

The present invention relates to a device for clamping non-rotating workpieces which have a portion or a shaft with a polygonal cross-section according to the generic term of Patent Claim 1.

Such a generic device is disclosed in document FR-A-2179206.

A clamping device of the generic type is used to fasten a workpiece in a precisely defined position on a processing machine, e.g. a machine-tool. By workpiece is meant in this context not just a blank to be machined but also a machining tool that must be precisely held in a processing machine. Obviously every tool is initially also a blank that has to be converted into the desired form. These considerations are of particular significance for electrical discharge metal processing machines. Here the "tool", namely the electrode, is very often manufactured individually from a copper blank by means of turning and/or milling and/or grinding so as to be subsequently clamped in an electrical discharge machine and used as a forming element.

However such electrode bodies are tools required to adhere to extraordinarily close tolerances not just in regard to centricity, i.e. within the X and Y axis, but also in regard to torsion about their centreline. In many instances a precise dimension and/or very close positioning tolerance must also be achieved along the Z axis.

Such electrode bodies are formed by a blank, e.g. from copper, being successively clamped and machined in a lathe and/or milling machine and/or grinding machine until it takes on its desired form to be subsequently

installed as a machining tool in an electrical discharge machine in order to machine a workpiece with the high degree of accuracy known, for example, from spark-erosion machines. In order for this accuracy to be guaranteed the body of the electrode must be machined to within the closest tolerances; this means that the clamping and fixing of the blank and/or semi-finished product and of the finish machined workpiece must be highly accurate not only during the individual forming operations but also finally at the electrical discharge machine-tool.

Suitable coupling devices for the clamping of electrode bodies to electrical discharge processing machines are known which permit a highly accurate centric arrangement with precise achievement of a desired set angular position of the electrode bodies on the erosion machines. In many instances however it is not possible to attach the electrode or electrode blank directly to such a coupling device with the result that a clamping device must be fitted as an intermediate holder. In addition to the necessary rigidity and precision such a clamping device is primarily required to ensure as high a reproducible accuracy as possible. Put another way this means that a workpiece, e.g. an electrode blank, in the process of machining or a finished electrode has to be removed from the clamping device in the course of successive erosion operations and fitted back into it again, and that the initially defined set position in the X, Y and possibly the Z axis as well and in regard to its angular position about the Z axis must be repeatedly reproduced with the utmost precision.

More particularly DE-PS 3347403 discloses a device for clamping electrode body blanks for erosion machines. This comprises a clamping body with a clamping chamber open at one end to receive the electrode body. Two adjacent side

walls of this clamping chamber are provided with clamping screws. Central positioning of the electrode body is assured by means of shims of the required thickness inserted into the clamping chamber; the electrode body is thereupon affixed by tightening the clamping screws. As this device is very simple in construction and therefore inexpensive, it can be used in large numbers so as to each hold one electrode that always remains clamped and hence fixed in its precise position. This device is not suitable for the repetitive clamping of workpieces subjected to exacting requirements for positional accuracy in the X, Y and Z axis and in regard to the angle of twist about their longitudinal axis.

DE-PS 2646951 discloses a device for attaching tools to spark-erosion machines or for similar non-rotating tools and which is intended to facilitate high-precision clamping of a tool arranged upon a cylindrical shaft. A clamping chuck with a cylindrical locator is provided for this purpose. In conjunction with a pin projecting radially out from the cylindrical shaft, one free end face of the locator serves to achieve precise compliance with the position on the Z axis while a paraxial stud arranged adjacent to this free end face serves to achieve the precise angular position in conjunction with the above mentioned pin. Provided the cylindrical chuck is accurately machined, it should also guarantee perfect positioning on the X and Y axes. The drawback of this device however is its complex and hence costly construction since to achieve the necessary degree of precision it requires a carefully machined chuck, an exactly cylindrical, preferably ground and hardened shaft as a tool carrier, an equally precise and hardened axial stud adjacent to the chuck and an equally precise and preferably hardened radial pin on the shaft as well as a perfectly faced free end face on the locator.

The large number of precision components that are needed make such a design expensive to manufacture and also sensitive to contamination and wear, with the result that for the latter reasons it can hardly be expected to achieve the necessary high repeat accuracy when clamping electrical discharge workpieces, for example. It may also be supposed that such a device is hardly suited to holding an electrode body blank during the machining process with sufficient rigidity, since the extreme forces that are at work here (e.g. during turning and milling) would overstress the point-to-point contact between the radial pin on the shaft and the axial bolt on the locator causing elastic or even plastic deformation which must obviously bring about an undesired limitation to repeat accuracy.

The invention is therefore based on the objective of avoiding the disadvantages of the disclosed clamping devices and of creating a device which is very simple in construction as it only comprises very few precision components and is therefore inexpensive to manufacture, which is moreover very robust and rigid so as to be used as a clamping device during the machining of a blank, and yet which affords an extraordinarily high, repetitive positioning accuracy with negligible sensitivity to contamination and wear.

This task is resolved by the features of patent claim 1. With the solution according to the invention it is possible to use for example quite normal square-section bright-drawn copper or steel bar as the shaft without any additional machining and which is obtainable inexpensively by the metre. If required, and this is frequently very desirable, it is also possible to directly clamp an electrode blank which possesses a polygonal cross-section, preferably a square or

rectangular cross-section. The clearly defined but not overspecified contact between two adjoining faces of the shaft or portion and the three webs achieves a precise positional fixing on the X and Y axis and in regard to the angle.

The fact that the cross-sectional dimension of the clamping chamber is so much greater than the cross-sectional dimension of the said portion or shaft that the portion or shaft can be inserted into the clamping chamber with a clearance facilitates easy setting and reduces the disadvantages caused as a result of contamination.

One particularly preferred embodiment consists in the portion or shaft of the workpiece and the clamping chamber having a square cross-section as a fundamental form, especially since square copper or steel bars which are to be used as electrode blanks or shafts to which the actual electrode bodies are to be brazed, for example, are easily obtainable in all possible dimensions and grades. It is not absolutely essential here for the said first and second inner walls of the clamping chamber which carry the webs to be precisely at right angles to one another although this is easy to achieve for example by machining the clamping member by means of wire discharge erosion.

If one axially oriented edge of the said square portion or shaft of the workpiece is chamfered, a condition can also be achieved whereby the portion or shaft can only be introduced into the clamping chamber in one way. This measure facilitates the handling of the device in accordance with the invention.

If a defined fixing on the Z axis is also desired, the

device can have a further datum face for fixing the said portion or shaft which is formed by an end piece which is either machined into the clamping chamber or attached to it. It is preferable to provide the clamping chamber in the area of this end piece with at least two diametrically opposed openings in order to remove any contamination of the clamping chamber by blowing out with compressed air.

Other variants and embodiments of the object of the invention are described in the dependent claims 2 to 15*.

The following now explains in greater detail one embodiment of the object of the invention by reference to the attached drawings.

In the drawings:

- Fig. 1 shows a perspective view of the clamping device with a clamped shaft which carries an electrode body blank,
- Fig. 2 shows a side elevation of the empty clamp,
- Fig. 3 shows a view of the empty clamp from above,
- Fig. 4 shows an axial cross-section through the clamp with clamped shaft along line IV-IV in Fig. 2;
- Fig. 5 shows an axial cross-section through a modified clamp with clamped shaft, in accordance with the illustration in Fig. 4.

The embodiments illustrated in the drawings of a device for the clamping of non-rotating workpieces or tools, generally indicated as 1, comprise a clamping body 2 that consists in this example of a cylindrical block made out

of tool steel, for example, that tapers towards the top. Other forms such as right parallelepipeds and so forth are also possible of course. Inside the clamping body 2 approximately coaxial to the Z axis, which is the vertical centreline through the clamping body, a clamping chamber 3 is provided which is always open at the top and possibly also open towards the bottom. Fig. 1 illustrates an embodiment that is open downwards while the example in accordance with Fig. 2 is provided with an end piece 4 which is attached to the clamping body 2 in some suitable manner or is integral to it. This will be explained in greater detail hereinafter.

The clamping chamber 3 serves to receive a shaft 5 at whose free end a workpiece 6, e.g. an electrode blank or a finish machined erosion electrode, is attached.

Clamping chamber 3 has a fundamentally square cross-section perpendicular to the Z axis and runs along this Z axis through clamping body 2. The inner walls of the clamping chamber are identified as 7, 8, 9 and 10. The four inner walls 7 to 10 are at least approximately perpendicular one to the other. The first inner wall 7 comprises two webs 11 and 12 that are spaced apart and parallel to each other and to the Z axis and which protrude into the interior of the chamber 3 and which are arranged within the area of the two edges of inner wall 7 that run along the Z axis, i.e. adjacent to inner walls 8 and 10 respectively. The webs are relatively narrow; the sum of the widths of webs 11* and 12* is preferably less than half the width of the side wall 7.

The second inner wall 8 has a single web 13 running parallel to the Z axis and which also protrudes into the interior of chamber 3. It lies adjacent to web 11 on inner wall 8 and is of a width that is in any event less

than half the width of inner wall 8.

Webs 11 and 12 and 13 serve as datum, and stop faces respectively for shaft 5, as will be explained later.

Shaft 5, which can preferably consist of bright drawn copper or of tool steel, also comprises a generally square cross-section whose surface finish without further machining is perfectly adequate for it to be clamped in clamping body 2 precisely and with a high repetitive positional accuracy. One longitudinal edge of shaft 5 is chamfered, preferably at an angle of 45° , forming a chamfered side face 14. In corresponding fashion the clamping chamber 3 comprises a chamfer by forming a side wall 15 inclined at 45° . The latter is diametrically opposite the two adjacent webs 11 and 13 on walls 7 and 8 of the clamping chamber 3.

The cross-sectional form of chamber 3 therefore corresponds to the cross-sectional form of shaft 5 to be received in it. The chamfer 14 on shaft 5 and the angled wall 15 in chamber 3 ensure that shaft 5 can only be introduced into chamber 3 in a single specified position.

The internal cross-section of chamber 3 is somewhat greater than the cross-section of shaft 5 with the result that there is a certain clearance around shaft 5 which on the one hand facilitates the insertion of shaft 5 and on the other minimizes and renders negligible the effects of any contamination.

For holding the shaft 5 in the clamping body 3 a clamping screw 16 is provided, preferably in the form of a set screw, which is screwed into a threaded bore 17 that passes through the wall of the clamping body 2. The centreline of this clamping screw 16 runs from the centre

of the angled side wall 15 to the edge between the two inner walls 7 and 8, and therefore points towards the two webs 11 and 13. Put another way, the direction of action of the clamping screw lies at least approximately on the median between the two inner walls 7 and 8 of clamping chamber 3. So that clamping screw 16 can fulfil this purpose it is located within the area of the angled wall 15 of clamping chamber 3 and runs perpendicular to the interior face of that inclined wall.

One further possibility (not illustrated) consists in using two clamping screws which pass through the clamping body 2 and emerge in the centre of the two inner walls 9 and 10 of the clamping chamber 3, so as to jointly thrust shaft 5 against webs 11, 12 and 13.

The lower region of clamping body 2 is provided with two diametrically opposed openings, for example in the form of slots; Figs. 1 and 2 each show only one of these. The purpose of these slots is to allow any contamination such as swarf or such like that may be present in the lower region of clamping chamber 3 to be blown out by means of compressed air, for example.

If additionally a positional fixing of shaft 5 and hence of workpiece 6 is desired on the Z-axis, the lower end of clamping chamber 3 can as already mentioned be provided with an end piece 4. One possibility here is to bolt this end piece 4 to clamping body 2 or attach it by other means, or to machine end piece 4 as an integral part of clamping body 2. The latter alternative is less advantageous however when the form of the clamping chamber 3 is to be achieved by means of wire discharge erosion which is known to facilitate extremely accurate machining. On the other hand there may be circumstances under which there is no reason whatever to provide a

separate end piece 4, namely when clamping body 2 rests on the level support face of a coupling component, a machine tool or such like and is attached to it (not illustrated).

Irrespective of whether a separate end piece 4 is provided or whether this is formed by another support face, the support of the lower end face of shaft 5 will guarantee positioning on the Z axis, and for the purposes of repetitive accuracy which is the primary objective, it makes absolutely no difference whether or not this end face is completely flat and/or perpendicular to the centreline of shaft 5 so long as the shaft is not driven into clamping chamber 3 with brute force. There is never the slightest requirement for this however, as there is always sufficient clearance for the effortless introduction of shaft 5.

One further embodiment of the device in accordance with the invention is illustrated in Fig. 5 in axial section. This essentially corresponds to the embodiment described above with the difference that clamping chamber 3 comprises spring-loaded thrust means that act on shaft 5.

In accordance with Fig. 5, inner walls 9 and 10 of clamping chamber 3, i.e. the inner walls that lie opposite webs 11 and 12 and 13 respectively, are each provided with a pocket 23 which receives a spring 22. The inner end of each pocket 23 is slightly tapered and pockets 23 each receive a ball 21 which is thrust towards the interior of clamping chamber 3 by the action of the springs. When shaft 5 (according to Fig. 5) is introduced, balls 21 are in contact with the adjacent side faces of shaft 5 and press it against webs 11 and 12 and 13 respectively. This achieves a certain rough centering of shaft 5 inside device 1 and at the same time

facilitates handling, since shaft 5 is held firmly in clamping chamber 3 by the thrust force of the balls 21 until clamping screw 16 is tightened down.

When clamping screw 16 is slackened off shaft 5 can be easily inserted into clamping chamber 3, if necessary until its lower end face comes to rest against end piece 4 or another support surface. If visible contamination is present here, compressed air is blown briefly through the lateral slots 18. With the embodiment according to Fig. 5 the spring-loaded balls 21 ensure that the shaft is roughly centered against webs 11 and 12 and 13 respectively. Clamping screw 16 is now gradually tightened and the shaft moves diametrically against webs 11 and 12 and 13 until two adjacent side faces lie hard on, in the example according to Figs. 4 and 5, face 19 against web 13 and face 20 against webs 10 and 11. The position in the X and Y axes (Fig. 4) as well as in regard to the angle of twist β is now clearly defined but not overspecified, while the Z axis is defined by the lower end face of shaft 5 resting against the end piece 4 or another support surface.



CLAIMS

1. A device for clamping non-rotating workpieces (6) which have a portion or shaft (5) with a polygonal cross-section, consisting of a clamping body (2) with a clamping chamber (3) polygonal in cross-section and formed within the clamping body to receive the said portion or shaft (5), with clamping means (16) adapted to clamp the said portion or shaft (5) in the clamping chamber (3) and with datum faces (11,12,13) on the clamping body (2) adapted to fix the said portion or shaft (5) at least in the X and Y axis and in regard to its angular position, wherein the datum faces for the portion or shaft (5) in the X and Y axis and for the angular position are formed on the one hand by first and second mutually spaced apart webs (11,12) projecting from a first inner wall (7) of clamping chamber (3) and on the other hand by a third web (13) arranged on a second adjacent inner wall (8) and projecting from the wall (8*), and wherein the clamping means (16) are arranged at least approximately opposite the webs (11,13) in such a way that they clamp the said portion or shaft (5) against the webs (11,12,13) characterized in that the first and second webs (11,12) are arranged each within the area of an axial lateral edge of the first inner wall (7) and the third web (13) within the area of the axial lateral edge of the second inner wall (8) which adjoins the said first inner wall (7), and wherein furthermore a chamfer is provided in the clamping chamber (3) that is formed by a wall (15) running at an angle of 45° to the two adjacent inner walls (9,10) of the clamping chamber (3) and lying diametrically opposite the two adjacent webs (11,13) at the said first and second inner walls (7,8) of the clamping chamber (3).

2. A device according to claim 1 characterized in that the clamping chamber (3) corresponds in cross-



-sectional form to the said portion or shaft (5) of the workpiece (6).

3. A device according to claim 1 characterized in that the first, second and third webs (11,12,13) run in axial direction (Z) of the portion or shaft (5) of the workpiece (6) and parallel to one another.

4. A device according to claim 2 characterized in that the cross-sectional dimension of clamping chamber (3) is so much greater than the cross-sectional dimension of the said portion or shaft (5) that the portion or shaft (5) can be inserted into the clamping chamber (3) with clearance.

5. A device according to claim 1 characterized in that the clamping means (16) are arranged so far as their direction of action on the median is concerned between the said first (7) and second (8) inner walls.

6. A device according to claim 5 characterized in that the clamping means comprise a clamping screw (16) passing through a wall (15) of the clamping chamber (3).

7. A device according to claim 1 characterized in that the clamping means comprise two clamping screws which pass through those walls (9,10) which are opposite the walls (7 and 8) provided with the webs (11,12 and 13 respectively).

8. A device according to claim 2 characterized in that the portion or shaft (5) of the workpiece (6) and the clamping chamber (3) have a square cross-section as their fundamental form.

9. A device according to claims 1 and 6 characterized



in that the clamping screw (16) is arranged within the area of the inclined wall (15) of the clamping chamber (3) and that its axis runs perpendicular to that surface of the inclined wall (15) which faces the interior of the clamping chamber (3).

10. A device according to one or more of the preceding claims characterized in that it comprises a further datum face for fixing the said portion or shaft in the Z axis which is constituted by an end face (4) of the clamping chamber (3).
11. A device according to claim 10 characterized in that clamping chamber (3) is provided with two diametrically opposite openings (18) in the area of the end face (4).
12. A device according to one or more of the preceding claims characterized in that the sum of the widths of the said first and second webs (11,12) is less than half the width of the said first clamping chamber inner wall (7).
13. A device according to one or more of the preceding claims characterized in that the width of the said third web (13) is less than half the width of the said second clamping chamber inner wall (8).
14. A device according to one or more of the preceding claims characterized in that on or in the walls (9,10) which lie opposite the webs (11,12 and 13) thrusting means (21,22) are provided which when the portion or shaft (5) is inserted into the clamping chamber (3) are in contact with its facing surfaces, thereby pressing the portion or shaft (5) against the webs (11,12 and 13).
15. A device according to claim 14 characterized in



-15-

that the thrusting means comprise balls (21) that are thrust towards the interior of the clamping chamber (3) by means of springs housed in pockets (23) in walls (9,10).

Translators note: obvious clerical errors in the German text have been corrected at the points masked with an asterisk (*).