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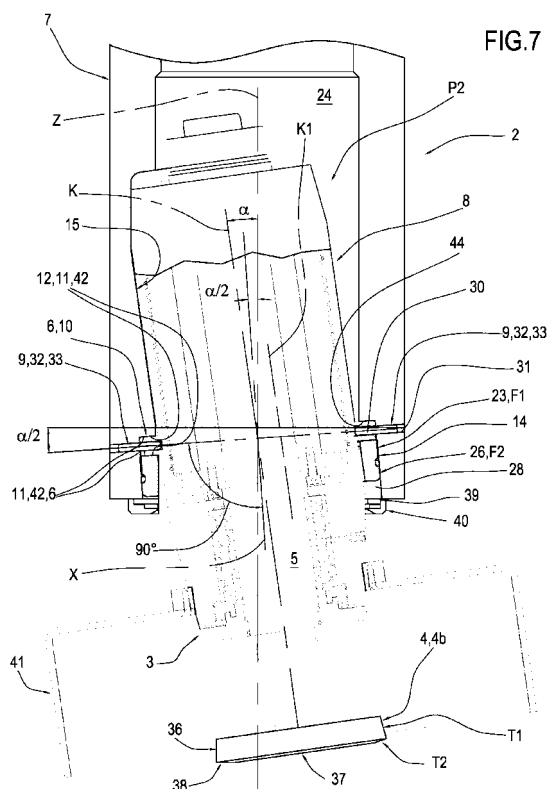
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(54) **Grinding machine and grinding method**

(57) A grinding machine comprises a horizontal workpiece holder table (19) and a grinding head (2) which comprises a spindle (3), with vertical axis (K), mounting a grinding wheel tool (4) and furnished with a shaft (5) connectable to the grinding wheel (4) to set the latter in rotation, the machine (1) further comprising inclining means (6) by which the shaft (5) can be set at an angle and which are configured to allow the shaft (5) to be positioned vertically in a first working position (P1), parallel with the first vertical axis (Z), and inclined at a predetermined acute angle (α) to a vertical direction (Z) in a second working position (P2) to tangentially machine simultaneously a first surface (17) of a workpiece (20), where the first surface (17) is parallel with the vertical direction (Z), and a second surface (18) of the workpiece (20), where the second surface (18) is at right angles to the vertical direction (Z).



Description

[0001] The invention consists in housing, while at the same time limiting the overall dimensions of, a spindle and grinding wheel mounting shaft equipped with a rotation mechanism which makes it possible to quickly vary the angle of the grinding wheel mounting shaft relative to the axis of the sleeve member of a vertical grinder. The invention allows different machining processes, both traditional and non-traditional, to be performed in a short time on a workpiece. The workpiece needs to be located once only. The explanation for this is very simple. With the grinding wheel mounting shaft parallel to the axis of the sleeve member, small diameters and small shoulders can be machined in the traditional manner using cup grinding wheels. By simply turning the spindle by 180° the axis of the grinding wheel mounting spindle forms an angle (α) to the axis of the sleeve member, so that it is possible, with a suitable grinding wheel mounted, to machine simultaneously both the diameter and the shoulder, or to tangentially machine even large surfaces on the inside or outside of the workpiece.

[0002] A need which is felt particularly strongly by operators in the trade is that of having a vertical axis grinder which can be used to perform a plurality of operations simultaneously, such as grinding flat surfaces, shoulders and diameters without having to retool the machine, and whose overall size is particularly limited. The very small size of the invented mechanism allows the sleeve member, in the preferred embodiment, to be inserted, for example, into a hole 310 mm in diameter with the grinding wheel mounting spindle in the position P1, and into a hole 306 mm in diameter P2 for a grindable length equal to the stroke of the sleeve member (700mm).

[0003] Other examples are the machining of shoulders and of inside and outside diameters, the machining of cones and/or conical surfaces (inside and outside) and so on.

[0004] In the majority of cases in the prior art, a vertical axis grinder is equipped with a workpiece holder table and a grinding wheel spindle head which works either with vertical axis or with horizontal axis.

[0005] These machines do not however meet the need for operating flexibility expressed by operators and, moreover, are very cumbersome and thus cannot be used to perform certain machine operations (in particular, inside diameter grinding operations) such as, for example: holes $\varnothing 300$ and 700mm in length, since the sleeve member is too cumbersome. The aim of this invention is therefore to meet the above mentioned needs by providing a grinding machine with a vertical axis sleeve member and an inclinable grinding wheel mounting shaft.

[0006] A further aim of the invention is to provide a grinding machine which is highly versatile, that is to say, which allows a plurality of machine operations to be carried out with great precision. A yet further aim is to propose a grinding method which allows shoulders and diameter surfaces of a mechanical part to be machined

extremely precisely and rapidly.

[0007] According to the invention, the above aims are achieved by a grinding machine comprising the technical characteristics described in one or more of the annexed claims.

[0008] The technical features of the invention, with reference to the above aims, are clearly described in the appended claims and its advantages are apparent from the detailed description which follows, with reference to the accompanying drawings which illustrate a preferred non-limiting example embodiment of it, and in which:

- Figure 1 is a front view of the grinding machine according to this invention, with inclinable grinding wheel mounting shaft;
- Figure 2 is a plan view of the grinding machine;
- Figure 3 is a plan view of a detail of the machine of Figures 1 and 2;
- Figure 4 is a cross section of the detail of Figure 3 through the section plane IV-IV in a first operating configuration;
- Figure 5 is an exploded perspective view of the detail of Figures 3 and 4 according to the invention;
- Figure 6 schematically illustrates the possible machine operations that can be performed with the machine according to the invention;
- Figure 7 is a cross section of the detail of Figure 3, according to the invention, through the section plane IV-IV in a second operating configuration;
- Figure 8 schematically illustrates another possible machine operation that can be performed with the machine according to the invention.

[0009] With reference to the accompanying drawings, the numeral 1 denotes a grinding machine according to the invention.

[0010] Figures 1 and 2 illustrate the machine in its entirety in a front view and in a plan view, respectively.

[0011] The machine 1 comprises a workpiece holder table 19, preferably equipped with means for rotationally driving it and/or for moving it (of known type and therefore not described or illustrated).

[0012] The workpiece holder table 19 is preferably of the magnetic type, or in any case equipped with means for holding the workpiece 20 and configured to allow the workpiece 20 to be locked to the surface of the table 19.

[0013] The reference numeral 2 denotes a grinding head 2 or a work head 2 (clearly visible in Figure 3 and partly hidden in Figure 1 by a door 43 which closes the operating area of the machine 1).

[0014] The grinding head 2 comprises a spindle 3 (hereinafter also referred to as grinding wheel 4), equipped with a shaft 5 connectable to the grinding wheel 4 to drive it in rotation to allow the workpiece 20 locked to the workpiece holder table 19 to be machined.

[0015] The grinding head 2 comprises an outer covering sleeve member 7 configured to house the spindle 3. In effect, it may be observed in Figure 4 that the sleeve

member 7 comprises an internal cavity 24 for housing the spindle 3.

[0016] The internal housing cavity 24 is substantially cylindrical in shape; this shape will be described in more detail below.

[0017] The spindle 3 comprises a shell 8 which rotatably mounts the shaft 5.

[0018] The shell 8 is shaped to fit (with clearance) into the cavity 24 of the sleeve member 7.

[0019] It should be noted that the shaft 5 is supported by the shell 8 by means of bearings. Thus, the shaft 5 can be driven in rotation relative to the shell 8. More specifically, the shaft 5 is connected to a motor, not illustrated, which drives the grinding wheel 4 in rotation.

[0020] According to the invention, the grinding wheel mounting shaft 5 may adopt two working positions, namely, a first working position P1, where the shaft 5 is vertical, and a second working position P2, where the shaft 5 is inclined at a predetermined acute angle α to a vertical direction Z so as to machine (tangentially) a first surface 17 (diameter surface), which is parallel with the vertical direction Z, and a second surface 18 (shoulder), which is at right angles to the vertical direction Z, simultaneously or almost simultaneously, as will become clearer as this description continues.

[0021] Thus, it should be noted that, more generally speaking, the machine 1 comprises inclining means 6 by which the shaft 5 can be set at an angle and which are configured to allow the shaft 5 to be positioned vertically in the first working position P1 and inclined at a predetermined acute angle α to the vertical direction Z in the second working position P2 such as to tangentially machine simultaneously a first surface 17 of a workpiece 20, where the first surface 17 is parallel with the vertical direction Z, and a second surface 18 of the workpiece 20, where the second surface 18 is at right angles to the vertical direction Z.

[0022] The inclining means 6 are described in more detail below. It should be noted, however, that the description which follows must be considered as a non-limiting example of the invention.

[0023] Described below by way of an example is a preferred embodiment, illustrated in Figures 4 and 7, of a preferred mechanism for inclining the shaft 5 between the aforementioned positions P1 and P2. With reference to the accompanying drawings, the shell 8 comprises a peripheral ring 10 having a central axis X which is inclined to the axis K of the shaft 5 at an angle equal to half the predetermined angle α (angle $\alpha/2$).

[0024] The ring 10 comprises an upper annular surface 21 and a lower annular surface 22, defining two respective parallel planes PP1 and PP2.

[0025] It should be noted that the straight lines which are normal (at right angles) to these planes (PP1, PP2) are inclined to the axis K of the shaft 5 at an angle equal to half the predetermined angle α (angle $\alpha/2$).

[0026] According to the preferred embodiment of the invention, the work head 2 comprises a guide 42 for the

ring 10.

[0027] The guide 42 is associated with the sleeve member 7. More specifically, in the example illustrated, the guide 42 is defined by the selfsame sleeve member 7 (in particular by an annular surface 44 which is inclined to the vertical at an angle equal to half the predetermined angle α) and partly by a bushing 14 which forms part of the work head 2 and which can be associated removably with the sleeve member 7.

[0028] The guide 42 is configured to allow the shell 8 to rotate about the central axis X of the ring 10 to take the shaft 5 to one of either the first position P1 or the second position P2

[0029] More generally speaking, the guide 42 defines means 11 by which the shell 8 is guided between the working positions P1, P2 and which are associated with the sleeve member 7.

[0030] The bushing 14, clearly visible in Figure 5, can be screwed to the sleeve member 7 (it should be noted that for this purpose the bushing 14 has a threaded portion F1).

[0031] The bushing 14 is cylindrical in shape. More specifically, it has a through hole 27 made in it. When the bushing 14 is coupled to the sleeve member 7, the shell 8 is inserted through the hole 27.

[0032] The bushing 14 comprises an upper annular surface 12.

[0033] Further, a portion 23 of the outer lateral surface of the bushing 14 is provided with threading F1 configured to be screwed to a respective threaded portion 25 of the lateral surface of the cavity 24 of the sleeve member 7.

[0034] Another portion 26 of the outer lateral surface of the bushing 14 is provided with toothing F2, that is to say, it is circumferentially provided with teeth.

[0035] The cavity 24 comprises, at the bottom opening, a cylindrical portion 28 having a central axis which is inclined at an angle equal to half the predetermined angle α (angle $\alpha/2$).

[0036] It should be noted that the threaded portion 25 of the sleeve member 7 is made at the cylindrical portion 28 whose central axis is inclined at an angle equal to half the predetermined angle α (angle $\alpha/2$).

[0037] It should therefore be noted that, when the bushing 14 is screwed to the cylindrical portion 28, the straight line at right angles to the upper surface of the 12 of the bushing 14, is substantially inclined to the vertical at an angle corresponding to half the predetermined angle α .

[0038] The work head 2 further comprises a pinion 29 which is meshed with the bushing 14 in order to drive it in rotation.

[0039] In particular, it should be noted that the pinion 29 is rotatably connected to the sleeve member 7. More specifically, it should be noted that the pinion 29 is provided with toothing which meshes with the toothing of the bushing 14 to form a gear. More generally speaking, the gear defines means 34 for driving the bushing 14 in rotation and which can be operated by the user in order to

rotate the bushing 14 in such a way as to impart to the bushing 14 a translational movement within the cavity 24 (and more specifically, within the portion 28) along a direction K1 parallel to the axis of the cylindrical portion 28.

[0040] According to another aspect, it should be noted that the sleeve member 7 has two radial holes 30 made in it (in the example illustrated, the holes 30 are located at 180° to each other).

[0041] The ring 10 also has peripherally made in it a pair of radial holes 31 (whose angular spacing from each other corresponds to that of the holes 30).

[0042] It should be noted that the radial holes 30 and 31 of the sleeve member 7 and of the ring 10 are configured to be engaged by pins 32. More specifically, each pin 32 engages one radial hole 30 and one radial hole 31.

[0043] The pins 32, as described in more detail below, make it possible to stop the rotation of the shell 8 with respect to the sleeve member 7, that is to say, they prevent the rotation of the shell 8 relative to the sleeve member 7.

[0044] More generally speaking, it should be noted that the pins 32 define anti-rotation means 33 of the shell 8 relative to the sleeve member 7.

[0045] Still more generally speaking, it should be noted that the pins 32 and the bushing 14 define means 9 for locking the shell 8 relative to the sleeve member 7 at the aforementioned positions (P1, P2). As shown in the accompanying drawings, the work head 2 also comprises a further ring 39, located at the opening of the cavity 24, and a cover 40 for closing the ring 39.

[0046] Also shown is a protective guard 41.

[0047] In the preferred embodiment, the ring 10 and the guide means 11 define, more in general, the inclining means 6 by which the shaft 5 is tilted between the first working position P1 and the second working position P2.

[0048] Below is a description of how the grinding machine 1 according to the invention operates, with reference in particular to certain machining cycles of mechanical workpieces.

[0049] Figure 4 illustrates the shaft 5 in the first working position P1 (with the axis K vertical).

[0050] In the working position P1, the machine 1 preferably has installed on it cylindrical grinding wheels 4 of the type labelled 4a in Figure 6.

[0051] With reference to Figure 6 again, the machine 1, when fitted with grinding wheels of type 4a, can machine diameters (these machine operations are labelled 35c in Figure 6) as well as inclined surfaces (these machine operations are labelled 35a and 35d in Figure 6).

[0052] It should be noted that in order to perform the machine operations (35a and 35d) on inclined surfaces 16 of the workpiece 20, the entire work head 2 (that is, the sleeve member 7) of the machine 1 is inclined by an angle corresponding to that of the inclined surface 16 being machined.

[0053] In other words, the axis K of the shaft 5 is positioned so it is substantially parallel to the inclined surface 16 to be machined.

[0054] Thus, according to this aspect, the machine 1 comprises further rotation means by which the sleeve member 7 is rotated about a direction Q (horizontal in the embodiment illustrated) at right angles to the vertical direction Z, and which are configured to allow the entire sleeve member 7 to be rotated in such a way that the axis K of the shaft 5 is parallel to an inclined surface 16 of the workpiece 20.

[0055] Advantageously, these rotation means allow the machine 1 to work conical surfaces 16 (machine operations 35a and 35d, Figure 6) with extreme precision. Indeed, the shaft axis K is aligned (positioned so it is inclined at the same angle to the vertical Z) with the surface 16 being machined and the grinding wheel 4 and the workpiece 20 are moved relative to each other along a direction parallel to the axis K of the selfsame shaft 5 (this may be done by moving the workpiece holder table 19 or the work head 2).

[0056] Figure 7 illustrates the shaft 5 with a grinding wheel of the type labelled 4b in Figure 6. The grinding wheel 4b has a lateral surface 36 which is inclined to its axis W, and an underside surface 37 which is substantially at right angles to its axis W.

[0057] Preferably, the lateral surface 36 is inclined at the predetermined angle α to its axis W.

[0058] It should be noted that the underside surface 37 of the grinding wheel 4b is connected to the lateral surface by a surface 38 which is inclined (to the axis W) in the opposite direction to the surface 36.

[0059] It should be noted that the inclined surface 38 preferably makes a 90° angle with the lateral surface 36.

[0060] More generally speaking, the grinding wheel 4b comprises two frustoconical portions: an upper portion T1 and a lower portion T2 (considerably smaller in volume).

[0061] Starting from the first working position P1, the operator, in order to perform the machine operations labelled 35b and 35e, must take the shaft 5 to the second working position P2.

[0062] To do that, the operator removes the pins 32 from the holes 30, thereby disengaging the shell 8 from the sleeve member (that is to say, removing the lock which prevents rotation of the shell 8 relative to the sleeve member 7).

[0063] After removing the pins 32, the user operates on the pinion 29 in such a way as to set it in rotation.

[0064] Rotating the pinion 29 (which, as mentioned above, is kinematically linked to the bushing 14) causes the bushing 14 to rotate relative to the sleeve member 7.

[0065] It should be noted that the bushing 14, since it is screwed to the sleeve member 7, is made to translate along the direction labelled K1 (more specifically, it is made to translate away from the inclined surface 44 of the sleeve member 7).

[0066] The shell 8 is made to rotate (manually in the example illustrated) by 180° about the axis X, which is inclined to the vertical direction Z by half the angle α (angle $\alpha/2$).

[0067] It should be noted that during rotation, the shell 8 rests on the upper surface 12 of the bushing 14, which thus makes it possible to guide the rotation of the shell 8 between the working positions (P1, P2).

[0068] Preferably, this rotation is performed manually.

[0069] Preferably, but not necessarily, the inside lateral surface of the cavity 24 of the sleeve member 7 comprises a portion 15 (hereinafter referred to as surface 15) which is shaped to form an abutment stop for - preventing the rotation of - the shell 8.

[0070] It should be noted that, in the embodiment illustrated, once the shell 8 has been rotated by 180°, the pins 32 are inserted into the respective housing holes (30,31) of the shell 8 and the sleeve member 7.

[0071] Thus, the pins 32 guarantee that the shell 8 is angularly centred relative to the sleeve member 7 both in the first working position P1 and in the second working position P2.

[0072] In Figure 7 the shaft 5 is in the second working position P2.

[0073] It should be noted that in the second working position P2 the shaft 5 is inclined to a vertical direction Z at an angle corresponding to the predetermined angle α (in this regard, see the angle subtended between the shaft axis K and the vertical Z in Figure 7).

[0074] In the example illustrated the predetermined angle α is an angle of 8°. Hence, half that angle (angle $\alpha/2$) is 4°.

[0075] More generally speaking, it should be noted that the angle is an acute angle (that is, smaller than 90°), and still more preferably, it is an angle less than 20°.

[0076] In the configuration of Figure 7 (shaft 5 in the second working position P2), the operator inserts the pins 32 into the holes 30 and 31 to prevent the shell 8 from rotating relative to the sleeve member 7.

[0077] The pins 32 keep the shaft 5 in a predetermined position.

[0078] It should also be noted that the operator once again acts on the pinion 29 to set the bushing 14 in rotation (in the opposite direction to that of the preceding rotation) causing it to translate along the direction K1 (towards the surface 44) in such a way as to tighten the ring 10 between the surface 44 of the sleeve member 7 and the upper surface 12 of the bushing 14.

[0079] It should be noted that in the configuration of Figure 7, the grinding wheel 4b can machine diameters (surface 17) and shoulders (surface 18) simultaneously.

[0080] In effect, with reference to Figure 6, the machine 1, when in this configuration, can perform the operations labelled 35b and 35e, tangentially machining a shoulder (horizontal surface 18) and a diameter (vertical surface 17) almost simultaneously.

[0081] It should be noted that the machine 1 can advantageously work on shoulders and inside diameters (machine operation 35e) even of small holes, without having to use shaft extensions connected to the shaft 5 (which inevitably lead to machining errors on account of misalignments with the axis K).

[0082] Advantageously, these shoulder and diameter machine operations are extremely precise, also because they are carried out without changing any tool or retooling the machine 1 in any way.

[0083] With reference to the ring 10, the following should be noted.

[0084] The ring 10 abuts on the top of it with the surface 44 of the sleeve member 7 and its underside with the surface 12 of the bushing 14.

[0085] It should be noted that in passing from the vertical position P1 to the inclined position P2 of the shaft, all the operator does is to rotate the shell 8 about an inclined axis X, at right angles to the surfaces 44 and 12.

[0086] Further, it should be noted that the inclining means 6 are configured to rotate the shaft 5 between the first and second positions (P1, P2) about an axis X which is inclined at an angle corresponding to half the predetermined angle α to the vertical direction Z.

[0087] Thus, the surface 44 and the surface 12 define an abutment and a guide for the ring 10. In particular, they define the guide 42.

[0088] It should also be noted that the pins 32 determine the angular centring of the shell 8 relative to the sleeve member 7, guaranteeing that the shaft is precisely and securely positioned in both positions P1 and P2.

[0089] Also defined according to the invention is a method for grinding a shoulder 18 and a diameter surface 17 (cylindrical) of a mechanical workpiece 20. The method comprises the following steps:

- preparing a grinding head 2 which comprises a spindle 3 mounting a grinding wheel 4 and equipped with a shaft 5;
- positioning the shaft 5 angularly so it is inclined at a predetermined angle α to a vertical direction Z;
- preparing a grinding wheel 4b having a first surface 36 which is inclined at an angle to an axis W of the selfsame grinding wheel 4b and a second surface 37 which is substantially at right angles to the axis W;
- connecting the grinding wheel 4b to the shaft 5;
- moving the grinding wheel 4b, once set in rotation, into contact with the shoulder 18 and/or with the diameter surface of the workpiece 20 in order to perform a machine operation.

[0090] Preferably, according to the method, the first surface 36 of the grinding wheel 4b is inclined at the predetermined angle α to the axis W of the selfsame grinding wheel 4b.

[0091] Preferably, the grinding wheel 4b comprises a third surface 38 connecting the first surface 36 and the second surface 37 and inclined at an angle to the axis W.

[0092] Further, still more preferably, the third surface 38 is at right angles to the first surface 36. Advantageously, the method allows a shoulder (surface 18) and a diameter surface (surface 17) to be simultaneously machined tangentially in an extremely precise and rapid manner. Indeed, it is not necessary to retool the machine

1 in any way between one machine operation and the other, since the two can be performed substantially simultaneously and with the same tool 4b.

[0093] It should be noted that the third surface 38 machines the shoulder 18 - tangentially - while the first surface machines the diameter surface 17 - also tangentially.

[0094] These machine operations can be performed simultaneously.

[0095] Figure 8 illustrates a grinding wheel 4c having a first portion T3, whose characteristics are similar to those of the grinding wheel 4b, as well as a second, frustoconical upper portion T4.

[0096] The frustoconical upper portion T4 comprises an upper surface 46 which is parallel to the lower surface 37, and a connecting surface 45 between the upper surface 46 and the lateral surface 36.

[0097] The connecting surface 45 is inclined to the axis W in the same direction as the lateral surface 36.

[0098] It should be noted that when the shaft 5 is in the second position P2 (as illustrated in Figure 8) the surface 45 allows "undercut" machining of a surface of the workpiece.

[0099] In other words, the grinding wheel 4c is inserted into a hole of the mechanical workpiece and is brought into contact - usually by a movement from the bottom up - with a horizontal surface of the workpiece 20.

[0100] Thus, the surface 45, at the top, comes into contact with the horizontal surface of the workpiece in order to machine it.

[0101] It should be noted that in an embodiment not illustrated, the shaft 5 might, without departing from the scope of the inventive concept, be inclinable to the vertical direction Z (in the same way and by the same means as those described above) at an angle α opposite to that shown in Figure 1. The invention described is susceptible of industrial application and may be modified and adapted in several ways without thereby departing from the scope of the inventive concept. Moreover, all details of the invention may be substituted by technically equivalent elements.

Claims

1. A grinding machine comprising a horizontal workpiece holder table (19) and a grinding head (2) which comprises a spindle (3), with vertical axis (K), mounting a grinding wheel tool (4) and furnished with a shaft (5) connectable to the grinding wheel (4), **characterized in that** it further comprises inclining means (6) by which the shaft (5) can be set at an angle and which are configured to allow the shaft (5) to be positioned:

- vertically in a first working position (P1);
- and inclined at a predetermined acute angle (α) to a vertical direction (Z) in a second working

position (P2) such that the grinding wheel (4) tangentially machines a first surface (17) of a workpiece (20), where the first surface (17) is parallel with the vertical direction (Z), and a second surface (18) of the workpiece (20), where the second surface (18) is at right angles to the vertical direction (Z).

2. The machine according to claim 1, wherein the inclining means (6) are configured to rotate the shaft (5) between the first and second positions (P1, P2) about an axis (X) which is inclined at an angle ($\alpha/2$) corresponding to half the predetermined angle (α) to the vertical direction (Z).

3. The machine according to claim 1 or 2, wherein the spindle (3) comprises a shell (8) which rotatably carries the shaft (5) and wherein the grinding head (2) comprises an outer covering sleeve member (7) configured to house the shell (8) in two different positions corresponding, respectively, to the first position (P1) and to the second position (P2) of the shaft (5) the inclining means (6) comprising guide means (11) by which the shell (8) is guided between the working positions (P1, P2) and which are associated with the sleeve member (7).

4. The machine according to claim 3, wherein the inclining means (6) comprise a ring (10) fixed to the shell (8) and having a central axis (X) which is inclined at an angle equal to half the predetermined angle (α) to the axis (K) of the shaft (5) and the guide means (11) comprise a guide (42) by which the ring (10) is guided, which is solidly connectable to the sleeve member (7) and which is configured to allow the shell (8) to rotate about the central axis (X) to move the shaft (5) to the first working position (P1) or to the second working position (P2).

5. The machine according to claim 4, wherein the guide (42) comprises an upper annular surface (44) which is inclined at an angle equal to half the predetermined angle (α) to the vertical direction (Z) and which is configured to form an upper abutment for the ring (10), and a lower annular surface (13) which is inclined at an angle equal to half the predetermined angle (α) to the vertical axis and which is configured to form a lower abutment for and to support the ring (10).

6. The machine according to the preceding claim, comprising a bushing (14) which can be screwed to the covering sleeve member (7), the lower annular surface (13) being a surface of the bushing (14).

7. The machine according to any of the claims from 3 to 6, wherein the covering sleeve member (7) comprises an inside surface (15) shaped to form an abut-

ment stop for the shell (8) in the second working position (P2).

8. The machine according to any of the claims from 3 to 7, comprising means for rotating the sleeve member (7) about a direction (Q) at right angles to the vertical direction (Z) and which are configured to allow the entire sleeve member (7) to rotate in such a way as to position the axis (K) of the shaft (5) parallel to an inclined surface (16) of the workpiece (20). 5
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9. The machine according to any of the claims from 3 to 8, comprising means (9) for locking the shell (8) relative to the sleeve member (7) in the positions (P1, P2). 15

10. A method for grinding a shoulder (18) and a diameter surface (17) of a workpiece (20), comprising the following steps: 20
 - preparing a grinding head (2) which comprises a spindle (3) mounting a grinding wheel (4) and equipped with a shaft (5), the method being **characterized in that** it comprises the following steps: 25
 - positioning the shaft (5) angularly so it is inclined at a predetermined angle (α) to a vertical direction (Z);
 - preparing a grinding wheel (4b) having a first surface (36) which is inclined at an angle to an axis (W) of the selfsame grinding wheel (4b) and a second surface (37) which is substantially at right angles to the axis (W); 30
 - connecting the grinding wheel (4b) to the shaft (5); 35
 - moving the grinding wheel (4b), once set in rotation, into contact with the shoulder (18) and/or with the diameter surface (20) for tangential grinding. 40

11. The method according to claim 10, wherein the first surface (36) is inclined at the predetermined angle (α) to the axis (W) of the grinding wheel (4b). 45
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FIG.1

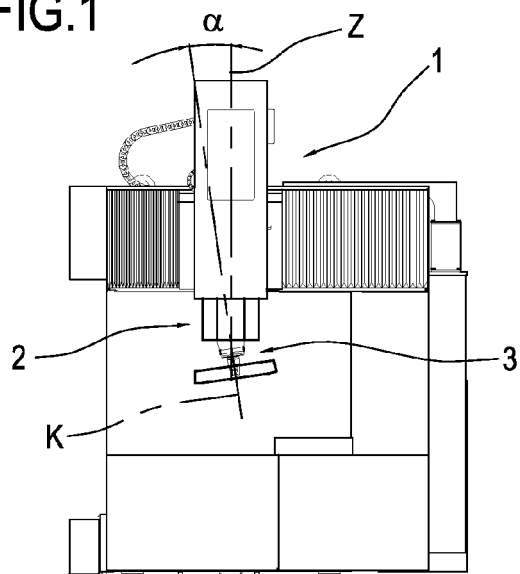


FIG.2

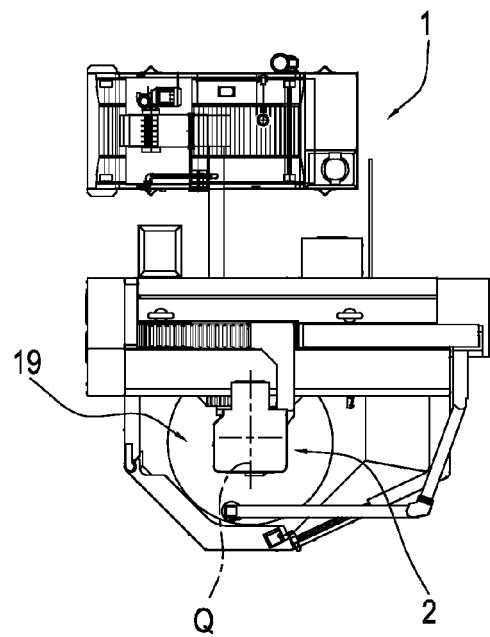


FIG.3

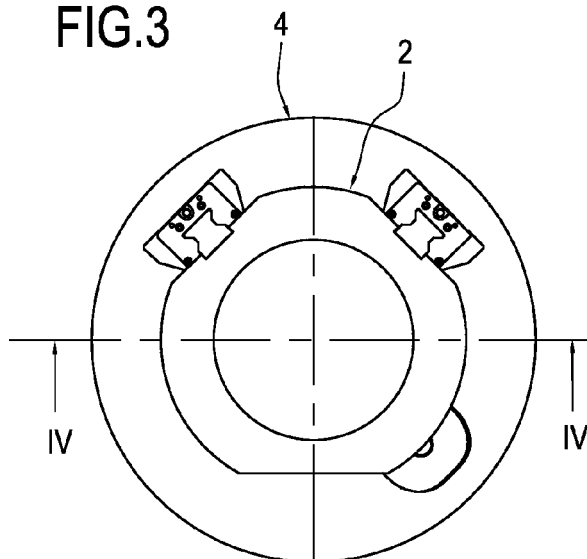


FIG.4

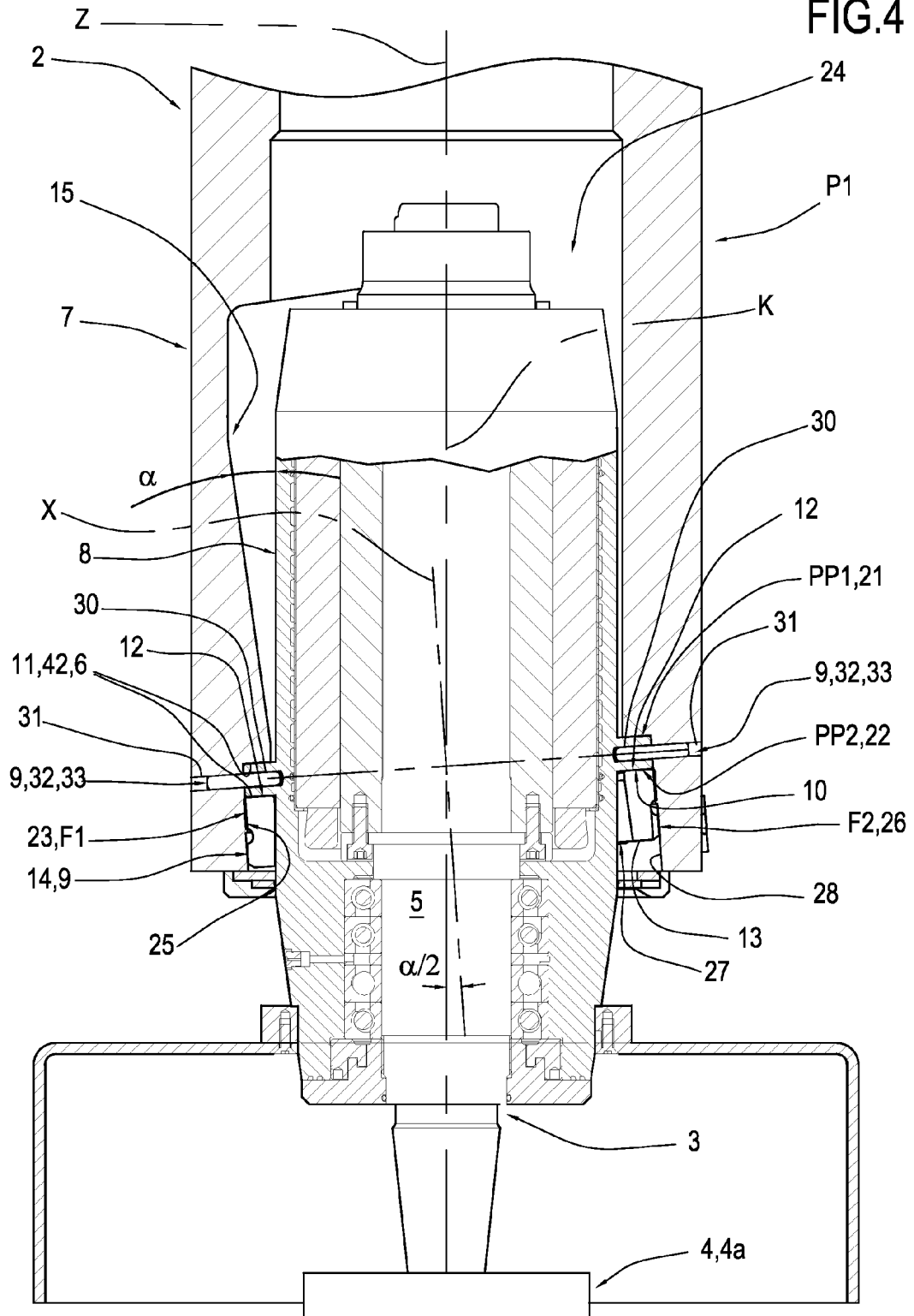


FIG.5

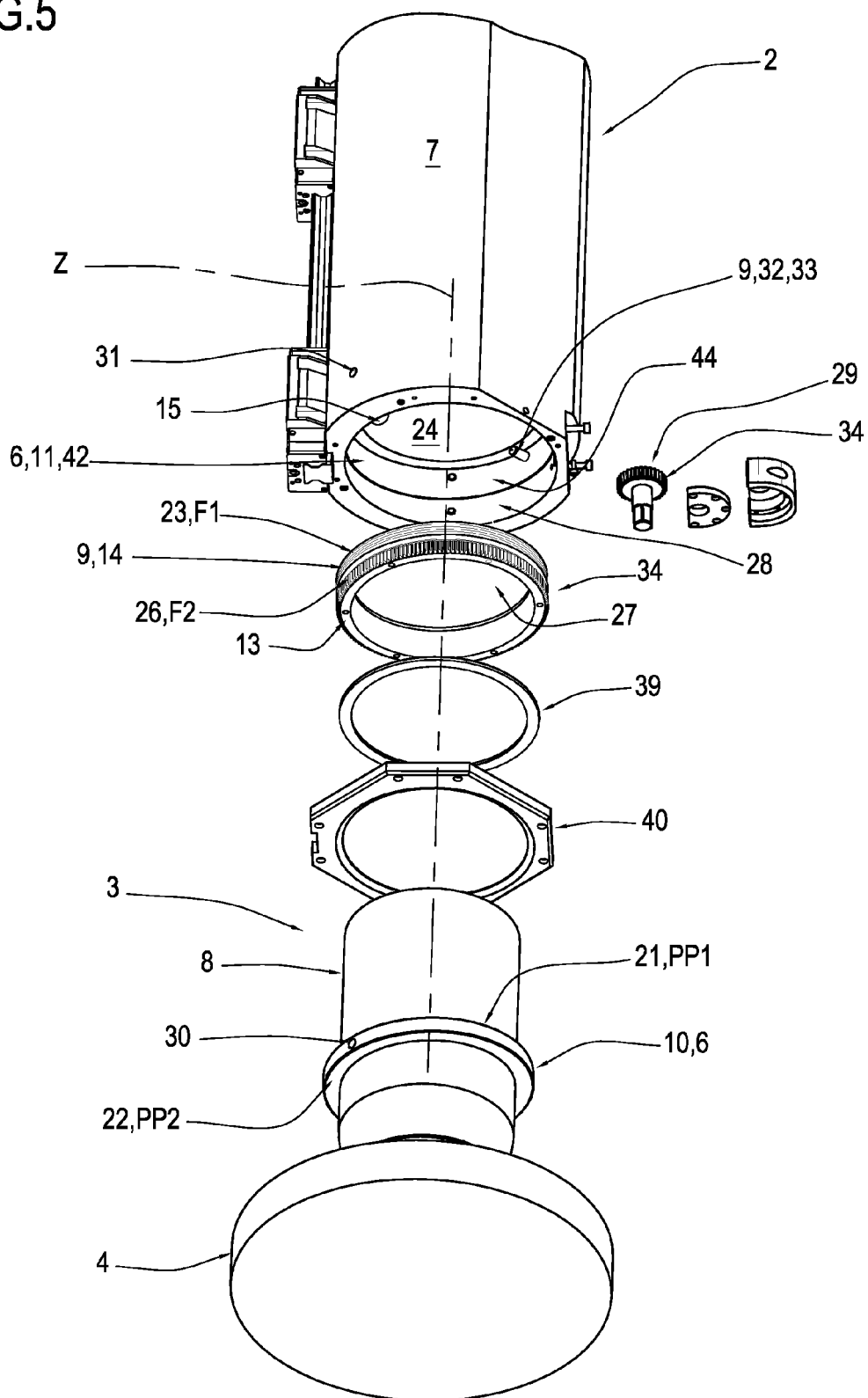
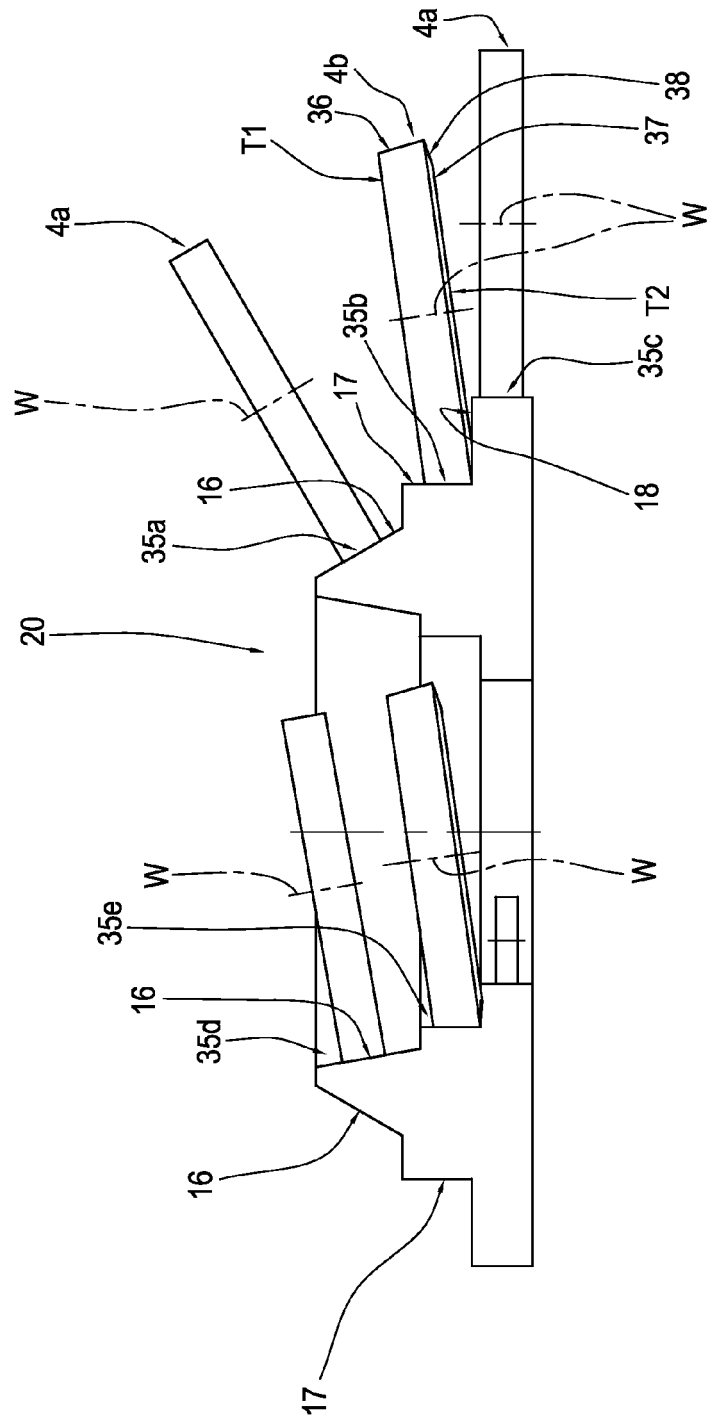


FIG.6



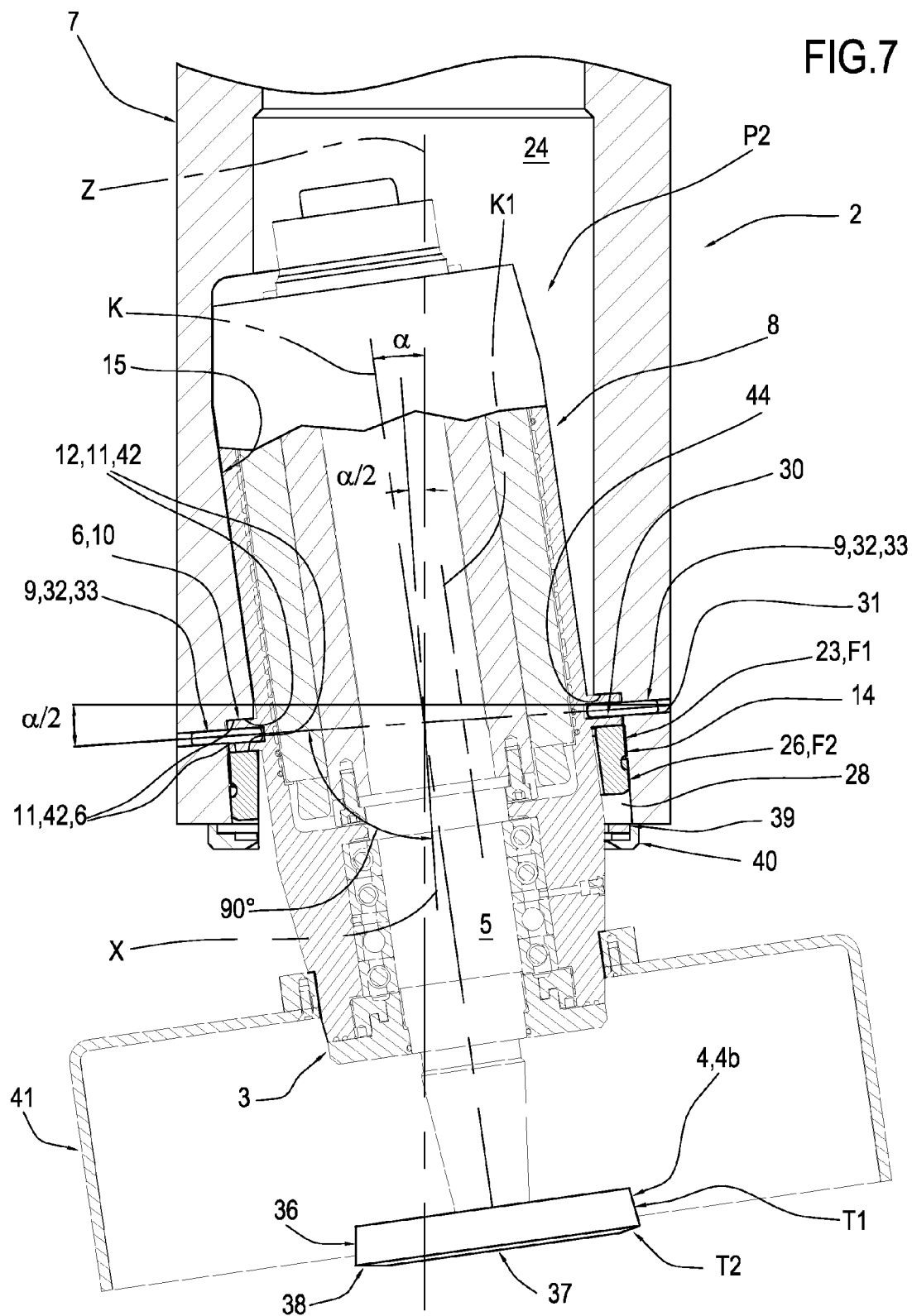
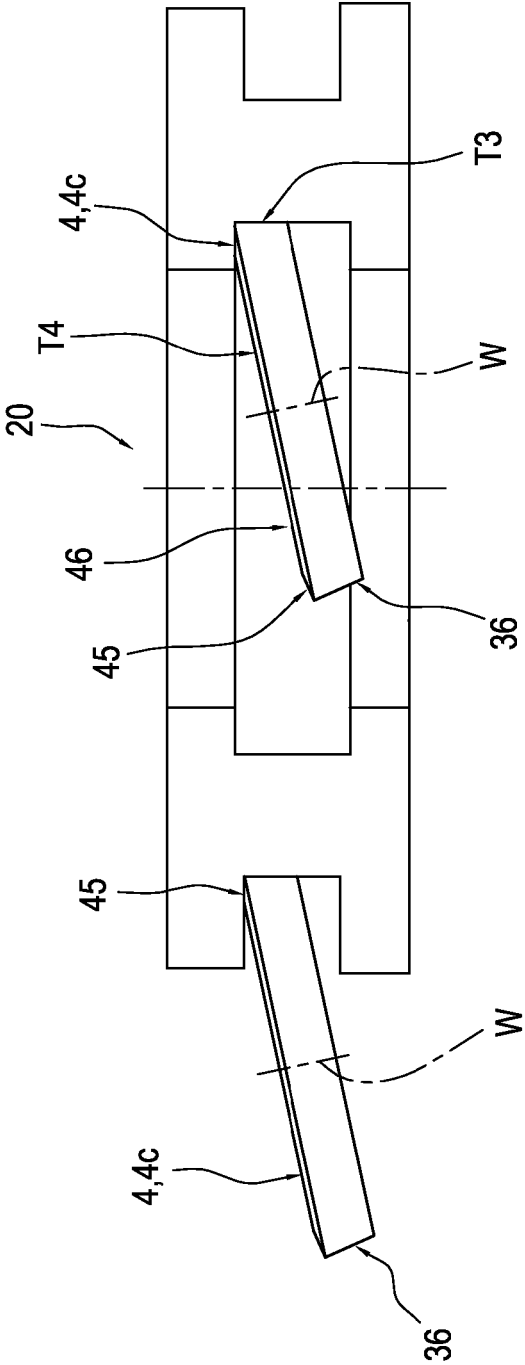


FIG.8





EUROPEAN SEARCH REPORT

Application Number
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