece can have a disadvantageous effect on the true or concentric running of the tool.

To achieve an efficient chucking action of the expansion chuck according to one aspect, the invention teaches that it is advantageous to keep the total volume of the overall pressure system, i.e. of the pressure chamber, of the pressure conduction system and of the pressure generating device, as small as possible. In one advantageous development of the invention, this smallest possible total volume is

achieved by making the radial dimension of the annular gap that forms the pressure conduction system and the pressure chamber very small. It is advantageous if the radial dimension of the annular gap is a maximum of 0.2 mm, preferably approximately 0.1 mm. This extremely narrow realization of the annular gap is also space-saving and is therefore advantageous with regard to particularly slim realizations of the expansion chuck.

The annular shape of the pressure conduction system creates space in the central area of the expansion chuck, which can consequently be used advantageously for other purposes. In one advantageous realization of the invention, for example, the base body is provided with a central passage which can be used as a coolant channel, for example.

In an additional advantageous configuration of the invention, an axial adjustment unit for the tool is provided which is also preferably located in the central area of the expansion chuck. In one advantageous configuration, this axial adjustment device comprises an adjustment pin which can be adjusted axially with respect to the base body and acts as an axial stop for the tool to be chucked, and is preferably guided in a central boring of the base body.

In one constructively particularly simple realization, the adjustment pin can be adjusted axially in the base body in the manner of a screw. For this purposes, the adjustment pin is provided with a male thread which interacts with a female thread of the central boring of the base body.

In one variant which is particularly advantageous from an operational point of view, the adjustment pin can be adjusted by means of a radially accessible set screw so that the axial adjustment can be made even when the tool has already been inserted. The set screw, which is preferably guided in the base body, is thereby provided on its inner end with a helical thread which meshes with an axial-linear gearing of the adjustment pin.

In accordance with another aspect of the invention, there is provided hydraulic expansion chuck with an expansion bushing on its tool-side end and surrounded by a pressure chamber, which expansion bushing can be deformed radially under the action of a pressure fluid that is contained in the pressure chamber to chuck a tool, with a pressure generating unit that is axially spaced with respect to a chuck axis of the expansion bushing and a pressure conduction system for the transmission of pressure from the pressure generating unit to the pressure chamber, wherein the pressure conduction system is formed by an annular gap which is concentric to the chuck axis.

Exemplary embodiments of the invention are explained in greater detail below with reference to the accompanying drawings, in which:

Figure 1 is a view in perspective of a hydraulic expansion chuck for chucking a tool,

Figure 2 is a side view of the expansion chuck illustrated in Figure 1,

Figure 3 is a longitudinal section along line III-III of the expansion chuck illustrated in Figure 2,

Figure 4 is a cross section along line IV-IV of the expansion chuck illustrated in Figure 2,

Figure 5 is a longitudinal section, rotated around the axis of the expansion chuck with respect to Figure 3, of the expansion chuck illustrated in Figure 2, and

Figure 6 is a view of the expansion chuck illustrated in Figure 5 with an alternative axial adjustment unit for the tool to be chucked.

Parts and dimensions that are the same in all figures are identified with the same reference numbers.

The hydraulic expansion chuck illustrated in various views in Figures 1 to 4 (and called "expansion chuck 1" below for short) is used to chuck a rotational tool (not shown), in particular a boring tool or milling cutter, onto the drive spindle of a machine tool (also not shown). The expansion chuck 1 is essentially rotationally symmetrical with respect to the expansion chuck axis 2 that forms the axis of rotation and, viewed in the direction of this expansion chuck axis 2, has a tool-side end 3 and a machine-side end 4. In the vicinity of the tool-side end 3 the expansion chuck 1 is drawn out into a long, narrow neck area 5, which on its free end has a receptacle 6 for the tool. The axial length L of the neck area 5 is thereby four to five times greater than the outside diameter D. In the preferred sizing, the length L is 100 mm for an outside diameter of 20 mm and an inside diameter d of the receptacle 6 of 12 mm. However, an even longer and/or narrower shape of the expansion chuck 1 or an even smaller inside diameter d can also be realized. The machine-side end 4 is provided with a fastening cone 7, e.g. realized in the form of an HSK (hollow shaft cone) shank, to connect the expansion chuck 1 to the drive spindle.

The expansion chuck 1 is essentially constructed in two parts and comprises a central base body 8, on the tool-side area of which an approximately bell-shaped chucking sleeve 9 is placed. The base body 8 and the chucking sleeve 9 are hard-soldered to each other both on the tool side and on the machine side, and are thus connected by a rigid and pressure-tight connection.

In the vicinity of the receptacle 6, the base body 8 is realized in the form of a thin-walled hollow cylinder. This thin-walled area of the base body 8 is called the expansion bushing 10. The expansion bushing 10 is preferably realized in one piece with the base body 8, although it can also be formed by a separate part. Between the inside wall of the chucking sleeve 9 and the facing outer wall of the base body 8, in the neck area 5, there is an annular gap 11. This annular gap 11 has only one extremely small radial dimension R of preferably 0.1 mm (which is equal to approximately one-tenth of the wall thickness of the expansion bushing 10) and is therefore shown, on account of the relative sizes, only in the enlarged Figure 4, and in Figure 4 it is best illustrated in an even further enlarged detail A. In Figure 3, the annular gap 11 is visible only as a thick black line, and is shown only for purposes of illustration.

The annular gap 11 extends in the axial direction over a majority of the length of the chucking sleeve 9 and in the vicinity of the receptacle 6 forms a pressure chamber 12, which holds a liquid pressure fluid F, in particular an oil. The area of the annular gap 11 which is extended in the direction of the machine-side end is elongated via the pressure chamber 12 forms a pressure conduction system 13 which creates a hydraulic connection with a pressure generating unit 14 which is axially offset with respect to the pressure chamber 12 and thus makes it possible to transmit pressure from the pressure generating device 14 into the pressure chamber 12. In the unloaded condition, the radial dimension R is essentially equal over the entire length of the annular gap 11, so that the pressure chamber 12 makes a continuous transition into the pressure conduction system 13.

As shown in particular in Figure 4, the pressure generating unit 14 comprises a cylinder bore 15 in which a pressure piston 16 is located. The pressure piston 16 is adjustably guided either directly in the cylinder bore 16 or - as shown in Figure 4 - in a sleeve 17 that is inserted into the cylinder bore 15. The pressure piston 16 is actuated by means of a tightening screw 18. The inner end of the pressure piston 16 carries a seal 19 which is made of an elastic material, in particular a rubber elastomer. The pressure generating device 14 further comprises a filling boring 20 which runs at an angle from the inner end of the cylinder bore 15 so that it is approximately tangent to the annular gap 11. The filling boring 20 is therefore in hydraulic

communication both with the cylinder bore 15 and, via a connecting groove 21, with the annular gap 11. The filling boring 20 is closed pressure-tight from the atmosphere by a ball seat 22.

Before the startup of the expansion chuck 1, first the combined volume of the pressure cylinder 15, the filling boring 20 and the annular gap 11 is completely filled with the fluid medium F by means of the opened filling boring 20. To prevent air bubbles from getting into the pressure system, this filling is performed under a vacuum. After the filling, the filling boring is closed pressure-tight by the ball seat 22. For the chucking of a tool that is inserted into the receptacle, a screwdriver can then be used to adjust the tightening screw 18 and thus the pressure piston 16 in the cylinder bore 15 so that the volume of the cylinder bore 15 filled with the pressure fluid F is reduced in size. As a result of this adjustment, a hydrostatic pressure of typically up to 1000 bar can be applied to the pressure fluid F. This pressure is transmitted via the annular gap 11 as the pressure conduction system 13 to the vicinity of the pressure chamber 12. Here, the hydrostatic pressure causes a deformation of the thin-walled expansion busing 10 radially inward toward the expansion chuck axis 2, as a result of which the tool is chucked in the receptacle 6. On the other hand, on account of the relatively large wall thickness of the expansion sleeve 9 that acts as the boundary for the pressure chamber 12 on the outside, no significant deformation by the action of the pressure occurs on the outer periphery of the expansion chuck 1.

To remove the tool from the expansion chuck 1, the pressure piston 16 is retracted by a few rotations of the tightening screw 18, as a result of which the pressure of the pressure fluid F is reduced. The elastically deformed expansion chuck 10 thereby resumes its original shape so that the tool can be removed.

The expansion chuck 1 further comprises an axial adjustment unit 23 for the tool, which is particularly easily visible in Figure 5, which is a longitudinal view that is rotated with respect to Figure 3. The axial adjustment 23 comprises an adjusting pin 24 which is approximately in the shape of a hollow cylinder and is guided so that it can slide in a central boring 25 of the base body 8. The tool-side end 26 of the adjusting pin 24 thereby projects into the receptacle and thus forms an axial stop for the tool to be inserted into the receptacle 6. To be able to adjust the

adjusting pin 24 and thus the stop for the tool in the axial direction, the adjusting pin 24 is provided near its machine-side end 27 with an axial-linear gearing 28. This gearing 28 meshes with a helical thread 29 which is attached on the end side to a set screw 30 which is guided in the base body 8 essentially radially with reference to the expansion chuck axis 2. One advantage of this construction is that the radial set screw 30 is accessible even when the tool is inserted in the receptacle 6.

In a constructively simplified variant of the axial adjustment 23 illustrated in Figure 6, the adjusting pin 24 is provided with a male thread 31 which corresponds to a female thread 32 of the boring 25. In this embodiment, the adjusting pin 24 can be adjusted by means of a screwdriver introduced into the receptacle 6.

Along the expansion chuck axis 2 in both of the embodiments of the expansion chuck 1 described above, a passage 34 is formed by the boring 25 and an aligned boring 33 of the adjusting pin 24. The passage 34 can be used as, among other things, a coolant channel, through which, during the operation of the machine tool, coolant can be conducted into the area of the receptacle 6 and thus into the vicinity of the tool.

On the periphery of the base body 8 there is also a counterbalance surface 35, i.e. a carefully calculated surface that is machined to preserve the axial symmetry of the base body, by means of which any imbalance produced by the asymmetrical pressure generating unit 14 can be precisely compensated. In this manner, during the operation of the expansion chuck 1, even at relatively high speeds of rotation, a highly accurate concentric running can be achieved, which is of particular importance given the long, narrow construction. Instead of the machined counterbalance area 35, a counterweight screw that is screwed to the base body 8 can also be used, and/or there can be one or more counterweight discs or other machined areas or borings.

Nomenclature

1	(Hydraulic) expansion clutch
2	Expansion clutch axis
3	(Tool-side) end
4	(Machine-side) end
5	Neck area
6	Receptacle
7	Fastening cone
8	Base body
9	Chucking sleeve
10	Annular gap
12	Pressure chamber
13	Pressure conduction system
14	Pressure generating unit
15	Cylinder bore
16	Pressure piston
17	Bushing
18	Tightening screw
19	Seal
20	Filling boring
21	Connecting groove
22	Ball seat
23	Axial adjustment unit
24	Adjusting pin
25	Boring
26	(Tool-side) end
27	(Machine-side) end
28	Gearing
29	Helical thread
30	Set screw
31	Male thread
32	Female thread
33	Boring
34	Passage
35	Counterbalance surface
L	Length
D	Outside diameter
d	Inside diameter
F	Pressure fluid
A	Detail

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CLAIMS:

1. Hydraulic expansion chuck with an expansion bushing on its tool-side end and surrounded by a pressure chamber, which expansion bushing can be deformed radially under the action of a pressure fluid that is contained in the pressure chamber to chuck a tool, with a pressure generating unit that is axially spaced with respect to a chuck axis of the expansion bushing and a pressure conduction system for the transmission of pressure from the pressure generating unit to the pressure chamber,

wherein

the pressure conduction system is formed by an annular gap which is concentric to the chuck axis.

2. Expansion chuck as claimed in Claim 1,

wherein

a base body that is central with respect to the chuck axis, carries the expansion bushing and a chucking sleeve that concentrically surrounds the base body, whereby the pressure chamber and the pressure conduction system are formed between the base body and the chucking sleeve.

3. Expansion chuck as claimed in Claim 1 or 2,

wherein

the base body and the chucking sleeve are connected to each other rigidly and pressure-tight.

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4. Expansion chuck as claimed in any one of the Claims 1 to 3,

wherein

the pressure generating unit is located in the chucking sleeve.

5. Expansion chuck as claimed in any one of the Claims 1 to 4,

wherein

the pressure generating unit comprises a cylinder bore with an adjustable pressure piston located in it and a filling boring, which connects the cylinder bore with the pressure conduction system.

6. Expansion chuck as claimed in Claim 5,

wherein

the pressure piston can be adjusted by means of a tightening screw.

7. Expansion chuck as claimed in any one of the Claims 1 to 6,

wherein

the chucking sleeve, on its tool-side, has a long, narrow neck area, the axial length of which is at least four times its outside diameter.

8. Expansion chuck as claimed in Claim 7,

wherein

the axial length of the neck area is at least 100 mm.

9. Expansion chuck as claimed in any one of the Claims 1 to 8, wherein the radial dimension of the annular gap is a maximum of 0.2 mm.

10. Expansion chuck as claimed in any one of the Claims 1 to 9, wherein the base body has a central passage.

11. Expansion chuck as claimed in any one of the Claims 1 to 10, wherein an axial adjustment unit for the tool.

12. Expansion chuck as claimed in Claim 11, wherein the axial adjustment unit comprises an adjusting pin that is axially adjustable with respect to the base body and forms an axial stop for the tool.

13. Expansion chuck as claimed in Claim 12, wherein the adjusting pin is guided in a central boring of the base body.

14. Expansion chuck as claimed in Claim 13, wherein the adjusting pin is provided with a male thread which interacts with a female thread of the boring for the axial adjustment of the adjusting pin.

15. Expansion chuck as claimed in Claim 13,

wherein

the adjusting pin has an axial-linear gearing which interacts with a helical thread of a set screw that is guided essentially radially with reference to the chuck axis in the base body for the axial adjustment of the adjusting pin.

16. Expansion chuck as claimed in any one of the Claims 1 to 15,

wherein

a counterbalance surface that is machined into a peripheral area to compensate for any imbalance caused by the pressure generating unit.

PATENT APPLICATION for
Hydraulic Chuck Slim Line

Fig. 1a

SHANK WITH EXPANSION SLEEVE (TREND-LINE)

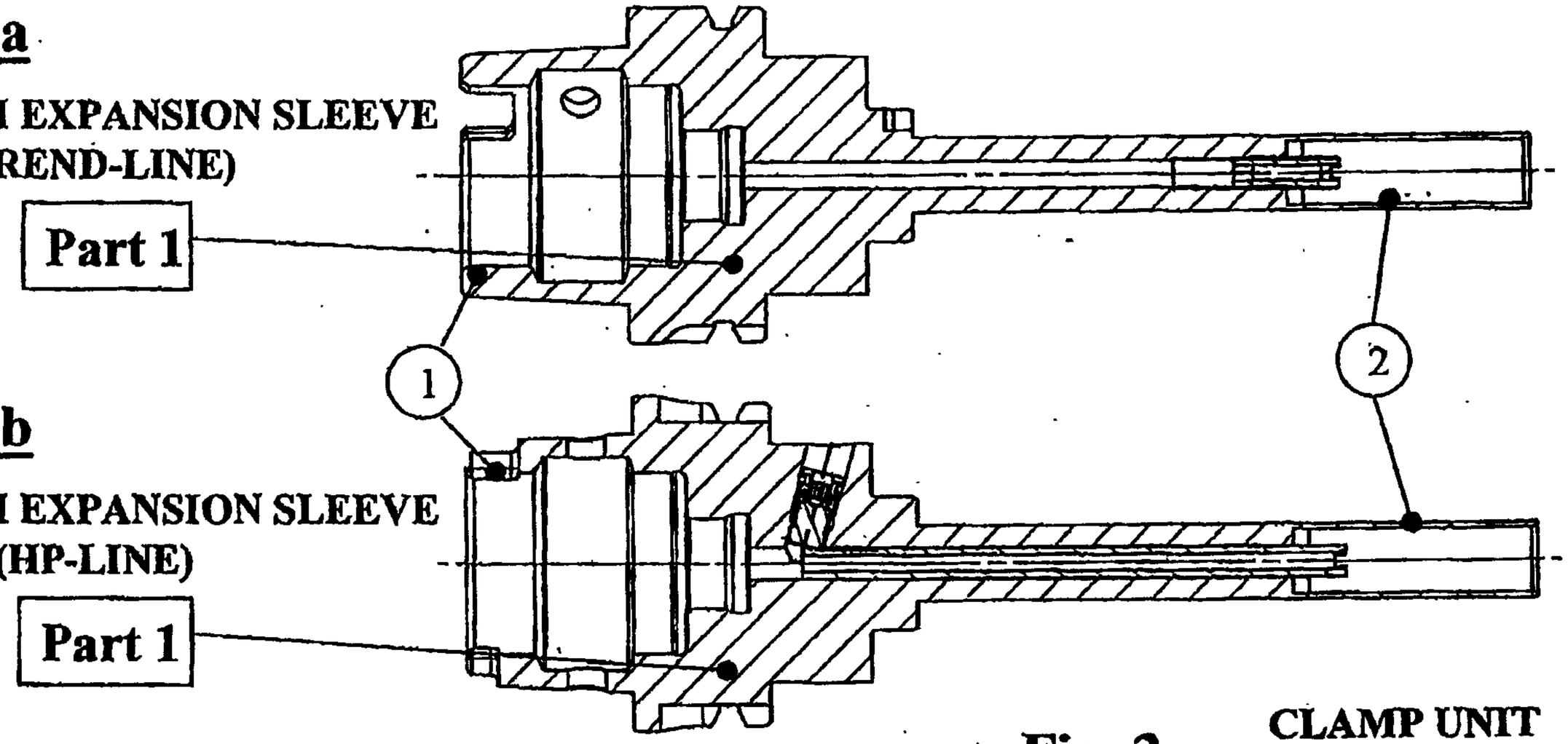


Fig. 1b

SHANK WITH EXPANSION SLEEVE (HP-LINE)

Fig. 2

CLAMP UNIT (Universal)

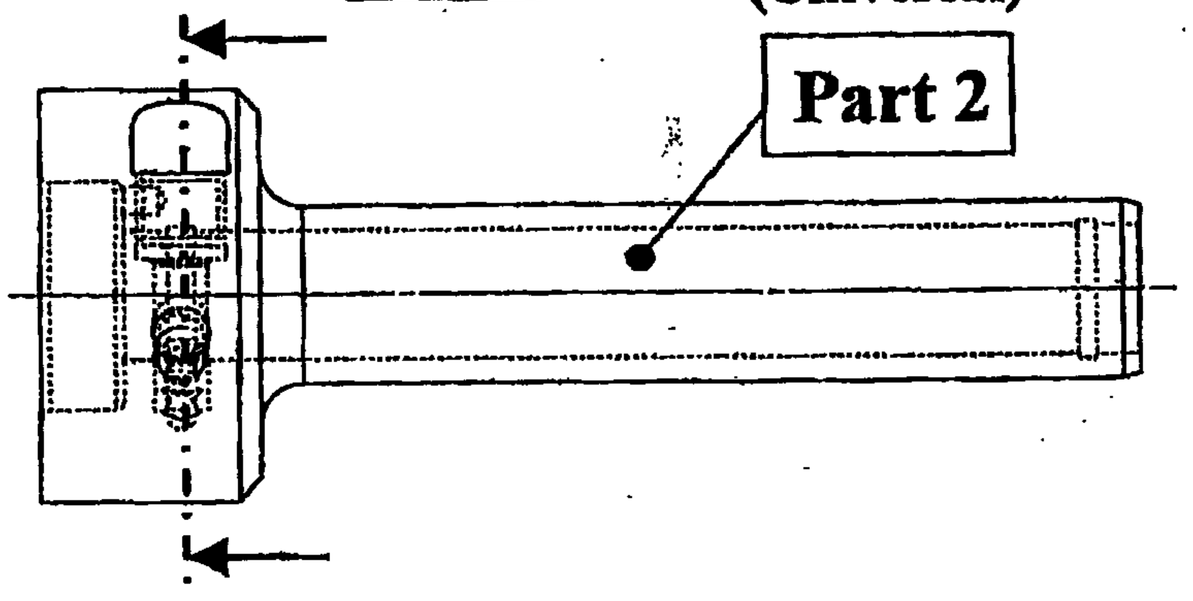
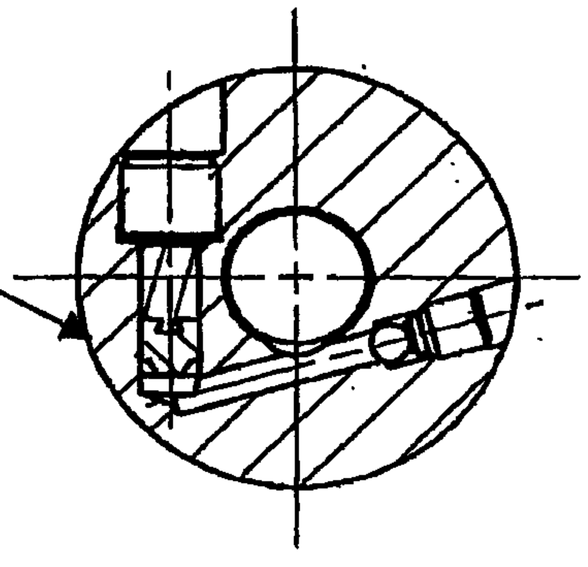


Fig. 3

Clamp mimic



Author: Josef Herud
10 February 2004

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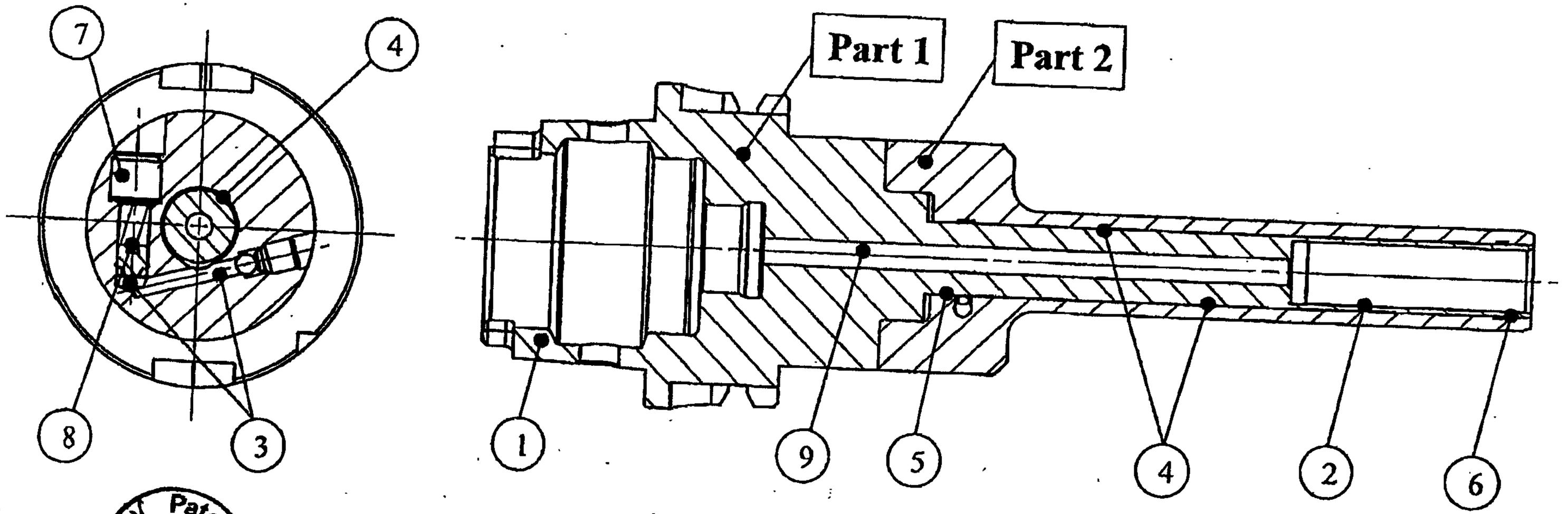
Fig. 4



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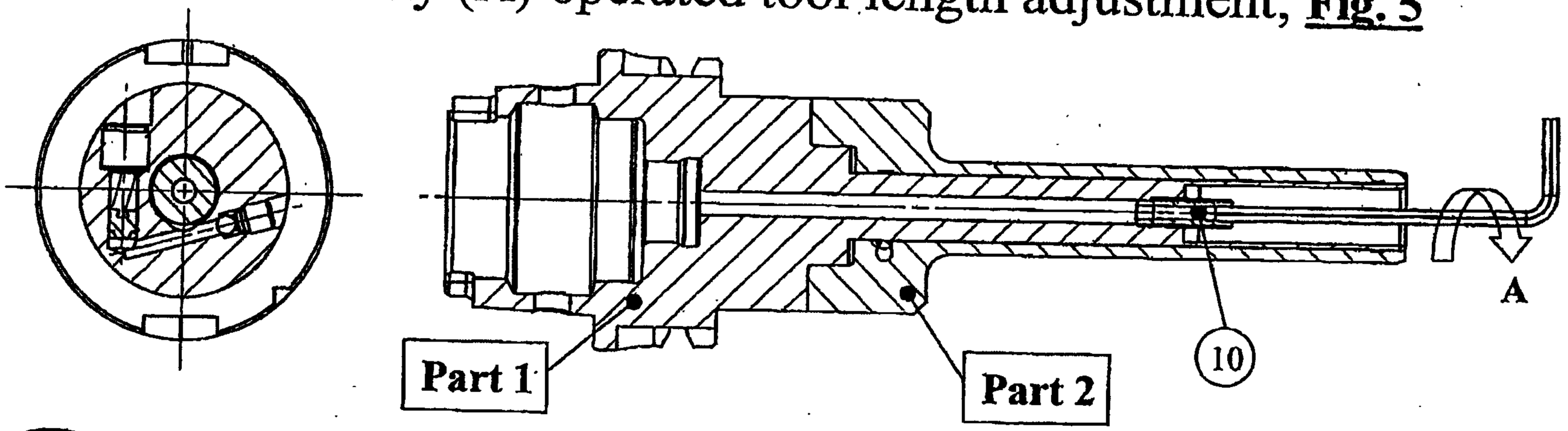
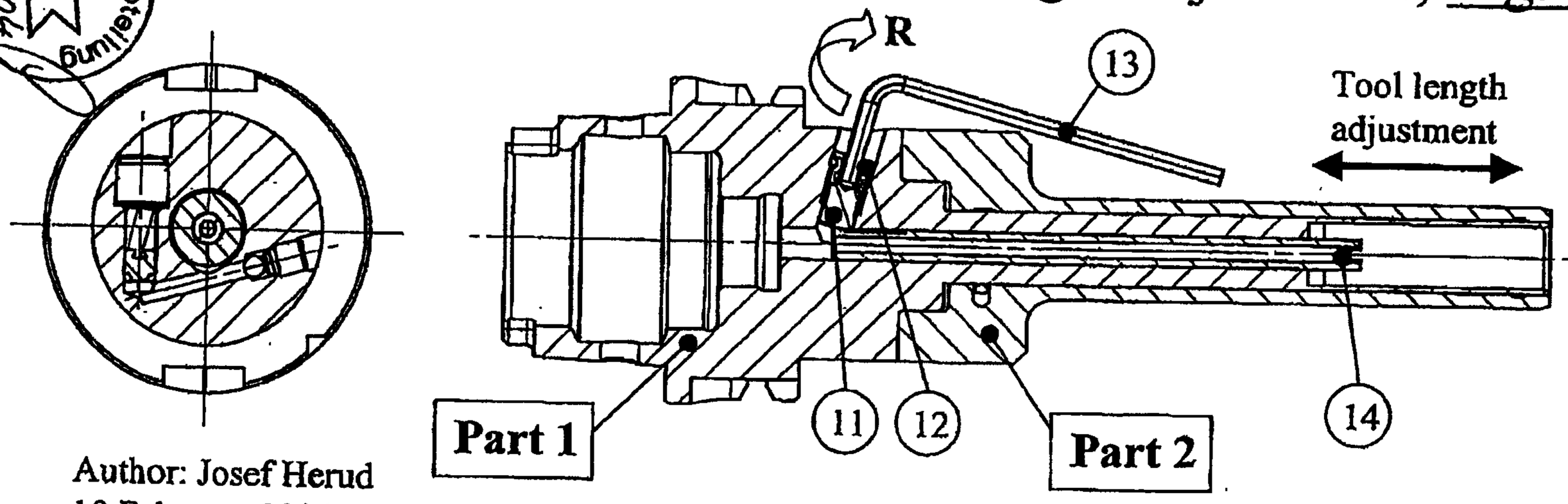
PATENT APPLICATION for

Hydraulic Chuck Slim Line

With axially (A) operated tool length adjustment; **Fig. 5**



With radially (R) operated tool length adjustment; Fig. 6



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