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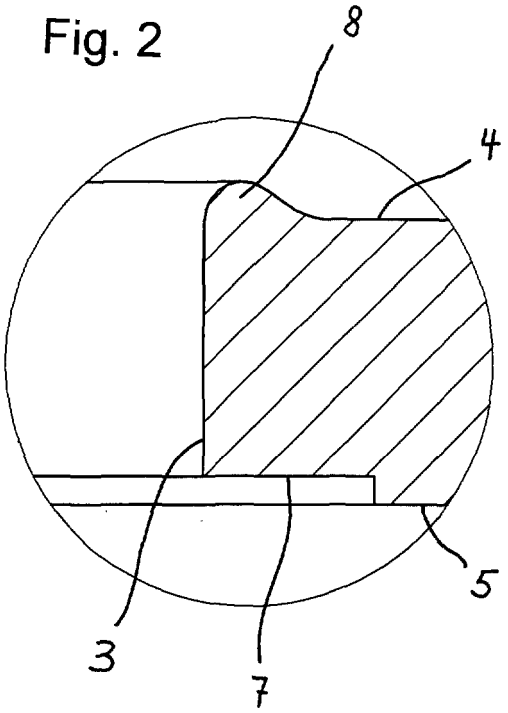
(54) Sealing plate and method for making the same

(57) The invention concerns a sealing plate, in particular a valve plate, as well as a method for making the same. The sealing plate consists of a metal plate (1) with essentially parallel plate surfaces (4, 5) and with one or more ports (3). It comprises at least one sealing bead (9) formed on at least one of the plate surfaces (4), surrounding at least one of the ports (3). This sealing bead (9) is provided with a pressed, flat sealing surface (10). To form the sealing bead (9), plate metal is upset forming a bead (8) on a plate surface (4) in a first step and the top of this bead (8) is flat pressed in a second step. Preferably, the bead (8) is built-up by free flowing upsetting.

Fig. 2



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Description

[0001] The invention concerns a sealing plate, in particular a valve plate, according to the preamble of claim 1, as well as a method for making the same.

[0002] Valve plates of this type are used in compressors for the cooling systems of refrigerators or in air conditioning systems of cars, for example.

[0003] A plate surface of an already known valve plate is provided with a circumferential groove surrounding a port of the valve plate, the material between said groove and the port forming a sealing bead. Its plate surfaces, including the sealing surfaces of the sealing beads, are flat grinded in order to ensure tight sealing. However, flat grinding is a rather expensive production process.

[0004] An object of the invention is to provide a sealing plate with one or more sealing beads having acurately shaped sealing surfaces and which can be produced at a lower cost.

[0005] This object is achieved with a sealing plate having the characteristics of claim 1 and with a method for making the same according to claim 9. Preferred embodiments are indicated in the dependent claims.

[0006] The invention is now explained in detail with reference to the drawings, which show preferred embodiments of the invention.

Fig. 1 shows a partial, cross-sectional view of a valve plate with a cylindrical port and with a bead of upset plate metal on the upper rim of the port;

Fig. 2 shows the encircled detail I of Fig. 1;

Fig. 3 shows the valve plate according to Fig. 1 with a pressed flat sealing surface on the bead;

Fig. 4 shows the encircled detail IV of Fig. 3 and, additionally, the cross-section of a flat embossing tool;

Fig. 5 shows a partial, sectional view of a sealing plate with a couple of beads of upset plate metal on each of the plate surfaces;

Fig. 6 shows the encircled detail VI of Fig. 5 and, additionally, the cross-section of a v-shaped embossing tool;

Fig. 7 shows the sealing plate according to Fig. 5 with pressed flat sealing surfaces on the beads and arranged between corresponding sealing members;

Fig. 8 shows the detail of a sealing plate also shown in Fig. 6, but with flat pressed sealing beads, as well as a flat embossing tool;

Fig. 9 shows a partial, sectional view of a sealing plate with a bead of upset plate metal bordering a wedge shaped groove;

Fig. 10 shows the encircled detail X of Fig. 9 and, additionally, the cross-section of a wedge shaped embossing tool;

Fig. 11 shows the sealing plate according to Fig. 9 with a pressed flat sealing surface on the bead;

Fig. 12 shows the encircled detail XII of Fig. 11 and, additionally, the cross-section of a flat embossing tool;

Fig. 13 shows a cross-sectional view of the border of a sealing plate with upset plate metal forming beads along its border on both sides of the plate;

Fig. 14 shows the encircled detail XIV of Fig. 13 and, additionally, the cross-section of a lateral embossing tool;

Fig. 15 shows the sealing plate according to Fig. 13 with pressed flat sealing surfaces on the beads;

Fig. 16 shows the encircled detail XVI of Fig. 15 and, additionally, the cross-sections of two flat embossing tools;

Fig. 17 shows an elevational view of a valve plate with a plurality of ports which are surrounded by a plurality of sealing beads;

Fig. 18 shows the valve plate of Fig. 17 in cross-section along the line XVIII-XVIII;

Fig. 19 is an enlarged, partial view of Fig. 18, showing the encircled detail XIX;

Fig. 20 is an enlarged, partial view of Fig. 18, showing the encircled detail XX;

Fig. 21 shows an elevational view of a sealing plate with a single port surrounded by multiple sealing beads;

Fig. 22 shows the sealing plate of Fig. 21 in cross section along the line XXII-XXII;

Fig. 23 is an enlarged, partial view of Fig. 22 showing the encircled detail XXIII;

Fig. 24 is an enlarged, partial view of Fig. 22 showing the encircled detail XXIV.

[0007] Fig. 1 shows part of a sealing plate 1 in cross-sectional view, in a plane comprising the axis 2 of a port 3 through the plate. An enlarged detail of this drawing is shown in Fig. 2. The sealing plate consists of a metal

which is soutable to be shaped by cold, plastic deformation, such as low carbon steel, copper or aluminum, for example. This metal plate has essentially parallel plate surfaces 4, 5 and one or more ports extending through the plate, only one of which is shown in the drawing. This port 3 is made with a stamping tool (not shown), the stamping direction of which is indicated by arrow 6. One of the plate surfaces is depressed in a zone 7 around the port 3, preferably in an embossing process. The displacement of plate metal from the depressed zone results in plate metal being upset on the opposite side of the plate, forming a metal bead 8 bordering the edge of the port 3. This bead constitutes an elevation of the plate surface 4.

[0008] The term "upset plate metal" refers, in a broad sense, to an elevation of plate metal on a plate surface, formed by plastic deformation of the plate. In the upsetting process, the upset metal is preferrably allowed to build up in a free flowing manner: It is not pressed against a surface of a shaping tool. As a result, the top of the bead 8 is convex in cross-section. In a second step this bead 8 is flat pressed, turning it into a sealing bead 9 with a flat sealing surface 10, as shown in Figs 3 and 4. An embossing tool 11 which is preferably used for this flat pressing of the bead 8 is shown in Fig. 4. With this method a sealing plate with a highly acurate flat sealing surface, which is of increased strength due to the local compression of plate metal, is formed rapidly and at low costs. The edges 14, 15 of the pressed, flat sealing surface 10 are usually slightly rounded, in the shape of a flow curve, whereas they would necessarily be sharp if the bead was flat grinded.

[0009] The sealing bead 9 has a preferred width 12 of 0.3 mm to 2 mm and a preferred height 13 of 0.02 to 0.2 mm. These dimensional indications also apply to the sealing beads in the examples described hereinafter and will not be repeated.

[0010] Fig. 5 shows the sectional view of a sealing plate 1 with two parallel beads 16, 17 on each of the plate surfaces 4, 5. These beads are shown in cross-section. In Fig. 6 the shape of an embossing tool 18 which is used for forming the beads 16, 17 on one plate surface 4 is shown as well. It is of v-shaped cross-section, with a working surface 19, and is used to press a v-shaped groove 20 into a surface of the sealing plate. As a result of this v-groove embossing, plate metal is upset along the groove on both sides of the same, forming said beads 16, 17 which, together, constitute a dual bead seal.

[0011] Adjacent to the v-shaped working surface 19, the embossing tool has a flat abutment surface 21 which is brought in flat engagement with the plate surface during the embossing step. The depth of the groove 20 is equal to the height 22 of the tip of the v-shaped working surface above the abutment surface 21. Between the working surface 19 and the abutment surface 21, the tool 18 has a recess 23 in order to allow free flowing upsetting of plate metal on both sides of the groove 20.

[0012] The identical v-shaped groove 24 on the opposite side of the plate is formed in the same way, and preferably at the same time, with a second embossing tool of the same kind (not shown).

[0013] Fig. 7 shows the sealing plate 1 of Fig. 5 with press-shaped, flat sealing surfaces on the sealing beads. The flat embossing tool which is used to form these flat sealing surfaces is shown in Fig. 8. This flat pressing methode and the characteristics of the resulting sealing surfaces correspond essentially to the flat pressing of a single bead seal as described with reference to Fig. 4. Having beads of upset plate metal on both plate surfaces, the sealing plate is preferably pressed between two parallel flat embossing tools (only one of which is shown in Fig. 8), thereby forming all of the sealing surfaces simultaneously.

[0014] Fig. 7 further shows a possible application of the sealing plate, where it is mounted between two parts 56, 57, in tight engagement with their respective connection surfaces. The grooves 20, 24 between the beads of the dual bead seals are closed by said connection surfaces of the parts 56, 57, forming chambers 57, 58. Depending on the application, it may be useful to fill these chambers with a gas or liquid and/or to apply a pressure to this chamber which is higher or lower than the environmental pressure on either side of the dual bead seal. For this purpose, pairs of grooves 20, 24, pressed into the plate surfaces of the sealing plate in opposite positions may be connected to one another by one or more conducts 26, thereby applying a certain pressure, created in one chamber 58 to a chamber 59 on the opposite side of the plate as well.

[0015] The conducts 26 may also be used to evacuate a liquid or a gas leaked through a first sealing line of a dual bead seal, in order to prevent it from leaking through the second sealing line of the same dual bead seal as well.

[0016] Fig. 9 shows, in sectional view, a portion of a metal plate 1, similar to the one shown in Fig. 5, but with only one groove 27 pressed into one of the plate surfaces. Fig. 10 shows on an enlarged scale the shape of this groove, as well as the shape of an embossing tool 31 which is used to press the groove 27 into the plate surface. The groove 27 has a first flank 28 which is perpendicular to the plane 30 of the plate and a second flank 29 which is inclined to the plane 30 of the plate. The embossing tool 31 is shaped correspondingly with an embossing edge 32 and an inclined working surface 33. The embossing process with an embossing tool of this kind is also called wedge embossing. In this process, sheet metal from the groove is displaced by said working surface 33 of the embossing tool and plate metal is thereby upset along the groove, forming a bead 34 bordering the inclined flank 29 of the groove.

[0017] Just like the v-shaped embossing tool of Fig. 6, the wedge shaped embossing tool shown in Fig. 10 has an abutment surface 35 defining the depth of the groove and a recess 36 between this abutment surface 35 and the working surface 33 which allows the free flowing upsetting of plate metal when the groove is pressed into

the plate surface.

[0018] Fig. 11 shows the result of the second production step: The bead 34 (Fig. 10) is provided with a pressed, flat sealing surface. The embossing tool 11 which is used to press-form this sealing surface is shown in Fig. 12. This method and its results have already been described with reference to Fig. 4.

[0019] Obviously, a dual bead seal with a v-shaped groove as shown in Fig. 7 could also be used on one of the plate surfaces only, while the single bead seal bordering a wedge-shaped groove as shown in Fig. 10 could also be provided on both sides of the sealing plate.

[0020] Fig. 13 shows in cross-section the outer border of a sealing plate with beads of upset plate metal provided along said border on each side of the plate. Fig. 14 shows how these beads are formed: A tool 37 is laterally pressed against the border surface 38 of the sealing plate, whereby the plate is upset along its border. Here again, the upset plate metal is not pressed into a certain shape by the press tool 37 or any other shaping tool during the action of this tool: the beads 39, 40 are formed by free flowing upsetting.

[0021] Again, these beads are flat pressed in a subsequent step of the manufacturing process, providing them with pressed, flat sealing surfaces as already explained with reference to Fig. 4. A part of the sealing plate with these sealing beads is shown in Fig. 15 and the press tools 11 which are used to press-shape these sealing surfaces are indicated in Fig. 16.

[0022] Fig. 17 shows a valve plate with sealing beads formed according to methodes described hereinbefore. Besides seven screw holes 40 provided along its periphery, this valve plate has seven inlet ports 41 and seven corresponding outlet ports 42. Each of these ports 40, 41 is individually surrounded on each of the plate surfaces by a dual bead seal 43 of the type shown in figures 7 and 8, separating it from neighbouring ports. Only the edges of the v-shaped groove 20 (see Fig. 7) of these dual bead seals 43 are shown in Fig. 17.

[0023] Fig. 18 shows the same valve plate in cross-sectional view. The two encircled details XIX and XX are shown on an enlarged scale in Fig. 19 and Fig. 20 respectively. The sealing beads 44, 45 of the dual bead seals 43 are shown in these views. Valve seats 46, 47 are formed on opposite plate surfaces, bordering the edges of the valve ports 41 and 42 respectively. These valve seats are sealing beads formed according to the method described with reference to the Figs. 1 to 4. The sealing surfaces of all the valve seats 46, 47 and all the other sealing beads 44 of this valve plate may be formed at once with the same flat pressing tool to ensure that all the sealing surfaces on the same side of the valve plate (or any other sealing plate) are in a common plane.

[0024] Fig. 21 shows another type of valve plate with a single valve port 48 and three screw holes 49. On both of the plate surfaces the valve port 48 is surrounded by a sealing bead 50. The valve plate is of four-sided contour and has sealing beads on both plate surfaces along two opposite sides 51, 52 of its outer border.

[0025] Fig. 22 shows the valve plate of Fig. 21 in cross-section. The two circled details XXIII and XXIV are shown at an enlarged scale in Figures 23 and 24 respectively. A valve seat 53 bordering an edge of the port 48 is formed on one of the plate surfaces according to the method described with reference to Figures 1 to 4. The sealing beads 50 are formed by wedge embossing and provided with pressed, flat sealing surfaces 54 as described with reference to Figures 9 to 12. The sealing beads 55 along the side 52 of the valve plate's outer border (see Fig. 24), as well as identical sealing beads along the opposite side 51, are formed by lateral embossing as described with reference to the figures 13 to 16.

[0026] Numerous variations of the described methods and embodiments are obvious for the one skilled in the art and the foregoing description shall not be construed as a limitation to the scope of the invention, which is solely defined by the following claims.

Claims

1. A sealing plate (1), in particular a valve plate, consisting of a metal plate, one or more ports (3) extending through the plate and one or more sealing beads (9) formed as an integral part of the plate on at least one of its sides, at least one of which surrounds at least one of the ports, **characterized in that** the sealing beads (9) are provided with a pressed, flat sealing surface (10).

2. A sealing plate according to claim 1, **characterized in that** the sealing beads (9) consist of upset plate metal.

3. A sealing plate according to claim 1 or 2, **characterized in that** at least one of its plate surfaces is provided with a press-shaped groove (20, 24, 27), plate metal upset along this groove forming at least one sealing bead bordering the groove.

4. A sealing plate according to claim 3, **characterized in that** the groove (20, 24) is of essentially symmetric, preferably v-shaped cross-section, plate metal upset along this groove forming sealing beads on either side of the groove.

5. A sealing plate according to claim 3, **characterized in that** the groove (27) is of wedge shaped cross-section, having a first flank (28) which is perpendicular and a second flank (29) which is inclined to the plate surface, plate metal upset along the groove forming a sealing bead bordering said inclined flank of the groove.

6. A sealing plate according to claim 1 or 2, **characterized in that** one of the plate surfaces of the metal

plate is depressed in a zone (7) around the border of at least one port, plate metal upset on the opposite plate surface forming a sealing bead bordering the same port.

7. A sealing plate according to one of the claims 1 to 6, **characterized in that** the flat sealing surface of the sealing bead is 0.3 to 2 mm wide.

8. A sealing plate according to one of the claims 1 to 7, **characterized in that** the sealing bead is 0.02 to 0.2 mm high.

9. A method for making a sealing plate according to one of the preceding claims, **characterized in that** a forming tool is pressed against a metal plate (1), thereby displacing plate metal to form a bead (8) on at least one plate surface (4) in a first step, and that this bead is flat pressed, providing it with a flat sealing surface (10) in a second step.

10. A method according to claim 9, **characterized in that** the bead (8) is formed by free flowing upsetting of plate metal.

11. A method according to claim 9, **characterized in that** the forming tool is a die stamp.

12. A method according to one of the claims 9 to 11, **characterized in that** the forming tool is laterally pressed against the outer border (38) of the metal plate, thereby upsetting the metal plate to form a sealing bead along said border on each of the plate surfaces.

Fig. 1

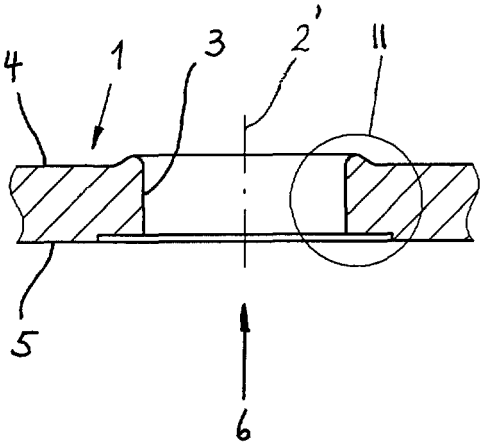


Fig. 2

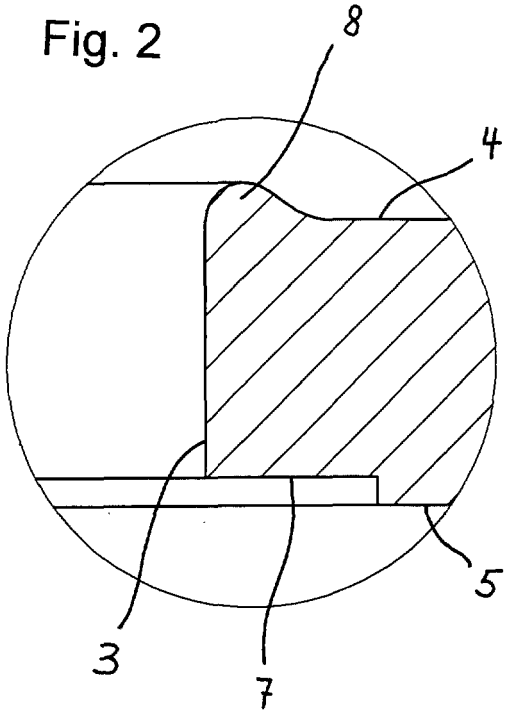


Fig. 3

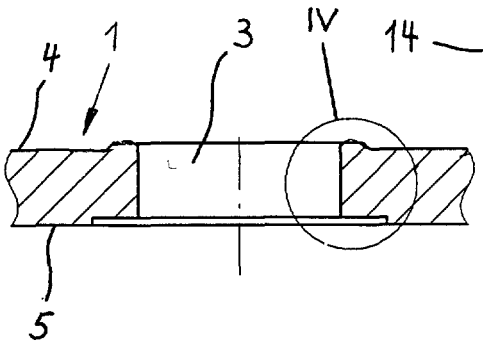


Fig. 4

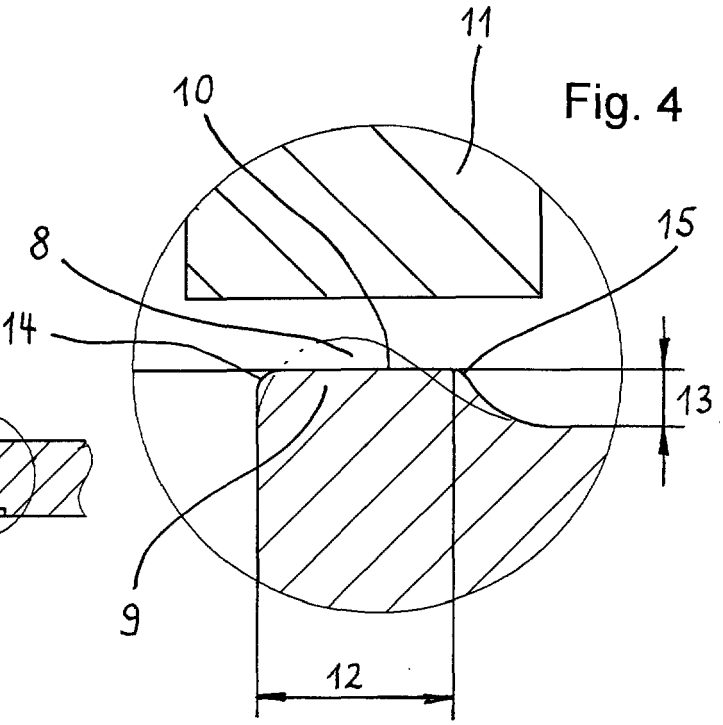


Fig. 5

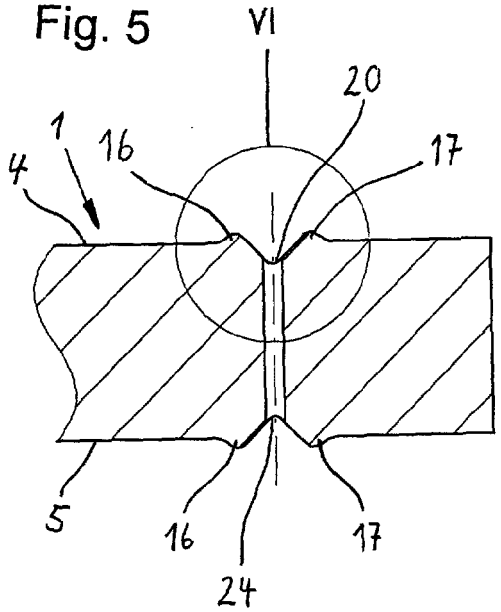


Fig. 6

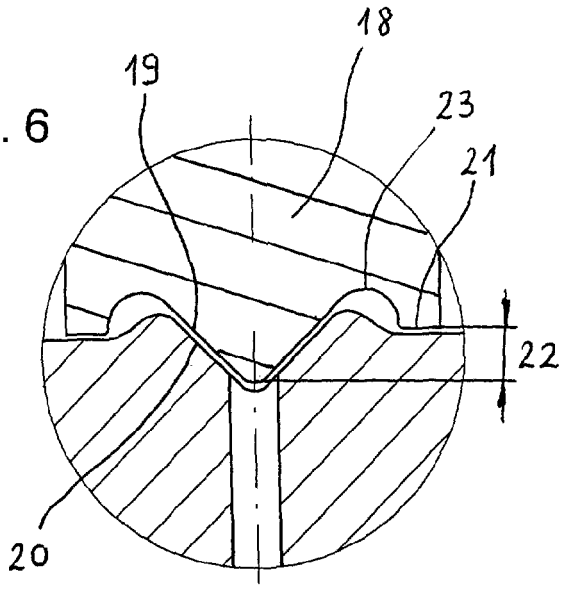


Fig. 8

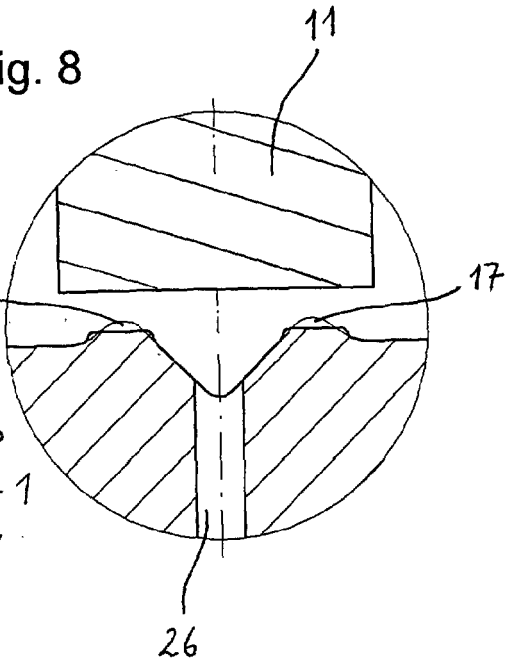


Fig. 7

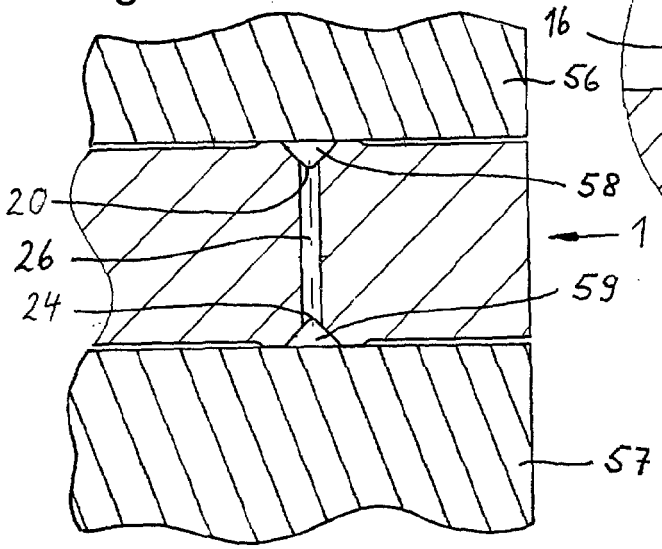


Fig. 9

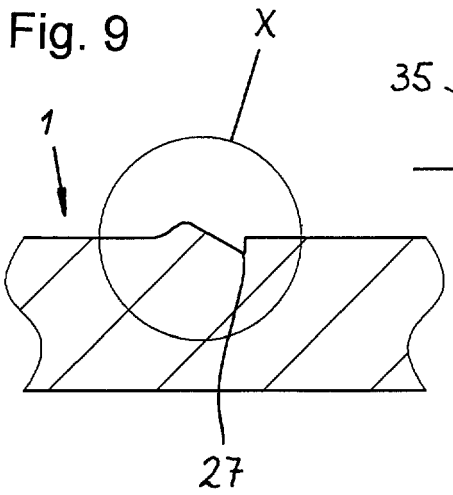


Fig. 10

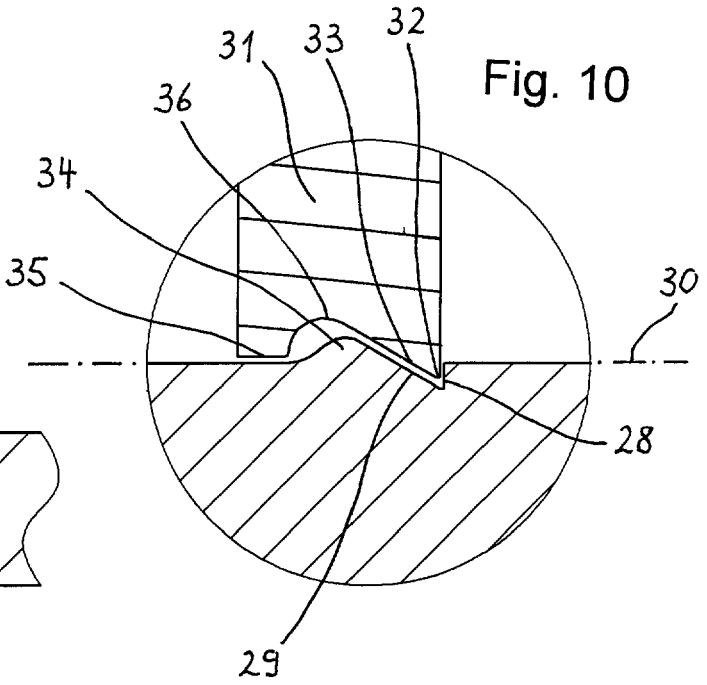


Fig. 11

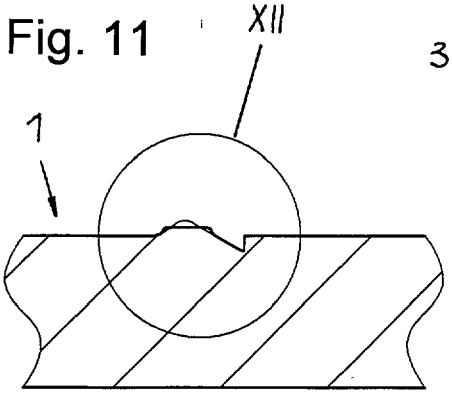


Fig. 12

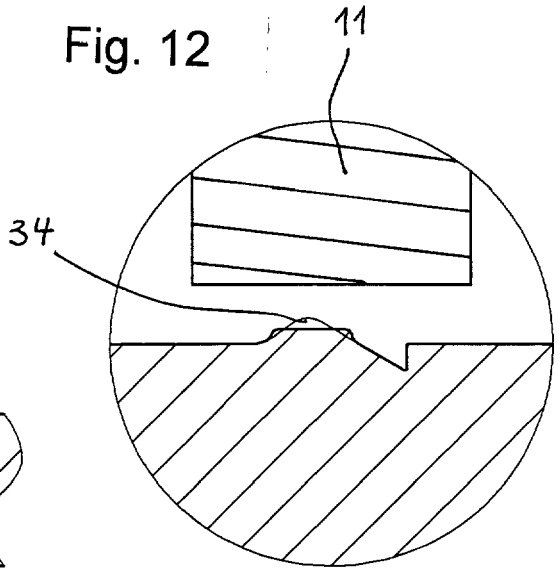


Fig. 13

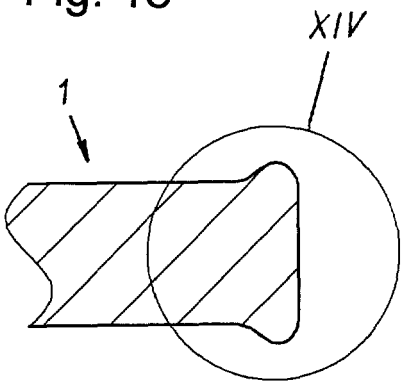


Fig. 14

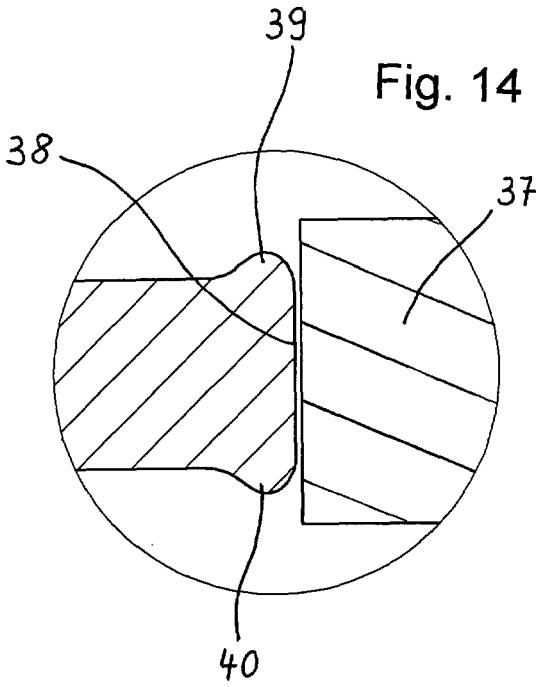


Fig. 15

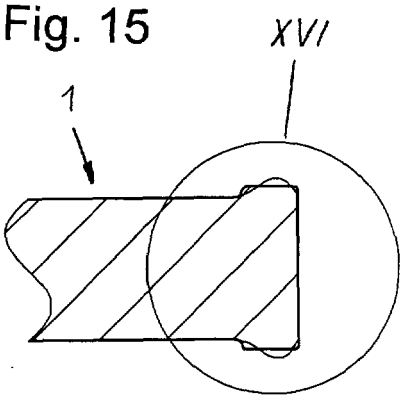


Fig. 16

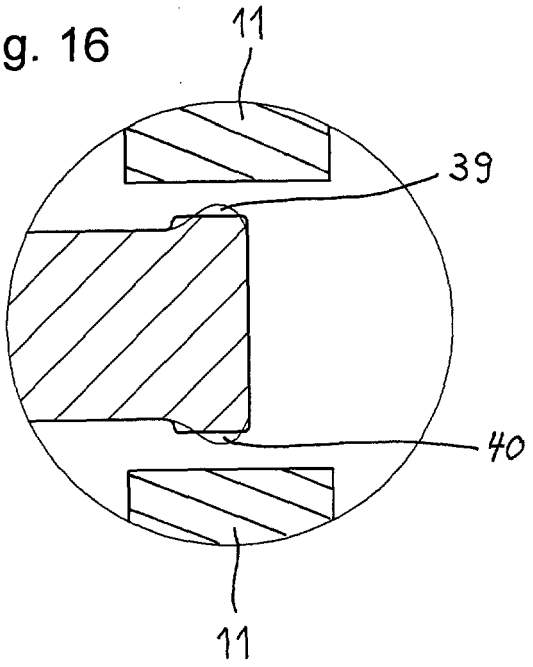


Fig. 17

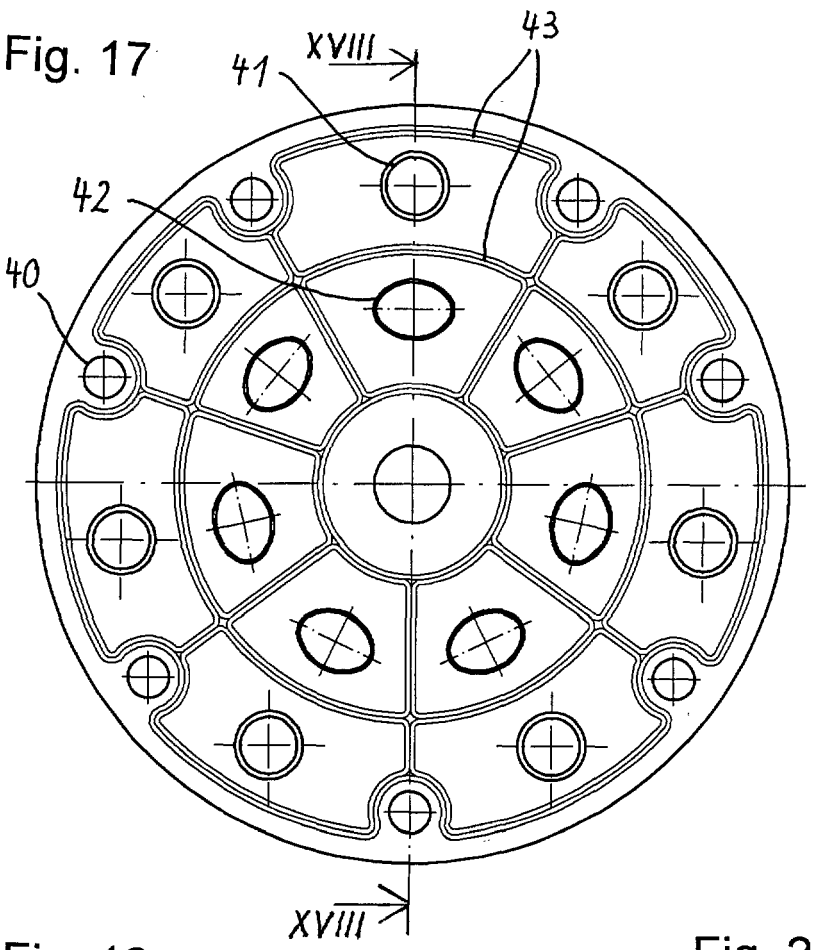


Fig. 18

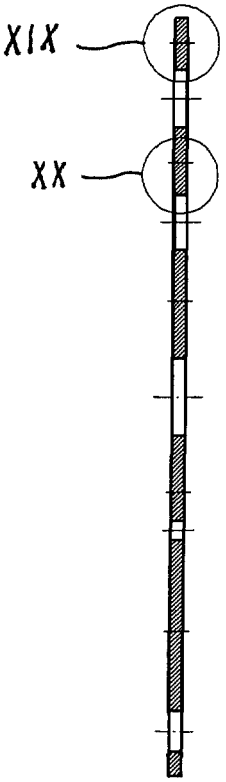


Fig. 19

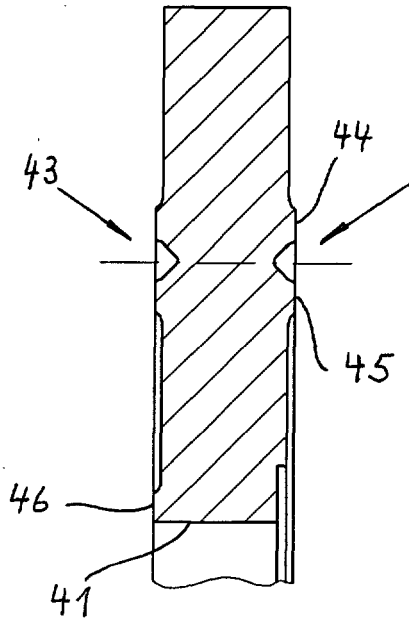


Fig. 20

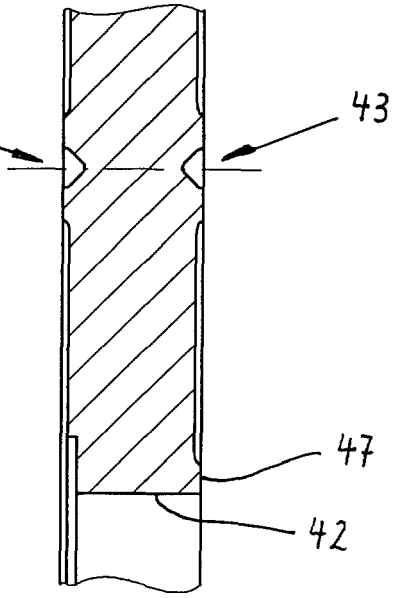


Fig. 21

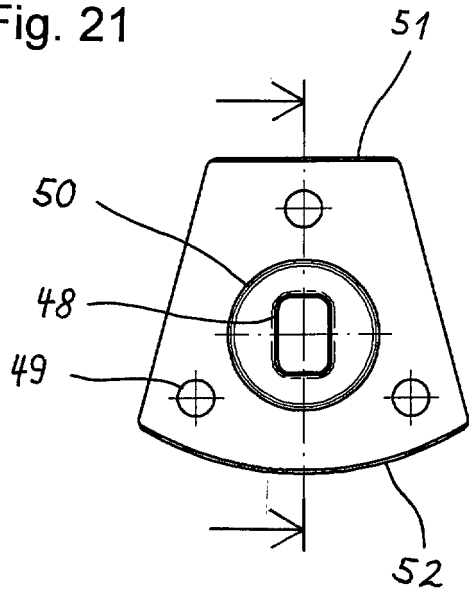


Fig. 22

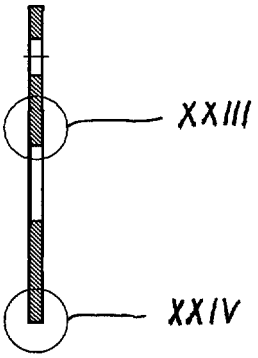


Fig. 23

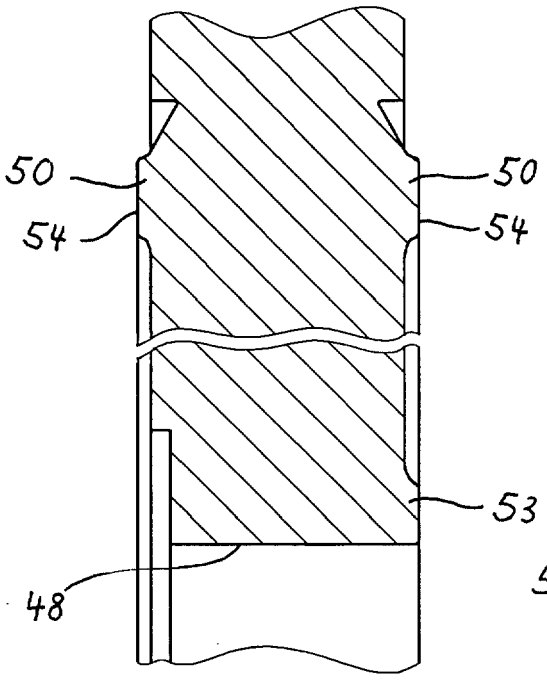
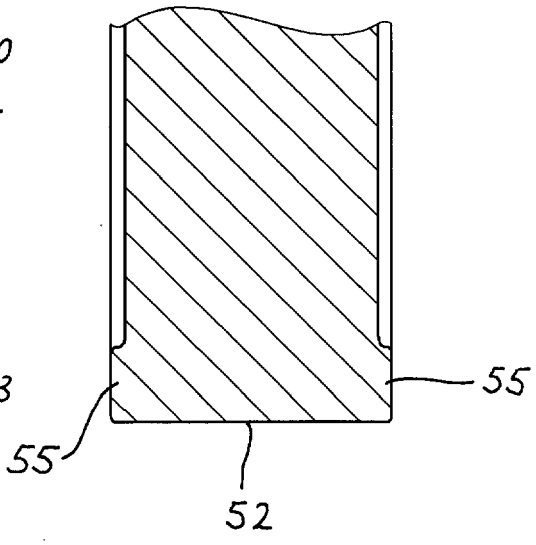


Fig. 24



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 40 5282

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 6 186 514 B1 (IKEDA HAYATO ET AL) 13 February 2001 (2001-02-13) * column 5, line 51 - column 7, line 5 * * figure 5 *	1,9 7,8	F04B39/10 F04B27/10
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