

Elastic element for a clamping and/or braking device

DESCRIPTION

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TECHNICAL FIELD

The disclosure relates to an elastic element for a clamping and/or braking device and to a pneumatic clamping and/or braking device having two or more such elastic elements.

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BACKGROUND

In the production of tool or machine parts, machining machines, in particular work spindles or other machine tools, are used which machine material from a workpiece by means of tools fastened to a shaft, in particular in order to bring it into the desired shape. The shaft can be an axis of rotation or pivot axis of such a machine. Furthermore, tables which rotate or pivot by means of a shaft are used to place tools or workpieces into the suitable machining position or to move workpieces at corresponding rotational speeds. A prerequisite for precise and efficient machining is, inter alia, a high rotational speed of the shaft. Emergency or safety systems therefore have the task of stopping the shaft in the event of a fault or failure of the systems, such as, for example, a power failure or cable breakage, or of holding it in a fixed position and thus fixing it.

Common machining machines have electromagnetic, hydraulic or pneumatic clamping and/or braking devices. Such devices have a friction lining which can be frictionally connected to the shaft by means of force transmission. This enables the shaft to be fixed at different speeds.

In hydraulic clamping devices, a chamber is acted upon by hydraulic oil and clamps the rotating shaft or disk firmly. Passive hydraulic clamps are also known. However, such hydraulic clamps have long reaction times or short reaction times require a very high outlay there. Furthermore, the hydraulic material, in particular hydraulic valves and hydraulic pipes, is costly and requires longer assembly times. The hydraulic oil also results in an additional outlay for maintaining cleanliness in the surroundings of a hydraulic clamp.

In pneumatic clamping and/or braking devices, elastic elements, in particular resilient plates, are usually acted upon by compressed air and can overcome some of the abovementioned disadvantages of hydraulic clamping devices.

EP 1 585 616 B1 and EP 1 651 881 B1 describe pneumatic clamping devices with two annular spring plates, which are introduced into a housing of the clamping devices and form a pressure space there, which can be acted upon by compressed air or aerated and aerated, in order to change the bending of the spring plates and thereby change between a closed state of the clamping devices, in which an object to be clamped, such as a rotatable shaft, is clamped, and an open state of the clamping devices, in which the object is free. In practice, however, it has been shown that the rubber coating of spring plates is displaced when acted upon by positive pressure and can bulge (radially outward) and thereby make the clamp leak.

SUMMARY

Proceeding from the prior art mentioned at the outset, the disclosure is based on the object of providing means which increase the tightness of a clamping and/or braking device.

The object is achieved with an elastic element having the features of independent patent claim 1 and with a clamping and/or braking device having the features of patent claim 6. Some of the preferred embodiments are described in the dependent claims, in the description and in the figures.

According to the solution according to the invention, a preferably annular elastic element for a clamping and/or braking device is proposed, said elastic element comprising: a spring plate having a first side surface and a second side surface facing away from the first side surface; a sealing layer made of an elastic material applied on the second side surface of the spring plate, the sealing layer comprising: an (e.g. inner or outer) edge extending along a circumference of the spring plate; and a first region adjoining the edge of the sealing layer (e.g. outwardly or inwardly), said first region extending along at least part of the circumference of the spring plate and having a smaller thickness compared to the edge; wherein the first region has a first portion along the circumference of the spring plate and a second portion adjoining the first portion (e.g. in the circumferential direction), wherein the first portion has a greater thickness than the second portion.

The first region has a smaller thickness compared to the edge in order thus, when used in the clamping and/or braking device, to create space for a pressure space in the device, while a bearing surface is formed at the edge, with which the elastic element can be placed on another similar elastic element in the device. This is also advantageous for the dynamics of the clamping and/or braking device. Because the first region has a first portion along the circumference of the spring plate and a second portion adjoining the first portion, wherein the first portion has a greater thickness than the second portion, a displacement of the edge of the

sealing layer (e.g. radially inwardly at an inner edge or radially outwardly at an outer edge) is at least inhibited or even entirely prevented. A leakage during the operation of the clamping and/or braking device is thereby prevented, without additional components having to be introduced into the housing of the device for building up a counterforce against the edge, which keeps the manufacture of the device simple. The dynamic properties of the elastic element are also not adversely affected by the first portion. The first portion is particularly effective if the first portion is at least 0.1 mm thicker than the second portion. The first portion is less thick than the edge, since the first portion is part of the first region.

The sealing layer preferably further comprises a second region (e.g. outwardly at an inner edge or inwardly at an outer edge) adjoining the first region of the sealing layer and extending along at least part of the circumference of the spring plate, wherein the thickness of the second region of the sealing layer is at least as great as the thickness of the first portion of the first region. The first portion thereby serves as a kind of bridge between the edge and the second region and connects these two elements to each other, which is particularly advantageous for the reduction of the leakage.

The spring plate and the sealing layer are preferably each annular.

The sealing layer of an annular elastic element according to the invention preferably further comprises: a further (e.g. outer or inner) edge along the circumference of the (outer or inner) circle of the ring; a third region adjoining the further edge of the sealing layer, said third region extending along at least part of the circumference of the circle and having a smaller thickness compared to the further edge; wherein the third region has a third portion along the circumference of the circle and a fourth portion adjoining the third portion, wherein the third portion has a greater thickness than the fourth portion. A displacement of the further edge of the sealing layer (e.g. radially outwardly or inwardly, depending on the kind of edge) is thereby at least inhibited or even entirely prevented. A leakage during the operation of the clamping and/or braking device is thereby also prevented there, without additional components having to be introduced into the housing of the device for building up a counterforce against the further edge, which keeps the manufacture of the device simple. The third portion is particularly effective if the third portion is at least 0.1 mm thicker than the fourth portion. The third portion is less thick than the edge.

An extension of the first and/or third portion of the sealing layer preferably decreases, preferably continuously, in the circumferential direction towards the respective edge. The first and/or third portion of the sealing layer can preferably taper in the direction of the respective edge. This enables the above-described effects for reducing the leakage to be realized with

simultaneous reduction of the additional material used and reduction of the restriction of the pressure space. The first and/or third portion of the sealing layer can preferably be tongue-shaped, trapezoidal or triangular.

- 5 Particularly preferably, the first region has a plurality of such adjoining first and second portions along the circumference of the spring plate and/or wherein the third region has a plurality of such adjoining third and fourth portions along the circumference of the inner circle (of the annular shape). Instead of only a first and/or third portion, a plurality of such thickenings are thus provided in the sealing layer at the one or more edges, which further
10 reinforce the above-described effects for reducing and/or preventing leakages.

Each of the first, second and/or third region can be annular (e.g. one, two or all three regions). Each of the edges of the sealing layer described here can be annular (e.g. one or all edges).

- 15 According to the solution according to the invention, a clamping and/or braking device for clamping and/or braking an object to be clamped and/or braked is furthermore provided, wherein the device comprises the following: a first elastic element according to the invention and a second elastic element according to the invention; a housing comprising a first housing part having an inner surface and a second housing part having an inner surface, wherein the
20 housing parts are arranged with respect to one another and fastened to one another in such a way that the inner surfaces of the housing parts together delimit an interior space within the housing; one or more clamping elements, wherein each clamping element has a clamping surface; a spring arranged in the interior space, comprising the first elastic element and the second elastic element, wherein the spring plate of the first elastic element is clamped in the
25 interior space with its first side surface facing the inner surface of the first housing part, and wherein the spring plate of the second elastic element is clamped in the interior space with its first side surface facing the inner surface of the second housing part, such that a pressure space is formed in the interior space between the sealing layers of the elastic elements, wherein the pressure space is ventable and is aeratable or can be subjected to positive pressure of a pressure
30 medium that is suppliable to the housing; wherein the spring is designed such that, when the pressure space is aerated or vented or the pressure space is subjected to positive pressure, a bending of at least one of the spring plates of the elastic elements is changable and the device thereby changes between an open state, in which an object to be clamped is spaced apart from the one or more clamping surfaces, and a closed state, in which at least one of the one or more
35 clamping surfaces transmits a clamping and/or braking force to the object; and wherein the thickness of the first portion of the first region of the sealing layer of at least one of the elastic elements is selected in such a way that, when the pressure space is aerated or the pressure space is subjected to positive pressure, a displacement (e.g. directed radially inward or

outward) of the edge of the sealing layer of the at least one elastic element is at least inhibited.

In addition to the abovementioned advantages of the elastic element for the tightness of the device while avoiding the introduction of additional components into the housing parts, the elastic elements according to the invention have further advantages within the scope of such a device.

The edge of the sealing layer can bulge into a connection for acting upon a pressure space, as a result of which cracks can arise and the device becomes more leaky. The pressure medium can thereby escape and the device cannot change from one state to the other state despite activation, for example in such a case of a leakage the device can always remain in the closed state. The pressure medium can also flow unintentionally from the pressure space into an external connection of the device as a result of the leakage, as a result of which the operation of the device can be disturbed and the pumps used therewith can be disturbed. This also has negative effects on the safety in connection with the object to be clamped or braked. The first portion of the sealing layer is therefore preferably arranged in the region of a housing connection of the clamping and/or braking device for subjecting a pressure space to overpressure.

The elastic material of which the sealing layer consists is preferably made of rubber, in particular acrylonitrile-butadiene rubber (NBR). The compression set of the NBR rubber is preferably reduced by 50% in order to produce a particularly stable and lasting operational safety. The sealing layer is preferably applied to the spring plate by means of vulcanization and fixed there, which is particularly stable and long-lasting.

The problem, which has not been overcome for a long time, of the fault-prone region in the region of an edge

of a sealing layer of an elastic element could be overcome by aspects of this disclosure.

Clamps can be provided by the means described here individually and in combination, which clamps seal reliably and effectively in the region of an edge of a sealing layer of an elastic element for the pressure medium, without additional components having to be installed in the housing of the clamp as a result. The dynamics of the clamp are also not adversely affected by the elastic element according to the invention.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1A shows a schematic cross section through an inwardly directed, passive pneumatic

clamping and/or braking device according to the invention in the closed state.

FIG. 1B shows a schematic cross section through an outwardly directed, passive pneumatic clamping and/or braking device according to the invention in the closed state.

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FIG. 2A shows a schematic cross section through an inwardly directed, passive pneumatic clamping and/or braking device according to the invention in the open state.

FIG. 2B shows a schematic cross section through an outwardly directed, passive pneumatic clamping and/or braking device according to the invention in the open state.

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FIG. 3A shows a schematic cross section through an inwardly directed, active pneumatic clamping and/or braking device according to the invention in the open state.

FIG. 3B shows a schematic cross section through an outwardly directed, active pneumatic clamping and/or braking device according to the invention in the open state.

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FIG. 4A shows a schematic cross section through an inwardly directed, active pneumatic clamping and/or braking device according to the invention in the closed state.

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FIG. 4B shows a schematic cross section through an outwardly directed, active pneumatic clamping and/or braking device according to the invention in the closed state.

FIG. 5A shows a cross section through an inwardly directed, pneumatic clamping and/or braking device according to the invention in a three-dimensional representation.

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FIGS. 5B to 5D show a variant of a housing part with an elastic element taken from FIG. 5A .

FIG. 6 shows an embodiment of a housing part of an inwardly directed, pneumatic clamping and/or braking device according to the invention.

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FIGS. 7A to 7C show an embodiment of the elastic element according to the invention.

FIG. 8 shows a detail of a cross section of a clamping and/or braking device according to the invention with two elastic elements according to the invention.

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Components which are represented in a plurality of figures bear the same reference symbols.

DETAILED DESCRIPTION

The disclosure relates to an annular elastic element and to a housing part for a pneumatic clamping and/or braking device and to a pneumatic clamping and/or braking device having such an annular elastic element.

When the device “clamp” or “clamping device”, the “clamping force” or the process of “clamping” is referred to in this document, the device of the “brake” or “braking device” or the “braking force” or the process of “braking” is likewise also encompassed.

FIGS. 1A to 5A and 8 show schematic cross sections through such a clamping device 10 according to the invention with a housing 3, which comprises two housing parts 3a, 3b, and with a spring 1 arranged in the housing 3, which comprises at least two annular elastic elements 1a, 1b according to the invention.

The clamping device 10 according to the invention comprises the following: a first elastic element 1a according to the invention and a second elastic element 1b according to the invention; a housing 3 comprising a first housing part 3a with an inner surface and a second housing part 3b with an inner surface (cf. 105 in FIG. 5A), wherein the housing parts are arranged with respect to one another and fastened to one another in such a way that the inner surfaces of the housing parts 3a, 3b together delimit an interior space within the housing 3; one or more clamping elements 8, wherein each clamping element has a clamping surface 7; a spring 1 arranged in the interior space, comprising the first elastic element 1a and the second elastic element 1a, wherein the spring plate (cf. 16 in FIG. 7C) of the first elastic element 1a is clamped with its first side surface (cf. 16a in FIG. 5A) facing the inner surface of the first housing part 3a in the interior space, and wherein the spring plate of the second elastic element 1a, 1b is clamped with its first side surface facing the inner surface of the second housing part 3b in the interior space, such that a pressure space 2 is formed in the interior space between the sealing layers 17 of the elastic elements 1a, 1b, wherein the pressure space 2 can be vented and aerated or can be acted upon with positive pressure of a pressure medium that can be supplied to the housing; wherein the spring 1 is designed such that, when the pressure space 2 is aerated or vented or the pressure space 2 is acted upon with positive pressure, a bending of at least one of the spring plates 16 of the elastic elements 1a, 1b can be changed and as a result the device 10 changes between an open state, in which an object 5 to be clamped is spaced apart from the one or more clamping surfaces 7, and a closed state, in which at least one of the one or more clamping surfaces 7 transmits a clamping force and/or braking force to the object 5. The device 10 according to the invention further comprises the means of the elastic element according to the invention mentioned at the outset, which bring about an improved sealing in

the region of one or more edges of the sealing layer of the elastic element. These means are explained in more detail in connection with FIGS. 7 to 8 .

FIGS. 1A, 1B, 4A and 4B each show such clamping devices 10 in the closed state in that the clamping surface 7 of the clamping element 8 touches the circumference of the object 5 . The clamping element 8 is also referred to as a clamping lip. The clamping element 8 can be formed in one piece with the remaining parts of the housing part 3a, 3b or can be a structurally separate component of the housing part 3a, 3b from the remaining parts.

The clamping force or action of the clamping surface 7 on the object 5 to be clamped takes place in a clamping plane which is spanned by two vectors which each form a radius of the annular elastic elements 1a, 1b or annular recess 11 (cf. FIG. 5A). The axis 9 can run through the center point of the ring of the components described here as annular and can therefore be referred to as the main axis of the clamping device 10 which can run perpendicularly to the clamping plane. When “inner” and “outer” region, edge or end are referred to in this document, inner edge, inner region or inner end are closer to the axis 9 than correspondingly outer edge, outer region or outer end. The same can, but does not have to, also apply to other components.

The clamping device 10 can be rotationally symmetrical about this main axis 9 . The main axis 9 can run approximately or precisely centrally through an opening of the clamping device 10 (opening 14 in FIGS. 5A, 5B). In FIGS. 1A, 4A, the object 5 to be clamped, for example a rotatable shaft of a machine or of a table, is placed within the opening 14 and the clamping force of the clamping device is therefore directed radially inwardly towards the main axis 9 (perpendicularly to the main axis 9) within the clamping plane. In FIGS. 1B, 4B, the object 5 to be clamped is placed outside the clamping device 10 and the clamping force of the clamping device is therefore directed radially outwardly away from the main axis 9 (perpendicularly to the main axis 9) within the clamping plane.

In FIGS. 1A, 2A, 3A, 4A, the clamping element 8 is located between spring 1 and opening 14 or main axis 9 . In FIGS. 1B, 2B, 3B, 4B, on the other hand, the object 5 to be clamped at least partially surrounds the clamping device 10, so that the clamping element 8 is located there between object 5 and opening 14 or main axis 9 . In FIGS. 1B, 2B, 3B, 4B, a component which at least partially fills the opening 14 and through which the main axis 9 extends can be introduced into opening 14 instead of the object 5 to be clamped.

In FIGS. 1A to 5A, the spring 1 is clamped in each case between two contact surfaces (101 and 102 in FIGS. 5C and 5D) within the housing 3 of the clamping devices 10 and extends between the two contact surfaces. In the pressureless initial state of the device 10 in FIGS. 1A to 2B, the

spring 1 can be slightly bent in order to be fixed firmly in the housing 3 in this state and the same can apply to any other state of the device 10, wherein the degree of bending of the spring 1 depends on the state in which the device 10 is located. If the device 10 is in a state in which the spring 1 is bent (for example bent more than in the pressureless initial state, such as, for example, in the open state), venting of an inner pressure chamber 2 of the spring 1 and ventilation of an outer pressure chamber 4 can lead to at least partial relaxation of the spring 1 while the spring 1 presses against the radial contact surfaces, the spacing of which increases somewhat, so that the housing 3 is thereby elastically deformed in the region of the clamping element 8 or the clamping surface 7 and the clamping surface 7 thereby touches the object 5 and is pressed against the object 5 with a (predefined) clamping force in order to clamp the object 5 firmly. The object 5 is clamped firmly and the clamping device 10 is in the closed state, as shown in FIGS. 1A and 1B . In the closed state of the device 10, the spring 1 can still be slightly bent even after the partial relaxation in order to be fixed firmly in the housing 3 in this state.

The clamping element 8 can be an elastic element, such as, for example, a spring fork, which in the pressureless initial state of the device 10 is brought by the spring force of the (slightly) bent spring 1 from an initial position, in which the elastic element is relaxed, into a clamped position, for example by bending the spring fork 8, until an equilibrium between a restoring force of the elastic element 8 and the spring force of the spring 1 arises in the pressureless initial state. In this equilibrium, the clamping surface 7 can press against the object 5 .

By additionally acting upon the outer pressure chamber 4 in the closed state with compressed air (for example with 4 bar or 6 bar), there is the optional possibility of increasing the clamping force by a predetermined value. This is indicated in FIGS. 1A, 1B by the optional additional compressed air pump (booster) 6 and the hatching (compressed air) in the outer pressure chamber 4 . The outer pressure chamber 4 can be connected by means of an opening in the housing 3 to a port I (also referred to as “close”), to which the compressed air pump 6 can be connected.

As a result, for example, an actuation of the device 10 is possible such that a change takes place between a braked movement (in the pressureless state) of the object 5 and a complete clamping of the object (in the case of a sufficient pressure application).

Even if two pressure chambers 2, 4 are shown and described here by way of example, the clamping device 10 can also be operated with a single pressure chamber which can be, for example, the inner pressure chamber 2 or the outer pressure chamber 4 .

FIGS. 2A and 2B show the clamping devices 10 from FIGS. 1A and 1B in each case in the open state in which the clamping surface 7 does not touch the circumference of the object 5 or is spaced apart from the circumference of the object 5 . The inner pressure chamber 2 can be connected by means of an opening in the housing 3 to a port II (also referred to as “open”), to which a compressed air pump 6 can be connected.

By acting upon the inner pressure chamber 2 by the compressed air pump 6 with compressed air (for example 4 bar or 6 bar) and venting the outer pressure chamber 4, the spring 1, compared with the closed state from FIGS. 1A, 1B, is more strongly (convexly) bent or clamped and a radial shortening of the spring 1 or of the distance between the two bearing surfaces occurs. The clamping surface 7 lifts off from the object 5 in order to release the clamping. The object 5 is freely movable (for example rotatable about axis 9 or movable linearly along axis 9) and the clamping device 10 is open.

It is possible to change back and forth between the closed state and the open state of the device 10 .

Such pneumatic clamps 10 have a number of advantages over hydraulic clamps.

By using the combination of elastic component, here a spring 1 together with elastic elements 1a, 1b, and compressed air, for example very short reaction times are achieved when switching between the open and closed state and a secure clamping of the object 5 is likewise brought about. The spring 1 can preferably be plate-shaped, as shown in more detail in FIG. 5, wherein two elastic elements 1a, 1b lying one on top of the other form the spring 1 and the inner pressure space 2 of the spring 1 between the plates 1a, 1b. The plates 1a, 1b can likewise be annular, as shown in FIG. 5, and can optionally additionally have radial slots, so that a change of the inner diameter is possible with particularly low forces. The elastic elements 1a, 1b can be coated with rubber, at least in the region of slots, in order to produce the tightness required for the compressed air. The elastic elements 1a, 1b are generally formed so pressure-resistant and so elastically bendable and arranged in the housing 3 of the clamping device 10 such that the inner pressure space 2 is formed within the spring 1 between the elastic elements 1a, 1b and the outer pressure space 4 is formed between each elastic element 1a, 1b and the housing 3 or the housing parts 3a, 3b of the clamping device 10 . FIG. 5 shows a three-dimensional view of a clamping device 10 similar to FIGS. 1A and 2A .

By aerating or acting upon the outer pressure space 4 with compressed air and venting the inner pressure space 2, as shown in FIG. 1A, the spring 1 is at least partially relaxed and brings about a clamping force on the object 5 to be clamped, in particular on the circumference of a

shaft 5 . As a result, in the event of an energy or pressure failure, the object 5 is clamped or the shaft 5 is immediately brought to a standstill and therefore offers a safety clamping. Such pneumatic clamps 10 can, depending on the magnitude, achieve holding moments of several 100 Nm and up to several 1000 Nm, which can be further increased by additionally acting upon the outer pressure chamber 4 with compressed air, as indicated in FIG. 1A by a pressure pump 6 (booster). Here, a compressed air of a few bar (for example 4 bar or 6 bar) is sufficient for providing a multiple of the holding moments which are achieved without a booster. In this case, use is made of the fact that small transverse bends of the plates 1a, 1b (perpendicularly to the longitudinal axis thereof) generate large spring forces when switching between the open and closed state of the clamp 10, which spring forces can be used for clamping or for releasing prestressed clamping devices 10 . This enables secure clamping and release even of rapidly rotating machine shafts 5 .

In the case of pneumatic material, the costs and the assembly outlay are also lower in comparison with the hydraulic material and the use of compressed air does not give rise to any additional outlay for producing cleanliness on the plant. Such pneumatic clamps also enable a small overall size, since a small transverse bend and a small (change in the) longitudinal extension of the spring, and therefore small volumes of the pressure chambers, are sufficient to apply the required clamping forces.

In the case of pneumatic clamps, a distinction is made in principle between passive clamping devices 10, as shown in FIGS. 1A to 2B, and active clamping devices 10, as shown in FIGS. 3A to 4B .

In the pressureless initial state, the spring 1 can be bent to different extents (transversely) and therefore be shortened radially to different extents. The inner side of the housing 3 can be adapted to the bend of the elastic elements 1a, 1b or can define said bend. A corresponding stop surface for the elastic elements 1a, 1b can be formed, for example, by a housing inner wall. The housing inner wall can be formed complementarily (e.g. concavely) to a (e.g. convex) bend of the elastic elements 1a, 1b .

In the case of passive clamping devices 10, in the pressureless initial state, the spring 1 is generally slightly elastically (e.g. convexly) bent or is prestressed and the clamping devices 10 can be closed (FIGS. 1A, 1B). The clamping device 10 is opened only by the action of force from the inside by acting upon the inner pressure chamber 2 with compressed air (FIGS. 2A, 2B). In most cases, the spring 1 is bent somewhat in the pressureless initial state, so that in the case of clamping or in the case of a pressure drop, the spring force given by the energy stored in the spring 1 is transmitted to the object 5 to be clamped as clamping force, in order to clamp the

object 5 .

In the case of active clamping devices 10, in the pressureless initial state (FIGS. 3A, 3B), the spring 1 is curved more strongly, in particular more strongly convexly, transversely outwardly than in the case of passive clamping devices, so that the distance between the two radial bearing surfaces is shortened and the clamping device 10 is opened. No clamping force is brought about on the object 5 via clamping surface 7 . The object is free, since the clamping surface 7 does not touch the object 5 or is spaced apart from the object 5 .

By plastic deformation of the elastic elements 1a, 1b, in the case of the same housing 3, the spring 1 can be curved more strongly transversely outwardly in the pressureless initial state and therefore be shortened more strongly radially than in the case of passive clamping devices. This smaller radial extension of the elastic elements 1a, 1b in the pressureless initial state can lead to an open state of the clamping device 10 in the pressureless initial state. Even in the case of plastic deformation, the elastic elements 1a, 1b are elastically bent and press against the bearing surfaces so that the spring is fixed in the housing. The inner space of the housing or the recesses can accommodate the curvature brought about more strongly by plastic deformation in the initial state.

The clamping force must now be induced actively from the outside, as shown in FIGS. 4A and 4B, in order to transfer the clamp into the closed state. Here, compressed air is introduced into the outer pressure space 4 by a compressed air pump 6 and therefore the spring 1 is acted upon with compressed air from the outside in such a way that the spring 1 is actively relaxed, the curvature of the spring 1 is reduced, the distance between the two bearing surfaces is increased, and the housing 3 is elastically deformed in the region of the clamping element 8 or the clamping surface 7, so that the clamping surface 7 touches the object 5 and brings about a clamping force on the object 5 and the object 5 is clamped firmly as a result. The active clamping device 10 is then in the closed state.

Depending on the field of application and prescribed safety regulations, an active or passive clamping system 10 is therefore used. If a safety clamping is primarily desired, a passive clamping device is generally used. With such pneumatic passive clamping systems, it is possible, even in the pressureless state, during a corresponding assembly of the device in an overall device, to generate a predetermined clamping force with which the object 5 to be clamped is acted upon. By being acted upon with overpressure or underpressure, the forces transmitted to this object can be increased, reduced or completely cancelled, which opens up diverse applications. If, on the other hand, a deliberate operation, such as a tool change, is to be carried out primarily with the clamping device, an active clamping device is generally used.

As represented in FIG. 5A, the housing 3 of the clamping devices 10 according to the invention comprises two housing parts 3a, 3b which are fixed to each other with fixing means, such as for instance screws, and are mounted such that, in the assembled state, the two housing parts 3a, 3b define the inner space 13 between the housing parts 3a, 3b within the housing 3 in which the spring 1 together with its annular elastic elements 1a, 1b according to the invention are arranged. The housing parts 3a, 3b each define a recess 11 which is likewise annular and which serve to receive the annular elastic elements 1a, 1b, as represented in FIGS. 5A to 5D . At least part of the first contact surface 101 of the housing part can extend (substantially) perpendicularly to the radial direction R of the annular recess 11 and/or part of the second contact surface 102 of the housing part can extend (substantially perpendicularly) to the radial direction R of the annular recess 11 .

An opening 14 (FIGS. 5A, 5B) extends through the center of the housing 3, into which opening the object 5 to be clamped, such as for instance a shaft, can be introduced. The housing can extend up to 360° around this opening and at least partially encloses the object 5 in at least one plane which is referred to as the clamping plane. The central main axis 9 of the clamping devices runs centrally through the opening 14 and perpendicularly to the clamping plane. In clamping devices according to FIGS. 1A, 2A, 3A, 4A, 5A, 8, the main axis 9 runs centrally through the shaft along the longitudinal axis thereof.

Located along the circumference of the housing 3 or the opening 14 is one or more of the clamping surfaces 7 which, in the case of an elastic deformation of the housing 3 in the region of the clamping element 8 or the clamping surface 7, brings about the clamping force on the outer circumference of the object 5 and can thereby clamp the object 5 . For an effective opening and closing of the clamping device 10 with respect to the object 5 to be clamped, without the risk of damage to the object 5, a symmetrical distribution of the clamping force along the clamping surface 7 or along the circumference of the object 5 is desirable. A non-symmetrical distribution of the clamping force can lead to damage to the object 5 . One or both contact surfaces 101, 102 are preferably circular within the clamping plane. The clamping surface 7 is preferably circular within the clamping plane. The clamping element 8 can be annular. All annular or circular components described here can each have, individually or in combination, as the center point, the point of intersection of the main axis 9 with the clamping plane (e.g. center point of the opening 14).

FIG. 5B shows an embodiment of the component 40, 50 according to the invention (here with the upper housing part 3a from FIG. 5A), wherein the respective housing part 3a of the component has an annular recess 11 for clamping the annular elastic element 1a, and wherein

the housing part 3a has an inner surface defined by the recess 11 (cf. 105 in FIG. 6). The annular recess 11 preferably defines an annular opening 12 in the housing part, wherein the annular opening is formed between a first annular edge 12a of the housing part and a second annular edge 12b of the housing part. The elastic element 1a can be clamped between the first annular edge 12a and the second annular edge 12b.

When the elastic element 1a is introduced with the first side surface (cf. 16a in FIGS. 5B, 7C) facing the inner surface through the opening 12 into the recess 11 and clamped in the recess 11, the first pressure space 4 is formed between the inner surface and the elastic element 1a. The elastic element according to the invention here has the means mentioned at the outset, which allow a reliable and effective sealing at the port II. These means are explained in more detail in connection with FIGS. 7 to 8 .

As shown in FIGS. 5C and 5D, the illustrated elastic element 1a of the spring 1 extends from a first bearing surface 101 within the housing part 3a to a second bearing surface 102 within the housing part 3a and can touch this. The first bearing surface 101 is here arranged radially further outward than the second bearing surface 102 as seen from the center point of the opening 14 .

FIG. 5C shows the portion of the housing part 3a represented in FIG. 5B in which the upper plate 1a of the spring 1 meets the first bearing surface 101 and is preferably in contact with this. FIG. 5D shows the portion of the housing part 3a represented in FIG. 5B in which the upper plate 1a of the spring 1 meets the second bearing surface 102 and is preferably in contact with this. However, it is also possible for one or more further components, via which the elastic element 1a exerts its spring force on the bearing surfaces 101, 102, to be located radially between the elastic element 1a and one or more of the bearing surfaces 101, 102 .

As can be seen in FIGS. 5B, 5D, the elastic element 1a is clamped in the recess 11 between inner sides of the housing part 3a . Each of the plates of the spring 1 is introduced in the direction of the main axis 9 of the clamping devices 10 through the opening 12 into the recess 11 of the respectively associated housing part during assembly along inner surfaces of the housing part 3a until the respective plate at the end of each of the two bearing surfaces 101, 102 abuts against a stop 112, 122 and therefore cannot be introduced further into the recess 11 . Since the extension of the elastic element 1a in the clamping plane or in the radial direction of the annular recess can be greater than the extension of the inner space defined by the housing part, the plate 1a can be bent or prestressed in the pressureless initial state.

FIG. 6 shows an embodiment of a housing part 3a, 3b of an inwardly directed, pneumatic

clamping and/or braking device 10 according to the invention. FIGS. 7A to 7C show an embodiment of the elastic element 1a, 1b according to the invention. FIG. 8 shows a detail of a cross section of a clamping and/or braking device according to the invention with two such elastic elements 1a, 1b according to the invention.

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The housing part 3a, 3b represented in FIG. 6 comprises an annular recess 11 with the housing inner surface 105 . The two housing ports I, II and the clamping element 8 are likewise represented. The elastic element 1a, 1b according to FIG. 7 is inserted into the annular recess 11 such that the connection seal 15 of the sealing layer 17 seals the port II and the region 25 is arranged on the port I. Furthermore, the elastic element with the sealing layer 17 is inserted upwards into the recess 11, so that the first side surface 16a of the spring plate 16 of the elastic element 1a, 1b faces the inner surface 105 . The elastic element is clamped in the recess 11 . Two such components comprising housing part 3a, 3b with clamped elastic element 1a, 1b are then fixed to each other, as shown in FIGS. 5A, 8 .

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As shown in FIGS. 7A to 7C, the elastic element according to the invention comprises a spring plate 16 having a first side surface 16a and a second side surface 16b facing away from the first side surface 16a; a sealing layer 17 made of an elastic material applied on the second side surface 16b of the spring plate 16, the sealing layer 17 comprising: an outer edge 18 extending along a circumference of the spring plate 16; and a first region 19 adjoining the outer edge 18 of the sealing layer 17 inwardly, said first region extending along at least part of the circumference of the spring plate 16 and having a smaller thickness compared to the edge 18; wherein the first region 19 has a first portion 19a along the circumference U of the spring plate 16 and a second portion 19b adjoining the first portion (in the circumferential direction U), wherein the first portion 19a has a greater thickness than the second portion 19b .

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As shown in FIGS. 7A, 7B, the sealing layer 17 can further optionally comprise a second region 20 adjoining the first region 19 of the sealing layer 17 inwardly, said second region extending along at least part of the circumference U of the spring plate 16, wherein the thickness of the second region 20 of the sealing layer 17 is preferably at least as great as the thickness of the first portion 19a of the first region 19 (cf. FIG. 7C in which the thickness of the first portion 19a is substantially as great as the thickness of the second region 20).

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As shown in FIG. 7B, an extension x of the first portion 19a of the first region 19 can decrease, preferably continuously, along the circumference U of the spring plate 16 towards the outer edge 18.

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As shown in FIG. 7A, the spring plate 16 and the sealing layer 17 are each annular, wherein the

sealing layer 17 preferably further comprises: a further, inner edge 21 along the circumference u of the inner circle of the ring; a third region 22 adjoining the inner edge 21 of the sealing layer 17 outwardly, said third region extending along at least part of the circumference u of the inner circle and having a smaller thickness compared to the inner edge 21; wherein the third region 22 has a third portion 19c along the circumference u of the circle and a fourth portion 19d adjoining the third portion (in the circumferential direction u), wherein the third portion 19c has a greater thickness than the fourth portion 19d. The third portion 19c can be configured in shape and/or extension x analogously to the first portion 19a as shown in FIG. 7B.

For better illustration, not shown here, the first region 19 can have a plurality of such adjoining first and second portions 19a, 19b along the circumference U of the spring plate 16. Alternatively or additionally, the third region 22 can have a plurality of such adjoining third and fourth portions 19a, 19b along the circumference u of the inner circle.

As can be seen in the combined view of FIGS. 5A, 7 and 8, the thickness of the first portion 19a of the first region 19 of the sealing layer 17 of at least one of the elastic elements 1a, 1b in the device 10 is selected such that, when the pressure space 2 is aerated or the pressure space 2 is subjected to overpressure, a displacement of the (here outer) edge 18 of the sealing layer 17 of the at least one elastic element 1a, 1b is at least inhibited or even entirely prevented. As a result, the tightness in the region of the edge of the sealing layer is increased without installing additional components in the housing parts.

Such additional components, which become unnecessary by aspects of this disclosure, can be pressure pieces (not illustrated here in FIG. 8) which would press (here radially from the outside) against the outer edge 18 in order to inhibit the curvature thereof radially toward the outside. These pressure pieces would be introduced into the housing parts 3a, 3b by means of sprinklers 30, 31 attached on the end face. Such holes 30, 31 would require a complex eroding and drilling and would necessitate special structural adaptations for the pressure pieces in the housing parts. This would make the production process more complicated and more expensive.

It is also more favorable and simpler merely to introduce boreholes for fixing means and connections in the direction of the axis 9 (cf. FIG. 5A) into the housing parts instead of additionally carrying out boreholes on the end face in the radial direction (cf. R in FIG. 5A).

The increased sealing in the region of the one or more edges 18, 21 of the sealing layer 17 of the elastic element 1a, 1b can be achieved by the means described here individually and in combination, with simultaneously minimal adaptations in the sealing layer 17 and without adaptation in the housing parts 3a, 3b. This enables secure operation of the clamping and/or braking device 10 without adversely affecting the dynamics of the device.

Preferred embodiments of the subject matter claimed by the appended claims are described in the description and in the figures. The optional features disclosed in the above description, the claims and the drawings can be used both individually and in any combination for the embodiment of the subject matter claimed here in accordance with the appended claims in its various configurations.

The various aspects and embodiments described above can be combined to create yet further embodiments. These and other changes can be made to the embodiments in light of the above detailed description. In general, the terms used in the following claims should not be construed as limiting the claims to the specific aspects and embodiments disclosed in the description and the claims, but as encompassing all possible embodiments together with the full scope of equivalents to which such claims are entitled.

Claims

1. A preferably annular elastic element (1a, 1b) for a clamping and/or braking device,
5 comprising:
a spring plate (16) having a first side surface (16a) and a second side surface (16b) facing
away from the first side surface (16a);
a sealing layer (17) made of an elastic material applied on the second side surface (16b)
of the spring plate (16), the sealing layer (17) comprising:
10 an edge (18) extending along a circumference of the spring plate (16); and
a first region (19) adjoining the edge (18) of the sealing layer (17), said first
region (19) extending along at least part of the circumference of the spring plate
(16) and having a smaller thickness compared to the edge (18);
characterized in that
15 the first region (19) has a first portion (19a) along the circumference (U) of the spring
plate (16) and a second portion (19b) adjoining the first portion, wherein the first
portion (19a) has a greater thickness than the second portion (19b).
2. The elastic element of claim 1, wherein the sealing layer (17) further comprises a second
20 region (20) adjoining the first region (19) of the sealing layer (17) and extending along
at least part of the circumference (U) of the spring plate (16), wherein the thickness of
the second region (20) of the sealing layer (17) is at least as great as the thickness of the
first portion (19a) of the first region (19).
- 25 3. The elastic element of claim 1 or 2, wherein an extension (x) of the first portion (19a) of
the first region (19) decreases, preferably continuously, along the circumference (U) of
the spring plate (16) towards the edge (18).
4. The elastic element according to any one of the preceding claims, wherein the spring
30 plate (16) and the sealing layer (17) are annular, wherein the sealing layer (17)
preferably further comprises:
a further edge (21) along the circumference (u) of the inner or outer circle of the
ring;
a third region (22) adjoining the further edge (21) of the sealing layer (17) and
35 extending along at least part of the circumference (u) of the circle and having a
smaller thickness compared to the further edge (21);
wherein the third region (22) has a third portion (19c) along the circumference
of the circle and a fourth portion (19d) adjoining the third portion, wherein the

third portion (19c) has a greater thickness than the fourth portion.

5. The elastic element according to any one of the preceding claims, wherein the first region (19) has a plurality of such adjoining first and second portions (19a, 19b) along the circumference (U) of the spring plate (16) and/or wherein the third region (22) has a plurality of such adjoining third and fourth portions (19a, 19b) along the circumference (u) of the circle.

6. A clamping and/or braking device (10) for clamping and/or braking an object to be clamped and/or braked, comprising:

a first elastic element (1a) according to any one of the preceding claims and a second elastic element (1b) according to any one of the preceding claims;

a housing (3) comprising a first housing part (3a) having an inner surface (105) and a second housing part (3b) having an inner surface (105), wherein the housing parts are arranged with respect to each other and fixed to each other such that the inner surfaces (105) of the housing parts (3a, 3b) together delimit an inner space within the housing (3);

one or more clamping elements (8), wherein each clamping element has a clamping surface (7);

a spring (1) arranged in the inner space comprising the first elastic element (1a) and the second elastic element (1b), wherein the spring plate (16) of the first elastic element (1a) is clamped with its first side surface (16a) facing the inner surface (105) of the first housing part (3a) in the inner space, and

wherein the spring plate (16) of the second elastic element (1b) is clamped with its first side surface (16a) facing the inner surface (105) of the second housing part (3b) in the inner space, so that a pressure space (2) is formed in the inner space between the sealing layers (17) of the elastic elements (1a, 1b), wherein the pressure space (2) is ventable and aeratable or can be subjected to overpressure of a pressure medium that is suppliable to the housing;

wherein the spring (1) is designed such that, when the pressure space (2) is vented or aerated or the pressure space (2) is subjected to overpressure, a bending of at least one of the spring plates (16) of the elastic elements (1a, 1b) is changable and thereby the device (10) changes between an open state, in which an object (5) to be clamped is spaced apart from the one or more clamping surfaces (7), and a closed state, in which at least one of the one or more clamping surfaces (7) transmits a clamping and/or braking force to the object (5); and

wherein the thickness of the first portion (19a) of the first region (19) of the sealing layer (17) of at least one of the elastic elements (1a, 1b) is selected such that, when the

pressure space (2) is aerated or the pressure space (2) is subjected to overpressure, a displacement of the edge (18) of the sealing layer (17) of the at least one elastic element (1a, 1b) is at least inhibited.

- 5 7. The clamping and/or braking device (10) according to claim 6, wherein the spring plates (16) of the elastic elements (1a, 1b) are clamped in the inner space such that the edges (18) of the sealing layers (17) of the elastic elements (1a, 1b) rest on one another.
- 10 8. The clamping and/or braking device (10) according to any one of the preceding claims, wherein the pressure space (2) is arranged within the spring (1) between the second side surfaces (16b) of the spring plates (16) of the elastic elements (1a, 1b).
- 15 9. The clamping and/or braking device (10) according to any one of the preceding claims, wherein the first portion (19a) of the sealing layer (17) of at least one of the elastic elements (1a, 1b) is arranged on a straight line with a connection seal (15), the sealing layer (17) of the at least one of the elastic elements (1a, 1b), for a housing connection (II) of the clamping and/or braking device (10) for subjecting the pressure space (2) of the clamping and/or braking device (10) to a pressure medium.
- 20 10. The clamping and/or braking device (10) according to any one of the preceding claims, wherein a further pressure space (4) is formed between the first side surfaces (16a) of the spring plates (16) of the elastic elements (1a, 1b) and the inner surfaces (105) of the housing parts (3a, 3b).
- 25 11. The clamping and/or braking device (10) according to claim 10, wherein the first spring plate (16) of the first elastic element (1a) is designed, by subjecting the further pressure space (4) to overpressure, to reduce its bending in order, when the inner or outer edge of the first spring plate (16) is supported on the inner surface (105) of the first housing part, to press with the outer or inner edge of the first spring plate (16) onto one of the
30 clamping elements such that a transmission of the clamping and/or braking force from the clamping surface of the clamping element to the object (5) to be clamped and/or braked is thereby effected and the device (10) changes from the open state to the closed state.
- 35 12. The clamping and/or braking device (10) according to claim 10 or 11, wherein the device (10) is designed such that, by aerating the further pressure space (4) or by subjecting the further pressure space (4) to overpressure, one of the clamping elements moves away from a portion of one of the inner surfaces (105) and/or the bending of at least

one of the spring plates (16) of the elastic elements is reduced, and thereby the device (10) changes from the open state to the closed state.

5 13. The clamping and/or braking device (10) according to any one of the preceding claims 10 to 12, wherein the first portion (19a) of the sealing layer (17) of at least one of the elastic elements (1a, 1b) is arranged in the region (25) of a housing connection (I) of the clamping and/or braking device (10) for subjecting the further pressure space (4) to overpressure.

10 14. The clamping and/or braking device (10) according to any one of the preceding claims, wherein the clamping and/or braking force is effected by the inner or outer edge of at least one of the spring plates (16) of the elastic elements (1a, 1b) being supported on one of the inner surfaces (105) and the outer or inner edge (16a, 16b) of the at least one spring plate (16) pressing onto the clamping element.

15 15. The clamping and/or braking device (10) according to any one of the preceding claims, wherein the device (10) is designed such that, by aerating the pressure space (2) or by subjecting the pressure space (2) to overpressure, one of the clamping elements (8) moves towards a portion of one of the inner surfaces (105) and/or the bending of at
20 least one of the spring plates (16) of the elastic elements is increased, and thereby the device (10) changes from the closed state to the open state.