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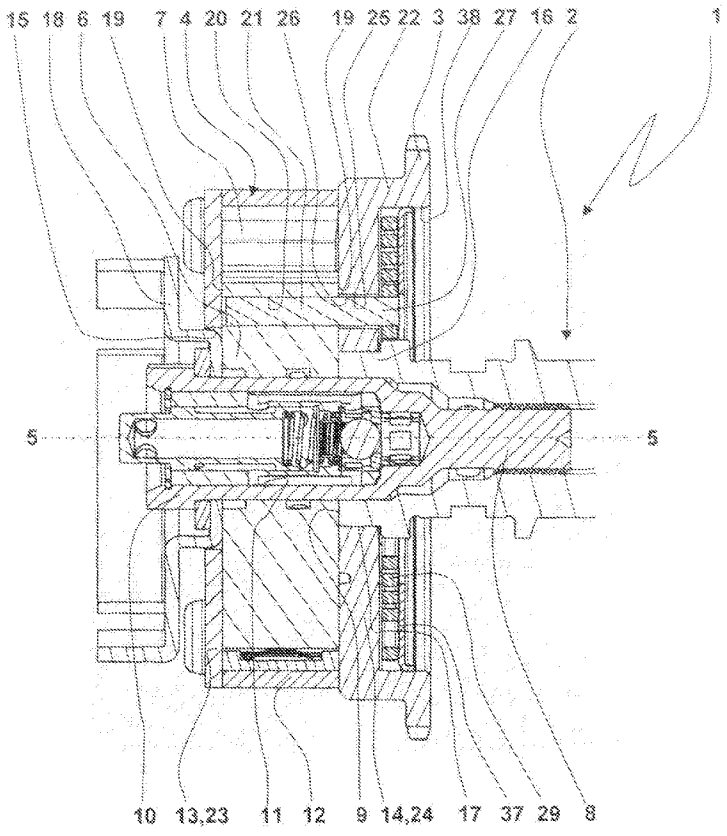
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(54) **Title:** CAMSHAFT ADJUSTER FOR AN INTERNAL COMBUSTION ENGINE



(57) **Abstract:** The invention relates to a camshaft adjuster for an internal combustion engine. In camshaft adjusters, spring elements which influence the moment conditions for the positional definition and influencing of the camshaft adjuster are usually arranged so as to lie on the inside of the housing. According to the invention, a spring element (29) is arranged outside the housing (4) in a camshaft adjuster (1), a spring base point of the spring element (29) being supported via a pin (21) which penetrates the housing (4) and is connected fixedly in terms of rotation to a rotor (6).

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Title of the Invention

Camshaft adjuster for an internal combustion engine

Description

Field of the Invention

The invention relates to a camshaft adjuster for an internal combustion engine, according to the precharacterizing clause of Claim 1. In particular, the invention relates to a camshaft adjuster, by means of which, in order to influence

- the charging of the combustion chamber,
- the combustion conditions,
- the performance data and
- the exhaust-gas values,

a relative angular position between a camshaft and a drive element which is driven by a crankshaft of the internal combustion engine, for example, via a drawing means can be changed in a targeted manner according to a control device.

Background of the Invention

US 6,311,654 B1 has disclosed a camshaft adjuster in the vane cell design, in which a chain sprocket drives a housing of the camshaft adjuster, in which housing an output element which is configured as a rotor is screwed fixedly in terms of rotation to a camshaft via a central screw. Vanes which are assigned to the rotor are arranged in pressure chambers of the housing in such a way that, depending on the hydraulic loading of the pressure chambers, the rotor and therefore the camshaft can be adjusted in the direction “early” or “late” relative to the housing and the drive gear. The do-

cument addresses the problem that a hydraulic pump for loading the pressure chambers is usually driven by a crankshaft, which has the consequence that the flow of the hydraulic medium is reduced, in some circumstances, at a low speed of the internal combustion engine. This can lead to undesirable adjustments of the camshaft adjuster.

In order to eliminate problems of the type explained above, JP A 9 264 110 proposes to connect a torsion spring between a drive element and an output element. For this purpose, the torsion spring is supported in the housing of the camshaft adjuster at one base point on the chain sprocket, while the other base point of the torsion spring is supported on the rotor.

This solution is considered problematic according to US 6,311,654 B1, as a bypass can be provided between the pressure chambers of the camshaft adjuster via the receiving space for the torsion springs, in some circumstances, which bypass can lead to undesirable operating states and even failure of the camshaft adjuster. In order to avoid problems of this type, US 6,311,654 B1 proposes to arrange the pressure chambers and the vanes so as to lie radially outside the receiving space for the torsion spring element, with the result that suitable sealing can be effected in a radial intermediate space in the housing. As a result, however, the overall radial structural size of the camshaft adjuster is increased. Radial dimensions which are increased in this way can be avoided according to US 6,311,654 B1 in that firstly the pressure chambers and secondly the receiving space for the torsion spring are arranged so as to lie axially next to one another with radially overlapping extents. Transfer of the hydraulic medium between individual pressure chambers via the receiving space for the spring element is avoided by a circularly annular dividing disc which is connected axially between the pressure chambers and the receiving space.

DE 40 32 586 A1 has disclosed a camshaft adjuster which is actuated via a control piston, in which a torsion spring arrangement which serves to transmit approximately a mean torque is arranged parallel to the adjusting

chambers between a drive gear and a camshaft. This refinement is based on the finding that, for adjustment in different directions, torques have to be generated in the camshaft adjuster which have opposite directions, the magnitudes of which, however, are different in some circumstances for different directions, with the result that, for example as a result of the drive movement and/or the friction conditions, a mean moment for the torque requirements for different adjusting directions results which is not equal to zero. In order to limit the moments which are to be produced in the camshaft adjuster to the difference of the extremes required from the main moment, and not to the absolute extreme which is greater in some circumstances, the document proposes to provide the mean moment by an energy accumulator which is configured as a torsion spring arrangement which is connected parallel to the adjusting chambers between the drive sprocket and the camshaft. The torsion spring arrangement is configured separately from the camshaft adjuster.

DE 690 28 063 T2 discloses a further refinement of the use of torsion spring elements for influencing the moment conditions for a camshaft adjuster.

DE 198 20 638 A1 discloses the use of a torsion spring in a camshaft adjuster for compensation of the tooth play of what are known as scissor gearwheels, cf. also US 5,056,613, US 4,747,321, US 4,739,670, US 3,365,973 and US 2,607,238.

Object of the Invention

The invention is based on the object of proposing a camshaft adjuster which is improved with regard to

- assembly,
- the required radial and/or axial installation space,

- influencing of the moment conditions in the camshaft adjuster, and/or
- the connection of a spring element to a drive element and/or output element of the camshaft adjuster.

Summary of the Invention

According to the invention, the object is achieved by the features of independent Claim 1. Further refinements of the solution according to the invention result in accordance with the features of dependent Claims 2 to 14.

The invention is based first of all on the finding that it is disadvantageous in some circumstances to connect a spring element for influencing the moment conditions of the camshaft adjuster between a drive element and the camshaft itself. A connection of this type requires suitable measures for connecting the spring element to the camshaft, which measures can increase the manufacturing expenditure for the camshaft, the mass, the mass moment of inertia and/or the installation space of the camshaft. Secondly, a spring element of this type cannot already be mounted during manufacture of the camshaft adjuster, but only when the camshaft adjuster is assembled with the camshaft.

Furthermore, the invention is based on the finding that, for refinements in accordance with US 6,311,654 B1, the spring element has to be mounted in the housing of the camshaft adjuster. This has the consequence that the spring element has to be secured, for example, for an open housing with exact positioning of the housing parts and at the same time guaranteeing the accessibility of the interior of the housing. Moreover, a torsion spring which is arranged in the housing is the reason for the problems which are addressed in US 6,311,654 B1 with regard to the risk of transfer of the hydraulic medium between individual pressure chambers via a receiving space for the spring element.

According to the invention, the spring element acts between the housing and the output element. Here, the spring element can be supported directly on the housing or the output element, or merely indirectly with components which are connected fixedly in terms of rotation to the housing or the output element being connected in between.

Furthermore, it is proposed according to the invention to arrange the spring element outside the housing. This makes mounting of the housing possible, in particular with an output element which lies in the latter, including closure of the said housing, with subsequent mounting of the spring element, without it being necessary for the camshaft to be present for this purpose. Rather, mounting of the spring element can already take place during manufacture of the camshaft adjuster in order to form one structural unit which then merely has to be connected to the camshaft.

For one refinement with an arrangement of the spring element outside the housing, a wide variety of different embodiments are possible:

a) for example, the output element can have a protrusion which is, in particular, hollow-cylindrical and

- extends with a sealing function between the housing and the circumferential face which lies on the outside through the housing from the inside outwards,
- makes connection of the spring element possible in the region of the outer circumferential surface in a manner which lies on the outside of the housing, and
- receives the camshaft in a manner which lies radially on the inside, for mounting of the camshaft adjuster with the camshaft.

b) In one alternative or cumulative refinement of the invention, a spring base point is supported on a section element. The supporting element is connected fixedly in terms of rotation to the output element

which is arranged in the housing. Here, the output element can be of single-piece or multiple-piece configuration with the section element. One wall of the housing has a cut-out. The supporting element extends through this cut-out, with the result that forces which are applied to the supporting element outside the housing can be transmitted through the cut-out to the output element. Here, the cut-out of the wall of the housing is configured in such a way that a relative rotation is made possible between the housing and the supporting element and therefore the output element. The supporting element can be configured separately from the spring element or integrally with the latter, it being possible for flexural elasticity to be provided primarily by the spring element, or jointly by the spring element and the supporting element by a connection of the respective rigidities one behind another.

One particular semi-finished product, for which the mechanical properties can be predefined in a simple structural manner, can be used if the supporting element is configured as a pin.

In a further refinement of the invention, simple connection of a pin of this type to the output element, in particular a rotor of a camshaft adjuster in the vane cell design, can be provided by a press joint fit.

According to one further proposal of the invention, the cut-out is provided in the wall of the housing with an extent in the circumferential direction, for example in the shape of a curved groove or a "banana-shaped" groove, with the result that the relative rotation between the housing and the supporting element is made possible in a cut-out or groove of this type.

In order to avoid an outflow of hydraulic medium from a pressure chamber of the camshaft adjuster, in particular transfer between individual pressure chambers, the invention proposes, furthermore, that a seal is provided

between the housing and the rotor in the surrounding region of the above-mentioned cut-out. The sealing action can be effected, for example,

- as has been described in the introduction, by a radial offset of the pressure chambers on one side and the cut-out on the other side, with a sealing region being connected in between,
- via a sealing washer or a sealing element, such as a labyrinth seal, a sealing ring or the like.

Any desired springs may be suitable as spring elements, such as tension or compression springs, helical springs made from elastic material such as spring steel or, for example, an elastomer element. According to one particular proposal of the invention, the spring element is configured with a helical torsion spring, in which the spring element extends in the circumferential direction of the camshaft adjuster, preferably with an angle of extent which is greater than 360°.

The spring element can be arranged on one end side of the camshaft adjuster. However, the spring element is preferably arranged on that end side of the camshaft adjuster which faces the cylinder head, with the result that the spring element is arranged between the housing of the camshaft adjuster and the cylinder head. Accordingly, that end side of the camshaft adjuster which lies opposite and faces away from the cylinder head can be used for other functions, for example for assembly of the camshaft adjuster with the camshaft via a central screw, the supply of hydraulic medium or an end-side adjusting unit.

A particularly compact refinement of the invention results if the spring element is arranged radially on the inside of a drive gear of the camshaft adjuster. For this purpose, the drive element of the camshaft adjuster can have a central bore or annular groove, in which the spring element is received. The bore or annular groove can serve as protection and/or for guidance of the spring element, without these functions and the receiving space

for the spring element necessarily requiring an increase in the installation space of the camshaft adjuster.

The spring element can be protected from contamination or mechanical impairments and limited axially against drifting or deflecting away by a cover, with the result that the spring element is arranged in the axial direction between the housing and the covering.

In one further refinement of the invention, the spring element can be hooked into the output element, the supporting element and/or the housing or a component which is connected fixedly in terms of rotation to a component of this type in the region of the base point in a simple manner, for mounting (and dismantling). For this purpose, the spring element has at least one hook-shaped spring base point which can be hooked, for example, into a lug, a journal or a bracket.

Furthermore, the invention has discovered that a movement of the spring element with elastic loading of the spring element is required in order to release hook-shaped spring base points of this type. Here, the overall elasticity of the spring element can be unsuitable, in order to predefine a force to a sufficient extent for release of the spring element from the associated component, in order that unintended release of the spring element can be avoided, for example during operation of the internal combustion engine. The invention therefore proposes that the spring element is supported on a stop in the radial direction in the surrounding region of the spring base point. Support of this type acts in the same direction, in which the hooking of the spring base point into the associated component is also released. This has the consequence that the overall rigidity of the spring element is not critical for release of the spring element, but rather changed boundary conditions which can influence the force level for the release of the spring element, in particular raise it, are active for the release of the spring element as a consequence of the wear of the stop.

Advantageous developments of the invention result from the patent claims, the description and the drawings. The advantages, which are mentioned in the introduction to the description, of features and of combinations of a plurality of features are merely by way of example, without them necessarily having to be achieved by the embodiments according to the invention. Further features are to be gathered from the drawings, in particular the geometries which are shown and the relative dimensions of a plurality of components with respect to one another and their relative arrangement and operative connection. The combination of features of different embodiments of the invention or of features of different patent claims is likewise possible in a manner which deviates from the selected back-references of the patent claims and is likewise suggested herewith. This also relates to features of the kind which are shown in separate drawings or are mentioned in their description. These features can also be combined with features of different patent claims. Features which are specified in the patent claims can likewise be omitted for further embodiments of the invention.

Brief Description of the Drawings

Further features of the invention result from the following description and the associated drawings, in which exemplary embodiments of the invention are shown diagrammatically and in which:

Figure 1 shows a camshaft adjuster according to the invention which is assembled with a camshaft, in longitudinal section;

Figure 2 shows an end-side view of the camshaft adjuster, with a viewing angle from the side which faces the cylinder head, without a cover which covers a spring element; and

Figure 3 shows an end view according to Figure 2, in this case with a cover which covers the spring element, however.

Detailed Description of the Invention

Figure 1 shows a camshaft adjuster 1 in longitudinal section, which camshaft adjuster 1 is assembled with a camshaft 2. The camshaft adjuster 1 in the exemplary embodiment which is shown in the figures is of the vane cell design which is known per se. The camshaft adjuster 1 has a drive element which is configured as a chain sprocket 3 in the exemplary embodiment which is shown. The chain sprocket 3 is drive-connected fixedly in terms of rotation to a further chain sprocket which is connected to the crankshaft, via a drawing means (not shown), a chain here. The chain sprocket 3 is connected fixedly in terms of rotation to a housing 4 or a part of the housing 4. A rotor 6 which is connected fixedly in terms of rotation to the camshaft 2 is arranged in the housing 4 such that it can be rotated relatively about the longitudinal axis 5-5 of the camshaft adjuster 1. There are pressure chambers 7 in the housing 6, in which pressure chambers 7 vanes which are connected fixedly to the rotor 6 can be pivoted according to the loading with the hydraulic medium, which is associated with the rotation of the rotor 6 relative to the housing 4. For the exemplary embodiment which is shown, the pressure chambers 7 are loaded with pressure via end-side feed channels of the camshaft adjuster 1. The fixed connection between the rotor 6 and the camshaft 2 is effected for the exemplary embodiment which is shown by means of a central screw 8 which is screwed on the end side into a central bore, having a thread, of the camshaft 2. The rotor 6 is captured and clamped between an end face 9 of the camshaft and a head 10 of the central screw 8, optionally with further components 18 being connected in between. The central screw 8 has an end-side blind bore 11 on that side which faces away from the camshaft 2, in which end-side blind bore 11 hydraulic elements are received for suitable loading of the camshaft adjuster 1 with the hydraulic medium. The hydraulic medium is fed from the blind bore 11 to the pressure chambers 7 via suitable, in particular radial channels.

The housing 4 is formed with an approximately U-shaped half section which has an approximately axially oriented base limb 12 and parallel, radially oriented side limbs 13, 14. The side limbs 13, 14 reach around the rotor 6 in a radially inward manner. Radially inner end faces 15, 16 of the side limbs 13, 14 form a gap, a contact face or a sealing face with a circumferential face 17 of the camshaft 2 and the component 18 which is connected fixedly in terms of rotation to the rotor 6. For the exemplary embodiment which is shown, the side limbs 13, 14 are formed with two substantially circularly annular discs 23, 24. The disc 24 for the side limb 14 has a hollow-cylindrical protrusion 22 with a bore 38 which extends in the direction of the cylinder head and bears the chain sprocket 13 radially on the outside. The disc 24, the protrusion 22 and the chain sprocket 3 are of single-piece configuration for the exemplary embodiment which is shown.

The base limb 12 is formed by a hollow-cylindrical outer casing of the housing 4, which has radially inwardly oriented projections for delimiting the pressure chambers 7 in the circumferential direction. The housing 4 therefore has discs 23, 24, which are configured separately from one another but are sealed with respect to one another, and the outer casing. A seal 19 is arranged between the side limbs 13, 14 and the rotor 6 which can be pivoted relative to the latter, which seal 19 prevents lubricant from passing from one pressure chamber into an adjacent pressure chamber and/or from migrating radially inwards or outside the camshaft adjuster 1. The seal 19 can be configured as a narrow gap or contact face between the side limbs 13, 14 and the facing end faces of the rotor 6. The arrangement of a labyrinth seal, an additional sealing element such as a sealing ring or the like is likewise possible.

The rotor 6 has a bore 20 which is oriented parallel with respect to the longitudinal axis 5-5 and can be configured as a through bore or blind bore. The spacing of the longitudinal axis of the bore 20 from the longitudinal axis 5-5 is greater than the diameter of the camshaft 2 in the region of the camshaft adjuster, but smaller than the diameter for an inner delimitation of

the pressure chamber 7. A supporting element which is configured as a cylindrical pin 21 is inserted into the bore 20 with an accurate fit, in particular with a press fit. The pin 21 extends in a contactless manner, in particular with formation of a play 26, through a cut-out 25 of the disc 24 on that side which faces away from the cylinder head, and protrudes from the disc 24 with an end region 27 on that side which faces the cylinder head. The end region 27 is arranged in the bore 38 in a manner which lies radially on the inside of the protrusion 22.

It can be seen in Figure 2 that the cut-out 25 is configured as a groove 28 which extends in the circumferential direction. The spring element 29 has hook-shaped spring base points 30, 31 which are connected elastically to one another via a helical torsion spring 32 which extends with a plurality of turns in the circumferential direction. The hook-shaped spring base point 30 which is bent in a hook-shaped manner approximately over a circumferential angle of 180° and has a diameter which is slightly greater than the external diameter of the end region 27 engages around the end region 27, while the hook-shaped spring base point 31 is bent in a hook-shaped manner approximately over a circumferential angle of 90° and is hooked into the projection 33 of the protrusion 22, which projection 33 is oriented radially inwards. The spring element 29 is formed from an elastic material, in particular a resilient metal. For the exemplary embodiment which is shown in the figures, a spring wire of the torsion spring 32 has a substantially rectangular cross section. A stop 34 is arranged in a manner which is offset approximately by 60° in the circumferential direction about the longitudinal axis 5-5 with respect to the projection 33, at a radius which corresponds approximately to the internal radius of the projection 33, on the outer side of which the torsion spring 32 is supported. In order to mount the spring element 29, the hook-shaped spring base point 30 of the spring element 29 is hooked into the end region 27 of the pin 21 for substantially finished mounting of the camshaft adjuster 1 itself and finished assembly of the housing 4. Furthermore, the associated region of the torsion spring 32 is positioned on the stop 34. The hook-shaped spring base point 31 is defor-

med elastically radially inwards, with loading of that region of the torsion spring 32 which extends in the circumferential direction between the projection 33 and the stop 34. The hook-shaped spring base point 31 is then hooked or clipped into the projection 33. Further support of further part regions of the torsion spring is possible, for example in the region of a further pin 35 which is configured in accordance with the pin 21, extends through a corresponding cut-out 36 and on which the torsion spring 32 is supported on the radially outer side. The torsion spring 32 is preferably configured with a radial play between individual turns, in order to avoid friction which impedes the pivoting between the rotor 6 and the housing 4.

A cover 37 is introduced radially on the inside into the protrusion 22. For the exemplary embodiment which is shown, the cover is configured as a circularly annular disc-shaped metal plate, the inner bore of the metal plate having a radius which is slightly greater than the radius of the outer side of the pins 35, 21. The cover 37 is bent over in the direction of the cylinder head radially on the outside. The cover 37 is deformed radially inwards by its insertion into the protrusion 22 and, for the operating position which is shown in Figure 1, bears with radial pressure against the inner bore 38 of the protrusion 22 in a manner which is positioned fixedly in the latter with a frictional fit. The protrusion 22 can have a suitable groove for an additional form-fitting connection.

List of Reference Numerals

1	Camshaft adjuster
2	Camshaft
3	Chain sprocket
4	Housing
5	Longitudinal axis
6	Rotor
7	Pressure chamber
8	Central screw
9	End face
10	Head
11	Blind bore
12	Base limb
13	Side limb
14	Side limb
15	End face
16	End face
17	Circumferential face
18	Component
19	Seal
20	Bore
21	Pin
22	Protrusion
23	Disc
24	Disc
25	Cut-out
26	Play
27	End region
28	Groove
29	Spring element
30	Spring base point

31 Spring base point
32 Torsion spring
33 Projection
34 Stop
35 Pin
36 Cut-out
37 Cover
38 Bore

Patent Claims

1. Camshaft adjuster (1) for an internal combustion engine, having
   a) a driven housing (4),
   b) an output element (rotor 6) which can be connected fixedly in terms of rotation to the camshaft (2) and can be rotated relative to the housing (4) for an adjusting movement of the camshaft adjuster (1), and
   c) a spring element (29) which acts between the driven housing (4) and the output element (rotor 6),

   characterized in that the spring element (29) is arranged outside the housing (4).

2. Camshaft adjuster according to Claim 1, characterized in that a spring base point (30) is supported on a supporting element (pin 21) which
   a) is connected fixedly in terms of rotation to the output element (rotor 6) which is arranged in the housing (4), and
   b) penetrates a cut-out (25) of a wall of the housing (4), a relative movement between the housing (4) and the supporting element (pin 21) being made possible.

3. Camshaft adjuster according to Claim 2, characterized in that the supporting element (pin 21) is supported with respect to an output element which is configured as a rotor (6) of the camshaft adjuster (1) in the vane cell design.

4. Camshaft adjuster according to Claim 3, characterized in that the supporting element is configured as a pin (21).

5. Camshaft adjuster according to Claim 4, characterized in that the pin (21) is connected to the rotor (6) via a press joint fit.

6. Camshaft adjuster according to one of Claims 2 to 5, characterized in that the wall of the housing (4) has a cut-out (25) which extends in the circum-

ferential direction and through which the supporting element (pin 21) passes, making a relative rotation possible.

7. Camshaft adjuster according to one of preceding Claims 3 to 6, characterized in that a seal (19) is provided between the rotor (6) and the housing (4) in the surrounding region of the cut-out (25).

8. Camshaft adjuster according to one of the preceding claims, characterized in that the spring element (29) is configured with a helical torsion spring (32).

9. Camshaft adjuster according to one of the preceding claims, characterized in that the spring element (29) is arranged on that side of the camshaft adjuster (1) which faces a cylinder head.

10. Camshaft adjuster according to one of the preceding claims, characterized in that the spring element (29) is arranged radially on the inside of the drive element or drive gear (chain sprocket 3) of the camshaft adjuster (1).

11. Camshaft adjuster according to one of the preceding claims, characterized in that a drive element (protrusion 22) of the camshaft adjuster (1) has a central bore (38) or annular groove, in which the spring element (29) is received.

12. Camshaft adjuster according to one of the preceding claims, characterized in that the spring element (29) is arranged in the axial direction between the housing (4) and a covering (cover 37).

13. Camshaft adjuster according to one of the preceding claims, characterized in that the spring element (29) has at least one hook-shaped spring base point (30, 31) which is hooked into the output element (rotor 6), the supporting element (pin 21) and/or the housing (4) or a component which is connected fixedly in terms of rotation to a component of this type.

14. Camshaft adjuster according to Claim 13, characterized in that the spring element (29) is supported on a stop (34) in the radial direction in the surrounding region of a spring base point (30), in which radial direction the hooking of the spring base point (30) into the output element (rotor 6), the supporting element (pin 21) or the housing (4) is released.

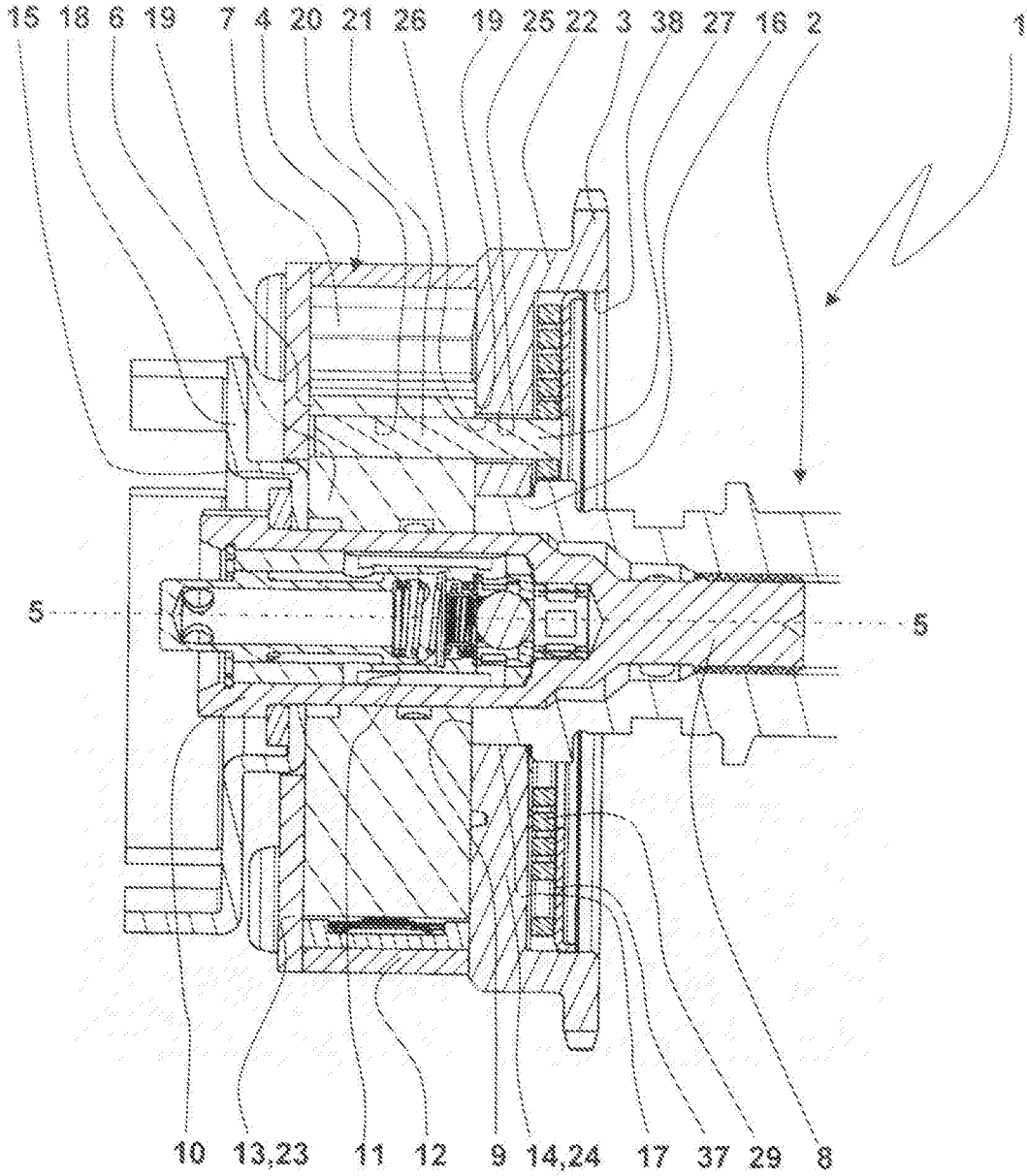

15 18 6 19 7 4 20 21 26 19 25 22 3 38 27 16 2 1
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10 13,23 11 12 9 14,24 17 37 29 8

Fig. 1

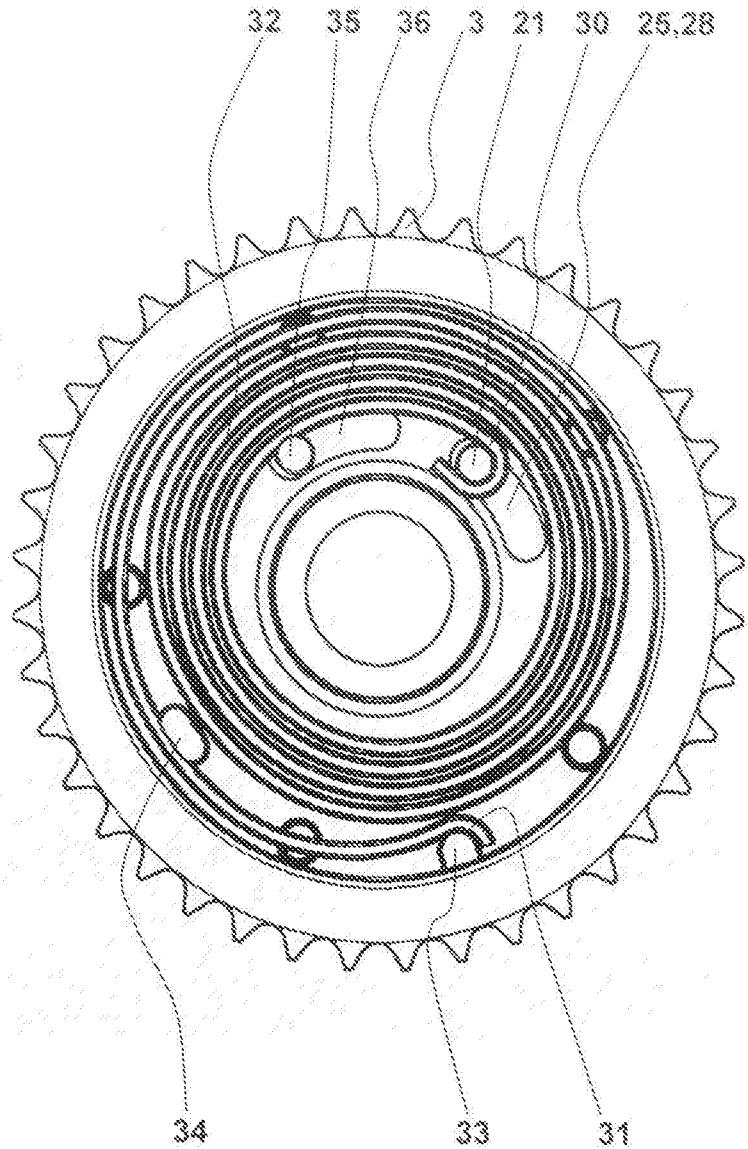


Fig. 2

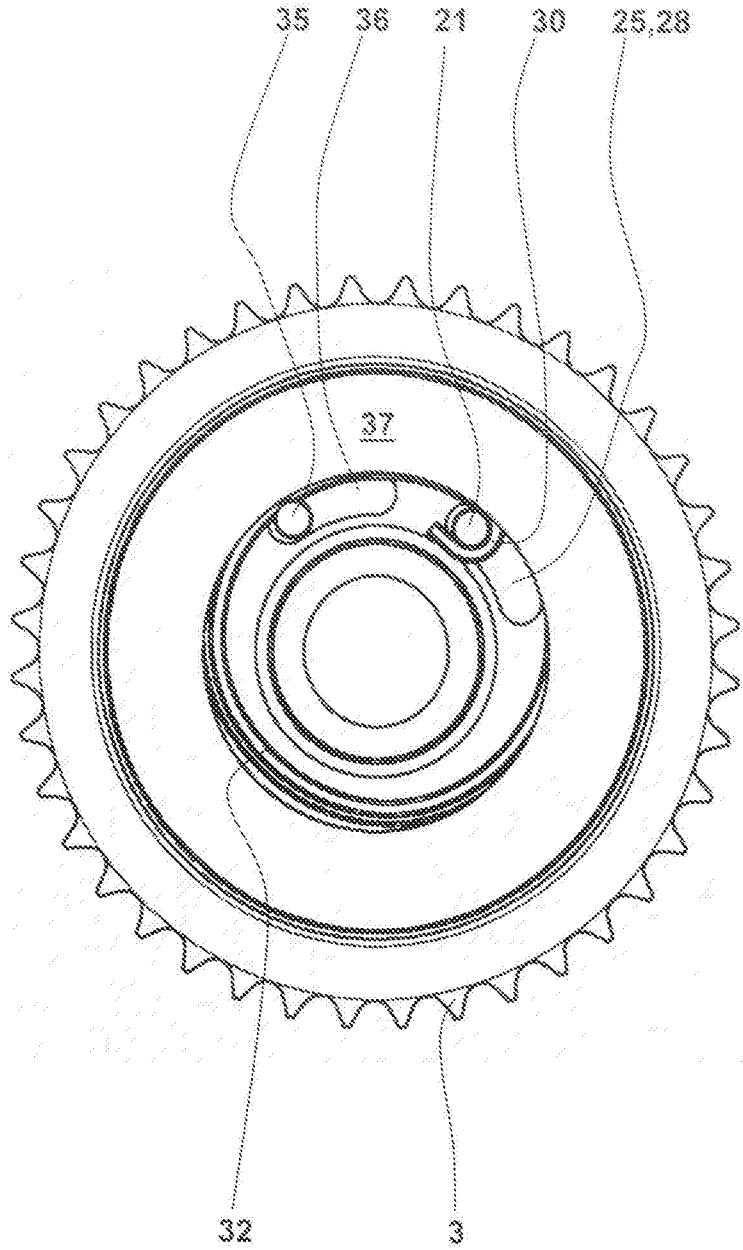


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2006/069360

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01L1/34 F01L1/344

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 365 112 A (DELPHI TECH INC [US]) 26 November 2003 (2003-11-26) abstract figures 3,12 column 4, paragraph 15	1-4,6, 12,13
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[X] Further documents are listed in the continuation of Box C.

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8 May 2007	16/05/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Paulson, Bo

INTERNATIONAL SEARCH REPORT

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