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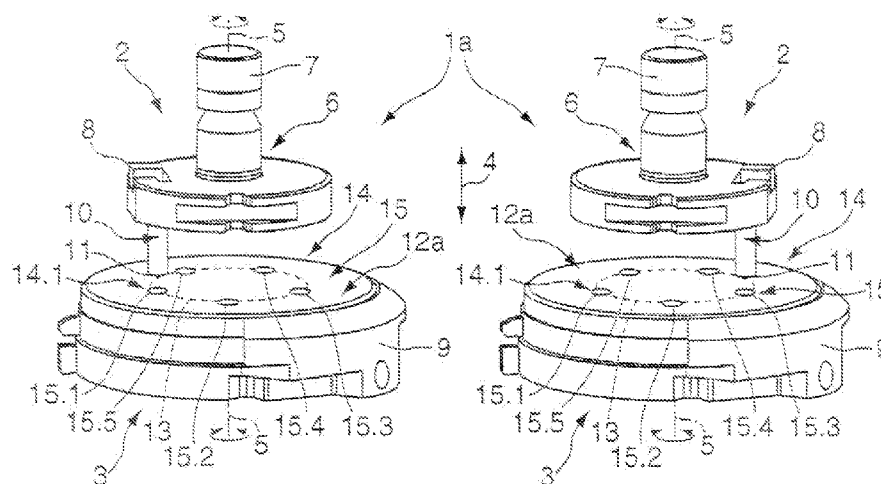
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(54) Title: REORIENTABLE ROTATABLE PROCESSING TOOL FOR CUTTING AND/OR FORMING PLATE-LIKE WORKPIECES



(57) Abstract: A tool for processing, in particular cutting and/or forming, plate-like workpieces, in particular metal sheets, comprises a first tool part (2) and a second tool part (3) which can be moved towards one another in a direction of travel (4) for processing a workpiece arranged between the tool parts (2, 3), wherein on the first tool part (2) at least one processing device (11) is provided and on the second tool part (3) at least two counter devices (15) are provided, and the processing device (11) on the first tool part (2) and the counter devices (15) on the second tool part (3) can be rotated relative to one another about at least one positioning axis (5), wherein the counter devices (15) on the second tool part (3) follow one another in the direction of the relative rotational movement of the processing device (11) and counter devices (15), and wherein by means of said relative rotational movement the processing device (11) and counter device (15) for processing the workpiece can be allocated to one another by at least one defined processing parameter. By allocating the processing device (11) to different counter devices (15) at least one processing parameter can be defined differently.

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REORIENTABLE ROTATABLE PROCESSING TOOL FOR CUTTING AND/OR FORMING PLATE-LIKE WORKPIECES

BACKGROUND

The invention relates to a tool for processing, in particular cutting and/or forming, plate-like workpieces, in particular metal sheets, with a first tool part and a second tool part, which
5 can be moved towards one another in a direction of travel for processing a workpiece arranged between the tool parts, wherein on the first tool part at least one processing device is provided and on the second tool part at least two counter devices are provided, and the processing device on the first tool part and the counter devices on the second tool part can be rotated relative to one another about at least one positioning axis, wherein the counter devices on the second tool
10 part follow one another in the direction of the relative rotational movement of the processing device and counter devices, and wherein by means of said relative rotational movement the processing device and a counter device for processing the workpiece can be allocated to one another by at least one defined processing parameter.

WO 0243892 A2 describes a tool of this kind for forming slots in metal sheets. The tool
15 comprises an upper tool part with a rectangular punch and a lower tool part with a opening adapted to the cross section of the punch. The punch has a cutting edge as a processing device. The cutting edge is inclined on the longitudinal sides of the punch relative to the plane of the metal sheet and on a transverse side of the punch perpendicular to the longitudinal sides. Two counter cutting edges are provided as counter devices on the opening which are arranged
20 respectively on a transverse side and on the longitudinal sides of the opening. At the beginning of the slotting process a strip is cut out which is still joined onto the metal sheet on one side, in that the cutting edge on the punch works together with a counter cutting edge on the opening. During the following slotting process the strip also remains joined to the metal sheet on one side. To cut free the strip the punch is rotated relative to the opening by 180°. Now the cutting
25 edge on the punch already used at the beginning works together with the second counter cutting edge on the opening. The processing of the workpiece is performed with identical processing parameters for the initial cut stroke and the severing stroke.

SUMMARY

The object of the invention is to provide a tool which has broader application potential than the prior art.

This object is achieved according to the invention by the tool according to claim 1.

5 Within the meaning of the invention by allocating the processing device to different counter devices at least one processing parameter can be defined differently. In this way one and the same processing device can process workpieces with different processing parameters. Owing to the broader application potential of the tool the tool does not need to be exchanged, for example when changing workpiece properties such as the thickness of the workpiece or
10 changing the contour to be produced. In the case of a machine tool with several tools according to claim 1 in a tool magazine a multiplication of the effect produced by the invention is possible. With a machine tool of this kind a plurality of processes can be performed on one and the same or on different workpieces with varying parameters, without the tools provided in the tool magazine having to be changed.

15 Particular embodiment variants of the tool according to claim 1 are described in the dependent claims 2 to 15.

According to claim 2 at least one of the two tool parts can be rotated about a tool rotation axis. At least one tool rotation axis forms a positioning axis about which the processing device and the counter devices can be rotated relative to one another. Usually tool rotation axes
20 are used for aligning processing devices and counter devices relative to the workpiece to be processed. In the case of the tool of the invention according to claim 2 at least one known tool rotation axis with an additional function is used such that a particularly simple design of tool is obtained according to the invention.

A simple and compact structure of the tool according to the invention is also described
25 in claim 3, in which the counter devices on the second tool part follow one another in the direction of the relative rotation of the processing device and counter devices about a positioning axis along a circular path at a distance from the relevant positioning axis, which is adjusted to the distance of the processing device allocatable thereto from this positioning axis. In this way the allocation of the processing device to the different counter devices can be
30 performed in a simple manner solely by rotation about said positioning axis. Further feeding

devices on one of the tool parts for the processing device or the counter devices are thus unnecessary.

With the advantageous development of the tool of the invention according to claim 4 and claim 5, one cutting edge is provided as a processing device on the first tool part and at least two counter cutting edges are provided as counter devices on the second tool part. In addition to this or alternatively at least two portions of an individual counter cutting edge are provided as counter devices on the second tool part. During the cutting of plate-like workpieces it may be necessary for example due to the changing thicknesses of the workpieces to define the width of the cutting gap between the cutting edge and the counter cutting edge allocated thereto to be different. This is possible with the tool according to the invention without changing the tools by the allocation of the cutting edge to different counter cutting edges and/or different portions of a counter cutting edge.

The tool of the invention according to claim 6 has a broader potential for application than the prior art in that by allocating one cutting edge to different counter cutting edges as processing parameter the cutting contour produced by means of the cutting edge can be defined differently.

Advantageously according to claim 7 a pressure surface is provided as a processing device and embossing contours are provided as counter devices, wherein by the allocation of the pressure surface to different embossing contours as processing parameter the embossed form produced by the interaction of the pressure surface and allocated embossing contour can be defined differently. In this way without changing the tools by a single tool different embossing shapes can be made in the workpieces to be processed. This also applies to the possibility of forming different shapes in a workpiece by the structure of a tool according to claim 8.

According to claim 9 on the first tool part at least two processing devices are provided and the latter can be allocated respectively to at least two counter devices on the second tool part. This results in a plurality of potential uses for the tool according to the invention.

According to claim 10 on a tool according to the invention with at least two processing devices on the first tool part an activating device is provided, by means of which one of the processing devices can be activated into a functional state. Any negative effects on the

processing device(s) not involved in processing the workpiece are reduced in this way, ideally completely avoided.

With the tool of the invention according to claim 11 a processing device can be brought by the activating device into a functional state, in which it projects relative to the processing device or other processing devices during tool processing in the direction of travel relative to the workpiece. Negative effects of the processing devices not involved in processing the workpiece can be simply reduced or avoided particularly effectively and simply with this tool.

An increase in the number of possible combinations of processing devices and counter devices that can be allocated to one another is achieved according to claim 12 in that on the first tool part at least two processing devices are provided which can be allocated to one and the same counter device on the second tool part.

According to claim 13 on a base of the first tool part a support provided with at least one processing device is mounted rotatably about a support axis. In addition to this or alternatively on a base of the second tool part a support provided with at least one counter device is mounted rotatably about a support axis. At least one support axis forms a positioning axis about which the processing device and the counter devices can be rotated relative to one another. To enable the relative rotational movement of a processing device and the counter devices in a tool according to claim 13 no rotation of the base is required.

A tool according to claim 14 enables a particularly flexible manufacturing process. As on the first tool part at least one processing device is provided on a tool insert, which is arranged on a base or on a support that is rotatable relative to the base and/or as on the second tool part at least one counter device is provided on a tool insert, which is arranged on a base or on a support that is rotatable relative to the base, the bases or bases and the support or supports rotatable relative to the base can be designed to be standard for different tools. Only by inserting the tool inserts into the base are tools defined for different purposes. If the individual tool inserts are also exchangeable, the purpose of a tool can be varied. Also individual tool inserts can be replaced due to wear without the not yet worn tool inserts having to be replaced.

The tool of the invention according to claim 15 is a follow-on tool of simple construction, by means of which complex processing can be performed on a portion of a workpiece without any intervening tool changes.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

5 The invention is explained in more detail in the following with reference to schematic drawings provided by way of example, in which:

Figure 1: shows a perspective view of a tool of a first type for punching workpieces with two different relative rotational positions of tool parts,

10 Figure 2: shows a perspective view of a tool of a second type for punching workpieces with two different relative rotational positions of tool parts,

Figure 3: shows a perspective view of a tool of a third type for punching workpieces,

Figure 4: shows the lower part of the tool according to Figure 3 in a plan view,

15 Figure 5: shows a perspective view of a tool of a fourth type for punching workpieces,

Figure 6: shows a perspective view of a tool of a fifth type for punching workpieces,

Figure 7: shows the lower part of the tool according to Figure 6 in a plan view,

Figure 8: shows a perspective view of a tool for embossing workpieces,

20 Figure 9: shows the lower part of the tool according to Figure 8 in a plan view,

Figure 10: shows a schematic cross section of a tool for rolling workpieces,

Figure 11: shows a perspective view of a tool for producing a hinge case and

Figure 12: shows the tool for producing a hinge case according to Figure 11 in a different relative rotational position of tool parts.

DETAILED DESCRIPTION

25 The tools 1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h shown in Figures 1 to 12 are all provided for use in a conventional numerically controlled base machine for cutting and forming metal sheets. In a machine tool of this kind a first tool part, the upper tool 2, is secured in a machine-side upper tool mount and a second tool part, the lower tool 3, is secured in a machine-side lower tool

holder. A metal sheet arranged between the two tool parts is positioned by means of a coordinate guide, supported by a workpiece table arranged next to the lower tool mount, in a horizontal plane between the two tool parts. To process the metal sheet the two tool parts arranged on opposite sides of the metal sheet are moved towards one another by a machine-side lifting drive in a vertical direction of travel 4. The two tool parts can be rotated by means of machine-side rotary drives about a tool rotation axis 5 parallel to the direction of travel 4. In principle, it is possible for the rotation of the tool parts to be performed about different rotary axes. However, the tools shown 1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h are designed for machines in which both tool parts can be rotated about a common tool rotation axis 5.

The upper tool 2 of all shown tools 1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h comprises a base 6 with a shaft 7 and an adjusting wedge 8. The shaft 7 is used for securing the upper tool 2 in the machine-side upper tool mounting. In this case the rotational position of the upper tool 2 is determined in relation to the machine-side tool mounting by the adjusting wedge 8. The lower tool 3 has a base 9 which is suitable for being secured in the machine-side lower tool mounting in a defined rotational position.

Figure 1 shows the tool 1a for punching metal sheets. The upper tool 2 and the lower tool 3 are shown in two different relative rotational positions. On the upper tool 2 a hole punch 10 is provided. The hole punch 10 has a circular cutting edge 11 as a processing device.

On the main body 9 of the lower tool 3 a cutting plate 12a is provided. On the cutting plate 12a along a circular path 13 in the direction of the rotational movement about the tool rotation axis 5 five openings are arranged in succession, which are denoted as a whole by the reference number "14". Each of the openings 14 is delimited by a circular counter cutting edge functioning as a counter device. The counter cutting edges are denoted as a whole by the number "15". Both the cutting edge 11 and the counter cutting edges 15 are arranged to be off-centre relative to the tool rotation axis 5. The distance of the cutting edge 11 and the distance of the counter cutting edges 15 from the tool rotation axis 5 are adjusted to one another.

On punching a hole with the tool 1a the cutting edge 11 on the upper tool 2 is moved past one of the counter cutting edges 15 of the lower tool 3 in the direction of travel 4. So that the cutting edge 11 can descend into the circular openings 14 in the direction of travel 4 the diameters of the counter cutting edges 15 are larger than the diameter of the cutting edge 11.

In addition, the diameters of the counter cutting edges 15 are different from one another. Depending on which of the counter cutting edges 15 the cutting edge 11 is allocated to, the width of the cutting gap between the cutting edge 11 and the respective counter cutting edge 15.1, 15.2, 15.3, 15.4, 15.5 is defined to be different. For example, the cutting edge 11 on the hole punch 10 has a diameter of 6.0 millimetres and a circular counter cutting edge 15.1 on an opening 14.1 has a diameter of 6.1 millimetres. The diameters of additional counter cutting edges 15.2, 15.3, 15.4 and 15.5 are 6.2 millimetres, 6.3 millimetres, 6.4 millimetres and 6.5 millimetres. Thus by means of the interaction of the punch-side cutting edge 11 with the counter cutting edge 15.1 a width of the cutting gap is defined as 0.1 millimetres, by the interaction of the cutting edge 11 with the counter cutting edge 15.2 a width of the cutting gap is defined as 0.2 millimetres etc.

The width of the cutting gap influences to a great extent the quality of the result of processing. In this way the width of the cutting gap is changed for example depending on the thickness of the metal sheet to be processed. In the aforementioned case by means of the interaction of the cutting edge 11 with the counter cutting edge 15.1 a metal sheet can be processed with a thickness of 1.0 millimetres, whereas by combining the cutting edge 11 with the counter cutting edge 15.2 a metal sheet with a thickness of 1.5 millimetres can be punched with comparable cut quality. Generally, with one and the same tool metal sheets of varying thicknesses can be processed with uniform quality.

The cutting edge 11 can be allocated to one of the counter cutting edges 15 in a simple manner by a relative rotational movement of the cutting edge 11 on the one hand and the counter cutting edges 15 on the other hand. The positioning axis about which the cutting edge 11 and the counter cutting edges 15 can be rotated relative to one another is in this case formed by the common tool rotation axis 5. The upper tool 2 can be rotated alone about the tool rotation axis 5 relative to the lower tool 3 and the lower tool 3 can be rotated alone relative to the upper tool 2. However, a change in the allocation can be achieved by superimposing rotational movements of the two tool parts about the tool rotation axis 5.

In the left part of Figure 1 the cutting edge 11 is assigned to the counter cutting edge 15.1, in the right part to the counter cutting edge 15.3. To move the tool 1a from the former rotational position thereto rotational position in the example shown a rotational movement of

the upper tool 2 relative to the lower tool 3 is performed about the tool rotation axis 5, until the cutting edge 11 is aligned in the direction of travel 4 above the counter cutting edge 15.3.

Figure 2 shows a tool 1b of a second type for punching metal sheets. A rectangular punch 16 provided on the base 6 of the upper tool 2 comprises a rectangular cutting edge 11 on its lower end as a processing device. The cutting edge 11 is arranged off-centre in relation to the rotation axis 5 of the upper tool 2.

On a cutting plate 12b of the lower tool 3 two rectangular openings 14 are provided. The larger of the openings 14 is only delimited on one side by a counter cutting edge 15.1 acting as a counter device, whereas the smaller of the openings 14 is surrounded by a rectangular counter cutting edge 15.2 acting as an additional counter device. The counter cutting edges are denoted as a whole by the reference number "15".

The cutting edge 11 on the rectangular punch 16 of the upper tool 2 can, as shown in the left part of Figure 2, be allocated to the counter cutting edge 15.1 on the larger of the openings 14. By means of a relative rotational movement of the upper tool 2 and the lower tool 3 about the tool rotation axis 5, according to the right part of Figure 2, the cutting edge 11 of the upper tool 2 is allocated to the counter cutting edge 15.2 on the smaller opening 14 of the lower tool 3. In this way the tool rotation axis 5 forms a positioning axis about which the cutting edge 11 and the counter cutting edges 15 can be rotated relative to one another.

If the tool 1b is located in the position shown in the left part of Figure 2, on the working movement of the tool parts in the direction of travel 4 a straight cut is produced in the workpiece, as in this case only a portion of the cutting edge 11, namely the straight portion, which is arranged externally in radial direction relative to the tool rotation axis 5, can interact with the counter cutting edge 15.1.

In the conditions according to the right part of Figure 2 however a rectangular region can be punched out of the sheet, as here the entire cutting edge 11 of the upper tool 2 interacts with the counter cutting edge 15.2 of the lower tool 3.

The processing device is formed in the case of tool 1b by the rectangular cutting edge 11. Depending on the relative rotational position of the tool parts of tool 1b the cutting edge 11 is allocated as a counter device to the counter cutting edge 15.1 or the counter cutting edge 15.2. As a processing parameter the cutting contour produced by means of the cutting edge 11 can be defined differently.

It is also possible with tool 1b to eject relatively large workpieces, punched out of the composite metal sheet, through the larger of the openings 14 from tool 1b. If a freely punched workpiece, once it has been cut by the tool 1b from the composite metal sheet, lies completely over the larger of the openings 14, it can pass down through the latter, provided it is the appropriate size. Alternatively, the freely punched tool can also be cut out of the composite metal sheet aligned relative to the lower tool 3, so that it does not lie over the larger of the openings 14.

Figures 3 and 4 show the tool 1c for punching metal sheets. The tool 1c coincides in structure largely with the tools 1a, 1b according to Figures 1 and 2. However, the processing device of the upper tool 2 and the counter devices of the lower tool 3 have been modified. In the case of tool 1c according to Figure 3 a single straight cutting edge 11 on a rectangular punch 16 of the upper tool 2 acts as a processing device. As counter devices four straight counter cutting edges 15.1, 15.2, 15.3, 15.4 are arranged on the circumference of a rectangular opening 14 of a cutting plate 12c. The reference number "15" is allocated overall to the four counter cutting edges 15.1, 15.2, 15.3, 15.4.

As a function of the relative rotational position of the upper tool 2 and lower tool 3 about the tool rotation axis 5 the cutting edge 11 is allocated to one of the four counter cutting edges 15.

In Figure 4 the dashed lines 17 show a projection of the cutting edge 11 of the upper tool 2 in the various relative rotational positions of the cutting edge 11 and the counter cutting edges 15. In the various relative rotational positions the distance between the cutting edge 11 and the counter cutting edge 15.1, 15.2, 15.3, 15.4 of the counter cutting edges 15 allocated thereto are different. In this way the width of the cutting gap is variable as a processing parameter.

Figures 5 to 7 relate to the tools 1d, 1e for punching metal sheets, which on the upper tool part comprise respectively at least two individually activatable processing devices. Tools of this kind are also known as multiple tools or multitools.

Both tools 1d, 1e have rotating cutting edges 11 on several punch inserts 18 as processing devices. For processing the workpiece only one of the punch inserts 18 is ever moved into a functional position. The respective punch insert is activated by means of an activating device of known design integrated into the upper tool 2. Depending on the relative

rotational position of an activating element 19 relative to the base 6 of the upper tool 2 supporting the punch inserts 18, one of the punch inserts 18 protrudes relative to one or the other in the direction of travel 4.

To change its rotational position relative to the base 6 the activating element 19 on the external circumference comprises a toothing 20. A machine-side pinion engaging in the toothing 20, which is not shown for reasons of simplicity, enables on rotation of the base 6 about the tool rotation axis 5 either a rotation of the activating element 19 at the same time as the base 6 or obstructs the activating element 19 in a joint rotary movement with the base 6. If the activating element 19 is obstructed in a rotary movement with the base 6, the rotation of the base 6 causes a rotation of the base 6 relative to the activating element 19. The rotation angle is selected so that the desired punch insert is activated.

The tool 1d according to Figure 5 has ten individually replaceable punch inserts. The cutting edges 11 are arranged in succession along a circular path 21 about the tool rotation axis 5. On the lower tool 3 die inserts 22 are provided. A total of ten individually replaceable die inserts follow a circular path 23 about the tool rotation axis 5. The die inserts 22 comprise circular openings 14 which are delimited by circular counter cutting edges 15 each forming a counter device respectively. The distance of the cutting edges 11 from the tool rotation axis 5 and the distance of the counter cutting edges 15 from the tool rotation axis 5 are adjusted to one another.

The punch inserts 18 of the upper tool 2 and thereby the cutting edges 11 arranged on the punch inserts 18 can be activated individually by means of the activating device for processing the workpiece. An activated punch insert, i.e. located in a functional position, can be allocated each of the die inserts 22 by rotation of the upper tool 2 and the lower tool 3 relative to one another about the tool rotation axis 5. Thus even with tool 1d the tool rotation axis 5 forms a positioning axis, about which the cutting edges 11 and the counter cutting edges 15 can be rotated relative to one another.

With ten different punch inserts 18 and ten different die inserts 22, as shown in Figure 5, a hundred different combinations are possible. In practice however, it is not always practical to design the tool 1d so that all possible combinations for processing the workpiece can actually be used. For example, five of the cutting edges 11 have a diameter of 6.0 millimetres, 6.2 millimetres, 6.4 millimetres, 6.8 millimetres and 7.0 millimetres. The diameters of five of the

counter cutting edges 15 are 6.1 millimetres, 6.3 millimetres, 6.5 millimetres, 6.9 millimetres and 7.1 millimetres. The cutting edge 11.1 with a diameter of 7.0 millimetres can in practice only be allocated to the counter cutting edge 15.1 with a diameter of 7.1 millimetres, as all of the other counter cutting edges 15 have a diameter that is too small. To process a metal sheet with a sheet thickness of 1.0 millimetres the cutting edge 11.2 with a diameter of 6.0 millimetres must interact with the counter cutting edge 15.2 with a diameter of 6.1 millimetres. In this case the width of the cutting gap is defined as 0.1 millimetres. For processing a metal sheet with a sheet thickness of 3.0 millimetres the width of the cutting gap has to be set to 0.3 millimetres, the cutting edge 11.2 consequently has to be allocated to the counter cutting edge 15.3 with a diameter of 6.3 millimetres.

The tool 1e also in the form of a "multitool" is shown in Figures 6 and 7. Contrary to tool 1d tool 1e only has two individually exchangeable punch inserts. The cutting edges 11 of which also enclose different contours. The tool 1e is also equipped with an activating device, which makes it possible to move one of the punch inserts 18 and the cutting edges 11 arranged thereon into a functional position for processing the workpiece.

The two punch inserts 18 and the cutting edges 11 arranged thereon are arranged off-centre relative to the tool rotation axis 5, but are a different distance from the tool rotation axis 5.

Figure 7 shows the lower tool 3 of the tool 1e in plan view. As shown in Figure 7 four of the openings 14 can be allocated to each of the punch inserts 18. The openings 14 are arranged in succession on two circular paths 24.1, 24.2 about the tool rotation axis 5. The two circular paths 24.1, 24.2 have different diameters to correspond with the different distances of the punch inserts 18 from the tool rotation axis 5. By means of this arrangement of the openings 14 offset in radial direction the installation space available on the lower tool 2 for openings 14 can be used to an optimum degree.

Also the cutting edges 11 and the allocatable counter cutting edges 15 on the tool 1e are configured so that by allocating the cutting edges 11 to different counter cutting edges 15 the width of the cutting gap is defined differently as a processing parameter.

Figures 8 and 9 show a tool 1f for embossing metal sheets. The upper tool 2 of tool 1f comprises a support 26 that is rotatable relative to the base 6 of the upper tool 2 about a support axis 25. The support axis 25 corresponds with the tool rotation axis 5. Toothing 20 is provided

on the outer circumference of the support 26. By means of a machine-side pinion engaging with the toothing 20 a rotational movement of the support 26 relative to the base 6 of the upper tool 2 is controlled, comparable to the activating rotational movement of the activating element 19 of tools 1d, 1e according to Figures 5 to 7.

5 In contrast to the tools 1d, 1e the processing device, a pressure surface 28 provided on a pressure element 27 is not attached directly onto the base 6 of the upper tool 2 but onto the support 26 that is rotatable relative to the base 6. With a rotation of the base 6 about the tool rotation axis 5 the machine-side pinion either permits a rotation of the support 26 at the same time as the base 6 or prevents the support 26 from making a common rotational movement with
10 the base 6. In this way the pressure surface 28 also rotates either with the base 6 or the base 6 performs a rotational movement relative to the pressure surface 28. Upon a rotational movement of the base 6 relative to the pressure surface 28 forming a processing device a relative rotational movement of the processing device is performed on the upper tool 2 relative to the counter devices on the lower tool 3, in that the lower tool 3 is rotated by means of the
15 machine-side rotary drive of the lower tool 3 to the same extent as the base 6 of the upper tool 2. The lower tool 3 together with the counter devices provided thereon thus performs a rotational movement relative to the standing support 26 and the processing device provided on the support 26. Advantageously, to produce the relative rotational movement of the processing device and counter devices it is not necessary for the upper tool 2 and the lower tool 3 to
20 perform independent rotational movements. It may be sufficient for both tool parts to be rotated only simultaneously about the tool rotation axis 5. In this way it is easier to control the rotary drives of the tool parts.

As shown in Figure 9 on the base 9 of the lower tool 3 individually replaceable embossing inserts 29 are arranged in succession along a circular path 30 in the direction of the
25 relative rotation movement about the tool rotation axis 5. Embossing contours 31 on the embossing inserts 29 with different shapes project from the base 9 of the lower tool 3 in the direction of travel 4.

Between the embossing inserts 29 brush inserts 32 are provided, the brushes of which project over the embossing contours 31 in the direction of travel 4. The brush inserts 32 are
30 used as a resilient tool bearing for the metal sheet to be processed.

Depending on the relative rotational position of the pressure surface 28 and the embossing contours 31 about the support axis 25 or the workpiece rotational axis 5 coinciding with the support axis 25 the pressure surface 28 is allocated to one of the embossed contours 31.

5 To process a workpiece the upper tool 2 and the lower tool 2 are moved towards one another in the direction of travel 4. Firstly, the brush inserts 32 ensure that the underside of the workpiece is spaced apart from the embossing contours 31. The pressure exerted by the pressure surface 28 on the workpiece means that the workpiece is pressed against the elastic force of the brushes in the region below the pressure surface 28 downwards against the
10 embossing contour arranged there. In this way the respective embossed shape is made in the underside of the workpiece. When the pressure is lifted from the workpiece the brush inserts 32 push the workpiece upwards. As a result the underside of the workpiece lifts up again from the embossing contours 31 in the direction of travel 4. After allocating the pressure surface 28 to a different embossing contour a different embossed shape can be made in the workpiece.

15 An alternative, not shown design of a forming tool is used for forming extrusions in metal sheets. The tool corresponds structurally largely to the tools 1a, 1b, 1c, 1d, 1e, 1f described above. Essentially the extrusion tool differs from the tools 1a, 1b, 1c, 1d, 1e, 1f described above in that it comprises a processing device on a first tool part in the form of a extrusion pin and two counter devices on a second tool part which are designed as extrusion
20 cups.

The extrusion pin and the cups are arranged in such a way that the pin can be allocated by a relative rotational movement of the pin and cups about the tool rotation axis to different extrusion cups. In the actual forming process the extrusion pin and the inside of a extrusion cup have a forming effect on the metal sheet. Depending on the internal dimensions of the extrusion
25 cup on the metal sheet a pushed-through hole is produced with varying dimensions. Accordingly by allocating the extrusion pin with cups to extrusion cups with different internal dimensions as processing parameters, the dimensions of the pushed-through hole produced can be defined to be different.

30 The internal dimensions of the extrusion cups can be selected so that with the extrusion tool by allocation of the extrusion pin to different extrusion cups it is possible to process metal

sheets of different thicknesses. In this case it should be taken into account that the internal dimensions of the extrusion cups also have to increase with increasing sheet thickness.

Figure 10 shows a schematic cross section view of a tool 1g for rolling a metal sheet in a cutting plane containing the tool rotation axis 5. The upper tool 2 comprises a roller 33, which is rotatable about a rotational axis 34 perpendicular to the lifting direction 4. The roller 33 has a conical forming surface 35 as a processing device. On the lower tool 3 a counter roller 36 is provided. The counter roller 36 is rotatable about a rotational axis 37, which is aligned to be parallel to the rotational axis 34 of the roller 33 of the upper tool 2. On the counter roller 36 two conical counter surfaces 38 are provided as counter devices.

To process a metal sheet the upper tool 2 and the lower tool 3 are moved towards one another in the direction of travel 4 until the metal sheet to be processed is clamped between the roller 33 and the counter roller 36. In the clamped state the forming surface 35 of the roller 33 and the opposite counter surface 38 of the counter roller 36 in the direction of travel 4 interact. By moving the metal sheet in a horizontal plane between the two tool parts a shoulder is created on the metal sheet in a continual operation.

Prior to processing the workpiece the forming surface 35 can be allocated to one of the two counter surfaces 38 by a relative rotational movement of the forming surface 35 and the counter surfaces 38 about the tool rotation axis 5. In the case of the tool 1g the distances between the two counter surfaces 38 from the tool rotation axis 5 differ. In this way the distance between the forming surface 35 and the counter surface 38 allocated thereto are different, depending on which of the two counter surfaces 38 of the lower tool 3 the forming surface 35 of the upper tool 2 is allocated to. The different distances are selected to that by changing the allocation of forming surface 35 and counter surface 38 metal sheets of different thicknesses can be processed.

Figures 11 and 12 show a tool 1h for forming a metal sheet, in particular for producing a hinge case on a metal sheet with two different relative rotational positions of the upper tool 2 and lower tool 3 of tool 1h. The upper tool 2 comprises a pressure punch 39 with two counter devices in the form of forming surfaces 40 and 41. The forming surface 40 is provided on a punch nose of the pressure punch 39. The forming surface 41 is formed by a casing surface of a semicircular recess 42 of the pressure punch 39. The forming surfaces 40, 41 follow in succession in the direction of a rotational movement about the tool rotation axis 5.

The lower tool 3 of tool 1h has a bearing surface 43 as a processing device, which during the processing of a workpiece depending on the relative rotational position of the tool parts works together with one of the forming surfaces 40, 41. The bearing surface 43 is provided on a bearing block 44 which in turn comprises a recess 45 that is open at the top.

5 In Figures 11 and 12 an area of the metal sheet to be processed is shown in the form of metal strip 46 with a metal sheet lug 47. To produce a hinge case in a preparatory stage the previously partly cut sheet metal lug 47 is bent upwards by means of the tool 1h in the relative rotational position of the tool parts according to Figure 11 with the interaction of the bearing surface 43 and the forming surface 40.

10 Firstly, the upper tool 2 is lifted from the position shown in Figure 11. Afterwards it is rotated relative to the lower tool 3 about the tool rotation axis 5 until the bent upwards sheet metal lug 47 projects into the semi-circular recess 42 of the pressure punch 39. With tool 1h a rotation of the upper tool 2 about 180° is required. The sheet metal lug 47 meanwhile remains on the bearing surface 43. Afterwards by lowering the upper tool 2 the sheet metal lug 47 is
15 formed to a hinge case by means of the forming surface 41 on the casing surface of the semicircular recess 42 and by means of the bearing surface 43, whereby a part of the pressure punch 39 is lowered into the recess 45 of the bearing block 44.

According to the allocation of the bearing surface 43 to one of the forming surfaces 40, 41 as processing parameters the shape to be achieved can be defined differently.

20 The tools 1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h described above are moved towards one another for tool processing by means of a not-shown, machine-side lifting drive in the direction of travel 4. Furthermore, the two tool parts are rotated respectively by means of also not shown, machine-side rotary drives about the tool rotation axis 5 and secured in the respective relative rotational position. The movement of the workpiece relative to the tool parts is performed by
25 means of a coordinate guide of the tool machine. To control all of the aforementioned drives of the tool machine a numerical control unit is used.

To allocate to one another a processing device and a counter device of one of the tools 1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h for processing a workpiece, the tool rotary drives are controlled by the control unit so that the necessary relative rotational position of the tool part is produced. In
30 the case of a multiple tool the desired processing device for processing a workpiece is also activated by the control unit.

Advantageously, the numerical control unit comprises storage means in which information about the tool, in particular the possible relative rotational positions of the tool parts are stored. Furthermore, for each relative rotational position of the processing and contour devices the processing parameters are stored, which are defined by said relative rotational position. On the basis of processing parameters provided in a processing program the control unit can determine the tool suitable for the respective workpiece processing by referring to the stored tool information and if necessary ensure that the suitable tool is inserted by means of a tool changing device. Furthermore, by means of the control unit the corresponding relative rotational position of the tool parts can be adjusted automatically.

What is claimed is:

CLAIMS

5 1. A tool for processing, in particular cutting and/or forming, plate-like workpieces, in particular metal sheets, with a first tool part (2, 3) and a second tool part (2, 3), which can be moved towards one another in a direction of travel (4) for processing a workpiece arranged between the tool parts (2, 3), wherein at least one processing device (11, 28, 35, 43) is provided on the first tool part (2, 3) and at least two counter devices (15, 31, 38, 40, 41) are
10 provided on the second tool part (2, 3), wherein the processing device (11, 28, 35, 43) on the first tool part (2, 3) and the counter devices (15, 31, 38, 40, 41) on the second tool part (2, 3) can be rotated relative to one another about at least one positioning axis (5, 25), wherein the counter devices (15, 31, 38, 40, 41) on the second tool part (2, 3) follow one another in the direction of the relative rotational movement of the processing device (11, 28, 35, 43) and the
15 counter devices (15, 31, 38, 40, 41), and wherein, by means of said relative rotational movement, the processing device (11, 28, 35, 43) and a counter device (15, 31, 38, 40, 41) for processing the workpiece can be allocated to one another by at least one defined processing parameter, characterised in that at least one processing parameter can be defined differently by allocating the processing device (11, 28, 35, 43) to different counter devices (15, 31, 38, 40,
20 41).

2. The tool according to claim 1, characterised in that the first tool part (2, 3) can be rotated about a tool rotation axis and/or the second tool part (2, 3) can be rotated about a tool rotation axis, and in that at least one tool rotation axis forms a positioning axis (5, 25), about
25 which the processing device (11, 28, 35, 43) and the counter devices (15, 31, 38, 40, 41) can be rotated relative to one another.

3. The tool according to any one of the preceding claims, characterised in that the counter devices (15, 31, 38, 40, 41) on the second tool part (2, 3) follow one another in the
30 direction of the relative rotational movement of the processing device (11, 28, 35, 43) and counter devices (15, 31, 38, 40, 41) about a positioning axis (5, 25) along a circular path (13,

23, 24, 30) at a distance from the relevant positioning axis (5, 25), which is adjusted to the distance of the processing device (11, 28, 35, 43) allocatable thereto from said positioning axis (5, 25).

5 4. The tool according to any one of the preceding claims, characterised in that a cutting edge is provided as a processing device (11, 28, 35) on the first tool part and at least two counter cutting edges are provided as counter devices (15, 31, 38) on the second tool part (3) or at least two portions of a single counter cutting edge are provided on the second tool part (3).

10 5. The tool according to any one of the preceding claims, characterised in that by allocating a cutting edge to different counter cutting edges as processing parameters the width of the cutting gap between the cutting edge and the counter cutting edge allocated thereto can be defined differently.

15 6. The tool according to any one of the preceding claims, characterised in that by allocating a cutting edge to different counter cutting edges as processing parameters the cutting contour produced by means of the cutting edge can be defined differently.

20 7. The tool according to any one of the preceding claims, characterised in that a pressure surface is provided as the processing device (11, 28, 35) and embossing contours are provided as counter devices (15, 31, 38), and in that by allocating the pressure surface to different embossing contours as processing parameters the embossed shape produced by the interaction of the pressure surface and the allocated embossing contour can be defined
25 differently.

30 8. The tool according to any one of the preceding claims, characterised in that a bearing surface is provided as the processing device (43) and forming surfaces are provided as counter devices (40, 41), and in that by allocating the bearing surface to different forming surfaces as processing parameters the shape produced by the interaction of the bearing surface and the allocated forming surface can be defined differently.

9. The tool according to any one of the preceding claims, characterised in that on the first tool part (2) at least two processing devices (11, 28, 35) are provided and the latter can be allocated respectively to at least two counter devices (15, 31, 38) on the second tool part (3).

10. The tool according to any one of the preceding claims, characterised in that on the first tool part (2) at least two processing devices (11, 28, 35) are provided and in that an activating device is provided by means of which one of the processing devices (11, 28, 35) can be activated into a functional state.

11. The tool according to any one of the preceding claims, characterised in that by means of the activating device a processing device (11, 28, 35) can be brought into a functional state, in which it projects towards the workpiece relative to the other processing device(s) (11, 28, 35) during tool processing in the direction of travel (4).

12. The tool according to any one of the preceding claims, characterised in that on the first tool part (2) at least two processing devices (11, 28, 35) are provided which can be allocated to one and the same counter device (15, 31, 38) on the second tool part (3).

13. The tool according to any one of the preceding claims, characterised in that on a base (6) of the first tool part (2) a support (26) provided with at least one processing device (11, 28, 35) is mounted rotatably about a support axis and/or in that on a base (9) of the second tool part (3) a support (26) provided with at least one counter device (15, 31, 38) is mounted rotatably about a support axis, and in that at least one support axis forms a positioning axis (5, 25), about which the processing device (11, 28, 35) and the counter devices (15, 31, 38) can be rotated relative to one another.

14. The tool according to any one of the preceding claims, characterised in that on the first tool (2) at least one processing device (11, 28, 35) is provided on a tool insert (18), which is arranged on a base (6) or on a support (26) that is rotatable relative to the base (6) and/or in that on the second tool part (3) at least one counter device (15, 31, 38) is provided on

a tool insert (22, 29), which is arranged on a base (9) or on a support (26) that is rotatable relative to the base (9).

- 5 15. The tool according to any one of the preceding claims, characterised in that by allocating the processing device (43) to a counter device (40, 41) a processing parameter can be defined for a preparative processing of a workpiece portion, in particular a workpiece lug (47), and in that by allocating the processing device (43) to a different counter device (40, 41) a processing parameter for subsequently processing one and the same workpiece portion, in particular one and the same workpiece lug (47), can be defined.

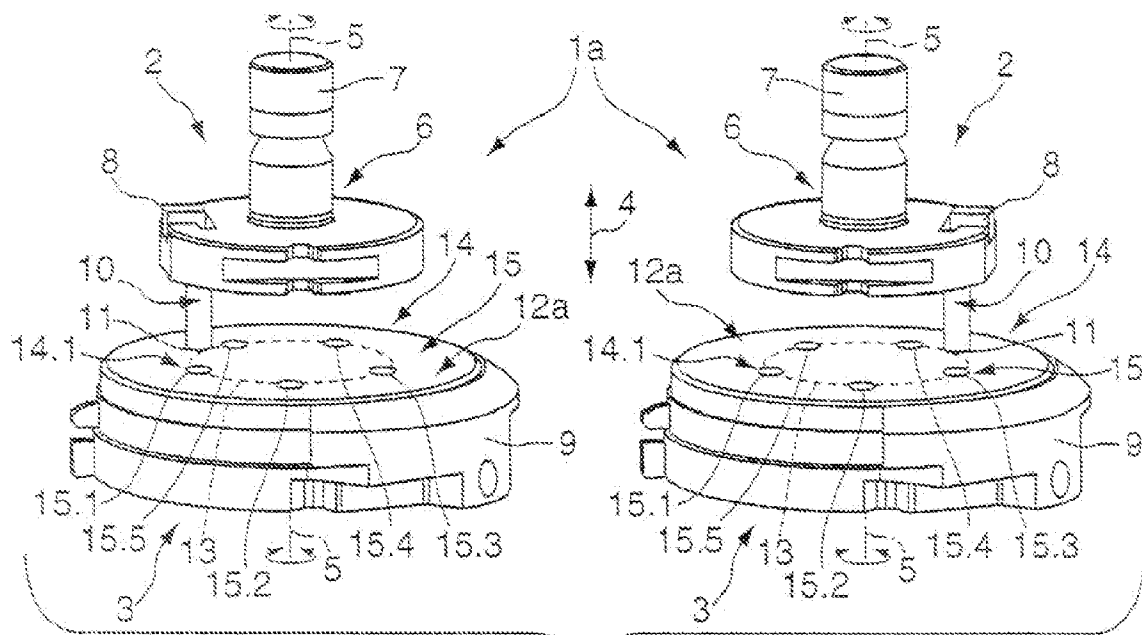


Fig. 1

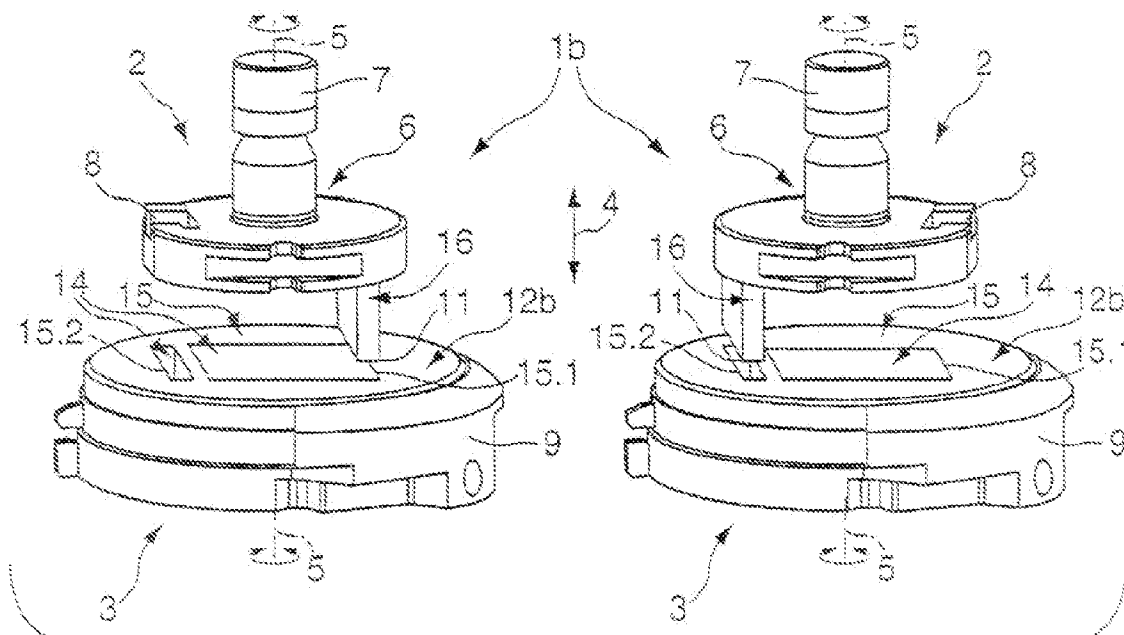


Fig. 2

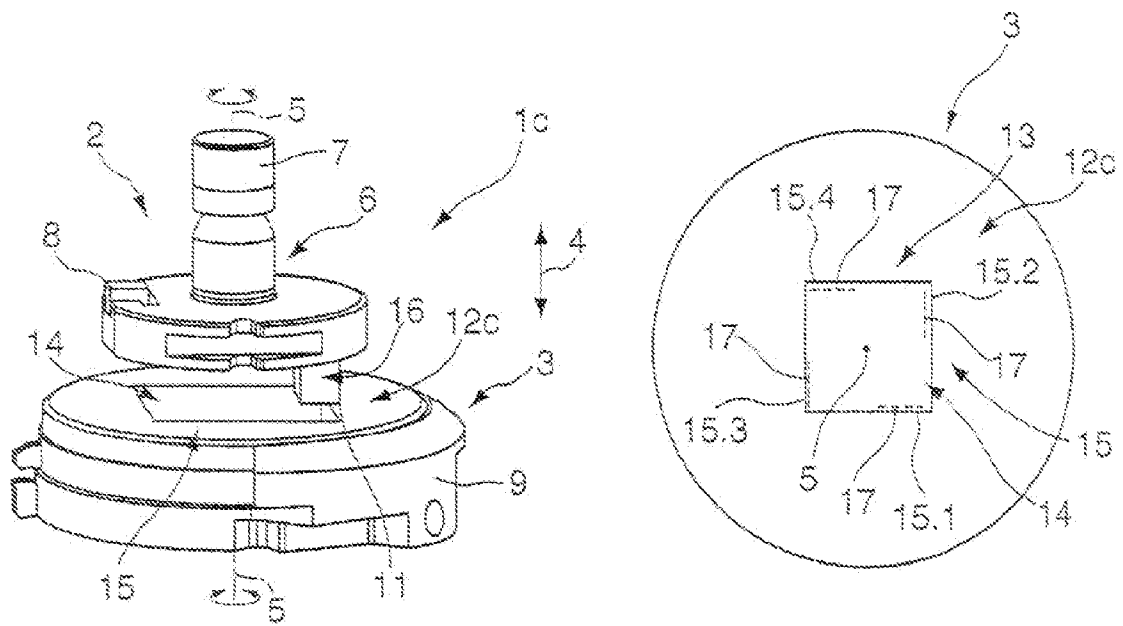


Fig. 3

Fig. 4

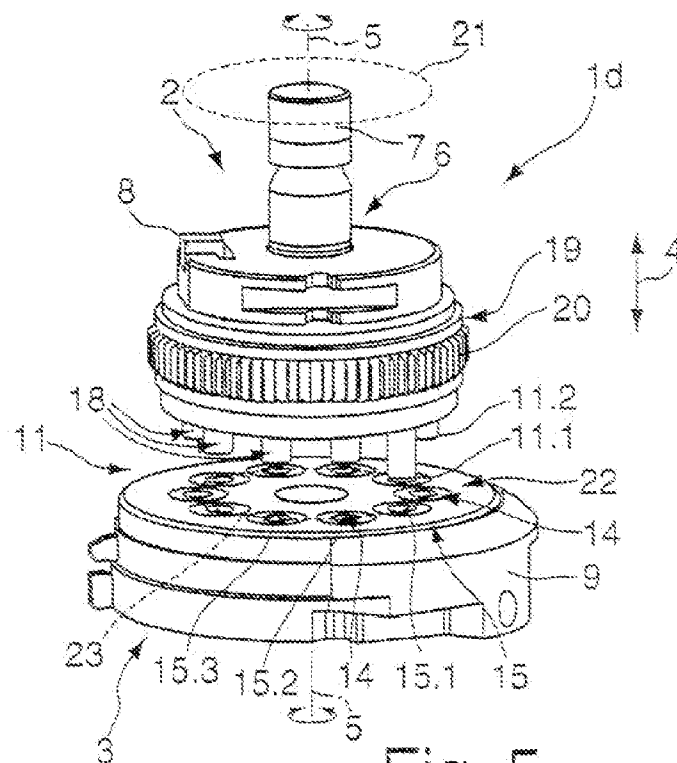


Fig. 5

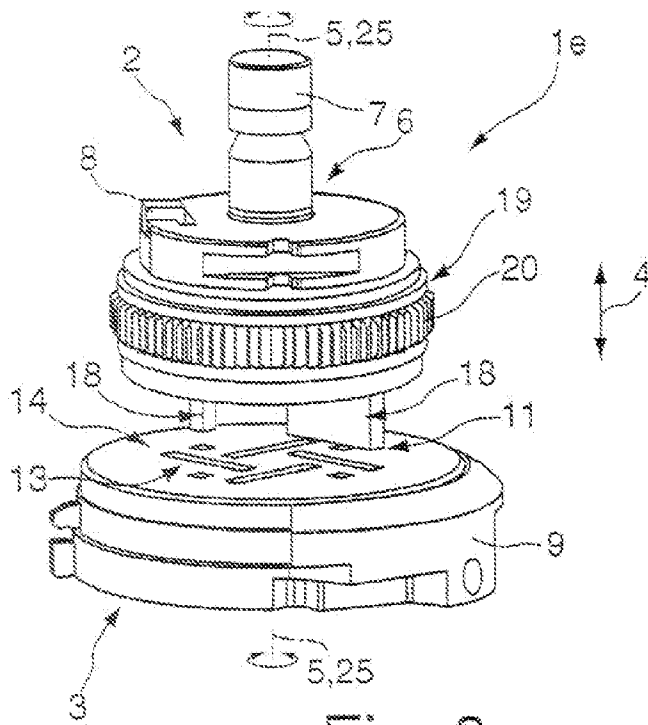


Fig. 6

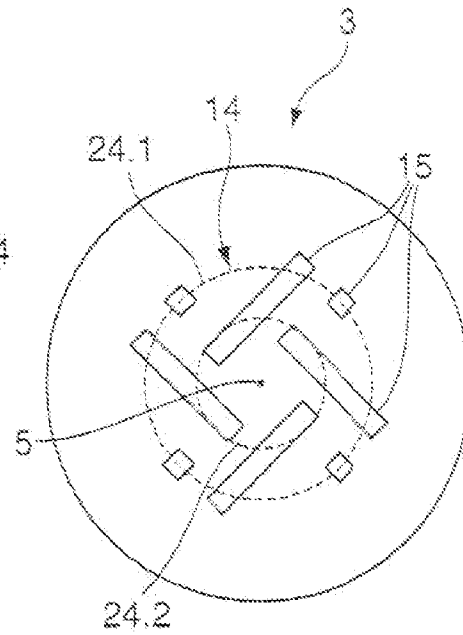


Fig. 7

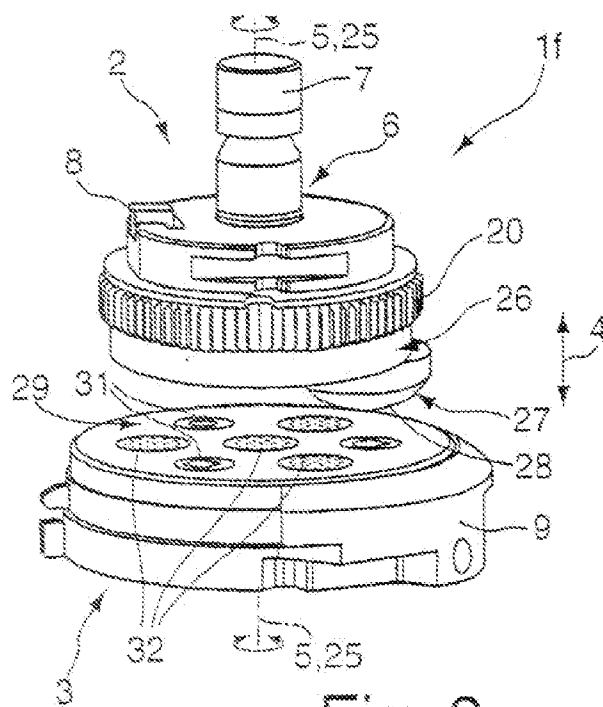


Fig. 8

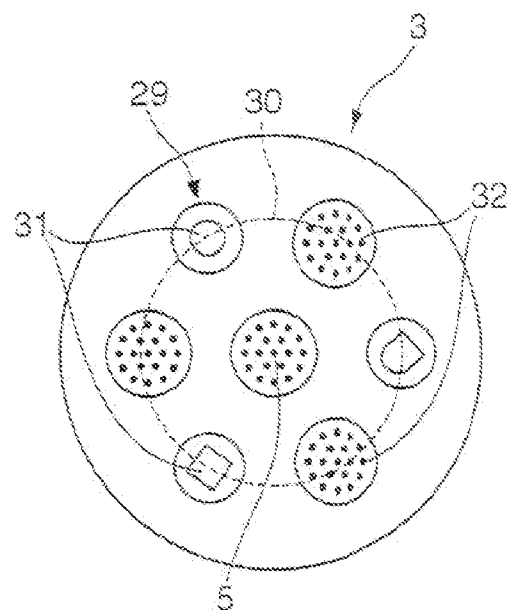


Fig. 9

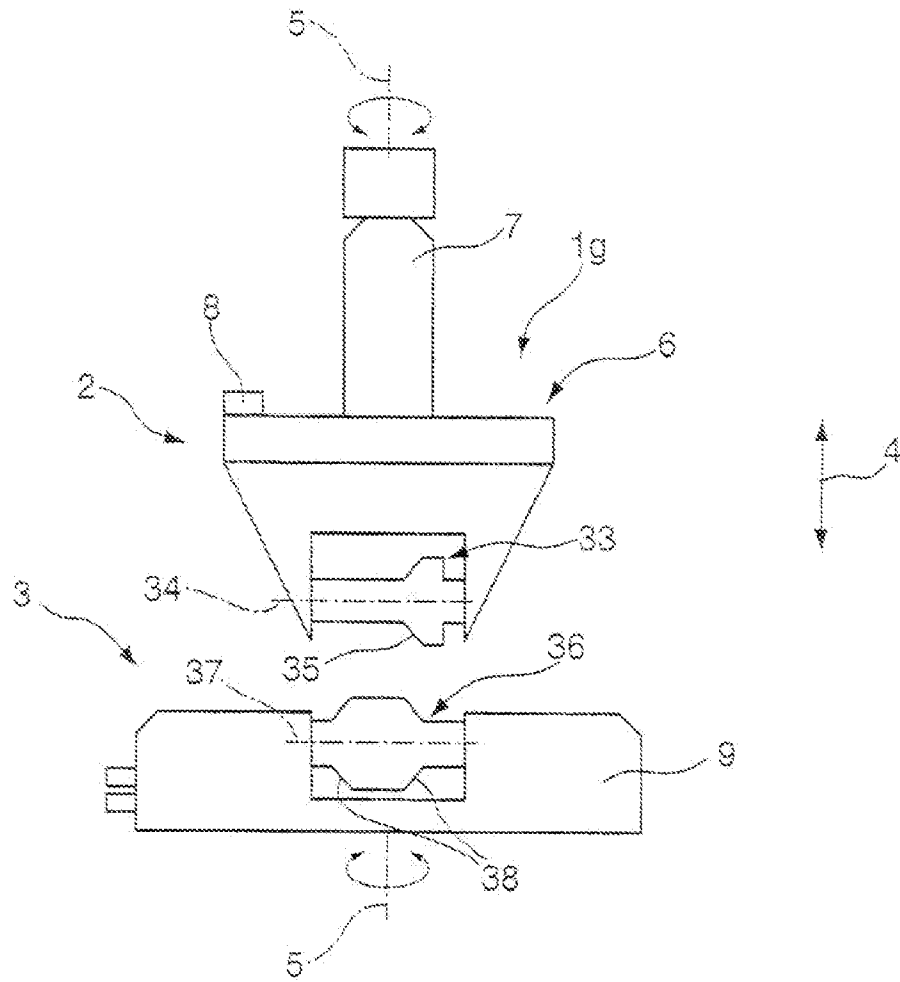


Fig. 10

5/5

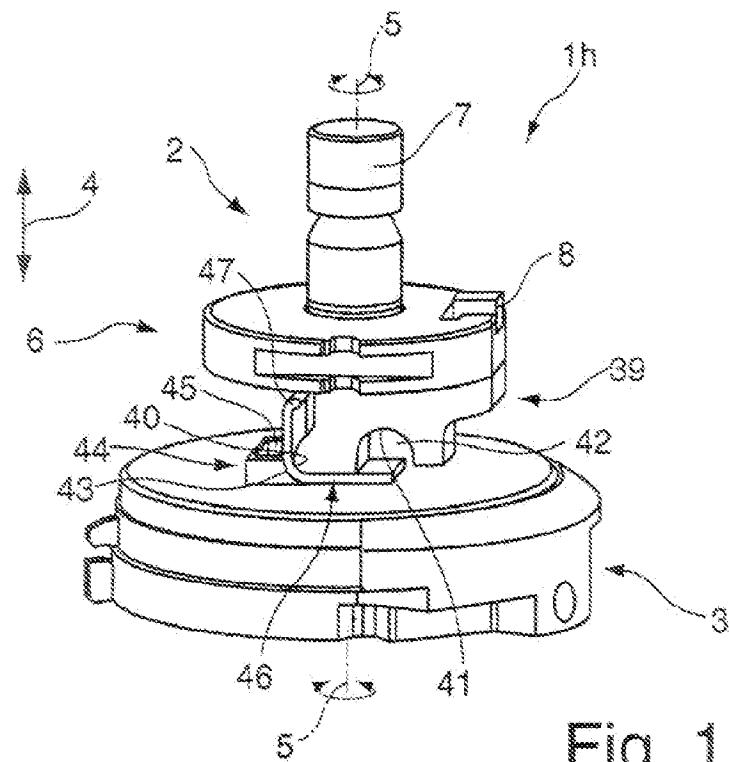


Fig. 11

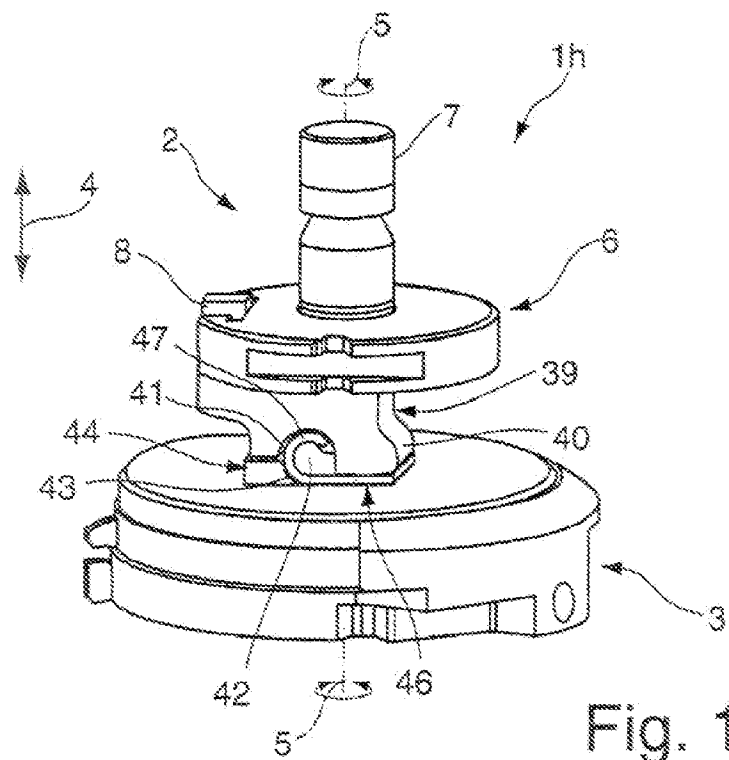


Fig. 12

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2007/081837

A. CLASSIFICATION OF SUBJECT MATTER

INV. B21D28/36 B21D28/12 B21D28/00 B21D28/26 B21D37/02

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B21D

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2005 005214 A1 (TRUMPF WERKZEUGMASCHINEN GMBH [DE]) 17 August 2006 (2006-08-17) paragraph [0027]; claims 1-7; figures 4-6,9,10 paragraph [0035] - paragraph [0036] paragraph [0046] - paragraph [0047]	1-15
X	EP 0 580 124 A (AMADA METRECS CO [JP]) 26 January 1994 (1994-01-26)	1-4,7, 9-11,13, 14
A	column 3, line 27 - column 4, line 1; claims 1-4,6; figures 1-4 ----- -/--	5,6,8, 12,15



Further documents are listed in the continuation of Box C.



See patent family annex.

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- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

Date of the actual completion of the international search

21 January 2008

Date of mailing of the international search report

01/02/2008

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2007/081837

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	page 5, line 127 - page 6, line 17; claim 1; figures 2-6,13,14	5-8,12, 15
X	EP 1 634 663 A (RAINER SRL [IT]) 15 March 2006 (2006-03-15)	1-4, 9-11,13, 14
A	claims 1,2; figures 1-4	5-8,12, 15
A	WO 02/43892 A (TRUMPF GMBH & CO [DE]; ERLENMAIER WERNER [DE]) 6 June 2002 (2002-06-06) cited in the application the whole document	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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