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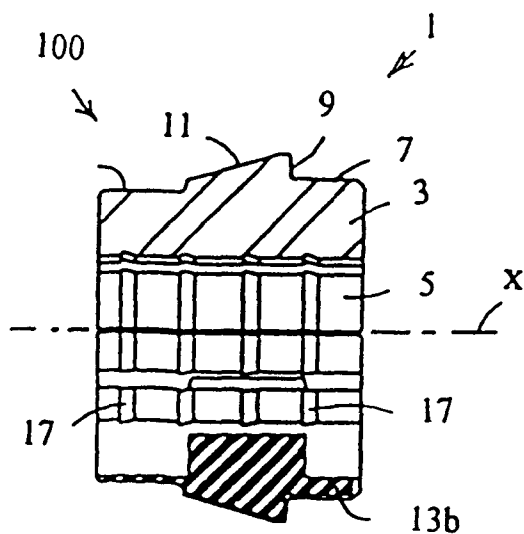


FIG. 2a

(57) Abstract: A system and a method for implementing collet (1) having a plurality of resilient and elastic coupling elements (13) intermediate solid jaws (3). The elastic coupling elements are appropriately profiled to allow radial expansion and contraction of the collet opening to accommodate turning operations over a wide range of workpiece nominal diameters while ensuring workpiece stability at high speed RPM. The collet has a predetermined elastic-to-solid cross-section ratio selected according to a threshold, which is the stability criterion.

COLLET FOR A LONG AUTOMATIC TURNING LATHE

Technical Field

The present claimed invention relates to a clamping device operative in a long-turning automatic lathe, which makes use of such a clamping device for holding and feeding long slender rod-shaped workpieces during processing.

Background Art

Clamping devices for the clamping of workpieces in machine tools are well known *per se*.

Clamping devices such as collet chucks are expendable machine parts. According to the state of the art, the collets primarily used for clamping workpieces are those manufactured in conformity with the DIN 6343 Standard. In accordance with the DIN 6343 Standard, such collets are implemented as a sleeve that is conical at one end on the exterior, and on the interior, feature a cylindrical borehole having a nominal diameter, which is specific to the respective collet. The sleeve that forms the collet has a plurality of radial slits, starting from the conical side on the exterior up to the borehole in the interior. Thereby, clamping jaws are formed, which run together into or are coupled together by a common ring disposed at the other end of the sleeve opposite to the conical end. Furthermore, a collet chuck is provided, having an interior cone accommodated to receive and fit the collet. Clamping of a workpiece takes place through axial displacement of a pressure tube, whereby the collet is pushed into the internal cone of the collet chuck. Since there are slits in the collet, the slit end of the clamping jaws are pressed radially together and thereby clamp the workpiece by frictional connection.

A collet chuck for machine tools is known from DE 100 57 977 A1. In that collet chuck, a collet tube and a chuck head form a divisible collet. That chuck head is divided into a plurality of clamping jaws by means of continuous axial and radial separating slits, which are joined to each other by means of elastic connecting elements. Because the chuck head is subject to a larger amount of wear than the collet tube, these collets are made in two separate portions.

The clamping of the workpiece is accomplished by an axial displacement of the collet in the collet chuck. In this case, the clamping is parallel to the longitudinal axis over the entire length of the collet. To achieve axial displacement, a traction tube engages with the collet, whereby traction forces are exerted on the collet. Accordingly, as a function of their construction, the collets previously known in the art are not suitable for use in long automatic turning lathes, because it is not possible to build a traction tube into such lathes.

The closest prior art is found in German patent No. DE 10 2005 024 840 B3, to SZM Spannwerkzeuge GmbH, which recites three clamping jaws mutually

attached together by a strip of rubber intermediate two adjacent jaws. The pieces of rubber have a constant cross-section, and fill a small portion of the volume opened between the two adjacent jaws.

Since industry requires high precision concentricity over a wide range of workpiece nominal diameters, the transfer of turning moments, and the transfer of feed forces in axial direction, it was accepted by the professional world up to now that the multi-segment chuck heads described hereinabove are preferably not be used in automatic long-turning lathes.

It is therefore one object of the present claimed invention to provide a clamping device for automatic long-turning lathes permitting to clamp a wide range of nominal diameters of slender rod-shaped workpieces with extremely high concentricity precision, with increased clamping force in an axial direction and with a good transfer of torque. Another object of the present claimed invention includes the implementation and the adaptation of such a collet for use in automatic long-turning lathes in such a way as to achieve economically viable production.

Disclosure of Invention

Problems are encountered with collets used on long-turning automatic lathes when turning high-precision workpieces at high RPM (Revolutions Per Minute). Such problems are related to the relatively restricted range of workpiece diameter that the collet is able to clamp, and to the lack of stability of the workpiece when high RPM speeds are reached.

A solution to those problems may be provided by a collet including a plurality of resilient and elastic coupling elements, which are appropriately profiled to allow sufficient radial expansion and contraction of the collet opening to accommodate turning operations over a wide range of workpiece nominal diameters while ensuring workpiece stability at high speed RPM.

The collet providing the solution may have a predetermined elastic-to-solid cross-section ratio selected according to a threshold, which is the stability criterion.

Brief Description of Drawings

A preferred embodiment of the invention is shown in the drawings and will be described in greater detail hereinbelow. In the drawings, like reference numerals and characters generally refer to the same parts throughout the different views. Also, the drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. In the following description, preferred embodiments of the present claimed invention are described with reference to the following drawings, in which:

Fig. 1 is a front view of a collet,

Figs. 2a and 2b are a cross-section of the collet along the line A-A shown in Fig. 1, illustrating two different embodiments,

Figs. 3a and 3b feature two different embodiments of elastic coupling elements,

5 Figs. 4a and 4b illustrate two different embodiments of clamping jaws, and

Fig. 5 depicts a schematic diagram of a longitudinal section of a long-turning automatic lathe operating the collet of Fig. 1.

Summary

10 It is an object of the present claimed invention to provide a system and a method for implementing a collet including a plurality of solid clamping jaws matched in mutual operative association with a same plurality of elastic coupling elements devices for realizing a collet for clamping a wide range of workpiece diameters.

It is thus an object of the collet to be configured to provide:

15 1. elastic coupling elements with:

a. elasticity, resiliency and geometry permitting sufficient expansion and contraction of the solid clamping jaws to accommodate a wide range of workpiece nominal diameters,

20 b. stabilizing means appropriate for ensuring controlled stability of the workpiece in stable clamping conditions during machining, and

c. exterior geometric dimensions suitable for preventing the elastic coupling elements from bulging out the volume defined by the compressed solid jaws in interference with the workpiece and with the machine tool,

2. solid clamping jaws with:

25 d. provisions for receiving the elastic coupling elements and stabilizing means disposed on the elastic coupling elements,

e. an interior jaw radius proportional to a maximum nominal workpiece diameter,

3. the solid jaws and the elastic coupling elements having:

30 f. an elastic-to-solid cross-section stability ratio criterion which must be kept within a predetermined threshold.

It is another object of the present invention to provide a system and a method for implementing a collet (1) operative for stably processing workpieces over a large range of nominal diameters and at high RPM (Revolutions Per Minute) speeds. The collet may have an exterior and an interior for use with a clamping device (CD) of a long-turning automatic lathe, one exterior portion of the collet being shaped as a truncated cone (11) and the interior of the collet may be configured as an interior clamping surface (5). The collet may be divided by continuous equally distributed axial and radial grooves (4) formed between and

separating a plurality of solid clamping jaws (3), which are mutually coupled by elastic coupling elements (13) extending in a radial and an axial direction. The method comprises configuring each coupling element with a predetermined cross-section and for coupling by a plurality of separate side surfaces (31S, 32S, 33S) and an interior surface (34) to each one of two adjacent solid jaws out of the plurality of solid jaws. Each coupling element is provided with at least one stabilizing leg (35), which is coupled to a couple of adjacent solid jaws. Each coupling element features controlled stability and with dimensions controlled for stability, and is implemented out of a material having a controlled hardness distribution and controlled dimensions.

It is a further object of the present invention to provide a system and a method for implementing a collet wherein the clamping jaws and the elastic coupling elements are configured for providing controlled stable radial deflection.

It is yet an object of the present invention to provide a collet wherein the configuration of the clamping jaws and of the elastic coupling elements comply with a predetermined stability criterion.

It is still an object of the present invention to provide a collet configured to have six clamping jaws disposed in equal spaced apart distribution for achieving workpiece stability at high speed processing RPM (Revolutions Per Minute).

It is yet a further object of the present invention to provide a a collet wherein each elastic coupling element has at least one stabilizing leg.

It is still a further object of the present invention to provide a collet configured to comply with a stability criterion, which defines the ratio of elastic material to solid material and which is at most $1/2$.

It is moreover an object of the present invention to provide a collet wherein the controlled stability of clamping jaws and of elastic coupling elements is achieved by appropriate selection of parameters. The parameters are selected alone and in combination from the group consisting of the nature of the elastic material, the number of the elastic materials, the number of layers of elastic material, the layers of elastic material, the hardness of the elastic material, the distribution of hardness of the elastic material, the dimensions of the elastic coupling elements, and the compliance with a stability criterion.

It is moreover another object of the present invention to provide a collet wherein the controlled stability of clamping jaws and of the elastic coupling elements is achieved by the appropriate selection of parameters. The parameters are selected alone and in combination, from the group consisting of clamping jaws dimensions and compliance with a stability criterion. The stability criterion defines the ratio of elastic material to solid material and which is selected in the range from $1/3$ to $1/4$.

It is moreover a further object of the present invention to provide a collet configured to operate on a workpiece (W) having a nominal diameter, and to expand to a maximum diameter beyond the nominal diameter.

It is yet another object of the present invention to provide a method for implementing a clamping device of a long-turning automatic lathe, including:

a collet (1), implemented according to any of the Claims 1 through 10;

a clamping sleeve (21), which is fastened to a spindle (19) of the long-turning automatic lathe and, at least in sections, exhibits a cone-shaped interior surface (28); and

a retaining nut (23), which engages with a thread arranged on the spindle (19) and surrounds the retaining ring segment (7) of the collet (1), in order to hold the collet (1) fast in the clamping sleeve (21), whereby the exterior surface (11) of the collet (1) and the conical interior surface (28) of the clamping sleeve (21) move against each other in a wedge-like manner.

It is yet still another object of the present invention to provide a method for implementing a clamping device wherein, within the spindle (19), an axially displaceable pressure tube (25) is located, which engages with the inwardly directed end of the clamping sleeve (21) in order to displace it axially for the purpose of clamping the collet (1).

It is yet an object of the present invention to provide a method for implementing a clamping device wherein the spindle (19) is fastened onto a carriage (29) which can be moved in the axial direction.

Modes for Carrying out the Invention

Fig. 1 illustrates a front view of a collet 1 pertaining to a clamping device CD, which is not shown, whereas Figs. 2a and 2b depict a cross-section taken along the line A-A of two different exemplary embodiments of the collet 1, respectively embodiment 100 and embodiment 200. The exemplary collet 1 is divided into six solid clamping jaws 3. The clamping device CD and the collet 1 have a common longitudinal axis designated as X. The clamping jaws 3 are arranged in such a way that the interior surfaces 5 formed by each one of the jaws 3, are configured to clamp around a circular cross-section extending along substantially the entire longitudinal extension of the jaws 3, thereby running parallel to the longitudinal axis X. In other embodiments, another number of clamping jaws 3 may also be used if desired. Furthermore, the clamping jaws 3 of the collet 1 may be configured to grip workpieces having a geometric cross-section other than circular, by means well known in the art.

The number and the configuration of the clamping jaws 3 and of the elastic coupling elements are determined according to workpiece stability considerations,

including compliance with a predetermined stability criterion, as described hereinbelow.

The clamping jaws 3 are separated in equally distanced distribution away from each other by radial profiled grooves 4 running parallel to each other and to the longitudinal axis X through the whole length of the collet 1. In addition, the clamping jaws 3 are permanently connected to each other by means of resilient coupling elements 13, shown as exemplary embodiments 13a and 13b in Figs., respectively 2a and 2b. The coupling elements 13 are possibly implemented out of an elastic material such as rubber or elastomeric material(s) forming elastic connecting parts, which are disposed into the radial grooves 4 intermediate the clamping jaws 3. The resilient elements 13 are fixedly fastened each to one pair of clamping jaws 3, by help of means well known to the art, such as vulcanization processes or gluing for example. The resilient elements 13 may be implemented as elastic coupling parts 13 made from one or more various elastic materials such as rubber or elastomeric materials, to controllably stabilize and allow controlled and stable radial deflection of each one of the individual clamping jaws 3, in radial compression inwards and in radial expansion outwards, relative to the axis X.

The collet 1 exhibits an exterior surface 11 configured as a truncated cone 11, which is formed by the exterior surfaces of the clamping jaws 3. The truncated cone 11 is hollow and divided by the radial grooves 4 into segments, with each segment forming a clamping jaw 3. Therefore, the radially deflecting portion of each clamping jaw 3 exhibits a wedge-shaped cross-section.

A retaining ring segment 7, which may be regarded as resulting from the splitting into segments of a solid retaining ring, is shown to join a base 9 of the truncated cone-shaped exterior surface 11. Each clamping jaw 3 is configured to have a retaining ring segment 7, which joins a base 9 of the hollow truncated cone 11. The exterior diameter of the retaining ring segments 7 at the base 9 is smaller than the largest exterior diameter of the truncated cone-shaped exterior surface 11, thereby configuring the base as a support surface, which is accommodated to accept displacement forces that are applied in the longitudinal direction of the axis X.

To improve the uptake of axial thrust forces, it is possible to provide a plurality of clamping grooves 17, which may be machined on the interior surfaces 5 of the clamping jaws 3, perpendicular to the longitudinal axis X.

Figs. 2a and 2b also depict circumferential clamping grooves 17 disposed in longitudinal separation on the interior surfaces 5. A person skilled in the art is familiar with the implementation of such clamping grooves in the interior of the collet 11, and will recognize additional options for their realization in practice.

Figs. 3a and 3b illustrate exemplary elastic coupling elements 13 of the embodiments, respectively 100 and 200. The longitudinal elastic coupling elements 13 are configured for fixed attachment into the profiled grooves 4 intermediate the solid clamping jaws 3, in longitudinal parallel alignment with the axis X.

An elastic coupling element 13 is generally divided into axially aligned consecutive portions including an elastic leading portion 31 having elastic leading side surfaces 31S, an elastic slanting portion 32 having elastic slanting side surfaces 32S, and an elastic trailing portion 33 having elastic trailing side surfaces 33S. The elastic coupling element 13 also has an interior surface 34 and at least one stabilizing leg 35 coupled to the interior surface and protruding radially out and away therefrom. The elastic coupling element 13 shown in Fig. 3a has one single stabilizing leg 35 whereas the elastic coupling element 13 shown in Fig. 3b has two stabilizing legs 35.

Figs. 4a and 4b depict each an exemplary longitudinally disposed solid clamping jaw 3 of the exemplary embodiments, respectively 100 and 200, for the fixed coupling thereto of a couple of elastic coupling elements 13, one coupling element 13 on each side thereof.

Each solid clamping jaw 3 has a retaining ring segment 7 having jaw leading side surfaces 41S, a truncated cone 11 having jaw wedge side surfaces 42S, and a trailing portion T with jaw trailing side surfaces 43S. The solid clamping jaw 3 also has a rest surface 44 and at least one leg channel 45 on each side thereof.

When solid clamping jaws 3 and elastic coupling element 13 are coupled together, the elastic coupling element 13 is disposed longitudinally in the interior of the profiled grooves 4 formed by two adjacent but separated apart solid clamping jaws 3. A longitudinal lateral portion of the interior surface 34 of the elastic coupling element 13 is disposed on and coupled to the rest surface 44 of the solid clamping jaws 3 such that the elastic leading side surfaces 31S, elastic slanting side surfaces 32S, and elastic trailing side surfaces 33S abut and couple with the, respectively, jaw leading side surfaces 41S, jaw wedge side surfaces 42S, and jaw trailing side surfaces 43S. Furthermore, a portion of the at least one stabilizing leg 35 is partially received and coupled in a corresponding at least one leg channel 45 of two adjacent solid jaws 3.

It is noted that the elastic coupling element 13 is so dimensioned as to leave a small gap G, not shown, relative to the outline of the clamping jaws 3, so that when compressed, the elastic coupling element will not bulge and protrude out of the grooves 4. This means that a side projection of a compressed elastic coupling element 13 will always be contained in the interior of and separated by a distance G from an envelope created by a side projection of a clamping jaw 3.

The elastic coupling elements 13 are configured to become firmly affixed to the solid clamping jaws 3 by any means known to the art such as for example vulcanization, gluing, casting, as well as single and double injection.

Each elastic coupling element 13 has a controlled configuration relative to resiliency and elasticity, and relative to a judicious selection of stability parameters. The degree of configuration control is relative to the nature and structure of the elastic material, number of elastic materials, layers of elastic material, elastic material hardness, distribution of elastic material hardness, dimensions of elastic coupling elements, composition, structure, and hardness of the material from which the elastic coupling element 13 is made, and compliance with a stability criterion. For example, the controlled radial and axial distribution of the material hardness over the elastic coupling element 13, may relate to the number of different materials used, and to the number of layers of the same hardness or different hardness of materials used. In addition, the dimensions of the different portions of the elastic element 13 also influence the deflection and the stability of the workpiece W clamped in the collet 1, for allowing the clamping a wide range of workpiece diameters. In short, a variety of parameters have to be controlled alone and in combination to assure that the clamping jaws 3 and the coupling elements 13 are configured to provide a desired degree of deflection and of stability of the collet 1 when clamping a workpiece W, as shown in Fig. 5.

a. Still with respect to elasticity, resiliency and geometry of the collet 1 when clamping close on a workpiece W, the solid jaws 3, which are initially disposed in a released state, deflect radially inward toward the axis X. Thereby deformation and stress patterns occurring under deflection may not be equally distributed in the elastic coupling elements 13, since for example the degree of deformation may be relative to the distance from the axis X. Hence, it is desirable to control the deformation pattern of the elastic coupling elements 13. As described hereinabove, it is possible to control the hardness of the material from which the elastic coupling element 13 is implemented, and the controlled distribution of such hardness over the elastic coupling element 13 to achieve desired properties, such as realizing a collet 1 for clamping a wide range of workpiece diameters. Controlled hardness of the material may be achieved continuously or discretely over the entirety of an elastic coupling element 13, or by use of layers of material coupled together to form an elastic coupling element.

Alternatively, it is possible to control the deformation pattern of an elastic coupling element 13 by an appropriate control of the geometric configuration. For example, variations in cross-section, stress relieving bores, grooves, and salencies may serve the purpose, even though not being depicted in the Figs. Evidently, the geometry and configuration of the solid jaws 3 has to be selected and taken in

consideration to achieve a mutual match with the configuration of the specific elastic coupling elements 13.

b. A further aspect of stability control of the solid jaws 3 is now considered. To this end, the solid jaws 3 are appropriately configured to support the profiled generally non-uniform predetermined cross-section of the longitudinal elastic coupling elements 13. Each elastic coupling element 13 may be provided with at least one stabilizing leg 35 protruding axially away from interior surface 34, to be fixedly received by a couple of adjacent clamping jaws 3 in at least one leg channel 45 disposed on both sides of the at least one stabilizing leg.

10 In addition, still for the sake of stability control, a stability ratio has to be respected, as described hereinbelow.

c. In relation with the exterior dimensions of the elastic coupling elements 13, care is taken to always leave a margin of expansion, for example a gap G, such that when material of the coupling elements is compressed to bulge, the bulging never interferes with either the clamping ability of the collet 1 or with the clamped workpiece W.

d. As described hereinabove, each clamping jaw 3 is configured to receive and support a portion of an elastic coupling element 13. That support relates to both partial and complete support of the elastic leading portion 31 and side surfaces 31S, of the elastic slanting portion 32 and side surface 32S, of the elastic trailing portion 33 and side surfaces 33S, and of the interior surface 34. In addition, each clamping jaw 3 is configured to receive and firmly retain at least a portion of at least one stabilizing leg 35.

e. To enhance stable forceful gripping for retention of a workpiece W in the collet 1, the interior diameter of a solid jaw 3 is configured in proportion to the maximum nominal collet diameter. For example, a collet 1 for a workpiece having a nominal diameter of 24 mm will have solid jaws 3 with an interior surface 5 having a diameter of 23.5 mm. This means that when looking at a cross-section of the solid jaw 3 and of the circular workpiece W, the workpiece will be gripped on the periphery thereof at only two points P, not shown, separated away from each other by the width of the cross-section of the clamping jaw 3. After some processing, when the diameter of the workpiece W may have been reduced to below the maximum nominal diameter of 24 mm, then a portion of say two thirds of the arc spanning the interior surface 5 of the solid jaw 3 will grip the outer diameter of the workpiece W.

f. An elastic-to-solid cross-section stability ratio may define a stability criterion that will ensure the stability of the clamping jaws 3 of the collet 1 when a workpiece W is machined at high RPM (Revolutions Per Minute) speeds. A cross-section of the collet 1 taken perpendicular to the axis X through the elastic leading

portion 31 and the jaws 3 provides a section through the elastic material of the elastic element 13 and through the solid material of the clamping jaws 3. It is the ratio of the areas of the elastic section surfaces to the solid section surfaces that defines the predetermined stability criterion. Tests have proven that a workpiece W may be firmly gripped and stably processed at high RPM speed when the stability ratio does not exceed $1/2$. This means twice as much solid material sections surfaces as elastic material sections surfaces. However, for superior results, the stability criterion may preferably be restricted to remain between boundary limits ranging from $1/3$ to $1/4$.

In other words, the collet 1 permits radial compression and expansion of the jaws 3 and provides stable retention of a workpiece W. A collet 1 is considered as providing stable retention of a workpiece W when precision machining at high RPM speeds is possible. Such a collet 1 is achieved by appropriate control and selection of stability parameters in compliance with a stability criterion. Stability parameters relate to the mutual matching geometry and dimensions of both the solid jaws 3 and the elastic elements 13, as well as to the material and structure of the elastic elements 13. Material of the elastic elements 13 refers to the type of selected elastic substance, such as rubber or elastomeric material, and structure of the elastic elements 13 relates to the a combination of materials, the number of materials, the number of layers, their disposition, hardness, and distribution of hardness in radial and axial direction.

Experience has shown that for most practical purposes and for achieving workpiece stability at high RPM processing speed, the number of clamping jaws 3 is best selected as six jaws disposed in equally spaced apart distribution.

Fig. 5 shows a conceptual representation of a longitudinal cross-section of a long-turning automatic lathe having a clamping device CD using the collet 1. A first portion of the clamping device CD is set up on a spindle 19 of the long-turning automatic lathe, in a manner well known to the art. The clamping device CD includes a clamping sleeve 21, which is directly coupled to the spindle 19, and contains the collet 1 and a retaining nut 23. The retaining nut 23 is configured for releasable attachment to the spindle 19, by screw-thread engagement for example. Furthermore, the collet 1 and the clamping sleeve 21 are both releasably fastened to the spindle 19 by means of the retaining nut 23, which is centered onto and guided by the retaining ring segments 7.

For the purpose of clamping a rod-shaped workpiece W, a pressure tube 25 is translated axially towards the collet 1, in the direction of the arrow A1 shown on the pressure tube 25, in alignment with the longitudinal axis X. In turn, the displacement of the pressure tube 25 translates the clamping sleeve 21 in the longitudinal axial direction. The conical interior surface 28 on the clamping sleeve

21 and the matching exterior surface 11 of the collet 1 are moved in relative motion against each other in a wedge-like manner, so that the solid clamping jaws 3 and the appropriately configured elastic elements 13 are deflected in an inward radial direction. The conical interior surface 28 of the clamping sleeve 21 and the exterior surface 11 of the collet 1 thereby remain in planar contact. The clamping of the workpiece W takes place along the entire axial length of the collet 1.

In contrast to the existing clamping devices for long-turning automatic lathe, which are well known in the art, the axial displacement of the collet 1 of the present claimed invention does not cause tilting, thus loss of stability of the clamping jaws 3 relative to the longitudinal axis X. Contact between the exterior surfaces 11 of the clamping jaws 3 and the conical interior surface 28 of the clamping sleeve 21 remains planar in all circumstances, thereby allowing the application of larger clamping forces, superior to common-practice forces. This is also advantageously evident during the processing of the clamped workpiece W, when for example, increased axial forces are applied during the boring of axial holes. The collet 1 is thereby pressed further into the clamping sleeve 21, whereby the clamping force is automatically increased. At the same time however, the planar contact between the clamping jaws 3 and the workpiece W prevents excessively large surface forces, which could cause damage to the surface of the workpiece.

During the processing of the workpiece W, a carriage 29 translates the workpiece W in the axial direction. In addition to the transfer of the torque delivered by the spindle 19, which is driven for example in the direction of the arrow AR shown as a circular arrow indicating rotation, the collet 1 must be able to accept axial forces as well, without the occurrence of any slippage of the workpiece W when clamped by the collet 1. This means that the clamping forces must be designed *a priori* to be suitably large.

Even though the collet 1 is configured for a wide range of nominal diameters of workpieces W, the collet 1 may allow passage therethrough of a larger than maximum nominal diameter, on condition that the machine tool on which the workpiece is processed allows such an operation. For example, a collet 1 for workpieces W of nominal diameter ranging from 17 to 20 mm may expand to allow the passage of stock material having a diameter of say 20.3 or 20.5 mm.

It will be appreciated by persons skilled in the art, that the present invention is not limited to what has been particularly shown and described hereinabove. The collet 1 described hereinabove is configured to operate according to control parameters, and within the boundaries of control parameters selected to ensure clamping of a wide range of workpieces W, such as a range spanning 3 mm, and permit stable and precise processing at high RPM speeds. The parameters

described hereinabove and other related parameters are thus control parameters to be observed for the implementation of the collet 1.

5 Rather, the scope of the present invention is defined by the appended claims and includes both, combinations and subcombinations of the various features described hereinabove as well as variations and modifications thereof which would occur to persons skilled in the art upon reading the foregoing description.

List of Items

	1	Collet
	3	Clamping jaw
5	4	Radial profiled grooves
	5	Interior surfaces of the clamping jaws
	7	Retaining ring segment
	9	Base of the truncated cone-shaped exterior surface
	11	Exterior surface
10	13	elastic coupling elements
	17	Clamping grooves
	19	Spindle
	21	Clamping sleeve
	23	Retaining nut
15	25	Pressure tube
	28	Conical inner surface of the clamping sleeve
	29	Carriage
	31	Elastic leading portion
	31S	Elastic leading side surface
20	32	Elastic slanting portion
	32S	Elastic slanting side surface
	33	Elastic trailing portion
	33S	Elastic trailing side surface
	34	Interior surface
25	35	Stabilizing leg
	41S	Jaw leading side
	42S	Jaw wedge side
	43S	Jaw trailing side
	44	Rest surface
30	45	Leg channel
		CD Clamping device
		W Workpiece

CLAIMS

1. A method for implementing a collet (1) operative for stably processing workpieces (W) over a large range of nominal diameters and at high RPM speeds, the collet having an exterior and an interior for use with a clamping device (CD) of a long-turning automatic lathe, one exterior portion of the collet being shaped as a truncated cone (11) and the interior of the collet being configured as an interior clamping surface (5), the collet being divided by continuous equally distributed axial and radial grooves (4) formed between and separating a plurality of solid clamping jaws (3) which are mutually coupled by elastic coupling elements (13) extending in a radial and an axial direction, the method being characterized by comprising the steps of:

configuring each coupling element with a predetermined cross-section and for coupling by a plurality of separate side surfaces (31S, 32S, 33S) and an interior surface (34) to each one of two adjacent solid jaws out of the plurality of solid jaws,

providing each coupling element with at least one stabilizing leg (35) which is coupled to a couple of adjacent solid jaws, and

implementing each coupling element out of a material having a controlled hardness distribution and controlled dimensions.

2. The method according to Claim 1, wherein:

the clamping jaws and the elastic coupling elements are configured for providing controlled stable radial deflection.

3. The method according to Claim 1, wherein:

the configuration of the clamping jaws and of the elastic coupling elements comply with a predetermined stability criterion.

4. The method according to Claim 1, wherein:

the collet is configured to have six clamping jaws disposed in equal spaced apart distribution for achieving workpiece stability at high speed processing RPM.

5. The method according to Claim 1, wherein:

each elastic coupling element has at least one stabilizing leg.

6. The method according to Claim 1, wherein:

each solid jaw out of the plurality of solid jaws is coupled to an elastic coupling element by side surfaces (41S, 42S, 43S), a rest surface (44), and by at least a portion of a stabilizing leg.

7. The method according to Claim 1, wherein:

the collet is configured to comply with a stability criterion which defines the ratio of elastic material to solid material and which is at most 1/2.

8. The method according to Claim 1, wherein:

controlled stability of clamping jaws and of elastic coupling elements is achieved by appropriate selection of parameters, selected alone and in combination, from the group consisting of elastic material nature, number of elastic materials, layers of elastic material, elastic material hardness, distribution of elastic material hardness, dimensions of elastic coupling elements, and compliance with a stability criterion.

9. The method according to Claim 1, wherein:

controlled stability of clamping jaws and of elastic coupling elements is achieved by appropriate selection of parameters, alone and in combination, from the group consisting of clamping jaws dimensions and compliance with a stability criterion which defines the ratio of elastic material to solid material and which is selected in the range from 1/3 to 1/4.

10. The method according to Claim 1, wherein:

the collet is configured to operate on a workpiece (W) having a nominal diameter, and to expand to a maximum diameter beyond the nominal diameter.

11. A system including a collet (1) having an exterior and an interior for use with a clamping device (CD) of a long-turning automatic lathe, one exterior portion of the collet being shaped as a truncated cone (11) and the interior of the collet being configured as an interior clamping surface (5), the collet being divided by continuous equally distributed axial and radial grooves (4) formed between and separating a plurality of solid clamping jaws (3), which are mutually coupled by elastic coupling elements (13) extending in a radial and an axial direction, the system being characterized by comprising:

each coupling element being configured with a predetermined cross-section accommodated for coupling by a plurality of separate side surfaces (31S, 32S, 33S) and an interior surface (34) to each one of two adjacent solid jaws out of the plurality of solid jaws,

each coupling element having at least one stabilizing leg (35) which is coupled to a couple of adjacent solid jaws, and

each coupling element being made out of a material having a controlled hardness distribution and controlled dimensions, whereby a collet operative for stably processing workpieces over a large range of nominal diameters and at high RPM speeds is obtained.

12. The system according to Claim 11, wherein:

clamping jaws and elastic coupling elements are configured for providing controlled stable radial deflection.

13. The system according to Claim 11, wherein:

the clamping jaws and the elastic coupling elements are configured to comply with a predetermined stability criterion.

14. The system according to Claim 11, wherein:

the collet is configured to have six clamping jaws disposed in equal spaced apart distribution for achieving workpiece stability at high speed processing RPM.

15. The system according to Claim 11, wherein:

each elastic coupling element has at least one stabilizing leg.

16. The system according to Claim 11, wherein:

each solid jaw out of the plurality of solid jaws is coupled to an elastic coupling element by side surfaces (41S, 42S, 43S), a rest surface (44), and by at least a portion of a stabilizing leg.

17. The system according to Claim 11, wherein:

the collet is configured to comply with a stability criterion which defines the ratio of elastic material to solid material and which is at most 1/2.

18. The system according to Claim 11, wherein:

controlled stability of clamping jaws and of elastic coupling elements is achieved by appropriate selection of parameters, selected alone and in combination, from the group consisting of elastic material nature, number of elastic materials, layers of elastic material, elastic material hardness, distribution of elastic material hardness, dimensions of elastic coupling elements, and compliance with a stability criterion.

19. The system according to Claim 11, wherein:

controlled stability of clamping jaws and of elastic coupling elements is achieved by appropriate selection of parameters, alone and in combination, from the group consisting of clamping jaws dimensions and compliance with a stability criterion selected in the range from 1/3 to 1/4.

20. The system according to Claim 11, wherein:

the collet is configured to operate on a workpiece (W) having a nominal diameter, and to expand to a maximum diameter beyond the nominal diameter.

21. A clamping device of a long-turning automatic lathe, including:

a collet (1), implemented according to any one of the method claims 1 through 10;

a clamping sleeve (21), which is fastened to a spindle (19) of the long-turning automatic lathe and, at least in sections, exhibits a cone-shaped interior surface (28); and

a retaining nut (23), which engages with a thread arranged on the spindle (19) and surrounds the retaining ring segment (7) of the collet (1), in order to hold the collet (1) fast in the clamping sleeve (21), whereby the exterior surface (11) of the

collet (1) and the conical interior surface (28) of the clamping sleeve (21) move against each other in a wedge-like manner.

22. The clamping device according to Claim 21, wherein, within the spindle (19), an axially displaceable pressure tube (25) is located, which engages with the
5 inwardly directed end of the clamping sleeve (21) in order to displace it axially for the purpose of clamping the collet (1).

23. The clamping device according to Claim 21 or 22, wherein the spindle (19) is fastened onto a carriage (29) which is moveable in the axial direction.

10

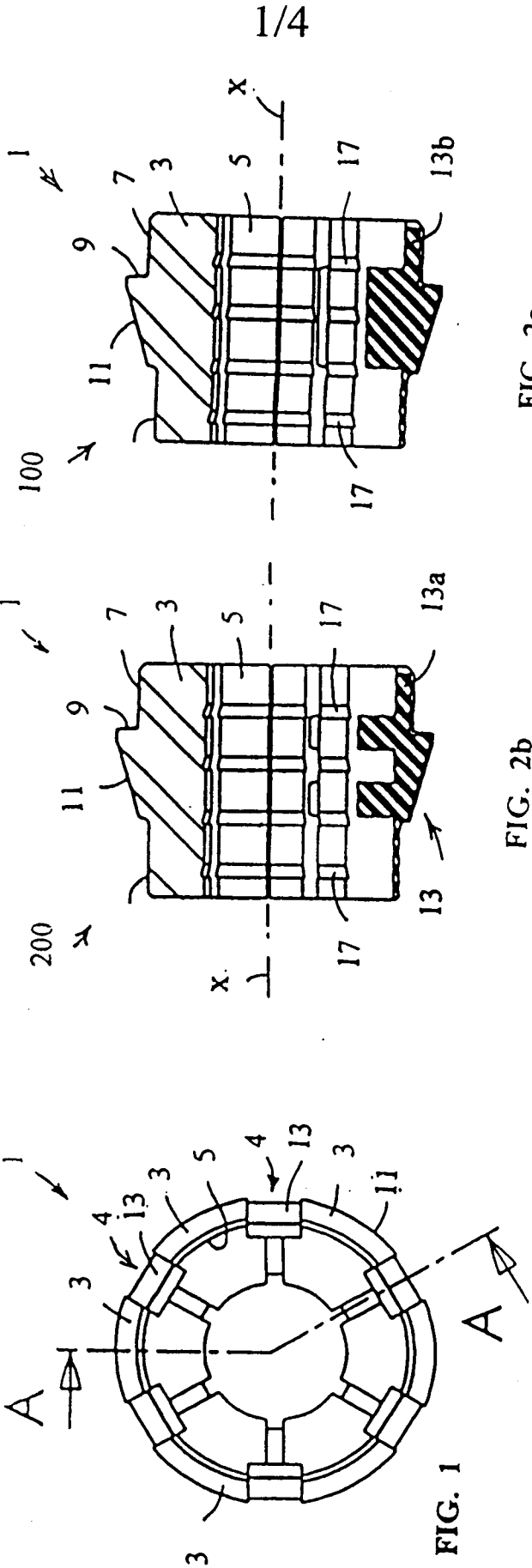
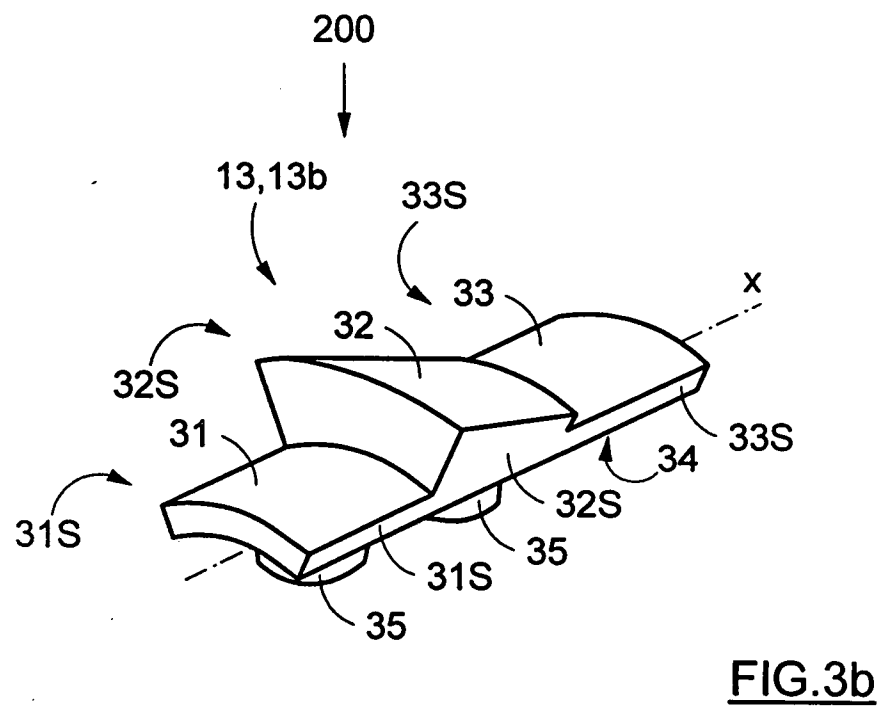
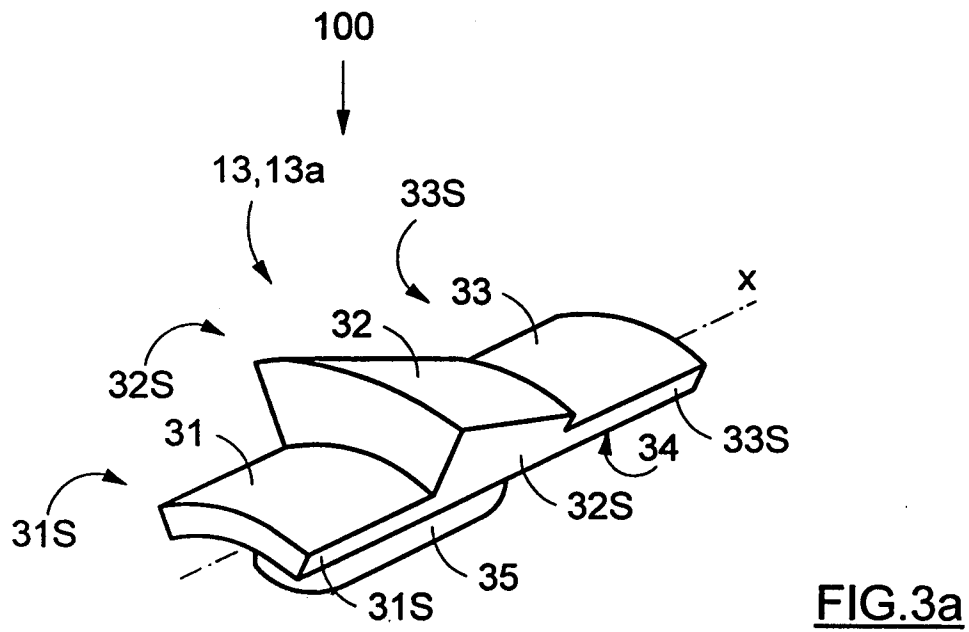


FIG. 2a

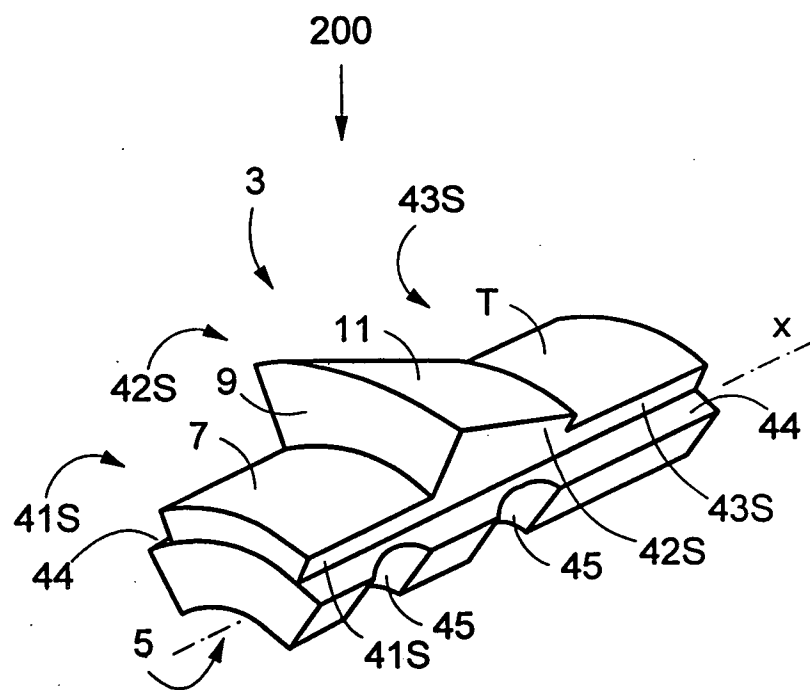
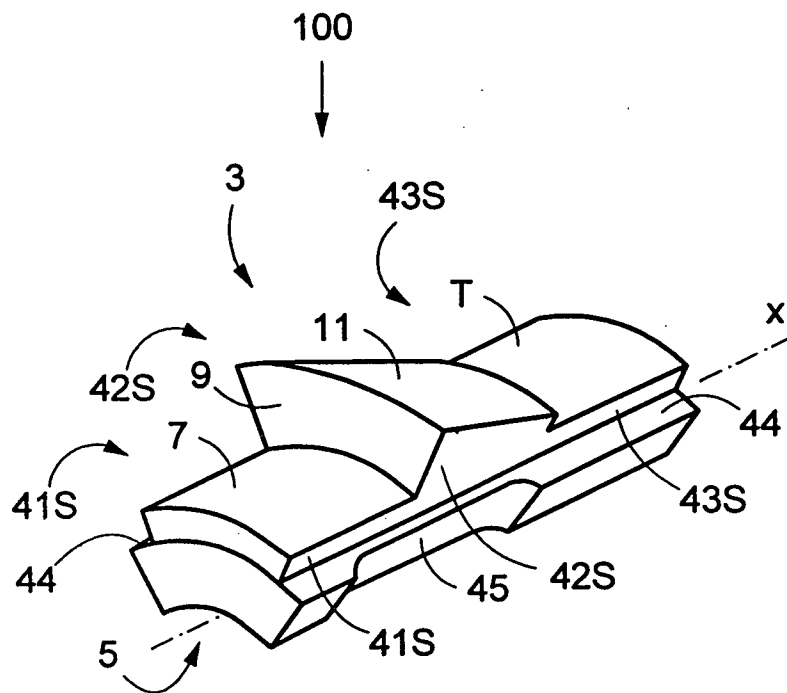
FIG. 2b

FIG. 1

2/4



3/4



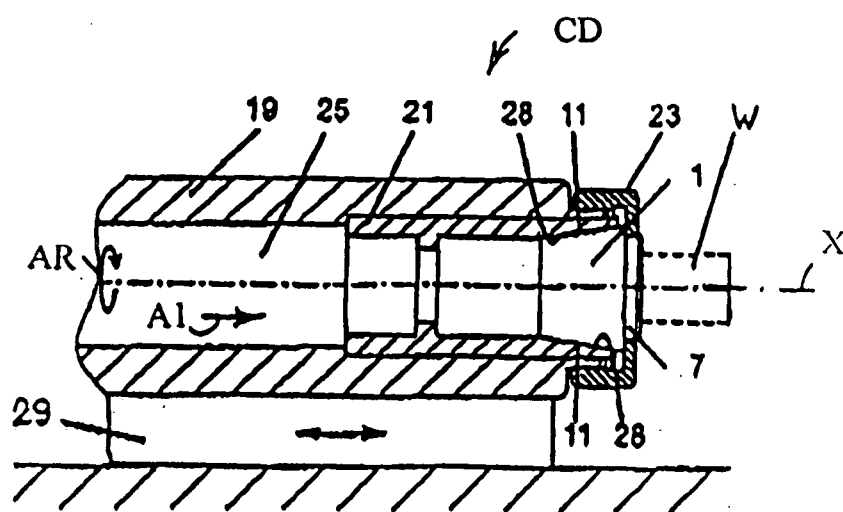


FIG. 5