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(54) **Utánállító rendszer**

Az európai szabadalom ellen, megadásának az Európai Szabadalmi Közlönyben való meghirdetésétől számított kilenc hónapon belül, felszólalást lehet benyújtani az Európai Szabadalmi Hivatalnál. (Európai Szabadalmi Egyezmény 99. cikk(1))

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SZTNH-100023828

Description

ADJUSTMENT SYSTEM

The invention relates to a readjustment system in accordance with the preamble of claim 1.

Readjustment systems of this type are used, for example, for readjustment in the case of wear of the tool or in the case of precision finishing of inner and outer contours of workpieces, wherein said contours can have a cylindrical, eccentric or out-of-round shape.

DE 10 2007 017 800 A1 discloses a readjustment system according to the preamble of claim 1, in which a spindle supports a membrane tilting head by which a cutting edge is adjustable in the radial direction so as to form a round, oval and/or trumpet shape in the longitudinal axis of the piston bolt or any other suited shape for a small connecting rod eye, for example. The membrane tilting head is adjusted via a linearly adjustable actuator, also referred to as tie rod, via which a tool head supporting the cutting edge and being operatively connected to a membrane can be tilted with respect to the spindle axis so as to bring about radial adjustment. The tie rod is supported in the spindle and co-rotates with the same. A rear end portion of the tie rod is guided out of the spindle and is supported there via a bearing arrangement on a slide adjustable via an actuator. In the known solutions the spindle is driven via a drive motor which is arranged in parallel to the spindle axle and is operatively connected to the spindle via a belt drive or the like. For precision finishing of bores, the adjusting means has to be configured so that diameter tolerances ≤ IT6 can be observed. The roundness, cylindrical shape or straightness of the surfaces to be machined has to reach values up to a maximum of 3μ. Moreover, it must be possible to produce profile shapes and/or defined ovality within the range of a few μ.

It is a drawback of said solutions that considerable construction space and efforts in terms of apparatuses are required for the spindle drive and also the bearing of the tie rod. Another drawback consists in the heat transmission through the tie rod.

In DE 44 01 496 C3 an adjusting means for machining round, out-of-round and/or non-cylindrical contours is described in which the adjustment of the cutting edge is performed via a head including piezoelectric translators. In the known readjustment system the head is approximately U-shaped, the piezoelectric actuator being arranged in a fixed leg of the U-shaped head and acting on an elastically deflectable leg at which the cutting edge is retained. By deforming the piezoelectric actuators, the elastically deflectable leg and thus the cutting edge can be adjusted in the radial direction. It is a drawback of this solution that the tool holder has to be configured to exhibit elasticity so that especially in the case of high cutting efficiency the quality required for precision finishing cannot be ensured. It is another drawback that the U-shaped tool holder requires considerable construction space. Furthermore, it is detrimental that due to the U-shaped tool head, an imbalance by which the machining accuracy can be further deteriorated is produced upon readjustment or actuation.

On the other hand, the object underlying the invention is to provide a readjustment system suited for precision finishing which excels by optimum rigidity and minimum imbalance.

This object is achieved by a readjustment system comprising the features of claim 1.

Advantageous further developments of the invention are the subject matter of the subclaims.

The readjustment system according to the invention comprises an advancing head supporting a cutting edge and being configured to have a piezoelectric actuator for radially adjusting the cutting edge. The advancing head includes a tool slide displaceable and, resp., adjustable in the radial direction as advancing direction which is operatively connected to the cutting edge and which is movable via the piezoelectric actuator, hereinafter referred to as piezo actuator, in the advancing direction along a guideway.

By guiding the tool slide, the adjusting movement of the piezo actuator is converted most exactly into an advancing movement, wherein inaccuracies resulting from a deflection of component parts of the advancing head required in prior art can be avoided. The arrangement according to the invention having a tool slide adjusted by a piezo actuator excels by optimum rigidity, wherein very exact adjustment is possible due to the precise guiding. Such a design furthermore permits arranging the tool slide largely symmetrically with respect to the axis of rotation of the spindle so that the imbalances that are inevitable in the prior art described in the beginning are minimized. The effective direction of the piezo actuators in this case preferably extends in the advancing direction.

In an embodiment of the invention, the tool slide is biased via a counterforce element in the direction of a home position. The piezo actuator then counteracts said biasing.

The structure of the readjustment system is especially simple if the counterforce element is formed by a spring or a spring assembly.

Said counterforce element, such as a spring assembly, can be arranged in parallel to the piezo actuator, for example, so that the readjustment system has a very compact design.

In order to increase the adjusting travel and/or the adjusting force, a plurality of piezo actuators can be arranged in parallel or in series to each other so that the adjusting travels of the individual piezo actuators or the adjusting forces applied by the individual piezo actuators are added up.

In a preferred embodiment of the invention, two units including at least two piezo actuators arranged mechanically in series are arranged in parallel to each other.

It is preferred in this variant when the counterforce element is arranged in a plane of symmetry between the two piezo actuator units.

The readjustment system has an especially simple and compact design when the guideway for the tool slide is delimited, on the one hand, by a support of the counterforce element and, on the other hand, by a support for the piezo actuator(s) so that said supports also delimit the adjusting travel of the tool slide.

In order to minimize soiling by chips, coolant/lubricant or the like, the guideway is separated against the working chamber by a cover.

In an embodiment of the invention, the advancing head of the readjustment system is designed to include a HSK (hollow shank taper) clamping system for clamping a tool configured to include the cutting edge.

Preferred embodiments of the invention will be illustrated in detail hereinafter by way of schematic drawings, in which:

Figure 1 shows a strongly schematized diagonal section of a first embodiment of a readjustment system;

Figure 2 shows a longitudinal section across the readjustment system according to Figure 1;

Figure 3 shows a diagonal section across a further embodiment of a readjustment system;

Figure 4 shows a longitudinal section across the readjustment system according to Figure 3 and

Figure 5 is a cut top view onto the readjustment system according to Figure 3.

In Figures 1 and 2, sections A – A and B – B of a readjustment system 1 according to the invention are shown. The readjustment system is mounted to a motor spindle of a machine tool or a machining unit. The readjustment system 1 comprises an advancing head 2 in which a tool slide 4 is movably guided in the adjusting direction. The latter includes a tool holder 6 into which a tool 8 can be inserted by means of a HSK (hollow shank taper) clamping system, for example.

In the shown embodiment, the tool 8 supports a cutting edge 10 protruding in the radial direction which is adjustable by the shown measure Z by appropriate displacement of the tool slide 4 in the radial direction (view according to Figure 2). The structure of the clamping system, the tool holder 6 and the tool 8 is known from the prior art so that more detailed explanations can be dispensed with.

The advancing head 2 includes a structure 12 in which the tool slide 4 is adjustable in the radial direction (vertical in Figures 1 and 2). For mounting on the tool spindle not shown in Figures 1 and 2, the structure 12 is configured to have a mounting flange 14 in which mounting bores 16 are formed, the hole layout and round centering of which correspond to that of an acceptance of the tool spindle not shown so that the structure 12 can be arranged at the tool spindle. In the structure 12, a parallel guideway 18 for the tool slide 4 is formed for guiding the latter in the adjusting direction Z. The guideway 18 substantially comprises two lateral guideways 20, 22 extending in parallel to the adjusting direction Z. The displacement is delimited by two supporting components 24, 26 against which the tool slide 4 abuts at its respective end position. In parallel to the plane of projection in Figure 1, the tool slide 4 is guided on a support 28 of the structure 12 and is covered in the direction of the working space, i.e. toward the cutting edge 10, by means of a cover 31 that primarily serves as a guideway and moreover prevents chips and/or coolant/lubricant or other impurities from entering into the guiding area. The cover 31 is preferably connected to the tool slide 4.

In accordance with Figure 1 illustrating a section along the line A – A in Figure 2, the tool slide 4 is biased in the direction of the (in Figures 1 and 2) left supporting component 26 via a counterforce element in the form of a spring 30 or a spring assembly. This spring 30 is supported on the (in Figures 1 and 2) right supporting component 24 and with its free end portion immerses into a holding space 32 of the tool slide 4 and is adjacent to an end face of said holding space 32 so as to bias the tool slide 4 in the stated direction toward the supporting component 26. The latter supports a piezo actuator 34 which in turn immerses into a piezoelectric acceptance 36 of the tool slide 4. Such piezoelectrically driven actuators have a particular expansion and retraction travel and are connected to the appropriate control of the machine tool or the machining unit, wherein synchronization with the associated axis, for example the Z axis, and the speed of the tool spindle can be performed. The piezo actuators 34 are primarily driven during rotation of the tool spindle via the machine control so as to exploit the adjusting/ actuating range. The function of such piezo actuators is known from the prior art described in the beginning so that in this respect, too, further explanations are dispensable. What is important is the fact that such piezoelectric elements are deformable when electric voltage is applied so that adjustment is effectuated via such variation of the shape. In this case, due to the system compression forces in accordance with an expansion of the piezo actuator 34 in the representation according to Figure 1 that are higher than tensile forces (in accordance with a shortening of the piezo actuator 34 in Figure 1) can be applied by piezoelectric elements. In order to compensate this, the spring 30 or the spring assembly is provided for acting on the tool slide 4 and thus also on the piezo actuator 34 in the direction of a shortening of the piezo actuator 34. In so doing, the latter is supported on the supporting component 26 positioned on top in Figure 1 and acts on the inner end face of the piezoelectric acceptance 36. When the piezo actuator 34 is expanded by appropriate control, the tool slide 4 is correspondingly adjusted to the right in the representation according to Figures 1 and

2 against the force of the spring 30. In the case of reverse control, the piezo actuator 34 is shortened and the respective adjusting movement of the tool slide 4 is performed by the spring 30.
As will be explained hereinafter, for increasing the stroke or the adjusting force a plurality of piezo actuators 34 can be arranged in series and/or in parallel so that the actuating forces and/or the actuating travels add up. This is also true for the spring 30. The guideway of the tool slide 4 in the adjusting direction according to the invention enables an extremely precise advancing movement that allows for a sufficient adjusting rate due to the very good responsive behavior of the piezoelectric control even in the case of high spindle speeds so that also complex geometries can be machined with high cutting efficiency.

By way of Figures 3 to 5, another embodiment of a readjustment system according to the invention is illustrated. The basic structure of the readjustment system 1 according to Figures 3 to 5 largely corresponds to that of the afore-described embodiment. Accordingly, an advancing head 2 of the readjustment system 1 is connected via the mounting flange 14 for co-rotation with the tool spindle 38 indicated in Figure 4, wherein an internal cooling or minimum lubricating system 40 by which the system can be cooled and lubricated is guided through the tool spindle 38. The tool 8 is inserted, as in the afore-described embodiment, in the tool holder 6 via a HSK (hollow shank taper) clamping system (cf. Figure 5). Said tool holder 6 is operatively connected with the tool slide 4 evident in Figure 3 which is guided within the structure 12 adjustably in the advancing direction. Similarly to the afore-described embodiment, the tool slide 4 is guided in the advancing direction via two lateral guideways 20, 22. The adjusting travel is delimited by the supporting components 24 and 26 formed at or attached to the structure, wherein the tool slide 4 abuts at its respective end positions against these supporting components. The support in the axial direction of the tool spindle is effectuated via the support 28 of the structure 12.

In this embodiment, the modular tool slide 4 is configured to have two piezoelectric acceptances 36a, 36b in each of which a plurality of piezo actuators 34a, 34b, 34c and 34d, 34e, 34f are successively arranged. Hence in the concrete embodiment, three piezo actuators 34 at a time are arranged in the associated piezoelectric acceptance 36a, 36b so that, when all three piezo actuators 34 are controlled, the partial strokes thereof add up. The control can be designed so that the same voltage pulse acts on each of the piezo actuators. On principle, it is also possible to differently control the individual piezo actuators for setting the adjustment. The maximum stroke is determined in this case by the individual strokes of the three piezo actuators 34a, 34b, 34c and 34d, 34e, 34f. The maximum force is correspondingly determined by the number of the piezo actuators arranged in parallel so that the advancing stroke and also the advancing force are variable and finely adjustable to a comparatively great extent. Also in this embodiment, the counterforce is applied by a spring 30 that is arranged in a plane of symmetry with respect to the two piezoelectric acceptances 36a, 36b in the representation according to Figure 3. As is evident especially from the top view according to Figure 5, the holding space 32 is offset toward the tool 8 vis-à-vis the two piezoelectric acceptances 36a, 36b. As is evident especially from the section in Figure 3, the piezo actuators 34a, 34b, 34c and, resp., 34d, 34e, 34f are supported on the supporting component 26, whereas the spring 30 is in turn supported on the supporting component 24 located on the right in Figure 3 and acts on the tool slide 4. In the shown embodiment, a force of approx. 850 N can be applied in the direction of compression, i.e. in the direction of compressing the spring 30, by each of the piezo actuators so that the total force is resulting from the sum of the individual forces. The spring rate of the spring 30 then is appropriately selected so that during machining also a force effective in the direction of tension of the piezo actuators 34, i.e. in the direction of relief of the spring 30, can be applied.

As mentioned already, the tool slide 4 in this embodiment has a modular design with the piezoelectric acceptances 36a, 36b and the spring holder 32 being formed at a base member. The piezoelectric acceptances 36a, 36b are closed at the front side toward the supporting component 24 via a front wall 44. Toward the support 28 the tool slide 4 is configured to have a base plate 46 attached to a base member 42 and closing the piezoelectric acceptances 36a, 36b on the support side. The guideway of the tool slide 4 is covered by the cover 31 toward the working space.

The person skilled in the art infers from the embodiment according to Figures 3 to 5 that for varying the adjusting travel and/or the adjusting force, the piezo actuators 34 can be appropriately arranged so as to add up the actuating forces and/or the actuating travels of the individual piezo elements.

As mentioned already, the direct adjustment of the tool slide 4 bearing the tool 8 in the adjusting direction considerably improves the precision vis-à-vis the solutions described in the beginning in which the adjustment is effected by elastic deflection of one leg of an advancing head.

The invention discloses a readjustment system comprising an advancing head, wherein a tool can be moved in an advancing direction via a tool slide. The tool slide is adjusted by means of at least one piezo actuator.

List of reference numerals

1	Readjustment system
2	advancing head
4	tool slide
6	tool holder
8	tool
10	cutting edge
12	structure
14	mounting flange
16	mounting bore
18	guideway
20	lateral guideway
22	lateral guideway
24	supporting component
26	supporting component
28	support
30	spring
31	cover
32	holding space
34	piezo actuator
36	piezoelectric acceptance

38 tool spindle

40 minimum lubrication / internal cooling

42 base member

44 front plate

46 base plate

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UTÁNÁLLÍTÓ RENDSZER

Szabadalmi igénypontok

1. Utánállító rendszer egy szerszámélet (10) hordozó hozzáállító fejjel (2), amely legalább egy piezoelektromos működtetőszervvel (34, 34a - 34f) van a szerszámél (10) radiális állításához felszerelve, **azzal jellemezve,** hogy a hozzáállító fejnek (2) egy radiális irányban eltolható szerszámtolattyúja (4) van, amely a szerszámél (10) állításához a piezoelektromos működtetőszerv (34, 34a - 34f) által radiális irányban meneszthető egy vezeték mentén.
2. Az 1. igénypont szerinti utánállító rendszer, ahol a piezoelektromos működtetőszerv (34, 34a - 34f) egyik hatóiránya a radiális irányban előtoló irányként húzódik.
3. Az 1. vagy 2. igénypont szerinti utánállító rendszer, ahol a szerszámtolattyú (4) legalább egy ellenerő-kifejtő elem által egy alaphelyzet irányában elő van feszítve.
4. A 3. igénypont szerinti utánállító rendszer, ahol az ellenerő-kifejtő elem egy rugó (30) vagy egy rugóelrendezés.
5. A 2. vagy 3. igénypont szerinti utánállító rendszer, ahol az ellenerő-kifejtő elem lényegében párhuzamosan van a piezoelektromos működtetőszervvel elrendezve.
6. Az előző igénypontok bármelyike szerinti utánállító rendszer, ahol számos piezoelektromos működtetőszerv van párhuzamosan és/vagy sorban elrendezve.
7. A 6. igénypont szerinti utánállító rendszer, ahol legalább két, egyenként legalább két egymással sorban elrendezett piezoelektromos működtetőszervet tartalmazó piezoelektromos működtetőszerv-egység egymással párhuzamosan van elrendezve.
8. A 7. igénypont szerinti utánállító rendszer, ahol a szerszámtolattyú (4) legalább egy ellenerő-kifejtő elem által egy alaphelyzet irányában elő van feszítve és az ellenerő-kifejtő elem lényegében szimmetrikusan van egy a két piezoelektromos működtetőszerv-egység közötti síkban elrendezve.
9. Az előző igénypontok bármelyike szerinti utánállító rendszer, ahol a szerszámtolattyú (4) legalább egy ellenerő-kifejtő elem által elő van feszítve egy alaphelyzet irányában és a vezeték egyrészt az ellenerő-kifejtő elem egy alátámasztása, másrészt pedig egy, a

piezoelektromos működtetőszerv vagy működtetőszervek számára kiképzett alátámasztás által van behatárolva.

10. Az előző igénypontok bármelyike szerinti utánállító rendszer, ahol a szerszámtolattyú (4) számára kiképzett vezeték egy burkolat (31) által egy munkatér felé le van fedve.

11. Az előző igénypontok bármelyike szerinti utánállító rendszer, **azzal jellemezve,** hogy a hozzáállító fej (2) egy HSK (hollow shank taper) befogó készülékkel rendelkezik egy a szerszáméllel (10) ellátott szerszám (8) befogásához.

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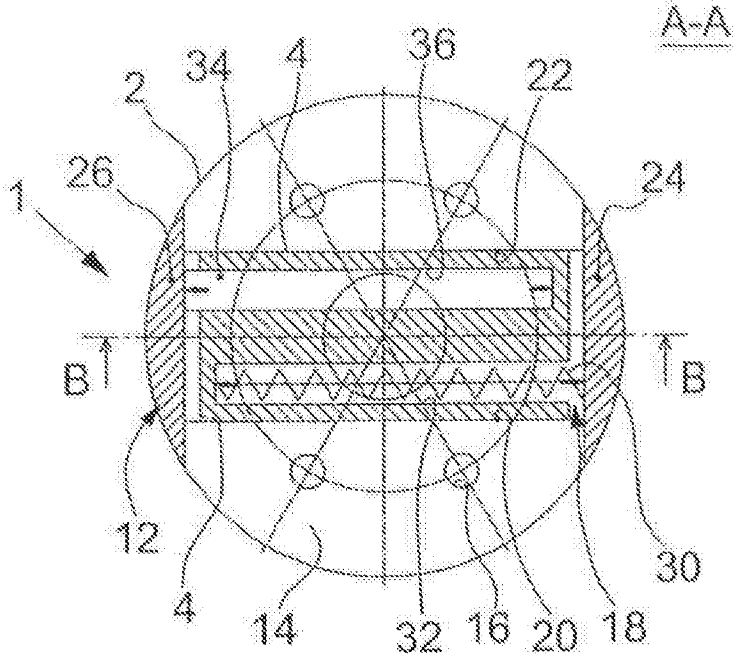


Fig.1

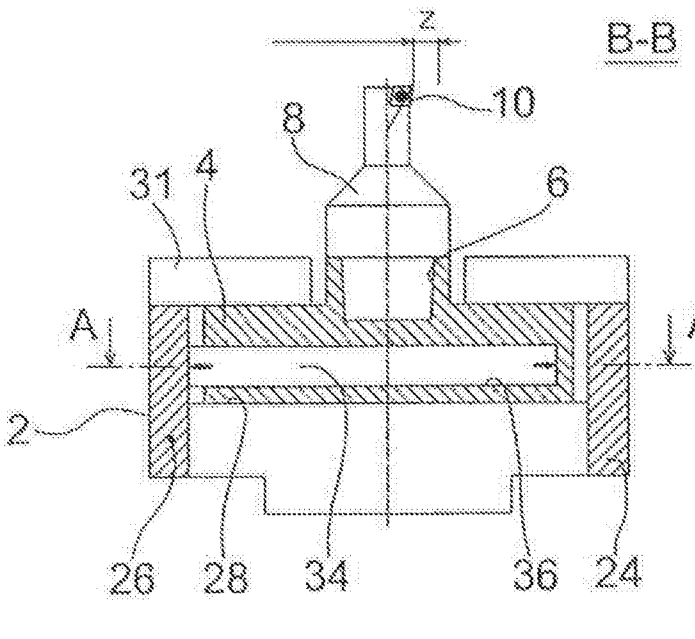
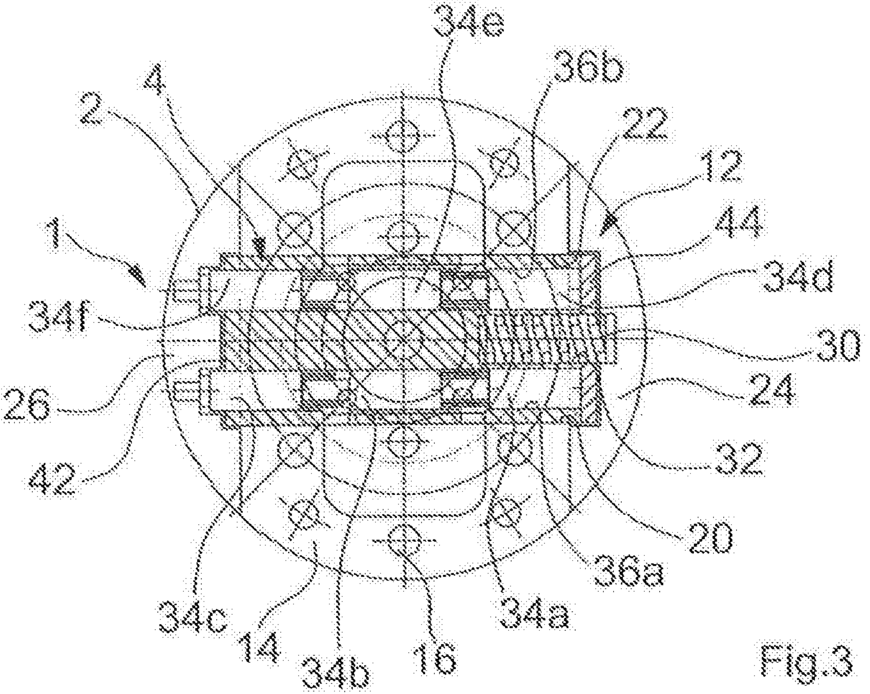


Fig.2


34e
36b
4
2
22
12
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34f
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42
32
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36a
34c
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34a
34b
16

Fig.3

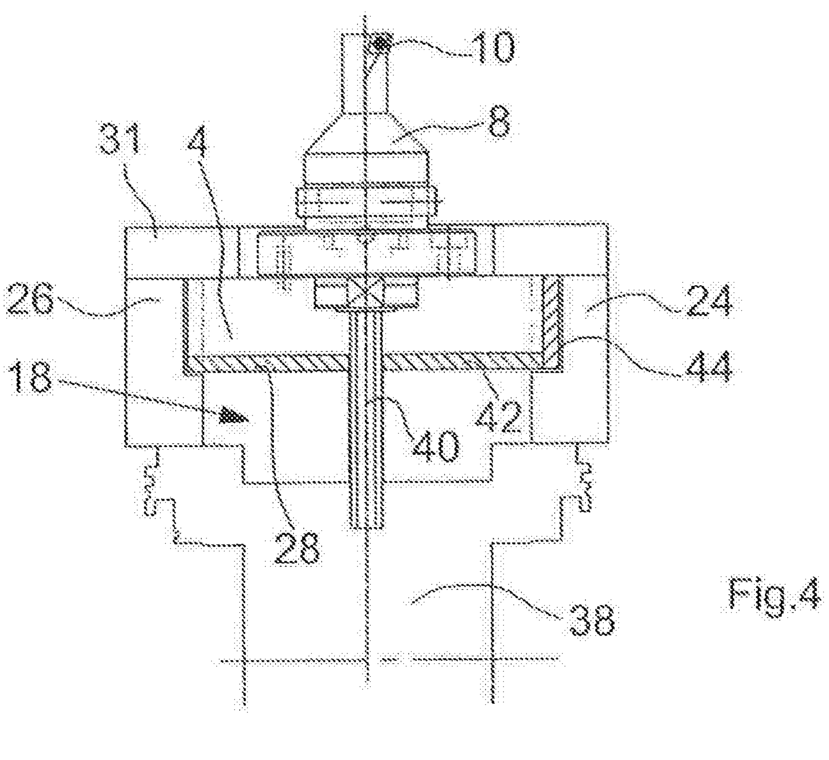
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Fig.4

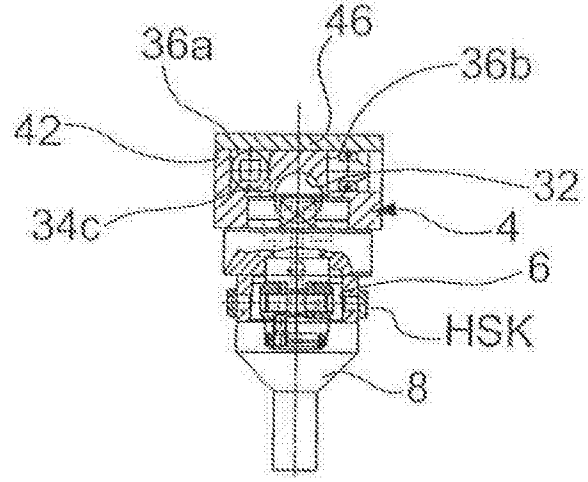

Fig.5