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Szelepvezérlés robbanómotorokhoz

Az európai szabadalom ellen, megadásának az Európai Szabadalmi Közlönyben való meghirdetésétől számított kilenc hónapon belül, felszólalást lehet benyújtani az Európai Szabadalmi Hivatalnál. (Európai Szabadalmi Egyezmény 99. cikk(1))

A fordítást a szabadalmas az 1995. évi XXXIII. törvény 84/H. §-a szerint nyújtotta be. A fordítás tartalmi helyességét a Szellemi Tulajdon Nemzeti Hivatala nem vizsgálta.

Area of the invention

The invention relates to a valve drive of an internal combustion engine, having a camshaft which comprises a carrier shaft and a cam piece arranged rotationally conjointly on said carrier shaft so as to be displaceable between a first and a second axial position, which cam piece has at least one cam group of directly adjacent cams with different cam elevations and has an axial slotted guide with a first and a second cam track, which cam tracks are each in the form of a groove and extend on the circumference of the axial slotted guide axially in opposite directions, and having an actuation element which can be coupled to the axial slotted guide for displacing the cam piece in the direction of both cam tracks.

Background of the invention

Such a valve drive, which serves for the variable actuation of gas exchange valves by means of displaceable cams and in the case of which a single actuating element is adequate for each cam piece in order to displace the cam piece in the direction of both cam tracks of the axial slotted guide, is known from DE 101 48 177 A1 considered generic. There, two cam pieces with alternatively configured axial slotted guides are disclosed, wherein the first axial slotted guide comprises a central guide web for forming inner guide walls for the actuating element in the form of a cylindrical pin dipping into the axial slotted guide and the second axial slotted guide merely consists of outer guide walls.

The latter configuration has the advantage that the production effort for the axial slotted guide through the omission of the guide web is significantly less. However, there is a considerable risk with regarding the functional safety of the valve drive with this configuration in that the displacement process of the cam piece is only completed completely, i.e. without incorrect displacement, when the mass inertia of the cam piece is adequate in order to move it into its other end position in a free-floating manner as it were following the passing-through of the intersection region of the cam tracks even without forced intervention of the cylindrical pin. A prerequisite for the adequate mass inertia of the cam piece obviously is a minimum rotational speed of the camshaft, which is directly dependent on the friction between the cam piece and the carrier shaft. Displacement of the cam piece rotating below this minimum rotational speed can result in that the cam piece stops "halfway" and a cam follower of multiple cams of the cam group impinging the gas exchange valve is simultaneously impinged in an uncontrolled manner and under high mechanical loads. In addition there is no longer any possibility in this case to subsequently displace the cam piece into one of the end positions by means of the cylindrical pin since the axial allocation between the cylindrical pin and the outer guide walls is then no longer present.

This function risk however is significantly smaller with the first configuration of the axial slotted guide with central guide web, the inner guide walls of which at low rotational speeds of the cam piece act as positive guide further accelerating the cylindrical pin. However, there is nevertheless the risk here that the cylindrical pin, having passed through the intersection region, does not enter the preset cam track but collides with the face end of the guide web likewise under high mechanical load.

A valve drive having the features of the preamble of Claim 1 is likewise evident from DE 101 48 178 A1 and DE 10 2007 037 232 A1.

Object of the invention

The present invention is therefore based on the object of further developing a valve drive of the type mentioned at the outset so that the mentioned functional restrictions and risks are at least partially eliminated. In concrete terms, the object therefore consists in ensuring a successful, i.e. complete change-over process of the cam piece when using a single actuating element for both displacement directions even at low rotational speeds of the camshaft, for example during the starting process of the internal combustion engine.

Summary of the invention

The solution of this object is obtained from the characterizing features of Claim 1 while advantageous further developments and configurations of the invention can be taken from the subclaims. Accordingly, the cam tracks are to be arranged in circumferential direction of the axial slotted guide one behind the other. A substantial difference of the invention compared with the known prior art thus relates to the mutual arrangement of the cam tracks on the axial slotted guide, which now run one behind the other, i.e. in series arrangement, and no longer next to one another, i.e. in parallel arrangement and consequently no longer intersect. Through the omission of the intersection region, the displacement of the cam piece takes place under continuous positive guidance of the axial slotted guide relative to the actuating element coupled therewith, so that a complete change-over process of the cam piece is ensured even at lowest rotational speeds of the camshaft.

With respect to the coupling of the actuating element to the axial slotted guide, the cam tracks are each formed as groove and the actuating element as cylindrical pin engaging in the grooves. Preferentially, the cam tracks in this case are each composed of successive track sections with different axial excursions of the groove walls delimiting the groove, namely a run-in section without axial excursion, a ramp section and an excursion section, wherein the excursion section has a significantly greater axial acceleration than the ramp section.

In addition to this, the cams are to have a common base circle region, which starts at the latest with the ramp section of the first cam track and terminates at the earliest with the excursion section of the second cam track. Since the common base circle region is to mean the angle region of the cam piece, in which all cams of the cam group are elevation-free, the displacement of the cam piece takes place in particular merely when the gas exchange valve assigned to the cam group is closed and the cam to be engaged is likewise located in its base circle position throughout the displacement process. Accordingly, no valve spring forces increasing the friction between cam piece and carrier shaft act on the cam piece during the displacement process. In order to keep the axial acceleration of the cam piece as low as possible, the start and the end of the base circle region and of the displacement process are ideally identical.

The excursion sections can each be composed of successive partial excursion sections with different radial excursions of the groove base delimiting the groove, namely a first partial excursion section without radial excursion and a second partial excursion section with groove base radially outwardly rising. In contrast with the groove geometries known from the prior art, with which the actuating pin is only "ejected" from the radially rising groove into its engagement-free rest position in the axial force-free state, it is practical here to superimpose the axial excursion and the radial excursion of the groove in order to maximize the respective cam angle of the excursion sections that is available and consequently delimit the comparatively high axial accelerations in the excursion sections to a mechanically controllable level.

Before this background it is finally provided that the second partial excursion section and the run-in section in each case directly adjoin one another, wherein the groove base runs radially steeply falling at the transition from the second partial excursion section to the run-in section. In particular with a groove base which with respect to the circumference of the axial slotted guide falls perpendicularly, i.e. with a sum angle of the cam tracks of 360° , the cam angles of the excursion sections with given length of the run-in section located in between can thus be maximized.

Brief description of the drawings

Further features of the invention are obtained from the following description and from the drawings, in which an exemplary embodiment of the invention is shown. It shows:

Figure 1

shows an extract of a valve drive according to the invention in longitudinal section;

Figure 2

shows the axial slotted guide in a first perspective view X according to Figure 5;

Figure 3

shows the axial slotted guide in a second perspective view Y according to Figure 5;

Figure 4

shows the axial slotted guide in a third perspective view Z according to Figure 5

Figure 5

shows a lateral view of the axial slotted guide according to Figure 1 with radial control diagram and

Figure 6

shows a complete excursion diagram of the axial slotted guide.

Detailed description of the drawings

In Figure 1, an extract of a variable valve drive of an internal combustion engine that is substantial for understanding the invention is disclosed. The valve drive comprises a camshaft 1, which comprises a carrier shaft 2 and -- corresponding to the number of cylinders of the internal combustion engine -- cam pieces arranged rotationally conjointly so as to be displaceable between two axial positions. For the purpose of axial displacement, the carrier shaft 2 is provided with external longitudinal splines and the cam piece 3 with corresponding internal longitudinal splines. The splines are known per se and not shown in more detail here.

The cam piece 3 comprises cam groups arranged on both sides of a bearing 4 each with two directly adjacent cams 5 and 6, which with same base circle radius have different cam elevations. Displacing the cam piece is effected outside the cam elevations during the common base circle region of the cams 5, 6. The cam elevations are each selectively transmitted to a gas exchange valve which is not shown in the known manner by a cam follower, such as for example a rocker arm, symbolized here by a cam roller 7, as a function of the current axial position of the cam piece 3. The different cam elevations are to mean different amounts of the respective cam excursion and/or different valve control times of the cams 5, 6.

For changing over between the cams 5 and 6, the cam piece 3 is provided with an axial slotted guide 8 produced as individual part and joined by means of a press fit. On the circumference of the axial slotted guide 8, two cam tracks 9, 10 in the form of grooves are formed, which axially extend in opposite directions and in

circumferential direction of the axial slotted guide 8 are arranged one behind the other, into which an actuating element 11 can be coupled. This is evident in more detail from the Figures 2 to 4, in which the axial slotted guide 8 is shown from different angle perspectives. The actuating element 11 is a cylindrical pin which is part of a likewise known actuator for such valve drives that is not explained in more detail here. The cylindrical pin 11 is axially stationary with respect to camshaft 1 but radially displaceably arranged in the internal combustion engine and serves for displacing the cam piece 3 in the direction of both cam tracks 9, 10.

The configuration of the cam tracks 9, 10 is obtained from viewing Figures 2 to 6 together. The views of the axial slotted guide 8 shown in the Figures 2 to 4 correspond to the view arrows X, Y and Z respectively in Figure 5, in which the axial slotted guide 8 shown in lateral view is additionally provided with a radial control diagram of the cam tracks 9, 10 according to the dashed line. The arrows shown in the Figures 1, 2 and 5 mark the direction of rotation of the camshaft 1. A complete excursion diagram with radial and axial excursion of the cam tracks 9, 10 as a function of the camshaft angle is evident from Figure 6.

The two cam tracks 9, 10 are each composed of successive track sections with different axial excursions (continuous line in Figure 6) of the groove walls 12 delimiting the groove. These track sections are an run-in section F and C respectively without axial excursion, a ramp section A and D respectively for offsetting axial position tolerances of the cylindrical pin 11 relative to the groove walls 12 and an excursion section B and E respectively, wherein the axial acceleration of the excursion sections B, E is significantly greater than that of the ramp sections A, D. In the shown exemplary embodiment, the common base circle region of the cams 5, 6 is identical to the track sections A to E, i.e. the common base circle region starts with the ramp section A of the first cam track 9 and terminates with the excursion section E of the second cam track 10. Compared with this, the cam elevations of the cams 5, 6 are in the region of the run-in section F.

The excursion sections B and E are each composed of successive partial excursion sections B1 and B2 respectively E1 and E2, which differ in the radial excursion of the groove base 13 (dashed line in Figure 5 and 6). Here, the first partial excursion sections B1 and E1 comprise a groove base 13 with constant depth that is identical to the sections F and A and C and D respectively, while the groove base 13 rises radially outwardly over the second partial excursion sections B2 and E2 in order to eject the cylindrical pin 11 from the respective groove into its non-engaged rest position even during the displacement process of the cam piece 3. The change-over of the cam piece 3 along the first cam track 9, i.e. from the currently active cam 5 to the cam 6 (see Figure 1) is effected in that the cylindrical pin 11 dips into the run-in section F -- depending on size and duration of the cam elevation, this already takes place during the opened gas exchange valve -- and subsequently passes through the ramp section A and the excursion section B, while the rotating cam piece 3 supporting itself on the cylindrical pin 11 is displaced into its second axial position. Even during the course of the second partial excursion section B2, the cylindrical pin 11 is lifted by the radially rising groove base 13 and towards the end of the displacement process, completely ejected from the cam track 9 into its non-engaged rest position.

Analogously to this, the pushing-back of the cam piece 3 along the second cam track 10 takes place, i.e. by the cam 6 that are then active onto the cam 5 in that the cylindrical pin 11 dips into the run-in section C and subsequently passes through the ramp section D and the excursion section E, while the rotating cam piece 3 supporting itself on the cylindrical pin 11 is pushed back into its first axial position. During this, the cylindrical pin 11 during the course of the second partial excursion section E2 is lifted by the radially rising groove base 13

and towards the end of the displacement process completely ejected from the cam track 10 into its non-engaged rest position.

As becomes evident from the Figures 2 to 5, the second partial excursion section B2 and E2 respectively and the run-in section C and F respectively directly adjoin one another, wherein the groove base 13 at the transition of these sections falls radially perpendicularly, in order to maximize above all the length of the excursion section B with different length of the run-in section C.

The engagement device shown in Figure 1 serves for fixing the cam piece 3 in its axial positions relative to the carrier shaft 2. The engagement device comprises 2 engagement bodies 15 which are displaceably mounted in a radial bore 14 of the carrier shaft 2 formed as through-bore located diametrically opposite and which run on the inner circumference of the cam piece as engagement grooves 16 and 17 formed as circumferential grooves, in which the engagement bodies 15 which are force-loaded in a radially outward direction by a spring means 18, are engaged in the respective associated axial positions.

The engagement bodies 15 are thin-walled formed sheet metal parts that are open on one side. The open side of these is formed in each case as a hollow cylinder mounted in the radial bore 14 and enclosing the spring means 18 formed as coil compression springs, while the closed side following thereon in each case is a hollow body which tapers in the direction of the engagement grooves 16, 17, which is initially configured conical and spherical at the face end. In order to ensure a low-resistance entering of the engagement bodies 15 of the radial bore 14 during the displacement process of the cam piece 3, the cam bodies 15 are provided with a pressure relief opening 19 in the conical region of the hollow body.

The function of the engagement device is not only restricted to fixing the cam piece 3 in the two axial positions, but also comprises braking the cam piece 3 in its axial movement towards the end of the partial excursion sections B2 and E2. This braking is created through contact friction of the spring-loaded engagement bodies 15 on the groove walls of the engagement grooves 16, 17 running axially adjacently on both sides of the apex 20. Other than shown in Figure 1, it is advantageous when the engagement grooves 16, 17 are embodied geometrically identically and the apex 20 – based on the distance of the axial positions of the cam piece 3 associated with the engagement grooves 16, 17 – runs in the centre.

List of reference characters

1	Cam shaft
2	Carrier shaft
3	Cam piece
4	Bearing
5	Cam
6	Cam
7	Cam roller
8	Axial slotted guide
9	First cam track
10	Second cam track
11	Actuating element / cylindrical pin
12	Groove wall

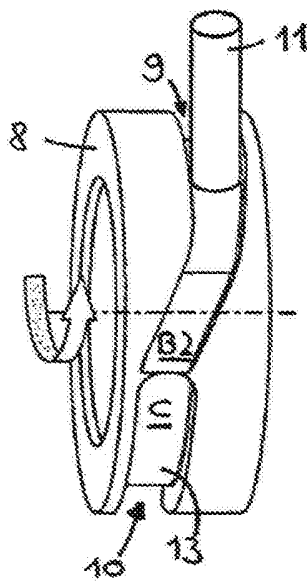
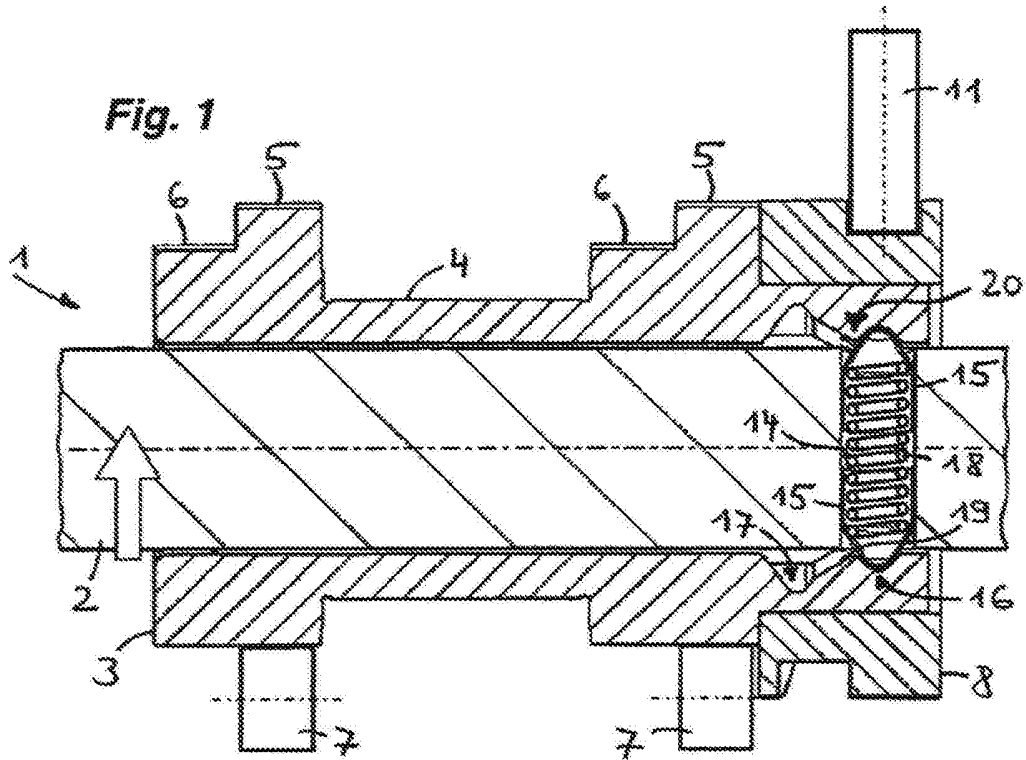
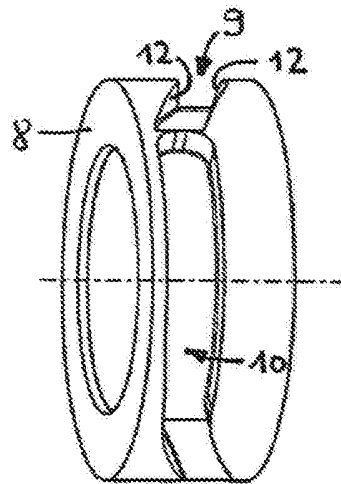
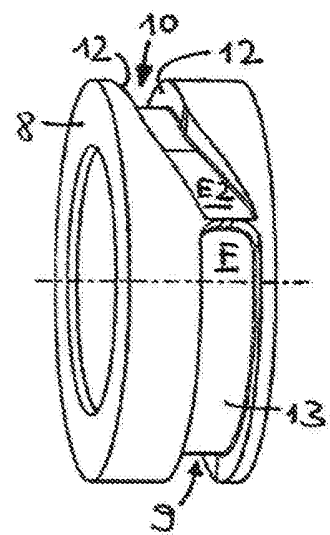
13	Groove base
14	Radial bore
15	Engagement body
16	Engagement groove
17	Engagement groove
18	Spring means / coil compression spring
19	Pressure relief opening
20	Apex point of the engagement grooves
A	Ramp section
B1, 2	Excursion section
C	Run-in section
D	Ramp section
E1,2	Excursion section
F	Run-in section

Szelepvezérlés robbanómotorokhoz

SZABADALMI IGÉNYPONTOK

1. Szelepvezérlés robbanómotorokhoz, bűtykös tengellyel (1), ami tartalmaz egy tartótengelyt (2), valamint egy azon elfordulásmentesen és egy első és egy második axiális helyzet között eltolhatóan elrendezett bűtyök elemet (3), ami tartalmaz legalább egy, közvetlenül szomszédos, különböző bűtyökmagasságú bűtyökből (5, 6) álló bűtyök csoportot és egy axiális kulisszát (8), ami el van látva egy első és egy második görbepályával (9, 10), amik horonyként vannak kialakítva és az axiális kulissza (8) kerülete mentén axiális irányban egymással szembe futnak; és egy, az axiális kulisszával összekapcsolható (8) működtető elemmel (11), ami a hornyokba (9, 10) hengeres csapként van kialakítva, és a bűtyök elemet (3) az első görbepálya (9) mentén az első axiális helyzetből a második axiális helyzetbe mozgatja, és a második görbepálya (10) mentén a második axiális helyzetből az első axiális helyzetbe mozgatja, **azzal jellemezve, hogy a két görbepálya (9, 10) az axiális kulissza (8) kerülete mentén egymás mögött, és nem egymás mellett van elrendezve.**
2. Az 1. igénypont szerinti szelepvezérlés, **azzal jellemezve, hogy mindkét görbepálya (9, 10) egymást követő, különböző szakaszokból (F, A, B, illetve C, D, E) áll, ahol a hornyot határoló falak (12) eltérő axiális kitérésűek, nevezetesen egy bevezető szakaszból (F, illetve C) axiális kitérés nélkül, egy felvezető szakaszból (A, illetve D) és egy löket szakaszból (B, illetve E), ahol a löket szakasz (B, illetve E) lényegesen nagyobb axiális gyorsulású, mint a az első görbepálya (9).**
3. A 2. igénypont szerinti szelepvezérlés, **azzal jellemezve, hogy a bűtyökök (5, 6) azonos alapkör tartományúak, ami legkésőbb az első görbepálya (9) felvezető szakaszával (A) kezdődik, és legkorábban a második görbepálya (10) löket szakaszával (E) végződik.**

4. A 2. igénypont szerinti szelepvezérlés, **azzal jellemezve, hogy** a löket szakaszok (B, E) egymást követő rész löket szakaszokból (B1, B2, illetve E1, E2) vannak összeállítva, amelyek horonyfeneketi (13) eltérő radiális kitérésűek, azaz egy radiális kitérés nélküli első rész löket szakaszból (B1, illetve E1) és egy radiálisan kifelé emelkedő horonyfenékekkel (13) ellátott második rész löket szakaszból (B2, illetve E2).
5. A 4. igénypont szerinti szelepvezérlés, **azzal jellemezve, hogy** a második rész löket szakasz (B2, illetve E2) és a bevezető szakasz (F, illetve C) közvetlenül határosak egymással, ahol a második rész löket szakasz (B2, illetve E2) és a bevezető szakasz (F, illetve C) közötti átmenetnél a horonyfenék (13) radiálisan meredek esésű, és – az axiális kúlszá (8) kerületére vonatkoztatva – merőlegesen esik lefelé.

**Fig. 2****Fig. 3****Fig. 4**

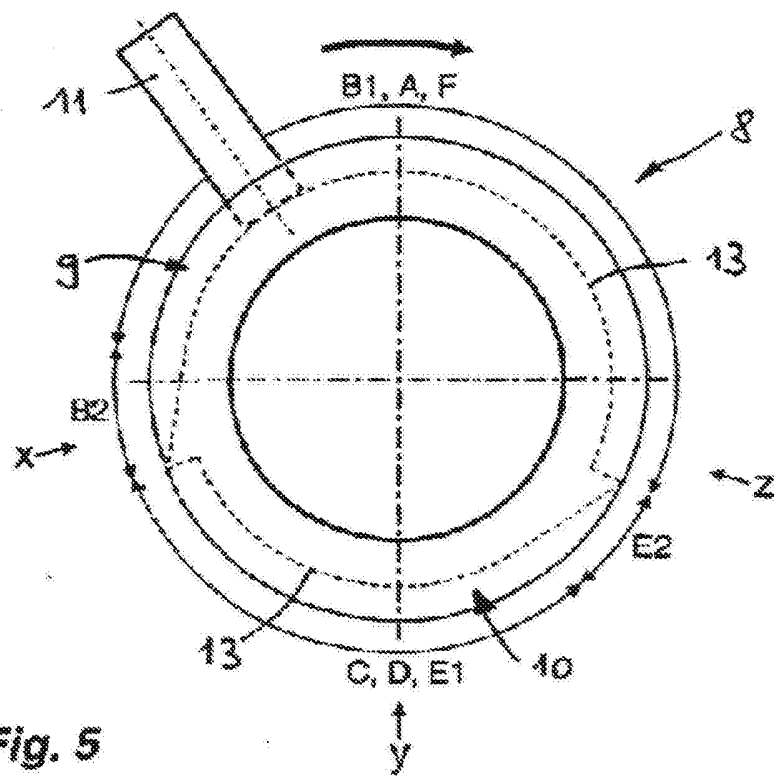


Fig. 5

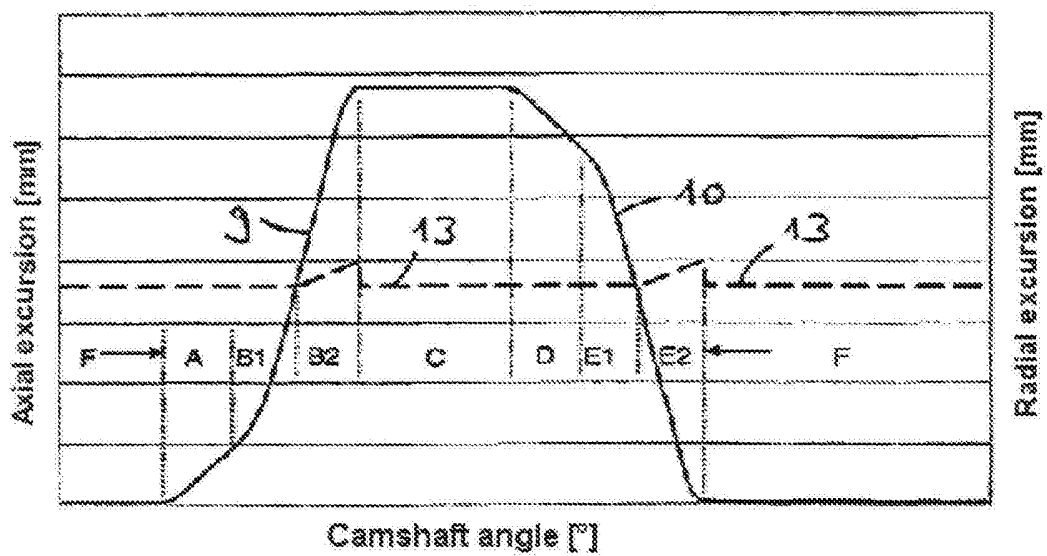


Fig. 6