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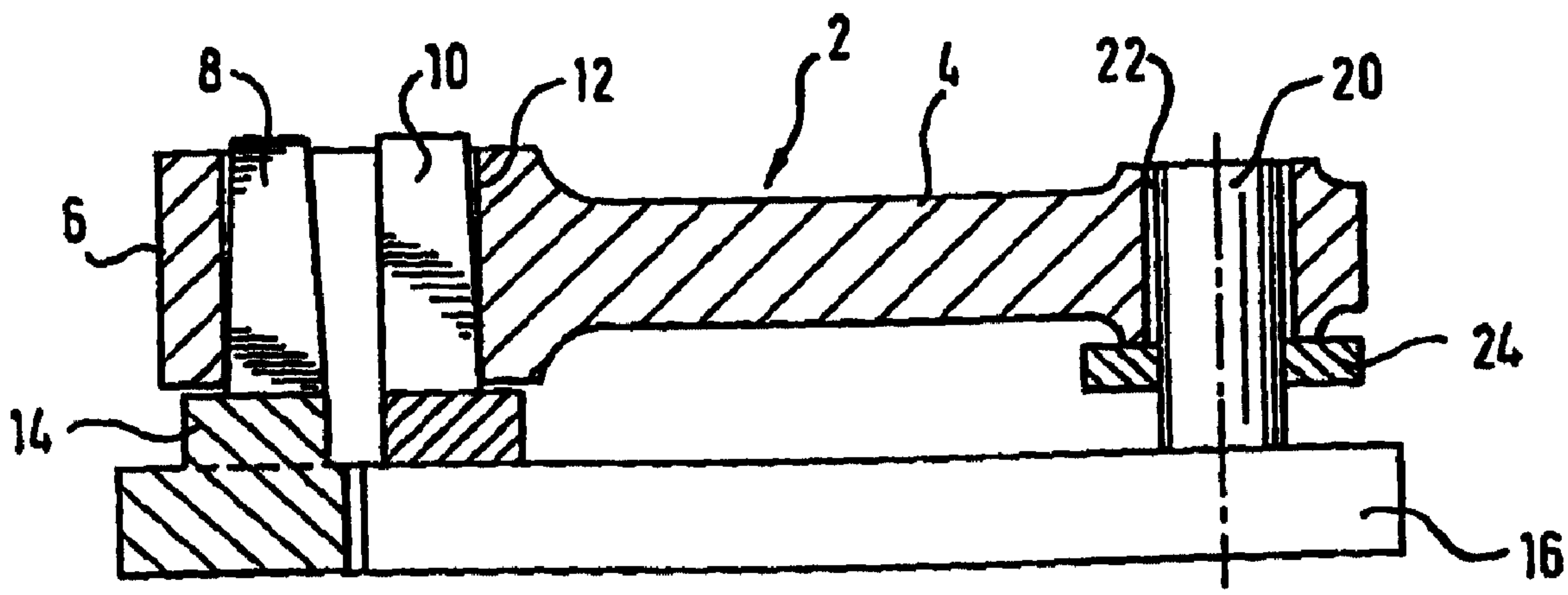
(54) Titre : DISPOSITIF DE SEPARATION PAR RUPTURE D'UNE PIECE ANNULAIRE
(54) Title: APPARATUS FOR CRACK SPLITTING AN ANNULAR PART



(57) Abrégé/Abstract:
The invention relates to a device for fracture-separating an annular piece, such as a connecting rod (2). This connecting rod (2) has one stationary and one mobile expandable jaw (8, 10), for inserting into the borehole formed by the annular piece, and an expanding device for separating the expandable jaws (8, 10). The invention is characterized in that the fracture behaviour of the device can be influenced. To this effect, the peripheral surface of the expandable jaws (8, 10) is so configured that the expandable jaws (8, 10) engage in the inner surface of the borehole only via a region of reference surfaces or lines which is defined locally with precision.

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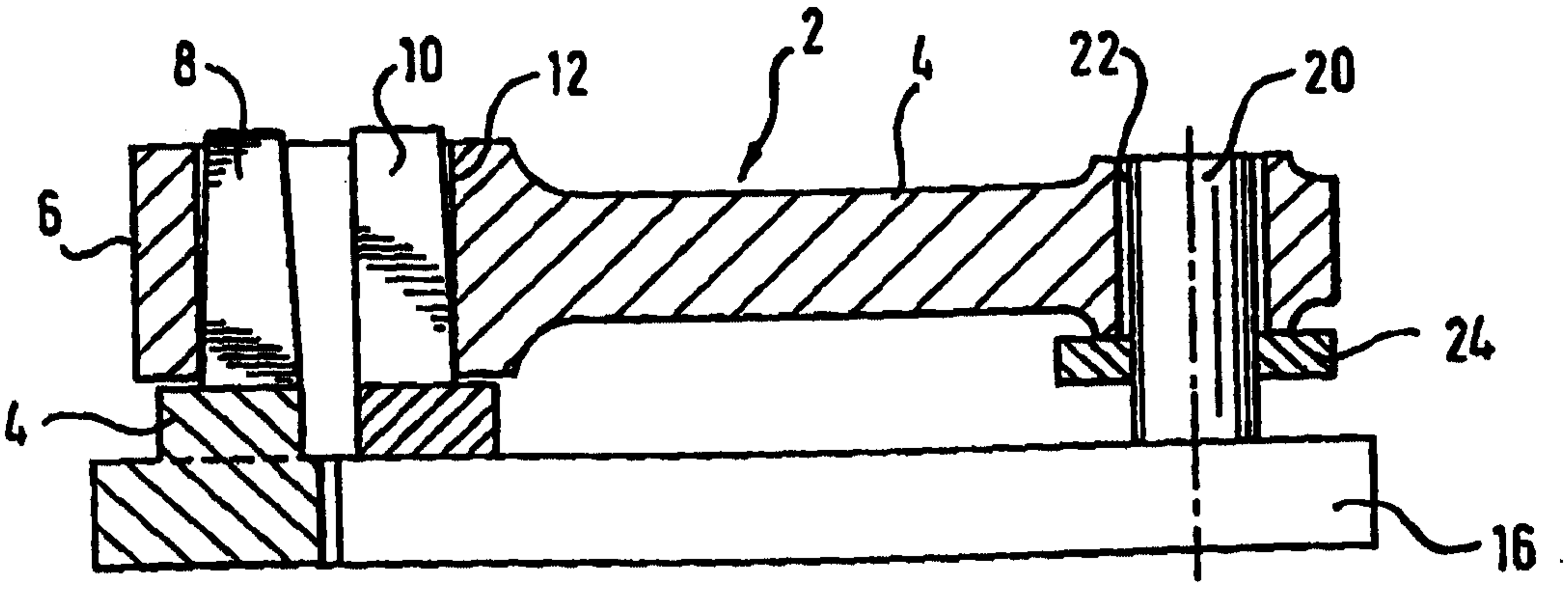
(54) Title: METHOD FOR FRACTURE-SEPARATING AN ANNULAR PIECE

(54) Bezeichnung: VORRICHTUNG ZUM BRUCHTRENNEN EINES RINGFÖRMIGEN BAUTEILS



(57) Abstract

The invention relates to a device for fracture-separating an annular piece, such as a connecting rod (2). This connecting rod (2) has one stationary and one mobile expandable jaw (8, 10), for inserting into the borehole formed by the annular piece, and an expanding device for separating the expandable jaws (8, 10). The invention is characterized in that the fracture behaviour of the device can be influenced. To this effect, the peripheral surface of the expandable jaws (8, 10) is so configured that the expandable jaws (8, 10) engage in the inner surface of the borehole only via a region of reference surfaces or lines which is defined locally with precision.

Apparatus for Crack Splitting an Annular Part

The present invention relates to an apparatus for crack splitting an annular part, such as the big-end of a connecting rod, by means of a fixed and a movable expander jaw for engaging the bore formed by the annular part, and by means of an expander means urging the expander jaws apart.

An apparatus of this kind is known, for example, from EP-0 396 797, as well as from EP-0 661 125. Such devices serve to split an integral annular part, in this case the big-end of a connecting rod, by cracking it into two parts, i.e. into a cap and rod. These prior art devices comprise expander jaws whose peripheral surface area is in full contact with the inner surface area of the bore, i.e. with the inner surface area of the big-end bore. Such a full contact of the expander jaws with the bore is generally deemed necessary for a neat split.

GB-A-724358 discloses an apparatus for crack splitting a special annular part (namely the race of a roller bearing) at a sole location on the circumference of the part. The apparatus has two movable expander jaws each substantially of semicircular cross-section for engaging a bore formed by the annular part. The outer surface area of the expander jaws is a snug, essentially full-contact fit in the inner surface area of the bore. For expansion a wedge is driven between the two expander jaws. The circumferential surface area of exclusively one of the expander jaws, called the first expander jaw in this case, is configured such that a defined partial portion of its outer circumference engages the inner surface area of the bore only via precisely localized partial surface area or points. This partial surface area or point (as measured over the substantially circular full outer circumferential surface area of both expander jaws) is given by a dished section extending over approx. 90° in the first expander jaw at which, with the exception of a "button-like" protuberance, there is no contact between the outer circumferential surface area of the first expander jaw and the inner surface area of the bore. The remaining section of the first expander jaw and substantially the whole of the second expander jaw are again in full contact with the inner surface area of the bore over a range of, in all, approx. 270°. At the location at which the "button-like" protuberance is in contact with the inner surface area of the bore, essentially only locally, a cracking notch is provided at the outer circumference of the annular part to define the position at which the part is to be split. The remaining section of the outer circumferential surface area of the first expander jaw as well as substantially the whole outer circumferential surface area of the second expander jaw are essentially in full contact with the inner surface area of the bore over an angular range of approx. 270°. On expansion, as it reads from this publication, the annular part is tensioned initially over its full circumference. In further expansion of the expander jaws a slight bend is produced in the part in the sections in the vicinity of the protuberance. Due to this combined loading of (normal) stress and flexural stress the annular part is split at a single location through the sole cracking notch so that a C-shaped configuration materializes having two opposing crack ends.

The present invention is based on the object of providing an apparatus for crack splitting an annular part with which the cracking response can be influenced with greater definition, especially at critical locations in the part and with which a better final result is achieved even when crack splitting parts made of materials of inconsistent hardness or of extreme strength; furthermore it is intended that this apparatus effectively avoids the "contraction effect" often encountered with conventional devices.

Tests have surprisingly indicated that best crack splitting is not always achievable by full contact of the peripheral surface area of the expander jaws with the inner surface area of the bore. Instead, it may be of advantage, depending on the the material of the annular part and its cracking response as well as other parameters, such as the geometry of the fracture surface area to introduce the cracking force only into a specific partial surface area portion or line of the piece concerned.

Thus, it may be expedient to introduce the cracking force limited to partial or linear surface areas either axially or circumferentially into the bore. In special instances it may also prove of advantage to introduce the cracking force both axially and circumferentially.

Tests have surprisingly indicated that such a configuration permits avoiding double fractures, crumbling and snags materializing when nuisance geometry involving bores, holes and the like exists within the crack surface as is often experienced with prior art devices. Thus, for instance, big-ends feature two holes in the region of the crack surface for bolting the cap and rod together after splitting. When splitting is initiated the crack flows from the crack initiating crevice, provided in manufacturing the connecting rod, in the region of the inner surface area of the bore around the bolting holes outwards, it being behind the bolting holes that the crack surfaces reunite. However, since the crack surfaces fail to be automatically propagated in the same plane on both sides of the bolting

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Configuring the partial surface area or line portion via which the cracking force is introduced is basically possible in many different ways. Defining or optimizing the particular configuration and localization may be done by trial and error.

Thus, for instance, the peripheral surface area of the expander jaws - as viewed in the axial direction of the bore - may be barrelled or also conical. The radius too of the expander jaws may be selected larger than the radius of the bore in the annular part to compensate the so-called contraction effects.

For particular applications it may be expedient to provide an elastic material at the peripheral surface area of the expander jaws. This elastic material may extend over the full peripheral surface area, but preferably, however, only partly. Tests have indicated that -

depending on the particular application - the elastic material may comprise a hardness of 50 to 95 Shore A.

For special applications it may be of advantage to configure the elastic material in the form of a sleeve. This sleeve may be arranged for example centered relative to the inner surface area of the bore.

Due to this arrangement of the elastic material peak stresses resulting in uncontrolled crack propagation can be prevented. Providing elastic material may also be particularly suitable in cases where the bore of the annular part needs to be split in the non-machined condition.

For specific applications the elastic material may also be arranged in the form of elastic segments on the peripheral surface area of the expander jaws.

In an apparatus having the features of the present invention the expander means may also be configured such that each expander jaw is configured two-part, i.e. each comprising an expander jaw core and an expander jaw shell, the outer surface area of the expander jaw shell engaging the inner surface area of the bore in the annular part.

The advantage of configuring the expander jaws with a core and shell is that the apparatus can now be adapted very simply to annular parts of differing shape and size, this merely requiring the expander jaw shell to be simply changed whereas no change to the expander jaw core including the expander means is required.

The configuration in accordance with the invention also makes it possible to influence the cracking response simply by swapping the expander jaw shell. Thus, to achieve a specific crack where necessary for an identical annular part the expander jaw shell can be swapped by another having a differently shaped outer surface area and repeated until the desired, optimum cracking response is attained.

Expander jaw shells can be produced in many different ways. One particularly simple and cheap embodiment to be produced is achieved by machining the expander jaw shell as a turned component which is split into two or more ring segments in a subsequent operation.

In principle the expander jaw shell or its ring segments are securable to the expander jaw core in many different ways, it being of advantage, however, to provide each expander jaw shell flanged at one edge suitable for receiving the retaining means, such as fastener bolts, quick-release fasteners, or the like.

As described above the present invention now makes it possible to introduce the cracking force into the annular part such that start and propagation of the crack are defined, thus enabling the cracking response to be precisely influenced by means of the present invention. In this respect by varying the geometry of the expander jaws in accordance with the present invention the cracking response can be influenced both in any non-machined and in either any rough-machined or finished condition of the bores and holes in the annular part.

According to one aspect of the present invention there is provided an apparatus for crack splitting an annular part, such as, for example, a connecting rod big-end, including a fixed and a movable expander jaw for engaging the bore formed by the annular part, the peripheral surface area of said expander jaws being configured such that said expander jaws engage the inner surface area of said bore only via a precisely localized partial surface area or linear portion, said partial surface area or linear portion running in the circumferential direction of said bore, and including an expander means for urging said expander jaws apart.

According to one aspect of the present invention there is provided an apparatus for crack splitting an annular part, such as, for example, a connecting rod big-end, including a fixed expander jaw and a movable expander jaw for engaging the bore formed by the annular part, the peripheral surface area of said expander jaws being configured such that said expander jaws engage the inner surface area of said bore only via a precisely localized partial surface area or linear portion and the radius (R) of said expander jaws being larger than the radius (r) of said bore, and including an expander means for urging said expander jaws apart.

Embodiments of the invention will now be detailed for further explanation and a better understanding of the invention with reference to the attached drawings in which:

Fig. 1 is a schematic plan view of the salient components of a first exemplary embodiment of the apparatus in accordance with the invention,

Fig. 2 is a schematic longitudinal section taken along the line I-I as shown in Fig. 1,

Fig. 3 is a schematic longitudinal section of a second exemplary embodiment of the present invention taken along the line I-I as shown in Fig. 1,

Fig. 4 is a schematic plan view on a magnified scale of a portion of the expander jaws in a third example embodiment of the present invention,

Fig. 5 is a schematic longitudinal section of a fourth exemplary embodiment of the present invention taken along the line I-I as shown in Fig. 1,

Fig. 6 is a longitudinal section through a expander jaw shell prior to the ring segments being separated, and

Fig. 7 is a plan view of the expander jaw shell as shown in Fig. 6.

Referring now to Fig. 1 there is illustrated an exemplary embodiment of an annular part in the form of a connecting rod big-end 2 to be split into a rod 4 and a cap 6 in the apparatus, details of which are described in EP-0 396 797.

Essential for splitting the rod 4 and cap 6 of the big-end 2 is the action of a movable expander jaw 8 and a fixed expander jaw 10 in a bore in the form of a cylindrical big-end bore 12 formed by the cap 6 and rod 4. The movable expander jaw 8 is secured to a movable part 14 of the apparatus and the fixed expander jaw 10 to a fixed part 16 of the apparatus. To split rod 4 and cap 6 the two parts 14, 16 of the apparatus are abruptly powered apart, for example by means of a striker impacting the movable part 16 of the apparatus. As an alternative splitting may also be achieved by a cleaving wedge (not shown) engaging with and being abruptly powered into a notch 18 configured axially in the middle of the two expander jaws 8, 10.

In the exemplary embodiment as shown in Fig. 1 and Fig. 2 the two expander jaws 8, 10 substantially comprise a semicircular cross-sectional surface area. As evident from Fig. 2 showing a longitudinal section taken along the line I-I as shown in Fig. 1 the expander jaws 8, 10 of the first illustrated exemplary embodiment are configured barrelled, the largest radius of the semicircular expander jaws 8, 10 being arranged in the middle of the big-end bore 12.

In the exemplary embodiment shown the portion having maximum radius extends over a width B of approx. 10% of the axial height H of the big-end bore 12, as a result of which the expansion force is introduced into a precisely defined middle portion of the big-end bore 12. This configuration is particularly suitable for materials of inconsistent hardness posing the risk of a partially high hardness resulting in a random start in the crack.

Referring now to Fig. 3 there is illustrated schematically a further embodiment of the present invention in a longitudinal section taken along the line I-I as shown in in Fig. 1. Here too, the expander jaws 8, 10 of this embodiment comprise a substantially semicircular cross-sectional surface area. However, the expander jaws 8, 10 in accordance with the second exemplary embodiment are configured conical. At the location where the diameter of the big-end bore 12 roughly corresponds to the outer diameter of the two expander jaws 8, 10 the big-end 2 is in contact with the expander jaws 8, 10 in the region of the big-end bore 12. A cylindrical retaining element 20 arranged on a fixed part 16 of the apparatus protrudes into a small-end bore 22. Arranged between the big-end 2 and the part 16 of the apparatus is a support 24 shiftable in the longitudinal direction of the retaining element 20. It is this arrangement that makes it possible to support the big-end 2 so that the bore centerlines of the small-end and big-end are located at a precise right angle to the movement of the movable part 14 of the apparatus on splitting the cap 6 from the rod 4. It is this location that is important for achieving a neat crack. Since the support 24 is height-adjustable it is possible to ensure this location even when the bore centerlines of the big-end and small-end fail to be in a single plane.

Due to the support of the big-end 2 the conical expander jaws 8, 10 and the big-end bore 12 are located concentrically, i.e. resulting in the force being introduced linearly into an outer edge of the big-end bore 12.

When the two expander jaws 8, 10 for splitting the cap 6 from the rod 4 are powered apart the crack propagates from the outer edge substantially along the centerline of the big-end bore 12. Due to the force being introduced along a very thin line at the edge of the big-end bore the embodiment as shown is particularly suitable for connecting rods made of a very hard material. However, the big-ends of connecting rods made of a less hard material may also be split by means of the exemplary embodiment as shown. To prevent the circumferential surface area of the big-end bore being deformed in splitting, the big-end may be provided with a phase [*should read: chamfer*] at the outer edge.

Referring now to Fig. 4 there is illustrated a further exemplary embodiment of the present invention. In this exemplary embodiment too the expander jaws 8, 10 comprise a substantially semicircular cross-sectional surface area, but unlike the expander jaws 8, 10 as described above these are configured cylindrical. Correspondingly the expander jaws 8, 10 feature a constant radius full-length.

In the exemplary embodiment as shown in Fig. 4, however, the radius R of the expander jaws 8, 10 is greater than the radius r of the big-end bore 12, as a result of which a roughly elliptical cross-sectional shape materializes for the expander jaws in the run-together condition.

It is due to this elliptical cross-sectional shape that the cracking force during splitting is first introduced into the big-end in region of the crack initiating crevices S, thus resulting in the big-end bore being "expanded" transversely to the longitudinal direction of the big-end during splitting. It is this "expansion" that counteracts the "contraction" often experienced in splitting big-ends and caused by stresses being released.

Referring now to Fig. 5 there is illustrated in conclusion a fourth exemplary embodiment of the present invention in which an elastic material 26 is secured, for example by cementing or coating, to the circumferential surface area of the expander jaws 8, 10. This arrangement of the elastic material 26 prevents peak stresses occurring when splitting big-ends having a non-machined big-end bore or should soilage be involved in splitting. The elastic material 26 surrounding the two expander jaws 8, 10 has the further advantage that the parts 14, 16 of the apparatus are additionally cushioned when powered apart.

Referring now to Fig. 6 there is illustrated a longitudinal section through a blank for an expander jaw shell. The blank still to be split comprises a shell segment 30 and a flanged segment 32. The shell segment 30 comprises a circular cylindrical inner surface area, the radius of which corresponds to the radius of a corresponding expander jaw core. In the present exemplary embodiment the outer surface area of the shell segment 30 is conically tapered at an angle of usually less than 1¡. In addition the upper face is chamfered to facilitate mounting the big-end bore on the expander jaws.

To produce the ring segments the expander jaw shell is split along the line T-T, resulting in two identical shell halves. For securing and centering the shell halves to the movable part 14 and to the fixed part 16 of the apparatus holes or semi-holes 34 are configured in the flanged segment 32.

It is due to this configuration that the apparatus can be simply adapted for splitting big-ends differing in shape and size, this merely requiring the ring segments or the shell halves to be removed and replaced by those of a different size. There is thus no need to retrofit or change the expander jaw core with all elements of the expander means.

In addition to this, making use of expander jaw shells enables the cracking response to be influenced by simple ways and means, if needed. To achieve the specific crack in each case, all that is needed is to make use of the ring segments or shell halves comprising the outer surface area most expedient for the desired cracking response.

PCT/EP98/04766 74 959 v2

Alfing Kessler Sondermaschinen GmbH July 22, 1999

Amended Claims

1. An apparatus for crack splitting an annular part, such as, for example, a connecting rod big-end (2), including

   - a fixed and a movable expander jaw (8, 10) for engaging the bore formed by the annular part,

   - the peripheral surface area of said expander jaws (8, 10) being configured such that said expander jaws (8, 10) engage the inner surface area of said bore (12) only via a precisely localized partial surface area or linear portion, said partial surface area or linear portion running in the circumferential direction of said bore (12), and including

   - an expander means for urging said expander jaws (8, 10) apart.

2. An apparatus for crack splitting an annular part, such as, for example, a connecting rod big-end (2), including

   - a fixed expander jaw (10) and a movable expander jaw (8) for engaging the bore formed by the annular part,

   - the peripheral surface area of said expander jaws (8, 10) being configured such that said expander jaws (8, 10) engage the inner surface area of said bore (12) only via a precisely localized partial surface area or linear portion and the radius (R) of said expander jaws (8, 10) being larger than the radius (r) of said bore (12), and including

- an expander means for urging said expander jaws (8, 10) apart.

3. The apparatus as set forth in claim 1 or 2,
characterized in that
said expander jaws (8, 10) comprise a substantially semicircular cross-sectional surface area.

4. The apparatus as set forth in claim 1 or 2,
characterized in that
the partial surface area or line portion runs in the axial direction and in the circumferential direction of said bore (12).

5. The apparatus as set forth in any of the claims 1 to 4,
characterized in that
said expander jaws (8, 10) comprise in a run-together condition a substantially elliptical cross-sectional shape.

6. The apparatus as set forth in claim 5,
characterized in that
the long axis of the elliptical cross-sectional shape of said expander jaws (8, 10) in the run-together condition runs transversely to the longitudinal direction of the big-end (2) and the precisely localized partial surface area or line portion running in the axial direction of said bore (12) is located substantially on a cracking plane (SE) running transversely to the longitudinal direction of said big-end (2) and defined by two opposing crack initiating crevices (S) so that in crack splitting a cracking force is first introduced into said big-end (2) in the region of said crack initiating crevices (S) and said bore (12) is expanded transversely to the longitudinal direction of said big-end (2).

7. The apparatus as set forth in claims 1, 3, 4 or 5,
characterized in that

the peripheral surface area of said expander jaws (8, 10) as viewed in the axial direction of the bore (12) is configured barrelled.

8. The apparatus as set forth in claim 1, 3, 4 or 5,
characterized in that
the peripheral surface areas of said expander jaws (8, 10) as viewed in the axial direction of the bore (12) are configured conical.

9. The apparatus as set forth in claims 1, 3, 4, 5, 7 or 8,
characterized in that
the radius (R) of said expander jaws (8, 10) is selected larger than the radius (r) of said bore (12).

10. The apparatus as set forth in claims 1, 3, 4, 5, 7, 8 or 9,
characterized in that
an elastic material is provided at the peripheral surface area of said expander jaws (8, 10).

11. The apparatus as set forth in claim 10,
characterized in that
the elastic material is rubber.

12. The apparatus as set forth in claim 10 or 11,
characterized in that
the elastic material comprises a hardness of 50 to 95 Shore A.

13. The apparatus as set forth in claims 10, 11 or 12,
characterized in that
the elastic material forms a sleeve whose length is smaller than the length of the bore.

14. The apparatus as set forth in claim 13,
characterized in that
the sleeve is arranged centered relative to the inner surface area of the bore.

15. The apparatus as set forth in any of the preceding claims 1 to 14,
characterized in that
each expander jaw is configured two-part, each comprising an expander jaw core and an expander jaw shell (30, 32), the outer surface area of the expander jaw shell engaging the inner surface area of said bore (12).

16. The apparatus as set forth in claim 15,
characterized in that
said expander jaw shell (30, 32) is releasably connected to the expander jaw core.

17. The apparatus as set forth in claim 15 or 16,
characterized in that
said expander jaw shells (30, 32) are made from a turned part split into ring segments.

18. The apparatus as set forth in any of the claims 15 to 17,
characterized in that
each expander jaw shell comprises a flange (32) at its one rim.

19. The apparatus as set forth in claim 18,
characterized in that
in said flange (32), holes or half-holes (34) for securing and centering the shell halves are configured on a movable part (14) of the apparatus or on a fixed part (16) of the apparatus.

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Fig.1

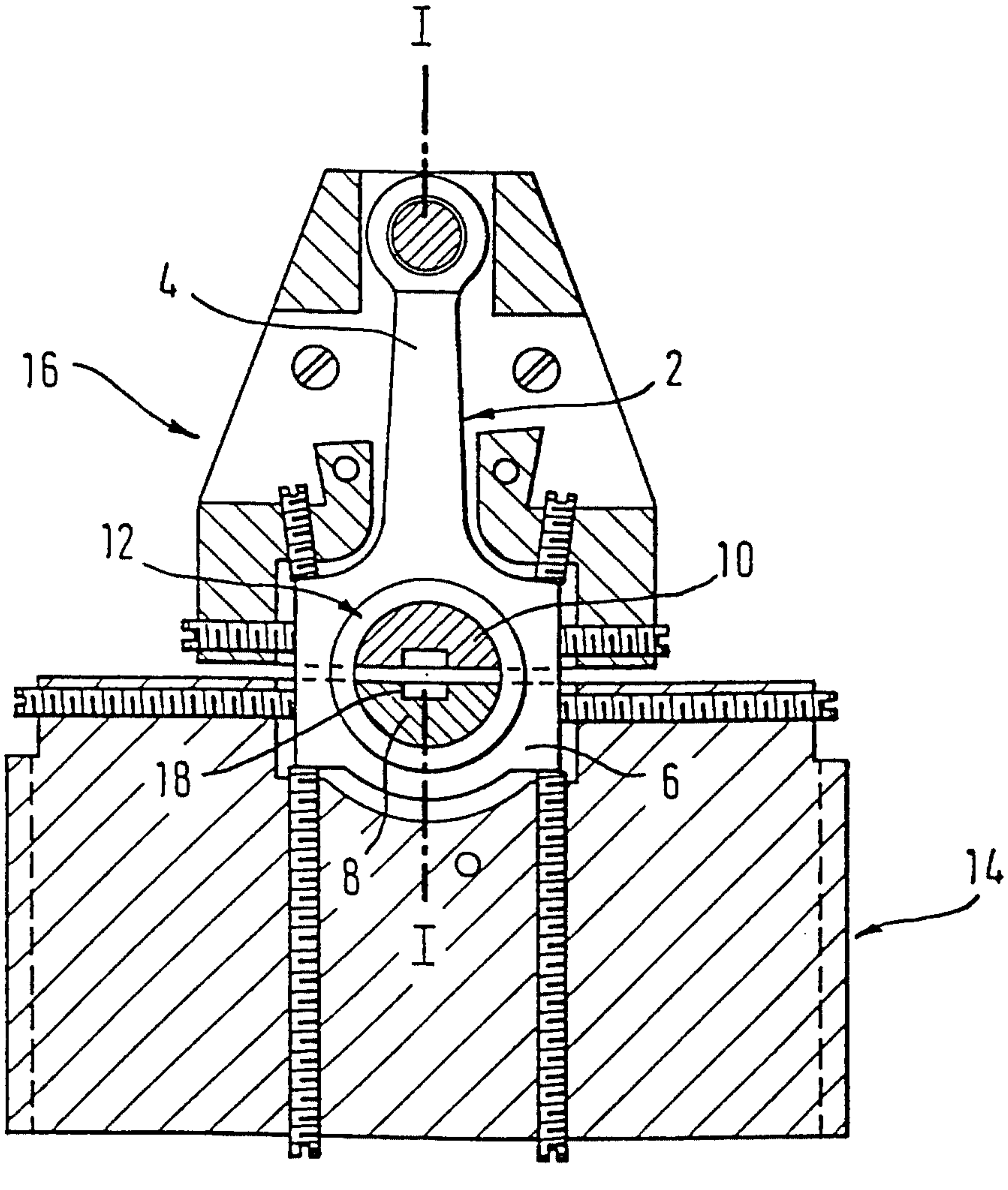


Fig. 2

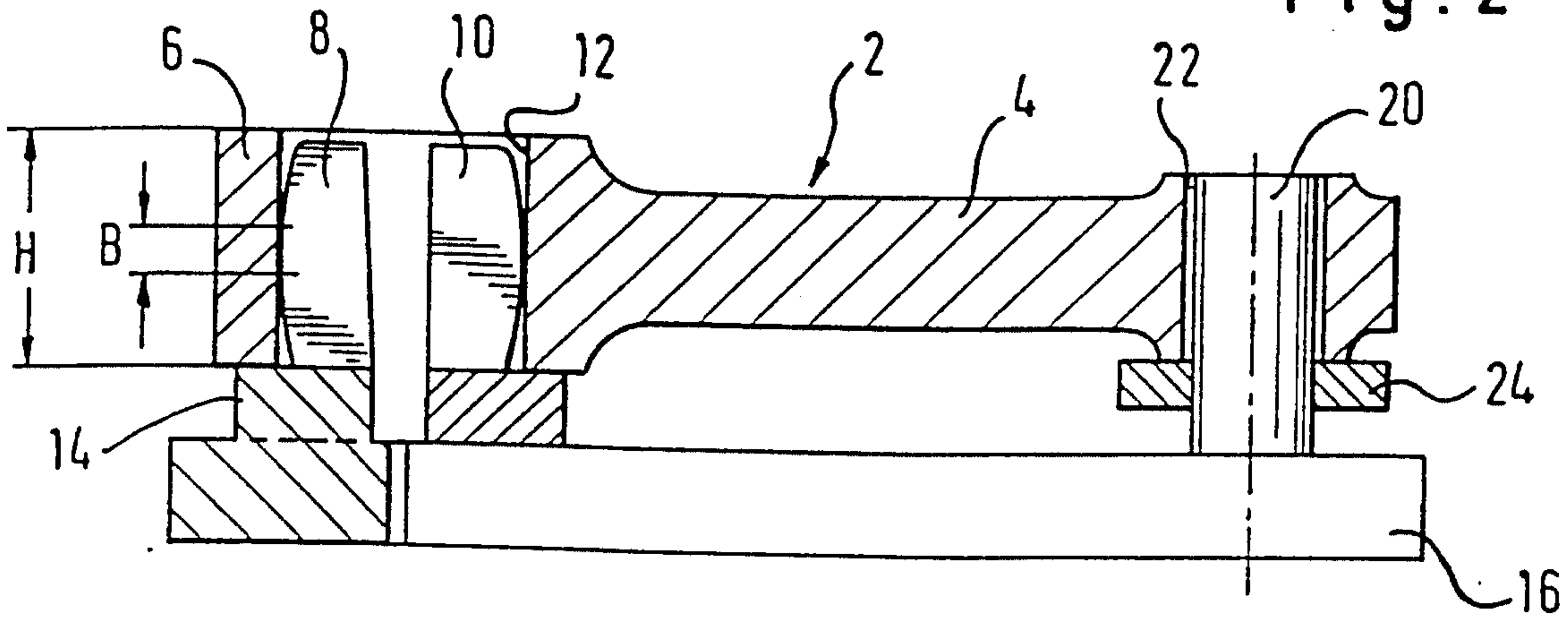


Fig. 3

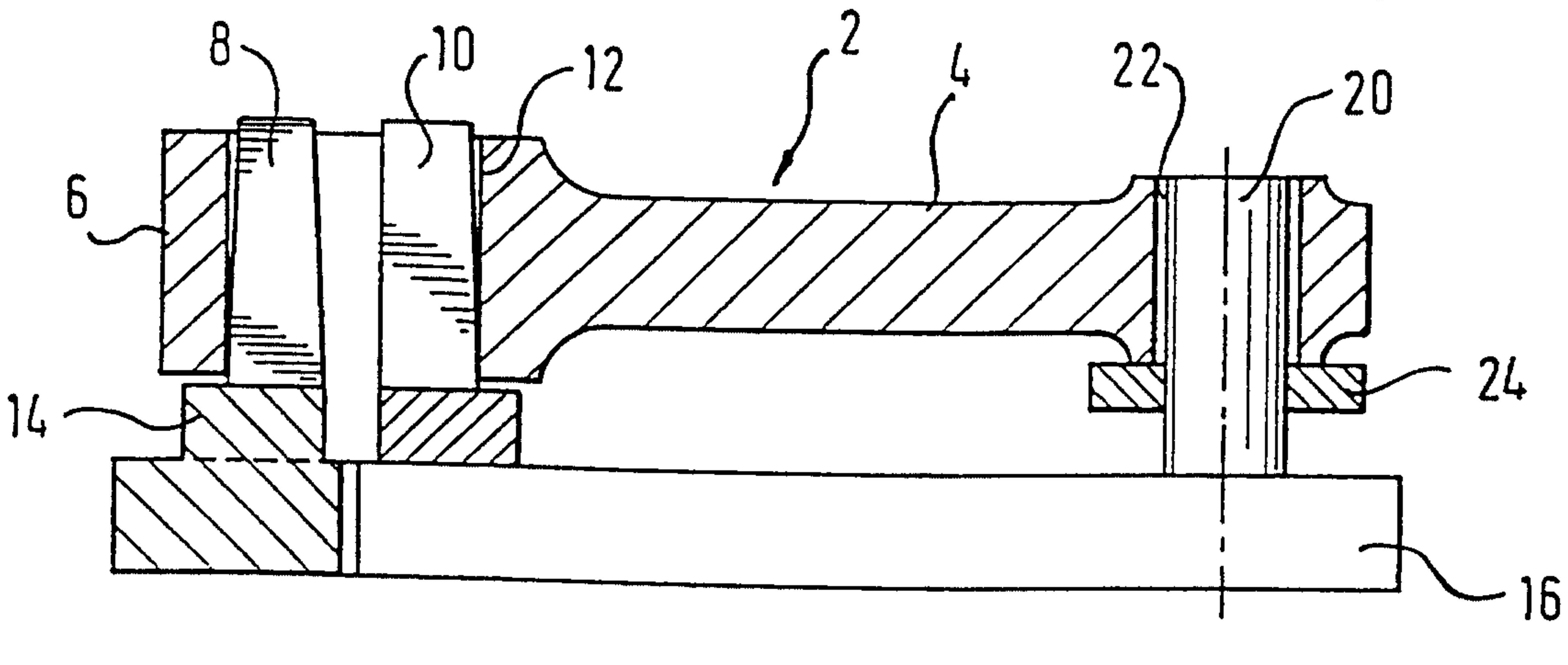


Fig. 4

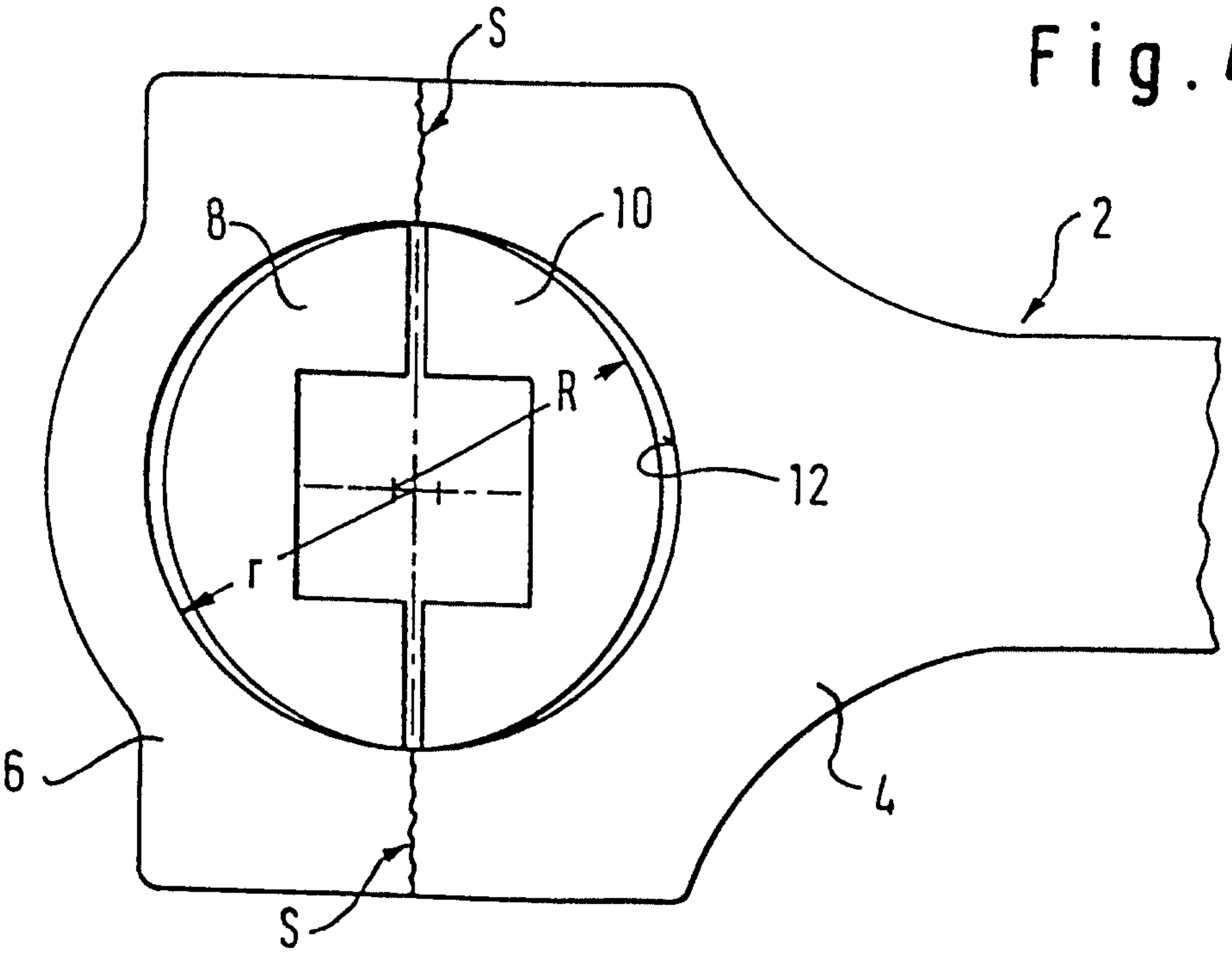


Fig. 5

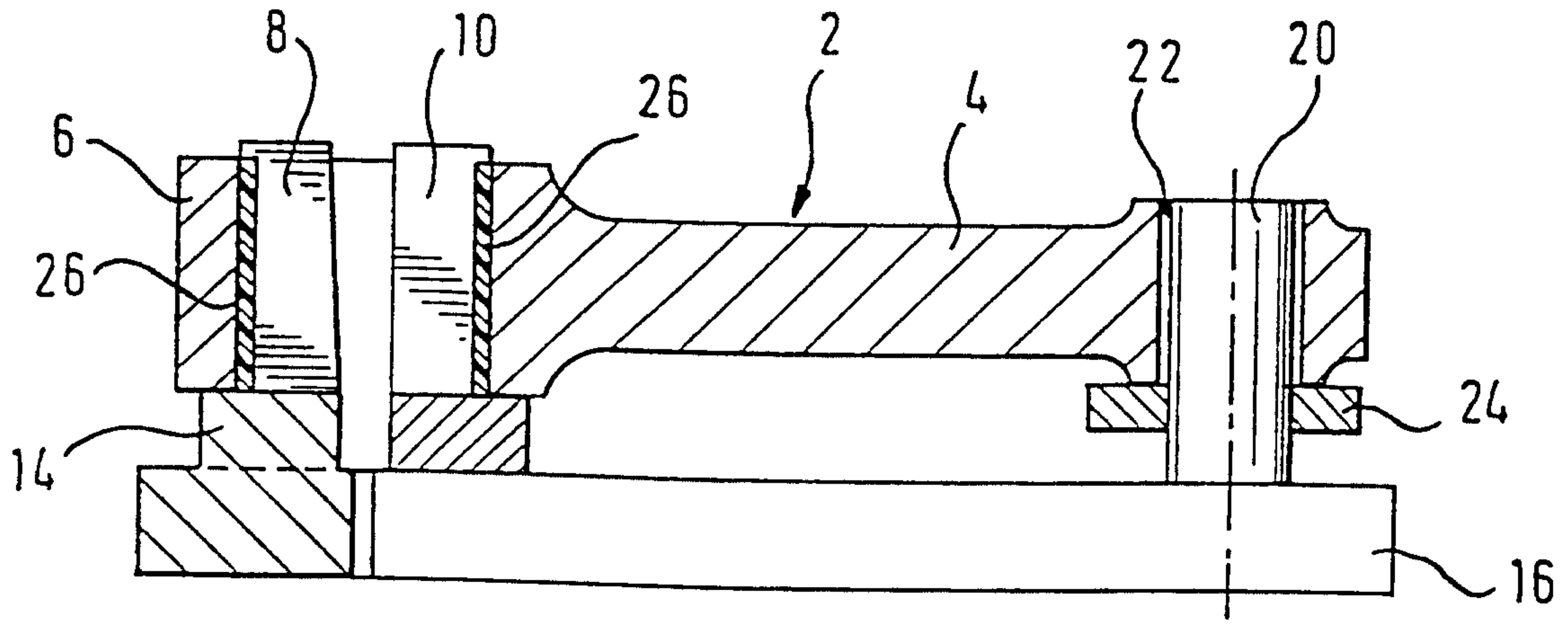


Fig. 6

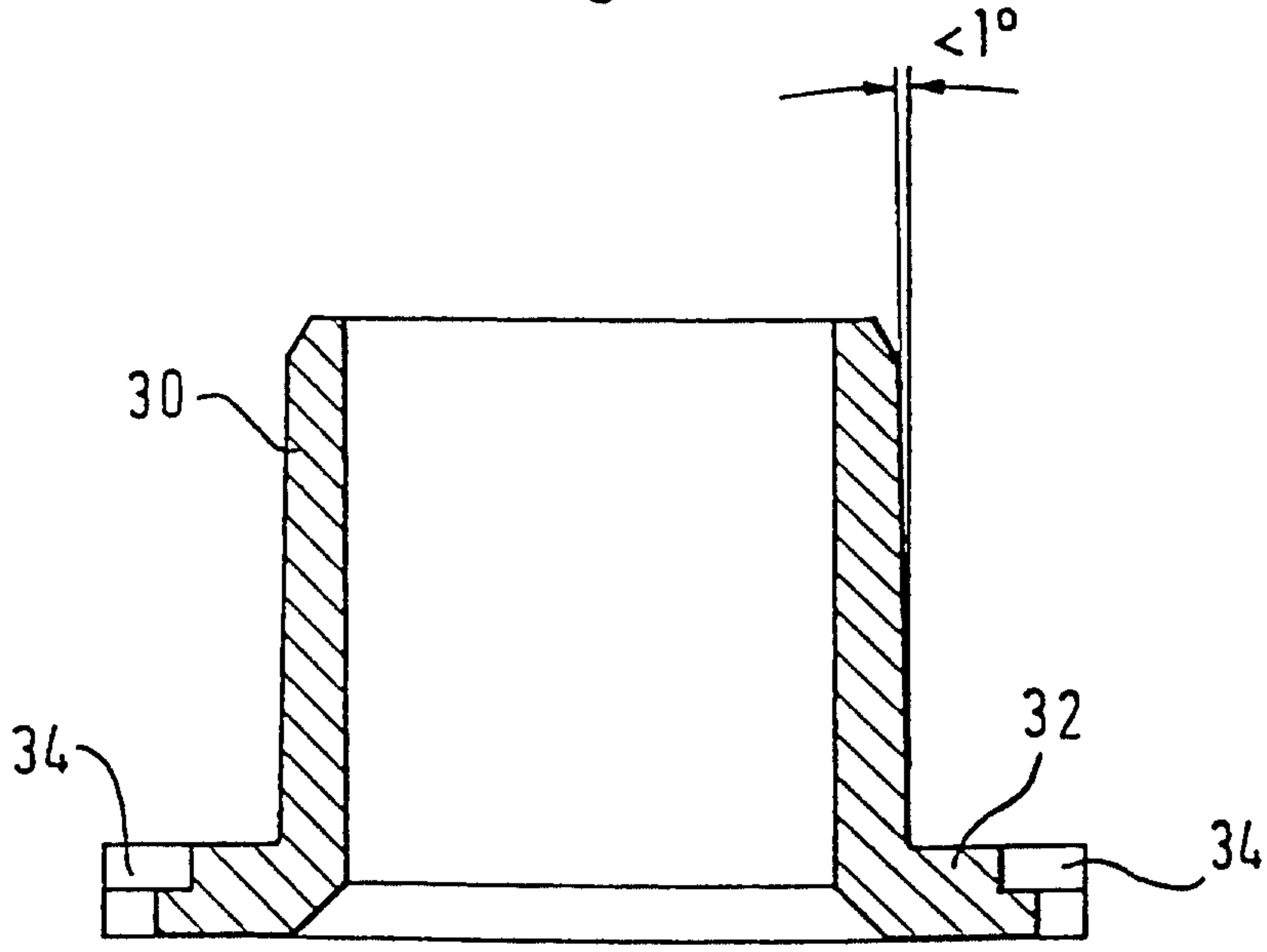
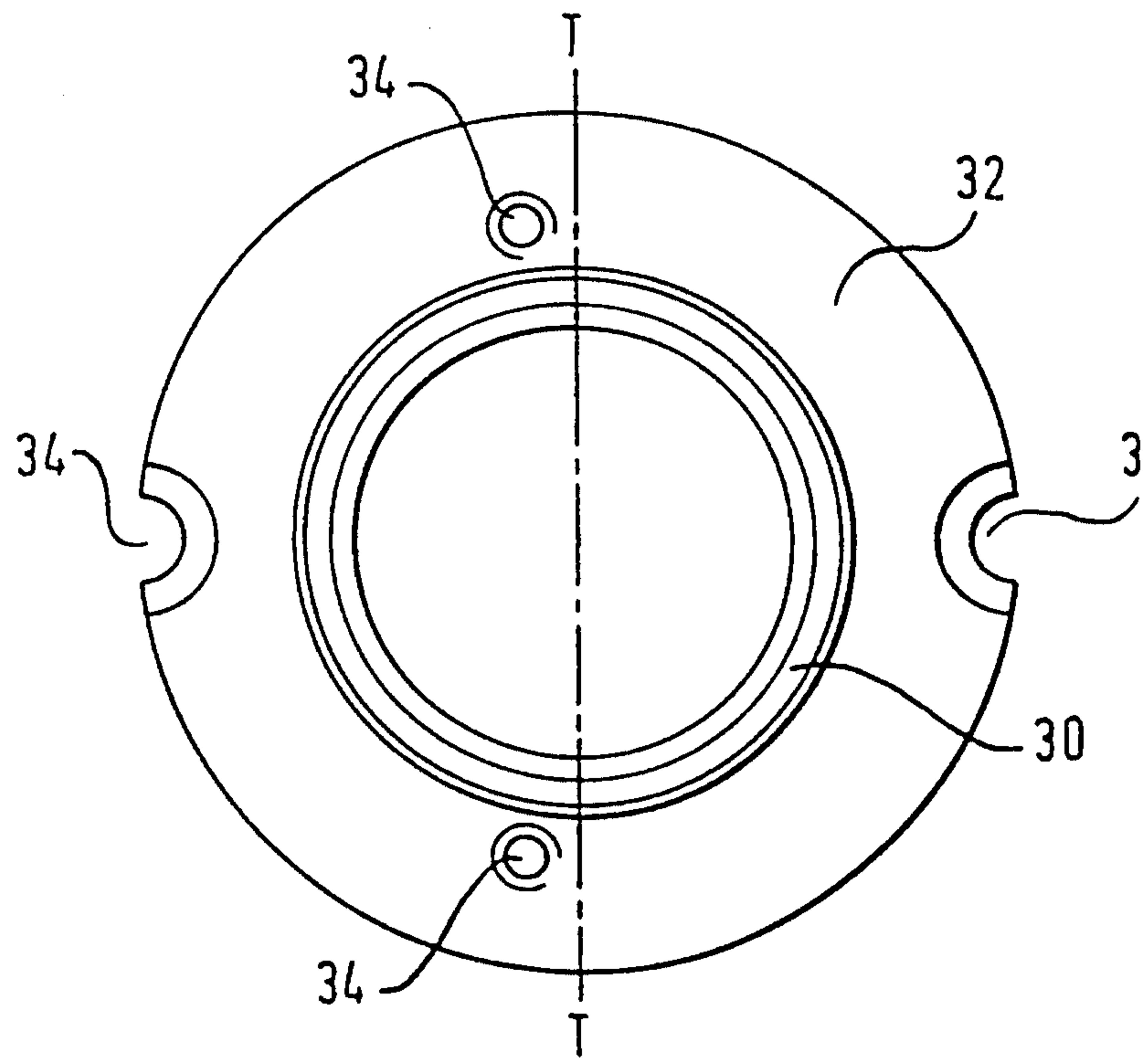
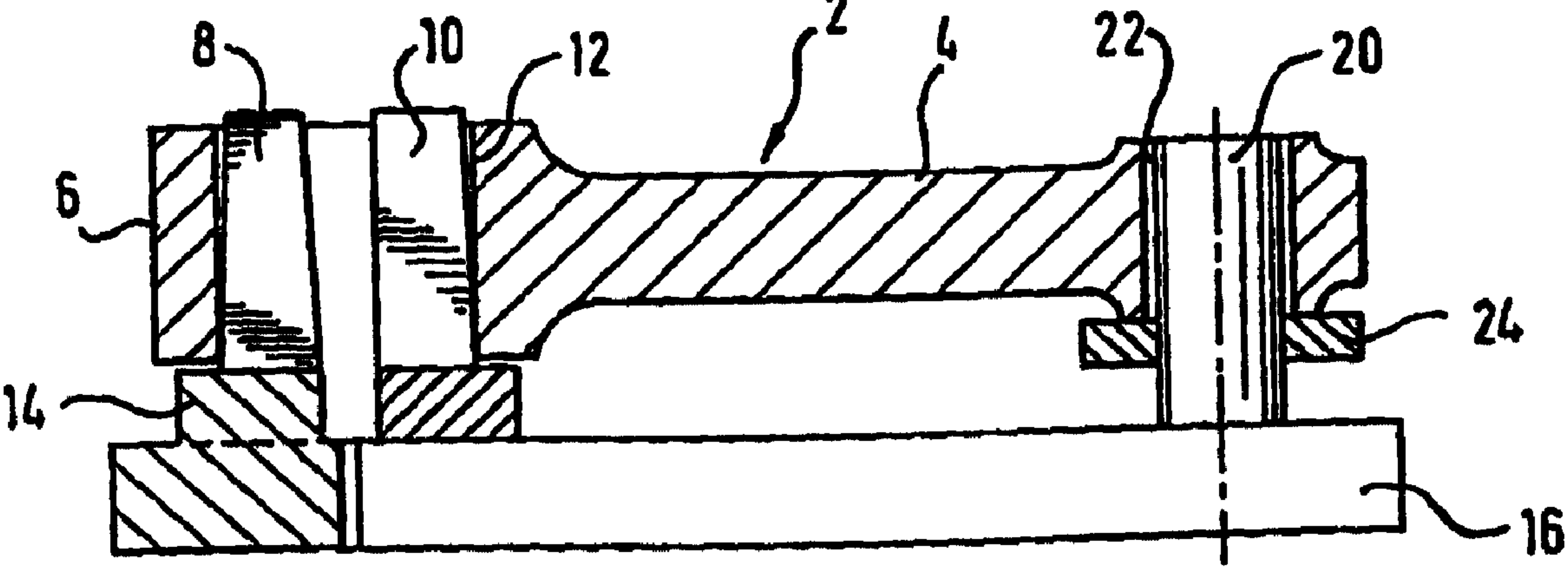


Fig. 7





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