(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 August 2011 (25.08.2011)

PCT

(10) International Publication Number
WO 2011/103116 A2

(51) International Patent Classification:
B23Q 9/02 (2006.01)

(21) International Application Number:
PCT/US2011/024975

(22) International Filing Date:
16 February 2011 (16.02.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10 2010 008 380.1
17 February 2010 (17.02.2010) DE
10 2010 011 947.4 18 March 2010 (18.03.2010) DE

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) **Title**: CONNECTION ELEMENT FOR FORMING AN INTERFACE BETWEEN TWO PARTS OF A MACHINE TOOL THAT CAN BE RELEASABLY CONNECTED TO EACH OTHER, AND METHOD FOR MANUFACTURING SUCH A CONNECTION ELEMENT

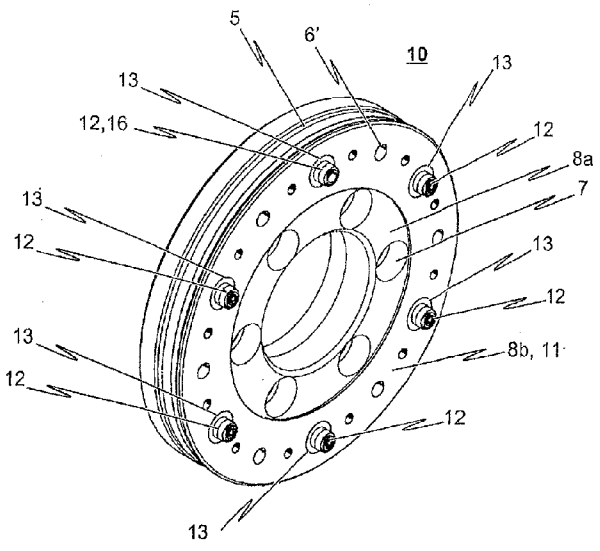

Fig. 1

(57) **Abstract**: The invention relates to a connection element (10; 30) for forming an interface (100) between a part (2) of a machine tool and a component (1) which can be releasably connected thereto, e.g. a lathe chuck flange or a spindle flange. Having the aim that mounting the connection element (10; 30) to a mating connection element (30; 10) may easily be carried out without having to perform a special adaption function, according to the invention it is provided that the connection element (10; 30) has a bearing face (11; 31) and at least two positioning elements (12; 32) which are each received in a recess (13; 33) formed in the bearing face (11; 31) of the connection element (10; 30), where they are connected to the connection element (10; 30) in a material-uniting manner. The invention further relates to a method for the reproducible production of such a connection element.

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CONNECTION ELEMENT FOR FORMING AN INTERFACE BETWEEN TWO PARTS OF A MACHINE TOOL THAT CAN BE RELEASABLY CONNECTED TO EACH OTHER, AND METHOD FOR MANUFACTURING SUCH A CONNECTION ELEMENT

The invention relates to a connection element according to the preamble of independent patent claim 1 and to a method for manufacturing such a connection element according to the preamble of independent patent claim 19.

Accordingly, the invention relates in particular to a connection element for forming an interface between two parts of a machine tool that can be releasably connected to each other, the connection element having a bearing face which is embodied in a manner complementary to a bearing face of a mating connection element which can be releasably fastened to the connection element and at least two positioning elements which are embodied in a manner complementary to positioning elements of the mating connection element.

The expression “machine tool” used herein describes all machines which serve to machine workpieces with tools, in particular forming, separating and joining machines in accordance with standard DIN 69 651 part 1 (machine tools for machining metal). In order to shape the workpiece, the machine tool creates a relative movement between the tool and the workpiece. Generally, forming and separating (i.e. substantially dividing, cutting and material-removing) and joining machine tools are used *inter alia* in engineering and toolmaking.

Forming machines serve as a rule for machining metals, such as steel or aluminum and plastics, dividing and cutting machine tools serve furthermore also for machining other materials, such as wood. Material-removing machine tools include for example eroding machines and laser machining machines.

The machining precision of cutting machine tools lies, depending on the type of machine, in the range from 1 mm to 1/1000 mm.

Ultraprecision machines achieve accuracies of less than 1/1 000 000 mm (for example for machining laser optics).

The expression “connection element” used herein should be understood in principle to mean a component which serves to form an interface between the machine tool and a subassembly which can be releasably connected to the machine

tool or between two components of a machine tool which can be releasably connected to each other. Such a connection element can be for example a receptacle for a workpiece holder of a machine tool, such as the workpiece receptacle in a milling machine. In particular, it is thus conceivable for the connection element to be embodied as a lathe chuck flange. On the other hand, a connection element within the meaning of the present invention can also be for example a spindle flange or a connection element in a palletizing system of a machine tool. It would also be conceivable, however, for the connection element that is described in detail hereinbelow to be used in interfaces between the base jaws and top jaws of chucks. Likewise, the solution according to the invention can be applied to cubic, stationary systems. In principle, the connection element described hereinbelow is a component which allows the positioning of two parts of a machine tool that can be releasably connected to each other.

The problem underlying the present invention is that, in an interface between two parts of a machine tool that are or can be releasably connected to each other, it is often only possible to orient these parts precisely relative to each other by means of complicated adjustment work. In addition, when changing the chuck on a machine tool, for example, it is as a rule necessary for the set-up time to remain at a minimum. In this case, the problem is not the actual removal of the old chuck and the subsequent mounting of the new chuck, but rather the optimal orientation of the newly fitted chuck relative, for example, to the tool spindle of the machine tool. In particular in the case of rotating systems, it is a frequent requirement for a concentricity of less than 0.002 mm to be achieved. In order to meet this requirement, complicated adjustment work has hitherto been indispensable, for example when changing the chuck on a machine tool, in order to reorient the newly fitted chuck relative to the tool spindle.

On the basis of this problem, the object of the present invention is to develop a connection element of the type mentioned at the beginning, such as a lathe chuck flange or a spindle flange for example, such that a mating connection element can be mounted easily on the connection element, the mating connection element orienting itself automatically with sufficient precision relative to the connection element without a special adjustment function having to be carried out for this purpose.

A further object underlying the invention is to specify a method for manufacturing a connection element, such as a lathe chuck flange or a spindle flange for example,

it being possible with this method to manufacture connection elements of the same quality in a reproducible manner.

With regard to the device, the object underlying the invention is achieved by the subject matter of independent patent claim 1. Advantageous developments of the connection element according to the invention are given in dependent patent claims 2 to 15. The object relating to the method is achieved according to the invention by the subject matter of independent patent claim 19, particular developments of the method according to the invention being given in dependent patent claims 20 to 26.

The solution according to the invention is based on the finding that, in order to precisely position and mutually orient two connection elements to be connected to each other (connection element on the one hand and mating connection element on the other), use should be made of suitable positioning elements which allow automatic orientation of the connection elements to be connected to each other when they are connected to each other. Specifically, it is provided according to the invention that the connection element has at least two positioning elements, which are each received in a recess formed in the bearing face of the connection element, where they are connected to the connection element in a material-uniting manner. These positioning elements connected in this way to the connection element are complementary to corresponding positioning elements of a mating connection element to be releasably fastened to the connection element.

The use of a material-uniting connection, in particular the use of an adhesive bond or the use of a material-uniting connection formed with a meltable metallic material for fixing the positioning elements of the connection element in the respective recesses formed in the bearing face of the connection element, makes it possible on the one hand for the connection element to be manufactured in a simple but nevertheless reproducible manner, it being possible on the other hand for the positional accuracy of the positioning elements connected to the connection element to be defined in advance.

In order to achieve this, it is provided according to the solution according to the invention for manufacturing the connection element that first a reference or master connection element is provided, this reference connection element having a bearing face the purpose of which is that the connection element to be manufactured bears thereon with its bearing face. The reference connection element has further at least two positioning elements, which are each received at predetermined positions in a

recess formed in the bearing face of the reference connection element and are fixed there. These positioning elements belonging to the reference connection element are preferably either sleeve-like positioning elements or bolt-like positioning elements. The positioning elements of the connection element are fastened releasably and preferably in a predefined manner to the positioning elements of the reference connection element.

The positioning elements of the connection element to be manufactured with the aid of the reference or master connection element are embodied in a manner complementary to the positioning elements of the reference connection element. If for example bolt-like positioning elements are used as positioning elements in the case of the reference connection element, the positioning elements of the connection element are embodied in a manner correspondingly complementary thereto as sleeve-like positioning elements which are designed to receive the bolt-like positioning elements of the reference connection element. If on the other hand the positioning elements of the reference connection element are embodied in a sleeve-like manner, bolt-like positioning elements embodied in a manner correspondingly complementary thereto should be used as positioning elements of the connection element, it being possible for said bolt-like positioning elements to be received by the sleeve-like positioning elements of the reference connection element.

Once the positioning elements of the connection element have been plugged onto the positioning elements, embodied in a manner correspondingly complementary thereto, of the reference connection element, they are fixed in their plugged-on position with the positioning elements of the reference connection element. In this case it is conceivable for example for a bore extending axially on the axis of symmetry of the positioning element to be provided through the positioning element of the reference connection element, said bore receiving a holding screw which is screwed into a threaded bore provided axially on the axis of symmetry of the positioning element of the connection element.

Once the positioning elements of the connection element have been connected to the positioning elements, embodied in a manner correspondingly complementary thereto, of the reference connection element, the connection element is oriented with its bearing face relative to the bearing face of the reference connection element, specifically such that the positioning elements, fixed to the positioning elements of the reference connection element, of the connection element are

received in the recesses formed in the bearing face of the connection element. In this way, the connection element is precentered with respect to the reference connection element.

Subsequently, there follows precision orientation of the connection element relative to the reference connection element, for example using measurement phases, which can be provided on the lateral faces of both the connection element and the reference connection element. In this way, the connection element is oriented perfectly relative to the reference connection element. In this perfectly oriented state, the connection element is connected firmly to the reference connection element with the aid of a releasable screw connection or the like. Subsequently, the positioning elements received in the recesses in the connection element are connected to the connection element in a material-uniting manner. This takes place according to the invention in that a liquid process material is supplied into the region between the lateral face of the recess and the positioning element inserted into the recess. Following the curing or hardening of the supplied process material, the connection between the connection element and the reference connection element is released again and the manufacturing procedure is concluded.

However, it should be pointed out that the provision of a measurement phase is optional. In the case of rotationally symmetrical parts, a measurement phase can serve to orient the latter precisely in relation to a reference. If for example a spindle flange is fastened on a machine spindle, it must in the process be oriented precisely with respect to the spindle axis. If a body, which can also be an entire chuck, is fastened on the lathe chuck flange, this body too has to be oriented precisely with respect to the axis thereof, the measurement phase being used for orientation. The two releasable connection elements can then be separated.

In order that the measurement phases can fulfill this function, they must either already be present at the flanges and be oriented in relation to the reference flange before the adhesive bond or the material-uniting connection is produced, or the measurement phase is ground only after the adhesive bonding or the material-uniting connection, the measurement phase of the reference flange serving as a reference point.

In the case of a cubic arrangement, the measurement phase can be dispensed with or be produced in an angular manner (X and Y direction) by means of flat ground

faces.

Exemplary embodiments of the solution according to the invention are described in more detail in the following text with reference to the appended drawings.

In the drawings:

Fig. 1 shows a three-dimensional view of an exemplary embodiment of a connection element according to the present invention, the connection element being embodied as a spindle flange;

Fig. 2 shows a three-dimensional view of an exemplary embodiment of a mating connection element embodied in a manner complementary to the connection element according to fig. 1, the mating connection element being embodied as a lathe chuck flange;

Fig. 3 shows an exemplary embodiment of an interface between two parts, which are releasably connected to each other, of a machine tool, in which the spindle flange according to fig. 1 is releasably connected to the lathe chuck flange according to fig. 2;

Fig. 4 shows a perspective view of the spindle flange according to fig. 1, which is releasably connected to the lathe chuck flange according to fig. 2, in order to form an interface between a workpiece receptacle and a tool spindle;

Fig. 5 shows a plan view of the workpiece receptacle according to fig. 4;

Fig. 6 shows a sectional view along the line A-A in fig. 5;

Fig. 7 shows a sectional view along the line B-B in fig. 5;

Fig. 8 shows an enlarged view of a detail from fig. 7;

Fig. 9 shows a sectional view through a reference lathe chuck flange for manufacturing a spindle flange according to fig. 1;

Fig. 10 shows an enlarged view of a detail from fig. 9;

Fig. 11 shows a sectional view of the reference lathe chuck flange according to fig. 9 having a fitted spindle flange in the manufacture of a spindle flange according to fig. 1;

Fig. 12 shows a sectional view through a reference spindle flange for manufacturing a lathe chuck flange according to fig. 2; and

Fig. 13 shows a detail view of a detail from fig. 12.

Exemplary embodiments of the connection element according to the invention are described in the following text with reference to the illustrations in figures 1 to 8. Specifically, these figures illustrate a connection element embodied as a spindle flange, to which a mating connection element embodied as a lathe chuck flange can be releasably fastened.

Figures 9 to 13 relate to an exemplary embodiment for manufacturing a spindle flange according to fig. 1 or a lathe chuck flange according to fig. 2.

Although the accompanying drawings show a spindle flange or lathe chuck flange as connection element, the invention is not limited to such flange systems. Rather, the present invention relates in general to connection elements which are suitable for forming an interface between two components of a machine tool. In particular, it is conceivable according to the present invention to use a connection element and a mating connection element to form an interface between the base jaws and top jaws of chucks. Likewise, the solution can also be applied to non-rotating systems, such as to cubic, stationary systems, for example.

Fig. 1 shows a three-dimensional view of an exemplary embodiment of a connection element according to the present invention, the connection element being embodied as a spindle flange 10. An exemplary embodiment of a mating connection element embodied in a manner complementary to the spindle flange 10 according to fig. 1 is shown in a three-dimensional view in fig. 2, the mating connection element in this exemplary embodiment being embodied as a lathe chuck flange 30.

As illustrated in fig. 1, the connection element embodied as a spindle flange 10 has a bearing face 11 which is embodied preferably with extremely good planarity. The

bearing face 11 of the connection element embodied as a spindle flange 10 is formed such that the bearing face of a mating connection element, such as the bearing face 31 of the mating connection element embodied as a lathe chuck flange 30 for example, can bear thereon with a precise fit. Accordingly, the mating connection element illustrated as a lathe chuck flange 30 in fig. 2 is embodied with a bearing face 31 designed in a manner complementary to the bearing face 11 of the connection element embodied as a spindle flange 10.

In order to achieve the situation in which the spindle flange 10 according to fig. 1 and the lathe chuck flange 30 according to fig. 2 automatically orient themselves relative to each other during mounting thereof, the connection element embodied as a spindle flange 10 according to fig. 1 has at least two positioning elements 12 – precisely six positioning elements 12 in the embodiment illustrated in fig. 1. Specifically, the positioning elements 12 employed in the embodiment illustrated in fig. 1 are conically tapering bolt-like positioning elements. These positioning elements 12 of the spindle flange 10 are embodied in a manner complementary to corresponding positioning elements 32 of the lathe chuck flange 30 illustrated in fig. 2. It can be seen from the illustration in fig. 2 that the positioning elements 32 provided in the bearing face 31 of the lathe chuck flange 30 are designed as sleeve-like positioning elements, which are designed and embodied in a manner complementary to the bolt-like positioning elements 12 of the spindle flange 10, in order in the assembled state to receive the bolt-like positioning elements 12 of the spindle flange 10.

Of course, it is also conceivable for at least some of the bolt-like positioning elements 12 of the spindle flange 10 to be designed as sleeve-like positioning elements. In this case, the corresponding positioning elements of the lathe chuck flange 30 must be embodied in a bolt-like manner.

As already indicated, in the illustrated embodiment of the solution according to the invention, the positioning elements 12, 32 serve for automatically orienting the spindle flange 10 and the lathe chuck flange 30 when these two flanges 10, 30 are connected to each other. The conical shaping of the positioning elements 12, 32 makes it easier to orient and center the flanges 10, 30 during the mounting process.

As illustrated in fig. 1, the connection element embodied as a spindle flange 10 has an annular body 8a which is offset slightly toward the inside and in which a total of six through-bores 7 which extend parallel to the axis of symmetry of the spindle

flange 10 are provided. These through-bores 7 serve – as can be seen in the illustration in fig. 6 – for receiving screws 9, with which the connection element embodied as a spindle flange 10 can be releasably fastened to a part of a machine tool, such as to a tool spindle 2 for example.

In the annular outer body 8b of the spindle flange 10, threaded bores 6' are formed in addition to the already mentioned positioning elements 12 and serve to receive fastening screws 6, with which the lathe chuck flange 30 according to fig. 2 is fastened in the mounted state to the spindle flange 10 (cf. fig. 6). Provided in a corresponding manner in the lathe chuck flange 30 according to fig. 2 are through-bores 6'' which are oriented with respect to the threaded bores 6' and through which the fastening screws 6 run in the assembled state.

The positioning elements 12 provided in the spindle flange 10 are each received in a recess formed in the bearing face 11 of the spindle flange 10 and are connected in a material-uniting manner there to the spindle flange 10, for example with the aid of an adhesive bond.

In the same way, the bearing face 31 of the mating connection element embodied as a lathe chuck flange 30 has corresponding recesses 33 into which the positioning elements 32 of the lathe chuck flange are plugged and are held there likewise for example with the aid of an adhesive bond.

The spindle flange 10 illustrated in fig. 1 is furthermore embodied with an anti-rotation means. To this end, it is provided in the embodiment illustrated that one positioning element of the total of six positioning elements 12 is embodied in a different manner than the remaining positioning elements. This differently designed positioning element is denoted by the reference sign "16" in the illustration according to fig. 1. Analogously hereto, one positioning element of the positioning elements 32 provided in the bearing face 31 of the lathe chuck flange 30 is embodied as an anti-rotation element. In the illustration according to fig. 2, this positioning element embodied as an anti-rotation element is denoted by the reference sign "36". Specifically, in the case of the lathe chuck flange 30 illustrated in fig. 2, an anti-rotation bolt is adhesively bonded or connected in a material-uniting manner in some other way in the sleeve-like positioning element 36, while the positioning element, embodied in a corresponding manner as an anti-rotation means 16, of the spindle flange 10 has a suitable receptacle.

Fig. 3 shows an exemplary embodiment of an interface 100 between two parts, which can be releasably connected to each other, of a machine tool, the spindle flange 10 according to fig. 1, on the one hand, and the lathe chuck flange 30 according to fig. 2, on the other hand, being releasably connected. It can be seen in particular that measurement phases 5 are provided on both flanges 10, 30 and can be used to orient the flanges 10, 30.

However, it should be pointed out that the provision of the measurement phase 5 is optional. In the case of rotationally symmetrical parts, the measurement phase 5 can serve to orient the latter precisely in relation to a reference. If for example the spindle flange 10 is fastened on a machine spindle, it must in the process be oriented precisely with respect to the spindle axis. If a body, which can also be an entire chuck, is fastened on the lathe chuck flange 30, this body too must be oriented precisely with respect to the axis thereof, the measurement phase 5 being used for orientation.

In order that the measurement phases 5 can fulfill this function, they must either already be present at the flanges 10, 30 and be oriented in relation to the reference flange before the adhesive bond or the material-uniting connection is produced, or the measurement phase 5 is ground only after the adhesive bonding or the formation of the material-uniting connection, the measurement phase of the reference flange serving as a reference point.

In the case of a cubic arrangement, the measurement phase 5 can be dispensed with or be produced in an angular manner (X and Y direction) by means of flat ground faces.

Fig. 4 illustrates a perspective view of an interface 100, formed with the spindle flange 10 according to fig. 1 and the lathe chuck flange 30 according to fig. 2, between a workpiece receptacle 1 and a tool spindle 2. Fig. 5 shows a plan view of the workpiece receptacle 1 according to fig. 4, while fig. 6 shows a sectional view along the line A-A and fig. 7 shows a sectional view along the line B-B in fig. 5.

It can be seen from figures 4 to 7 that, in the exemplary embodiment illustrated, the spindle flange 10 is releasably connected to the lathe chuck flange 30 with the aid of fastening screws 6. As already explained, to this end corresponding through-bores 6'' are provided in the lathe chuck flange 30 and suitable threaded bores 6' are provided in the annular outer body 8b of the spindle flange 10, which means

that the lathe chuck flange 30 can be mounted on the spindle flange 10 with suitable fastening screws 6. Of course, other possibilities for fastening the lathe chuck flange 30 to the spindle flange 10 also come into question here. Instead of a screw connection, it is conceivable for example to use a bayonet system, in particular a bayonet system according to DIN 55027, hydraulic couplings etc., to connect the two flanges 10, 30.

It can furthermore be seen in the illustration in fig. 6 that, in the exemplary embodiment illustrated, the spindle flange 10 can be releasably fastened to the tool spindle 2 with the aid of screws 9, which run through the through-bores 7 provided in the annular inner body 8b of the spindle flange 10. The workpiece receptacle 1 itself is fastened to the spindle flange 10 fastened to the tool spindle 2 by further screws 6, which run through the through-bores 6'' provided in the lathe chuck flange 30.

In the following text, with reference to the illustrations in figures 7 and 8, the special connection between the spindle flange 10 and the lathe chuck flange 30 in the case of the interface 100 illustrated in fig. 4 is described in more detail. As can be seen in particular from fig. 8, on the one hand the bolt-like positioning elements 12 assigned to the spindle flange 10 and on the other hand the sleeve-like positioning elements 32 assigned to the lathe chuck flange 30 serve to orient the two flanges 10, 30 precisely relative to each other. Both in the case of the spindle flange 10 and in the case of the lathe chuck flange 30, the respective positioning elements (bolt-like positioning elements 12 and sleeve-like positioning elements 32) are each received in corresponding recesses 13, 33, which are provided in the corresponding bearing faces 11, 31 of the spindle flange 10 and lathe chuck flange 30, respectively. The positioning elements 12, 32 received in the recesses 13, 33 are each held in the recesses 13, 33 for example with the aid of an adhesive bond.

For this purpose, each recess 13, 33 formed in the bearing face 11, 31 of the spindle flange 10 or lathe chuck flange 30 has at least one bore 14a, 14b or 34a, 34b opening into the lateral face of the recess 13, 33. These bores 14a, 14b introduced into the bearing face 11 of the spindle flange 10 or bores 34a, 34b introduced into the bearing face 31 of the lathe chuck flange serve for supplying liquid process material 3 into the region between the lateral face of the corresponding recess 13, 33 and the positioning element 12, 32 inserted into the recess 13, 33. The respective outer openings of the bores 14a, 14b and 34a, 34b are indicated in the illustration in fig. 3.

Moreover, the recess 13 formed in the bearing face 11 of the spindle flange 10 and the recess 33 formed in the bearing face 31 of the lathe chuck flange 30 each have a first seal 15a or 35a facing the corresponding bearing face 11, 31 and a second seal 15b or 35b facing away from the corresponding bearing face 11, 31. With this seal system 15a, 15b or 35a, 35b, the region available for forming the material connection between the lateral face of the recess 13, 33 and the positioning elements 12, 32 inserted into the recess 13, 33 is spatially limited.

It is particularly preferably provided that each recess 13 formed in the bearing face 11 of the spindle flange 10 and each recess 33 formed in the bearing face 31 of the lathe chuck flange 30 has a total of two bores 14a, 14b and 34a, 34b, respectively, opening into the corresponding recess 13, 33, these bores 14a, 14b and 34a, 34b serving for supplying liquid process material 3 into the region between the lateral face of the recess 13, 33 and the positioning element 12, 32 inserted into the recess 13, 33.

It can be seen in particular in the illustration in fig. 8 that the two bores 14a, 14b and 34a, 34b are formed in a symmetrical manner with regard to the first and second seals 15a, 15b and 35a, 35b. This special arrangement of the bores 14a, 14b and 34a, 34b on the one hand and of the seals 15a, 15b and 35a, 35b on the other hand prevents the positioning element 12, 32 obtaining an axial force component as a result of a corresponding decrease in volume of the process material 3 during the curing or hardening of the process material 3, which axial force component would alter the position of the positioning element 12, 32 inserted into the corresponding recess 13, 33.

The use of a suitable process material 3 makes it possible for the recesses 13, 33 each to be formed as cylinder bores running perpendicularly to the bearing face 11, 31, these cylinder bores in particular not having to be formed in a highly precise manner. In order to form the material-uniting connection between the positioning elements 12, 32 received in each case in a recess 13, 33 formed in the bearing face 11, 31 of the connection element 10, 30 and the connection element 10, 30, use is preferably made of a process material 3 in the form of an adhesive or in the form of a metallic or solder-like meltable material.

In the following text, a possible method for manufacturing a spindle flange according to fig. 1 is described with reference to the illustrations in figures 9 to 11.

The method according to the invention is characterized in that first of all what is known as a reference connection element is provided. The reference connection element for manufacturing a spindle flange is – as seen in the sectional illustration in fig. 9 – a reference lathe chuck flange 50. This reference lathe chuck flange 50 has a bearing face 51, which is complementary to the bearing face 11 of the spindle flange 10 to be manufactured. Furthermore, the reference lathe chuck flange 50 according to the illustration in fig. 9 has a multiplicity of positioning elements 52, which are each received in a recess 53 formed in the bearing face 51 of the reference lathe chuck flange.

In order to manufacture a spindle flange 10 according to fig. 1, the reference lathe chuck flange has a total of six positioning elements 52, these positioning elements 52 defining the position and orientation of the positioning elements 12 of the spindle flange 10.

The positioning elements 52 of the reference lathe chuck flange 50 are embodied in a manner complementary to the positioning elements 12 of the spindle flange 10 to be manufactured. Since in the embodiment illustrated in fig. 1 the spindle flange 10 has bolt-like positioning elements, the reference lathe chuck flange 50 illustrated in fig. 9 is thus provided with sleeve-like positioning elements 52. These sleeve-like positioning elements 52 of the reference lathe chuck flange 50 are formed individually to receive conically tapering bolt-like positioning elements 12 of the spindle flange 10, wherein, in the embodiment of the reference lathe chuck flange 50 illustrated in fig. 9, the positioning elements 52 are pressed into the bearing face 51 of the reference lathe chuck flange 50, and wherein the shaping of the depressions, which are formed in a manner complementary to the conically tapering bolt-like positioning elements 12 of the spindle flange 10, have been coordinate ground.

As an alternative to this, it would also be conceivable, however, for the sleeve-like positioning elements 52 of the reference lathe chuck flange 50 to be received in corresponding recesses 53 formed in the bearing face 51 of the reference lathe chuck flange 50 and to be adhesively bonded or connected in a material-uniting manner in some other way there.

It is characteristic of the reference lathe chuck flange 50 illustrated in fig. 9 that the positioning elements 52 received or provided in the bearing face 51 of the

reference lathe chuck flange 50 are provided with a bore extending axially along the axis of symmetry of the positioning elements 52. A holding screw 4 runs through this bore from behind through the positioning elements 52 of the reference lathe chuck flange 50.

When a spindle flange 10 according to fig. 1 is manufactured, on the reference lathe chuck flange 50 first of all the positioning elements 12 of the spindle flange are inserted into the sleeve-like positioning elements 52 of the reference lathe chuck flange 50 and are fastened there with the aid of the holding screw 4 in a defined manner and in particular with a defined and predefined pretensioning. Subsequently, the spindle flange 10 is positioned on the bearing face 51 of the reference lathe chuck flange 50 in such a way that the positioning elements 12, held by the positioning elements 52 of the reference lathe chuck flange 50, of the spindle flange 10 are received in the corresponding recesses 13 formed in the bearing face 11 of the spindle flange 10.

Following this, the spindle flange 11 is screwed slightly to the reference lathe chuck flange 50, whereupon, by means of the measurement phases 5 on the two flanges 10, 50, the latter are mutually oriented perfectly and subsequently definitively screwed together. Screwing can take place for example with the abovementioned fastening screw 6.

Once the oriented spindle flange 10 has be fixed to the reference lathe chuck flange 50, process material 3 is filled into the cavity between the recesses 13 formed in the bearing face 11 of the spindle flange 10 and the positioning elements 12, inserted into the recesses 13, of the spindle flange 10. Once the process material 3 has cured, the screws 4, which hold the positioning elements 12 of the spindle flange 10 on the positioning elements 52 of the reference lathe chuck flange 50, and then the fastening between the flanges 10, 50 can be released.

The lathe chuck flange 30 according to fig. 2 is manufactured analogously to the spindle flange 10. To this end, instead of the reference lathe chuck flange 50, a reference spindle flange 70 is used and is shown in a longitudinal sectional view in fig. 12 and in a detail view in fig. 13. In order to avoid repetitions, reference is made at this point to the above statements, in particular to the statements regarding the manufacture of the spindle flange 10.

The process material 3, which is used to fix the positioning elements 12, 32 into

the corresponding recesses 13, 33, should be as resistant as possible to all kinds of coolants and lubricants which are used in machine tools. On the other hand, it would also be conceivable, however, to seal the process material 3 in a suitable manner after curing. Furthermore, the process material has to be strong enough and withstand certain loadings, in particular transverse forces, impacts, etc. Preferably, the process material should have a lifetime of at least 10 years.

The solution according to the invention is not limited to a spindle flange or to a lathe chuck flange, but results from the appended patent claims.

Patent claims

1. A connection element (10; 30) for forming an interface between a part (2) of a machine tool and a component (1) which can be releasably connected thereto, the connection element (10; 30) having a bearing face (11; 31) which is embodied in a manner complementary to a bearing face (31; 11) of a mating connection element (30; 10) which can be releasably fastened to the connection element (10; 30) and at least two positioning elements (12; 32) which are embodied in a manner complementary to positioning elements (32; 12) of the mating connection element (30; 10), characterized in that the positioning elements (12; 32) of the connection element (10; 30) are each received in a recess (13; 33) formed in the bearing face (11; 31) of the connection element (10; 30), where they are connected to the connection element (10; 30) in a material-uniting manner.

2. The connection element (10; 30) as claimed in claim 1, wherein each recess (13; 33) formed in the bearing face (11; 31) of the connection element (10; 30) has at least one bore (14a, 14b; 34a, 34b) opening into the lateral face of the recess for supplying liquid process material (3) into the region between the lateral face of the recess (13; 33) and the positioning element (12; 32) inserted into the recess (13; 33).

3. The connection element (10; 30) as claimed in claim 1 or 2, wherein each recess (13; 33) formed in the bearing face (11; 31) of the connection element (10; 30) has a first seal (15a; 35a) facing the bearing face (11; 31) and a second seal (15b; 35b) remote from the bearing face (11; 31) for spatially delimiting the region, which serves to form the material-uniting connection, between the lateral face of the recess (13; 33) and the positioning element (12; 32) inserted into the recess (13; 33).

4. The connection element (10; 30) as claimed in claim 3, wherein each recess (13; 33) formed in the bearing face (11; 31) of the connection element (10; 30) has two bores (14a, 14b; 34a, 34b) opening into the lateral face of the recess (13; 33) for supplying process material (3) into the region between the lateral face of the recess (13; 33) and the positioning element (12; 32) inserted into the recess (13; 33), the two bores (14a, 14b; 34a, 34b) being formed symmetrically with regard to the first and second seals (15a, 15b; 35a, 35b).

5. The connection element (10; 30) as claimed in one of the preceding claims, wherein at least some of the positioning elements (12; 32) of the connection

element (10; 30) are embodied and designed in a sleeve-like manner in order to receive bolt-like positioning elements (32; 12), embodied in a manner correspondingly complementary thereto, of the mating connection element (30; 10).

6. The connection element (10; 30) as claimed in claim 5, wherein the sleeve-like positioning elements (12; 32) of the connection element (10; 30) are embodied to receive conically tapering bolt-like positioning elements (32; 12) of the mating connection element (30; 10).

7. The connection element (10; 30) as claimed in one of the preceding claims, wherein at least some of the positioning elements (12; 32) of the connection element (10; 30) are embodied and designed in a bolt-like manner in order to be able to be received by sleeve-like positioning elements (32; 12), embodied in a manner correspondingly complementary thereto, of the mating connection element (30; 10).

8. The connection element (10; 30) as claimed in claim 7, wherein the bolt-like positioning elements (12; 32) of the connection element (10; 30) taper conically and are embodied so as to be able to be received by sleeve-like positioning elements (32; 12), embodied in a manner complementary thereto, of the mating connection element (30; 10).

9. The connection element (10; 30) as claimed in one of the preceding claims, wherein the positioning elements (12; 32) are arranged circularly and equidistantly in the bearing face (11; 31) of the connection element (10; 30) and wherein, for designing the rotatory orientation of the connection element (10; 30) relative to the mating connection element (30; 10), at least one positioning element (16; 36) of the connection element (10; 30) is designed and embodied differently from the remaining positioning elements (12; 32) of the connection element (10; 30), in order to receive a predefined or predefinable positioning element (36; 16), embodied in a manner complementary thereto, of the mating connection element (30; 10) or to be received by a predefined or predefinable positioning element (36; 16), embodied in a manner complementary thereto, of the mating connection element (30; 10).

10. The connection element (10; 30) as claimed in one of the preceding claims, wherein the recesses (13; 33) formed in the bearing face (11; 31) of the connection

element (10; 30) are each formed as cylinder bores running perpendicularly to the bearing face (11; 31).

11. The connection element (10; 30) as claimed in claim 10, wherein, in the connection element (10; 30), for each of the cylinder bores formed in the bearing face (11; 31) of the connection element (10; 30), a holding bore (18; 38), running from the face (17; 37) of the connection element (10; 30) that opposes the bearing face (11; 31) up to the cylinder bore, is formed for receiving a holding screw (4) during the production of the connection element (10; 30).

12. The connection element (10; 30) as claimed in one of the preceding claims, wherein each positioning element (12; 32) has axially on its axis of symmetry a threaded bore (19; 39) for receiving a holding screw (4) during the production of the connection element (10; 30).

13. The connection element (10; 30) as claimed in one of the preceding claims, also having on a lateral face at least one measuring phase (5) for aligning the connection element (10; 30) with a mating connection element (30; 10) which is releasably fastened to the connection element (10; 30).

14. The connection element (10; 30) as claimed in one of the preceding claims, wherein at least one bore (20; 40), running through the connection element (10; 30) perpendicularly to the bearing face (11; 31), is also provided for receiving a screw (6) which can be used to releasably fasten the connection element (10; 30) to a mating connection element (30; 10).

15. The connection element (10; 30) as claimed in claim 14, wherein the at least one bore (20; 40) running through the connection element (10; 30) is formed as a threaded bore.

16. The connection element (10; 30) as claimed in one of the preceding claims, wherein a process material (3), in the form of an adhesive or in the form of a metallic or solder-like meltable material, is used to form the material-uniting connection between the positioning elements (12; 32), which are each received in a recess (13; 33) formed in the bearing face (11; 31) of the connection element (10; 30), and the connection element (10; 30).

17. An interface (100) between two parts (1, 2), which can be releasably

connected to each other, of a machine tool, wherein the interface (100) has a first connection element (10) as claimed in one of the preceding claims associated with one part (1) of the machine tool and a second connection element (30) as claimed in one of the preceding claims associated with the other part (2) of the machine tool.

18. The use of a connection element (10; 30) as claimed in one of claims 1 to 16 as a receptacle for a workpiece holder of a machine tool, in particular as a lathe chuck flange.

19. The use of a connection element (10; 30) as claimed in one of claims 1 to 16 as a spindle flange or in a palletizing system of a machine tool.

20. A method for manufacturing a connection element (10; 30) as claimed in one of claims 1 to 16, in particular for forming an interface (100) between two parts (1, 2), which can be releasably connected to each other, of a machine tool, characterized in that the method has the following method steps:

a) providing a reference connection element (50; 70) having a bearing face (51; 71) which is embodied in a manner complementary to the bearing face (11; 31) of the connection element (10; 30), the reference connection element (50; 70) having at least two positioning elements (52; 72) which are each received in a recess (53; 73) formed in the bearing face (51; 71) of the reference connection element (50; 70),

b) placing the positioning elements (12; 32) of the connection element (10; 30) onto the positioning elements (52; 72) of the reference connection element (50; 70) and fastening them to the positioning elements (52; 72) of the reference connection element (50; 70);

c) positioning the connection element (10; 30) on the bearing face (51; 71) of the reference connection element (50; 70) in such a way that the positioning elements (12; 32), which are placed onto the positioning elements (52; 72) of the reference connection element (50; 70), of the connection element (10; 30) are received in the corresponding recesses (13; 33) formed in the bearing face (11; 31) of the connection element (10; 30);

d) orienting the connection element (10; 30) in relation to the reference connection element (50; 70) and fixing the oriented connection element (10; 30) on the reference connection element (50; 70); and

e) introducing liquid process material (3) into the hollow space between the recesses (13; 33) formed in the bearing face (11; 31) of the connection element

(10; 30) and the positioning elements (12; 32), inserted in the recesses (13; 33), of the connection element (10; 30).

21. The method as claimed in claim 20, wherein, in method step c), the positioning elements (12; 32), which are placed onto the positioning elements (52; 72) of the reference connection element (50; 70), of the connection element (10; 30) are fastened to the positioning elements (52; 72) of the reference connection element (50; 70) with the aid of holding screws (4), the holding screws (4) running from behind through the positioning elements (52; 72) of the reference connection element (50; 70).

22. The method as claimed in claim 21, wherein the holding screws (4) are removed again after the curing of the process material (3) introduced in method step e) into the hollow space between the recesses (13; 33), formed in the bearing face (11; 31) of the connection element (10; 30), and the positioning elements (12; 32), inserted in the recesses (13; 33), of the connection element (10; 30).

23. The method as claimed in claim 21 or 22, wherein, in method step c), the positioning elements (12; 32), which are placed onto the positioning elements (52; 72) of the reference connection element (50; 70), of the connection element (10; 30) are fastened to the positioning elements (52; 72) of the reference connection element (50; 70) at a predefined or predefinable pretensioning with the aid of the holding screws (4).

24. The method as claimed in one of claims 21 to 23, wherein, in method step d), the connection element (10; 30) is oriented in relation to the reference connection element (50; 70) with the aid of measuring phases (5) on the connection element (10; 30) and the reference connection element (50; 70).

25. The method as claimed in one of claims 21 to 24, wherein, in method step d), the oriented connection element (10; 30) is fixed to the reference connection element (50; 70) with the aid of screws (6).

26. The method as claimed in one of claims 21 to 25, wherein the positioning elements (52; 72) of the reference connection element (50; 70) are designed and embodied in a sleeve-like manner for receiving conically tapering bolt-like positioning elements (12; 32) of the connection element (10; 30), the positioning elements (52; 72) of the reference connection element (50; 70) being pressed into

the bearing face (51; 71) of the reference connection element (50; 70), and the shaping of the depression, which is formed in a manner complementary to conically tapering bolt-like positioning elements (12; 32) of the connection element (10; 30), being jig milled.

27. The method as claimed in one of claims 21 to 25, wherein the positioning elements (52; 72) of the reference connection element (50; 70) are designed and embodied in a bolt-like manner in order to be received by sleeve-like positioning elements (12; 32) of the connection element (10; 30), the positioning elements (52; 72) of the reference connection element (50; 70) being adhesively bonded into a recess (53; 73), provided in the bearing face (51; 71) of the reference connection element (50; 70), or otherwise connected in a material-uniting manner.

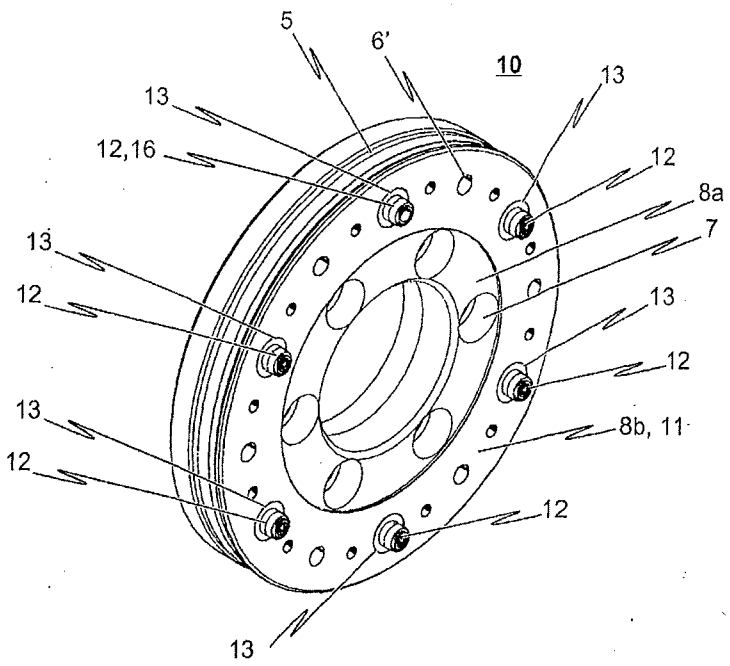
5
6'
10
13
13
12,16
12
8a
7
13
12
13
12
13
12
8b, 11
12
13

Fig. 1

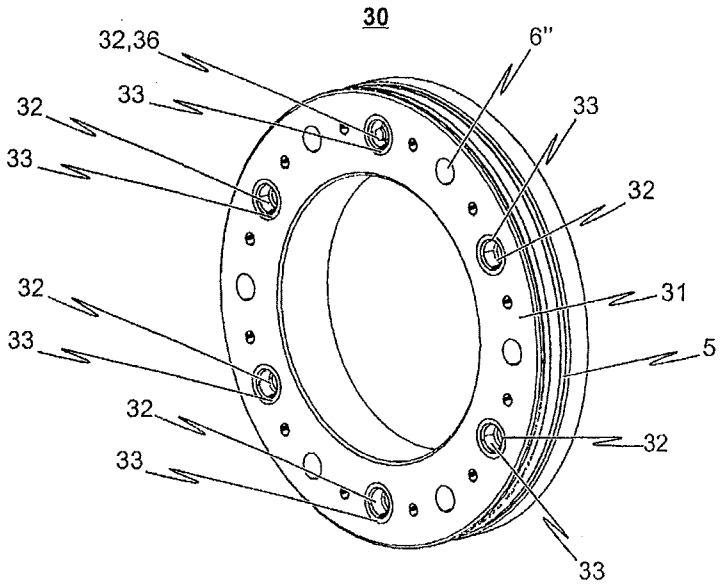
30
32,36
6"
33
32
33
33
32
31
5
32
33
32
33
33

Fig. 2

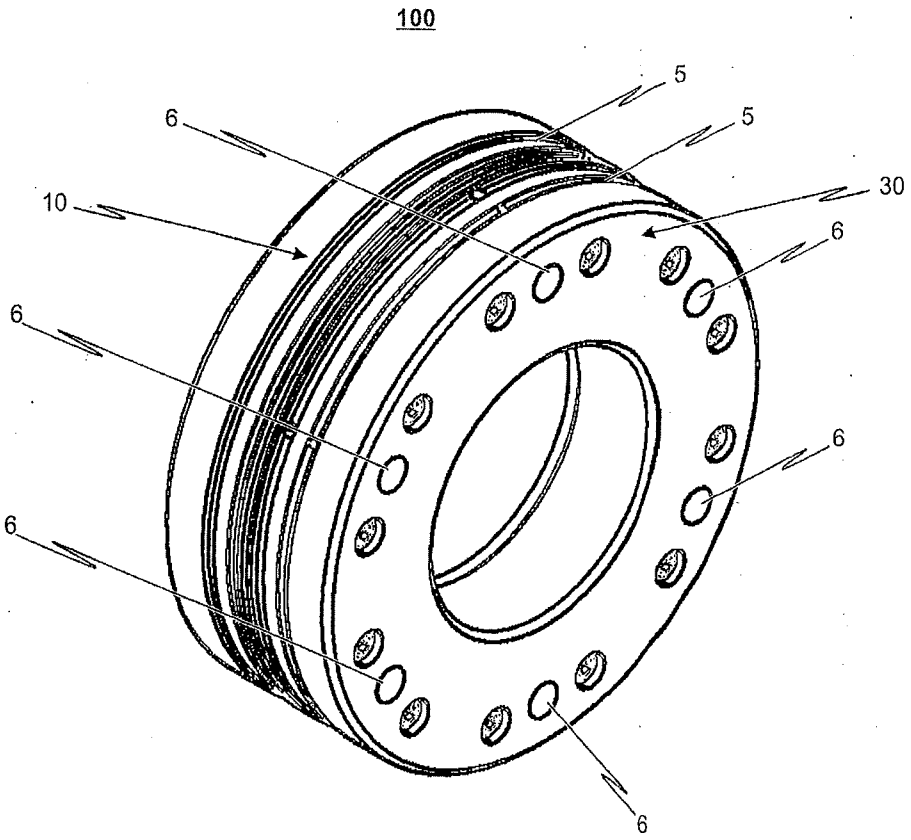

Fig. 3

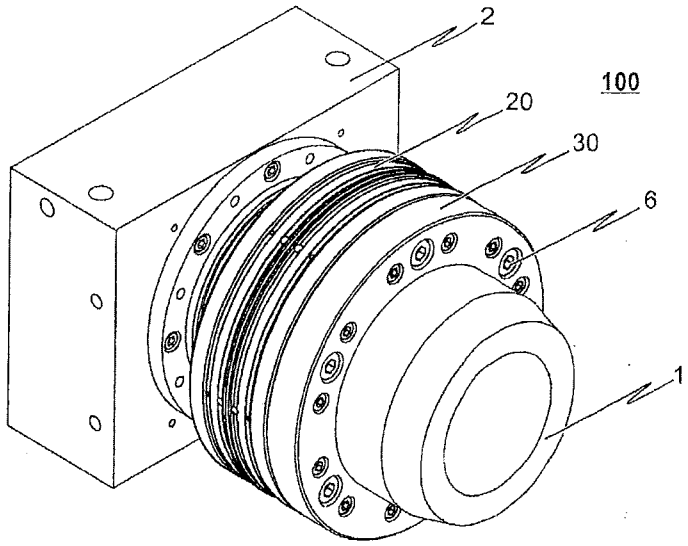

Fig. 4

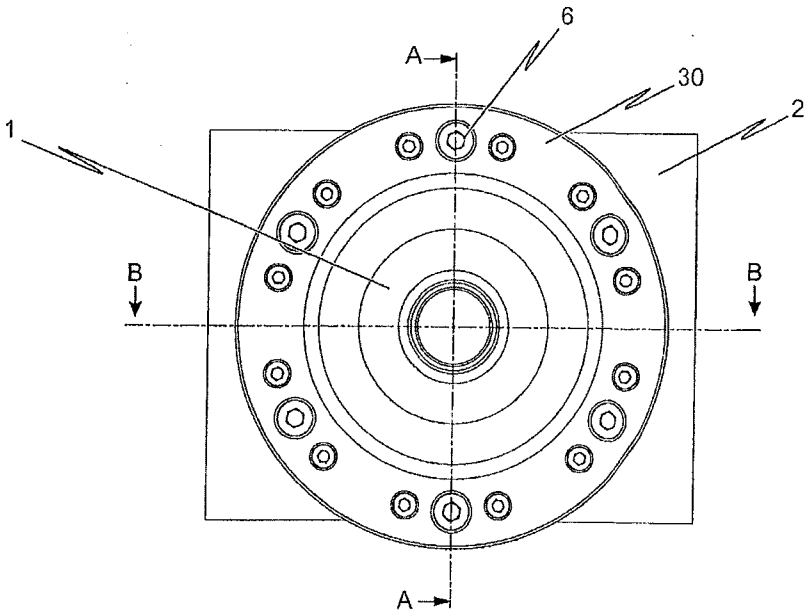

Fig. 5

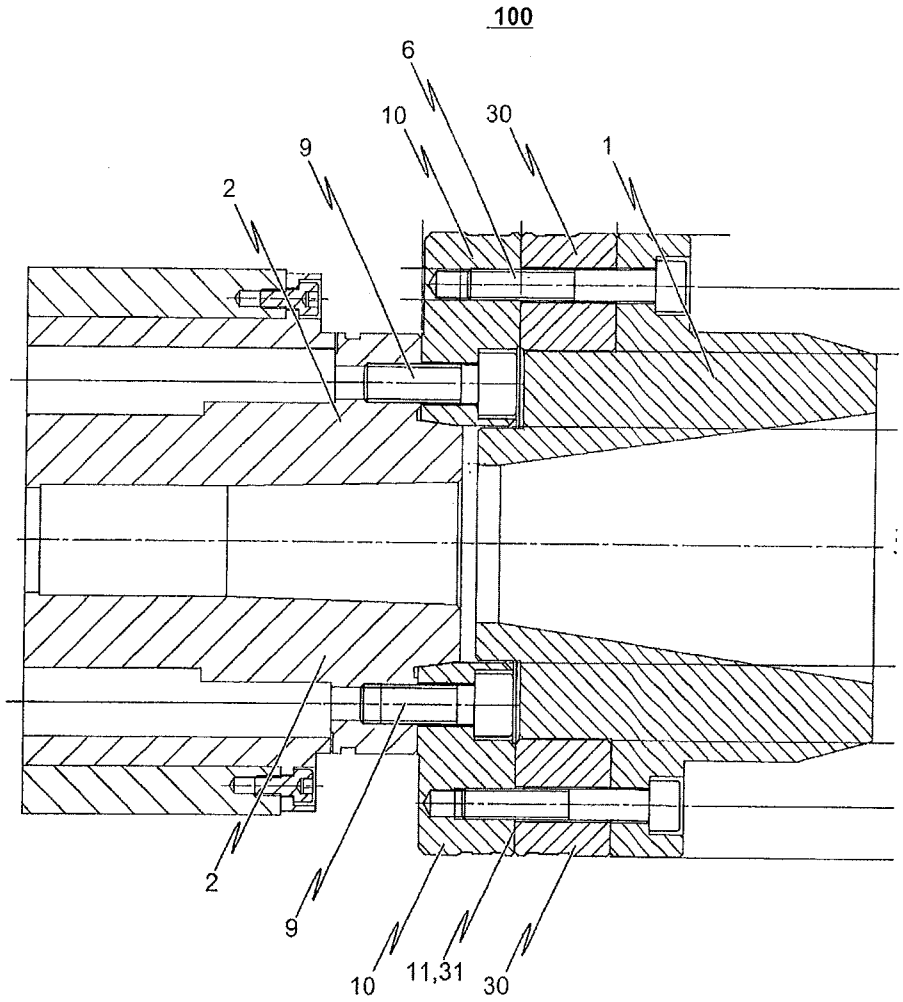

Fig. 6

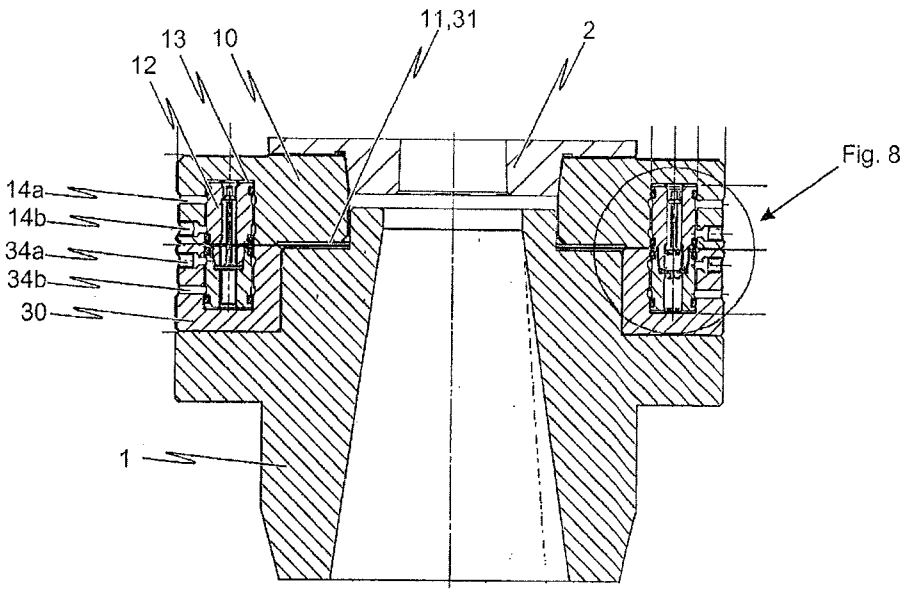
11,31
13
10
2
12
Fig. 8
14a
14b
34a
34b
30
1

Fig. 7

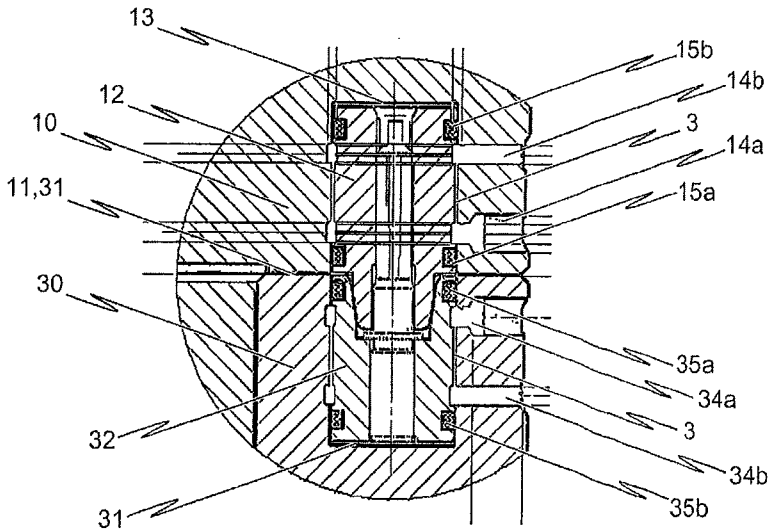
13
15b
14b
12
3
10
14a
11,31
15a
30
35a
34a
3
32
34b
31
35b

Fig. 8

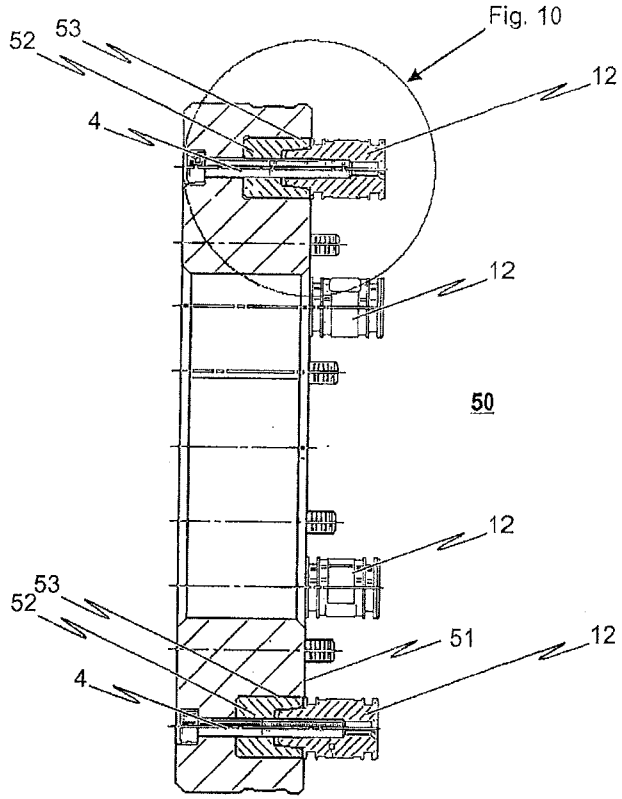

Fig. 9

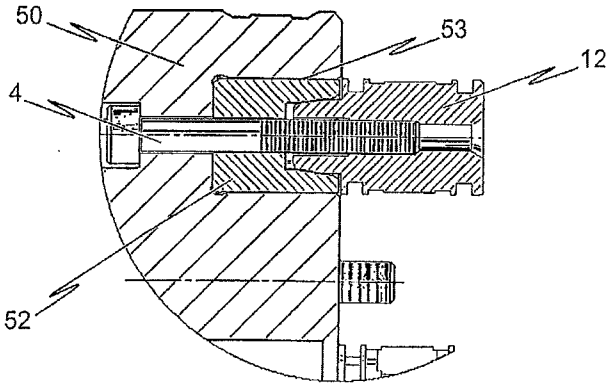

Fig. 10

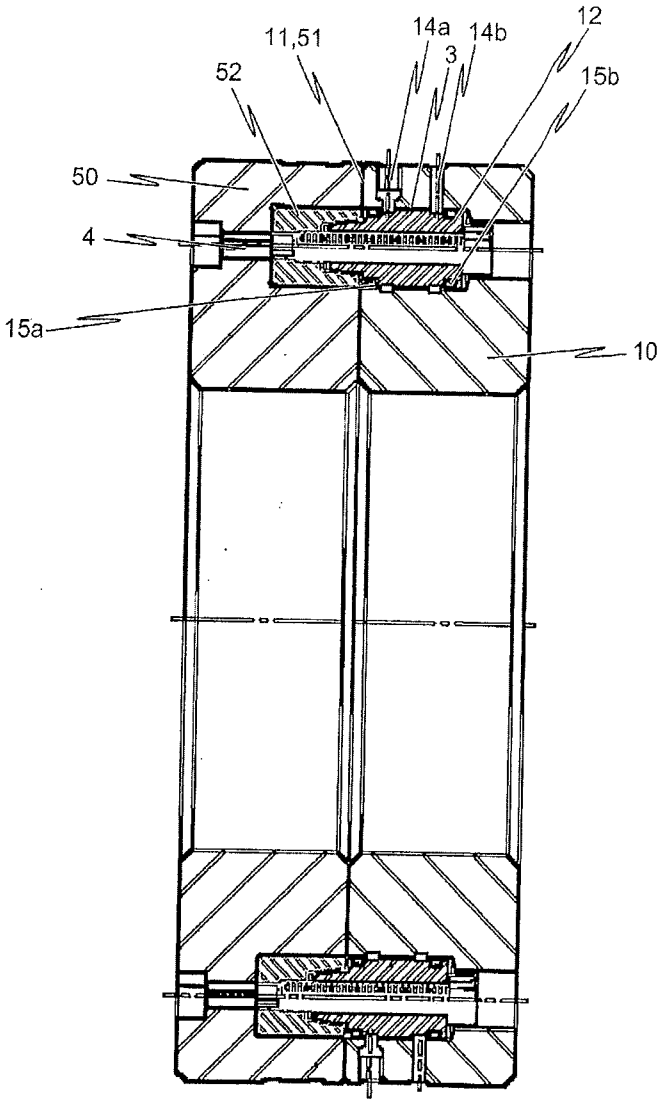

Fig. 11

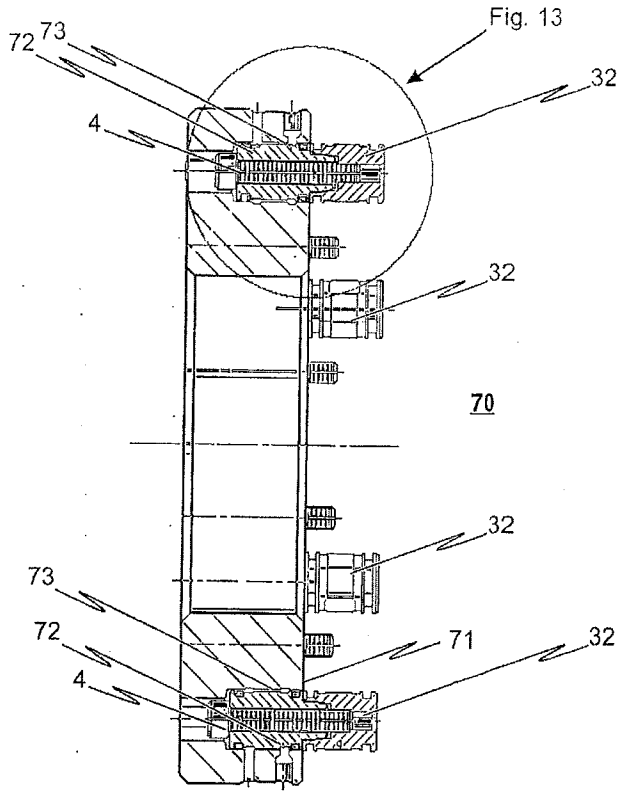

Fig. 12

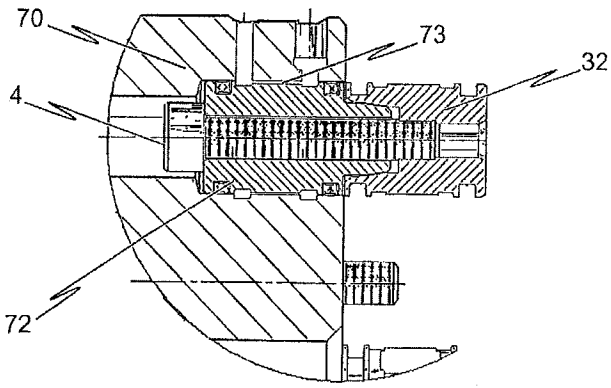

Fig. 13