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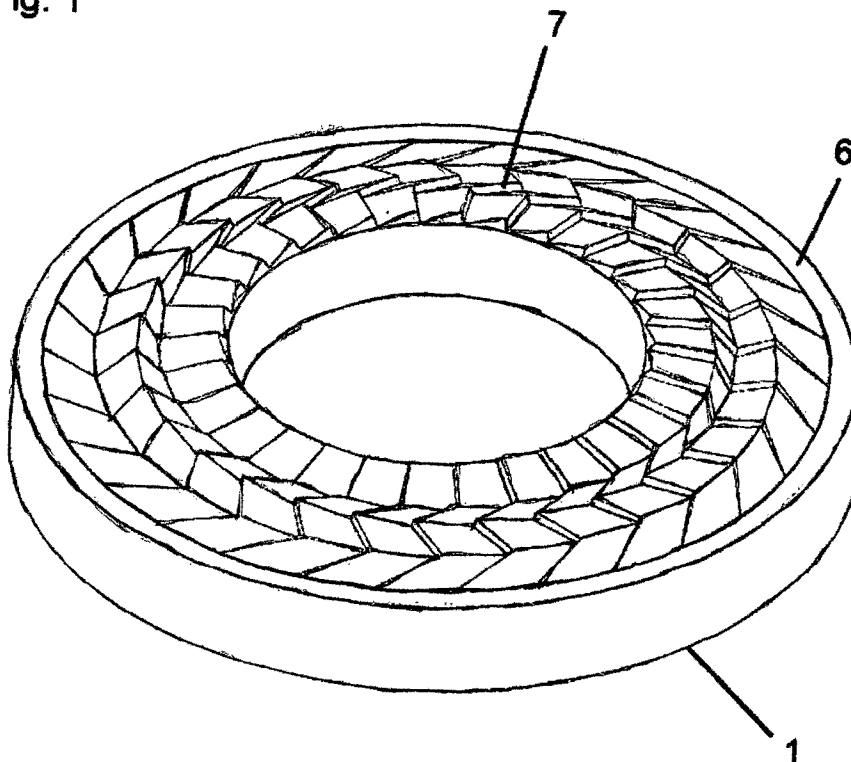
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(54) Title: CORROSION-RESISTANT SCREW-SECURING DISK

**Fig. 1**



(57) Abrégé/Abstract:

The invention relates to a corrosion-resistant screw-securing disc having an annular, stainless steel disc body for arrangement between a screw head and a flat support (5), with a disc upper side (6) and a disc underside (1). The surfaces of the disc upper side (6) and of the disc underside (1) of the disc body are compacted by a stamping process, wherein the disc body has a material thickness of at least 1.5 mm and has a convex shape.

### Abstract

The invention relates to a corrosion-resistant screw-securing disc having an annular, stainless steel disc body for arrangement between a screw head and a flat support (5), with a disc upper side (6) and a disc underside (1). The surfaces of the disc upper side (6) and of the disc underside (1) of the disc body are compacted by a stamping process, wherein the disc body has a material thickness of at least 1.5 mm and has a convex shape.

Corrosion-resistant screw-securing disk

The invention relates to a corrosion-resistant screw-securing disk having a ring-shaped stainless-steel disk body for placement between a screw head and a flat support.

Screw-securing disks have the task of counteracting loosening processes in the case of screw connections. Such loosening processes result from losses in preload force in the screw connections, which occur as the result of settling processes and/or creep processes in the case of the parts that are screwed together.

In order to counteract such loosening processes, screw-securing disks have a spring effect, the spring force of which is dimensioned in such a manner that it can balance out a loss in preload force brought about by the settling processes and/or creep processes, to such an extent that the clamping force required for operational reliability of the screw connection is maintained.

In the case of great demands on corrosion protection, in particular also in the foods sector, screw connections made of

stainless steel are used. The screw-securing elements are also produced from stainless steel in the case of connections using stainless-steel screws. Aside from the good corrosion protection properties of stainless steel, contact corrosion is prevented by means of the same galvanic potential of the screw-securing elements.

Fundamentally, stainless steel has only slight spring effects. In the case of special stainless-steel alloys, an increased spring effect can be implemented by means of a heat-treatment process. These special stainless-steel alloys as well as the heat-treatment process are very expensive, for one thing, and for another thing the corrosion properties are negatively influenced by the heat-treatment process. Last but not least, the spring properties achieved as an end result are generally not sufficient to meet the requirements. Against this background, heat-treated stainless-steel materials are only rarely used in practice for screw-securing elements.

Stainless steel having the material number 1.4301 or 1.4401 according to DIN EN 10027-2:2015-07 (X5CrNi18-10 and X5CrNiMO 17-12-2, respectively) is frequently used as a spring stainless steel having good or very good corrosion properties. In the case of this stainless steel, compaction of the surface is

brought about by means of strain hardening when rolling the strip. This compaction leads to a limited spring effect in the case of thin sheet-metal thicknesses up to 1 mm, wherein the spring effect increases with a decreasing sheet-metal thickness. It is remarkable for this material that it has only a very restricted spring effect at greater thicknesses when it is strain-hardened, which effect is not sufficient to balance out seating in the case of screw connections. After strain hardening, this material can be processed further or reshaped only to a limited extent.

This is where the invention takes its start. The invention is based on the task of making available a corrosion-resistant screw-securing disk having a stainless-steel disk body, which disk can be used even in the case of great demands on corrosion protection, for example in the foods sector, has a high spring effect, and can be produced cost-advantageously. According to the invention, this task is accomplished by means of a screw-securing disk having the characteristics of the characterizing part of claim 1.

With the invention, a corrosion-resistant screw-securing disk having a stainless-steel disk body is made available, which can be used even in the case of great demands on corrosion

protection, for example in the foods sector, has a high spring effect, and can be produced cost-advantageously. Because of the fact that the surfaces of the disk upper side and the disk underside of the disk body are compacted by means of a stamping process, wherein the disk body has a material thickness of at least 1.5 mm and wherein the disk body has a convex shape, a high spring effect is achieved to compensate setting effects, in order to maintain the preload force of a screw connection. The material thickness, which must be dimensioned to be sufficiently great, in combination with the compaction of the edge layer in the reshaped state and the surface tension that occurs during bracing, leads to the desired spring effect. In this regard, it was surprisingly found that the spring effect increases with an increasing material thickness. Preferably the screw-securing disk is configured in one piece. Preferably the disk body has a material thickness of at least 2 mm, particularly of at least 2.5 mm, in particular of at least 3.0 mm.

In a further development of the invention, at least one of the surfaces of the upper side and underside of the disk body is provided with knurling. In this regard, line contours are stamped into the surface, thereby achieving point-like additional compaction of the surface. In this way, the surface tension of the screw-securing disk and thereby the spring effect

that occurs is adjustable. Preferably both surfaces of the upper side and the underside of the disk body of the screw-securing disk are provided with knurling. In this regard, the two surfaces can be provided with different knurling with regard to the knurling depth and/or knurling pattern, one from the other, and thereby the spring effect can be maximized.

In an embodiment of the invention, the stainless-steel disk body is produced from stainless steel having the material number 1.4401 or 1.4301 according to DIN EN 10027-2:2015-7. These are cost-advantageous materials that demonstrate excellent corrosion properties. By means of the use of such a commercially available and formable starting material, stamping the knurling is easily possible, and good compaction of the surface of the screw-securing disk is achieved. The compaction of the soft starting material is combined, in the process, with shaping by means of compaction of the surface and point-like additional compaction in the form of knurling on one or both sides of the screw-securing disk by means of a stamping process.

In a further embodiment of the invention, an outer and an inner ring-section surface are arranged on the underside of the screw-securing disk, which faces the support, at an angle relative to one another, wherein the outer edge of the outer ring-section

surface lies on the support in the non-braced state of the disk, and wherein the two ring-section surfaces enclose an acute angle with the support, in each instance, and wherein the angle  $\alpha$  formed between the outer ring-section surface and the support is greater than the angle  $\beta$  formed between the inner ring-section surface and the support. As a result, the setting force acts at a steeper angle relative to the flat support, i.e. the force component in the vertical direction is greater than the force component in the horizontal direction. As a result, the outer edge of the surface of the outer ring section is pressed into the flat support more strongly when the screw is tightened, and thereby an improved securing effect is achieved. Furthermore the outside diameter of the disk can be kept relatively small while obtaining a high securing effect.

In a further development of the invention, the acute angle between the outer ring-section surface and the support amounts to between  $10^\circ$  and  $20^\circ$ , preferably between  $12^\circ$  and  $15^\circ$  in the non-braced state. These values yield good spring properties and securing properties of the disk. Preferably the acute angle between the inner ring-section surface and the support amounts to between  $3^\circ$  and  $15^\circ$ , preferably between  $5^\circ$  and  $10^\circ$  in the non-braced state.

It is advantageous if the angle  $\gamma$  between the two ring-section surfaces is an obtuse angle. Preferably the acute angle  $\beta$  between the inner ring-section surface and the flat support is about half as great in the non-braced state as the acute angle  $\alpha$  between the outer ring-section surface and the flat support.

In a further embodiment of the invention, the surface of at least one contact surface, preferably of both contact surfaces is structured to be polished. In this way, the very good corrosion resistance of the stainless-steel material of the screw-securing disk, which is already very good, is additionally increased.

Other further developments and embodiments of the invention are indicated in the other dependent claims. An exemplary embodiment of the invention is shown in the drawings and will be described in detail below. The figures show:

Figure 1 the schematic representation of a stainless-steel screw-securing disk;

Figure 2 the schematic sectional representation, cut in half, of the screw-securing disk from Figure 1, and

Figure 3 the schematic representation of a stainless-steel screw connection with a securing disk according to

Figure 1, wherein the left side of the figure shows the securing disk on the non-braced state, and the right side of the figure shows the securing disk in the braced state.

The screw-securing disk selected as an exemplary embodiment is produced from V4A stainless steel having the material number 1.4401 (X5CrNiMo 17-12-2) and comprises a convex disk body formed in ring shape, having a material thickness of 2.5 mm. The screw-securing disk has a disk upper side 6 and a disk underside 1, the surfaces of which are compacted by means of a stamping process, in each instance.

The disk underside 1 is configured to be convex and is divided into two ring-section surfaces 2, 3, an outer ring-section surface 2 and an inner ring-section surface 3, which are set at an angle relative to one another.

The screw-securing disk is structured in such a manner that in the non-braced state it lies on a flat support 5 with the outer edge 4 of its outer ring-section surface 2. In this regard, the outer ring-section surface 2 encloses an angle  $\alpha$  with a flat support 5 in the non-braced state, and the inner ring-section surface 3 encloses an angle  $\beta$  with the flat support 5 in the

non-braced state (see Fig. 3). In this regard, the angles  $\alpha$ ,  $\beta$  are configured as acute angles, wherein the angle  $\beta$  always has a smaller value than the angle  $\alpha$ . In the exemplary embodiment, the angle  $\alpha$  amounts to  $14^\circ$  and the angle  $\beta$  amounts to  $6^\circ$ .

On its upper side 6, which faces away from the support 5, the screw-securing disk is configured to be domed. A knurling 7 is circumferentially introduced into the surface of the upper side 6 within the frame of the stamping process, and thereby additional compaction is achieved. In the exemplary embodiment, the knurling 7 is structured by means of an arrangement of continuous lines (see Fig. 1). Depending on the desired partial compaction of the surface, other knurling patterns can also be introduced. In the exemplary embodiment, both the upper side 6 and the underside 1 are provided with a knurling 7. To increase the corrosion resistance, the surfaces of the upper side 6 and the underside 1 are polished.

Claims

1. Corrosion-resistant screw-securing disk having a ring-shaped stainless-steel disk body for placement between a screw head and a flat support (5), having a disk upper side (6) and a disk underside (1) faces the support, characterized in that the surfaces of the disk upper side (6) and the disk underside (1) of the disk body are compacted by means of a stamping process, wherein the disk body has a material thickness of at least 1.5 mm and has a convex shape.
2. Screw-securing disk according to claim 1, characterized in that the disk body has a material thickness of at least 2.0 mm, preferably at least 2.5 mm.
3. Screw-securing disk according to claim 1 or 2, characterized in that at least one of the surfaces, preferably both surfaces of the upper side and underside (6, 1) of the disk body is provided with knurling (7).
4. Screw-securing disk according to claim 3, characterized in that both surfaces of upper side and underside (6, 1) of the disk body are provided with different knurling (7) with

regard to knurling depth and/or knurling pattern, one from the other.

5. Screw-securing disk according to one of the preceding claims, characterized in that the stainless-steel disk body is produced from stainless steel having the material number 1.4401 or 1.4301 according to DIN EN 10027-2:2015-07.
6. Screw-securing disk according to one of the preceding claims, characterized in that an outer and an inner ring-section surface (2, 3) are arranged on its underside (6), which faces the support (5), at an angle relative to one another, wherein the outer edge of the outer ring-section surface (2) lies on the support (5) in the non-braced state of the disk, and wherein the two ring-section surfaces (2, 3) enclose an acute angle with the support (5), in each instance, and wherein the angle  $\alpha$  formed between the outer ring-section surface (2) and the support (5) is preferably greater than the angle  $\beta$  formed between the inner ring-section surface (3) and the support (5).
7. Screw-securing disk according to one of the preceding claims, characterized in that at least one of the surfaces

of upper side and underside (6, 1) of the disk body is polished.

8. Screw-securing disk according to claim 6 or 7, characterized in that the acute angle  $\alpha$  between the outer ring-section surface (2) and the support (5) amounts to between  $10^\circ$  and  $20^\circ$ , preferably between  $12^\circ$  and  $15^\circ$  in the non-braced state, wherein the acute angle  $\beta$  between the inner ring-section surface (3) and the support (5) amounts to between  $3^\circ$  and  $15^\circ$ , preferably between  $5^\circ$  and  $10^\circ$  in the non-braced state.
9. Screw-securing disk according to one of claims 6 to 8, characterized in that the angle  $\gamma$  between the two ring-section surfaces (2, 3), facing the flat support (5), is an obtuse angle.
10. Screw-securing disk according to one of claims 6 to 9, characterized in that the acute angle  $\beta$  between the inner ring-section surface (3) and the flat support (5) is about half as great in the non-braced state as the acute angle  $\alpha$  between the outer ring-section surface (2) and the flat support (5).

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[two drawing pages, Fig. 1 to 3]

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Fig. 1

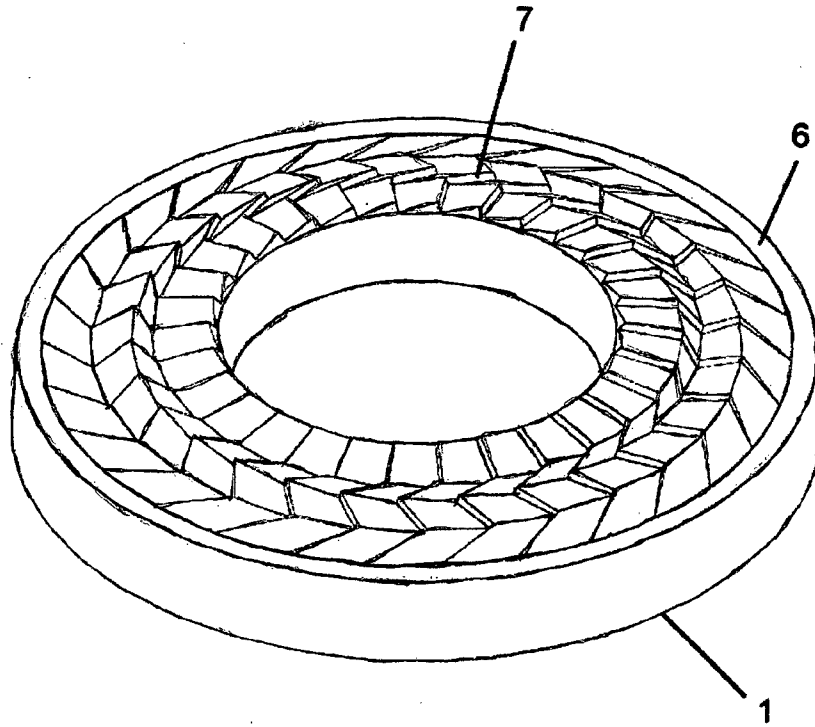


Fig. 2

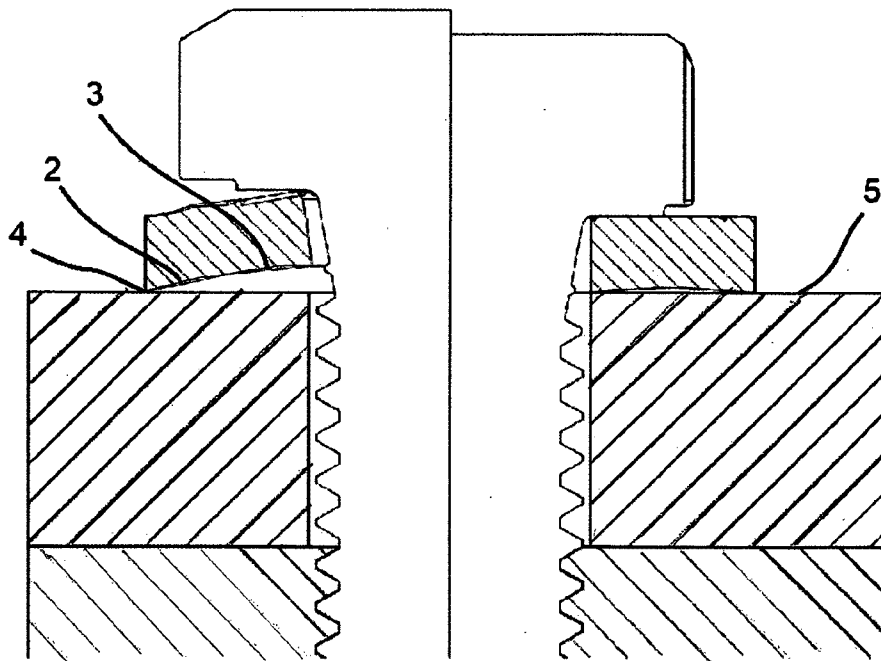


Fig. 3

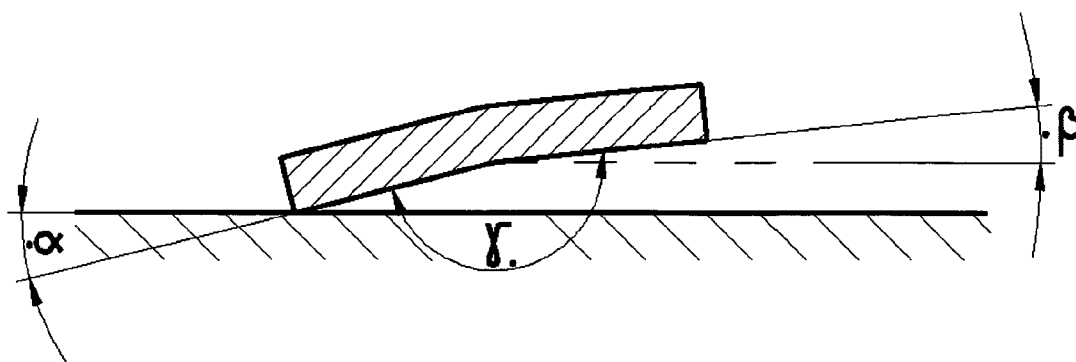


Fig. 1

