

Valve rotating device for exhaust valves of internal
combustion engines

The invention relates to a valve rotating device for exhaust valves of internal combustion engines, in particular marine diesel engines, said device being arranged on a valve housing for valve spindle 1 beside a first drive element for opening the valve and a second drive element for closing the valve, with a neutral device which rotates valve spindle 1 during the closing movement or the opening movement thereof and releases the rotation in the counter direction and, in order to transmit the rotational movement to the valve spindle, an outer helical toothing 16 is provided on valve stem 3 of valve spindle 1 and associated inner helical toothing 14 is provided on an inner ring 13 supported by means of the neutral device, wherein outer helical toothing 16 corresponds, in the axial direction, at least to the length of the opening lift of valve spindle 1 plus the minimum engagement length of the helical toothing.

Such a valve rotating device is described in EP 0892154 A1. A wrap spring serves as a neutral device, said wrap spring permitting a rotation of the valve via the outer toothing only in a specific displacement direction of the valve.

Another known device (DE 10 2004 020 754 A1) comprises a hydraulic cylinder as an upper drive element and a compressed-air cylinder as a lower drive element. A supporting cylinder is rigidly connected to the hydraulic cylinder, whilst a rotary cylinder is connected via a neutral device to the compressed-air cylinder. The rotary cylinder and supporting cylinder engage with one another via a helical toothing. During the closing movement of the valve, the neutral device transmits the rotational movement of the rotary cylinder to the valve spindle, until its seat runs rotating against a stationary seating element in the

valve housing. As a result of the rotational movement of the valve spindle, a desired mutual grinding-in of the seating region on the valve disc with the seating element on the housing side occurs.

The supporting cylinder comprises an inner helical toothing running continuously over its whole length, which in the axial direction corresponds at least to the length of the opening lift of the valve spindle plus the minimum engagement length of the helical toothing. The rotary cylinder comprises an outer helical toothing, which in the axial direction is shorter, roughly by the length of the opening lift, than the inner helical toothing of the supporting cylinder.

In contrast, the problem underlying the present invention is to achieve a marked reduction in the overall volume in the radial and axial direction with a valve rotating device of the type mentioned at the outset, to reduce the production cost and thus to ensure a more universal application of the device, for example also in four-stroke engines.

According to the invention, this problem is solved by the fact that inner ring 13 is mounted on an axial ball-bearing 62 inside a recess of a housing cover 4 of valve housing 2 and comprises, at its outer periphery, a ratchet toothing 57 which interacts with ratchet elements 41 of the neutral device.

This construction according to the invention enables, with a low outlay on toothing, a particularly small and therefore lightweight design on account of the ingenious arrangement of the axial ball-bearing for carrying away the axial toothing forces and on account of the integration of the inner ring with the neutral device.

As a result of the fact that the valve stem itself comes into question as a toothing partner for the outer helical toothing, the valve rotating device according to the invention can moreover be implemented with a smaller number of components than in the case of the known valve rotating device.

In the case of large marine drives, especially with two-stroke diesel engines, it may be expedient for the first drive element to be formed by a hydraulic cylinder for controlling the opening lift of the valve spindle and for the second drive element to be formed by the compressed-air piston of a compressed-air cylinder for controlling the closing movement of the valve spindle.

For a four-stroke engine, wherein the upper drive element is formed by a valve cam for controlling the opening lift of the valve spindle, the lower drive element advantageously comprises a spring element for controlling the closing movement of the valve spindle.

To advantage, the outer helical toothing is provided on a portion of the valve stem between its guide in the valve housing and the end of the stem.

The outer helical toothing can be formed on a hollow-cylindrical sleeve, which is secured on a corresponding seat of the valve stem by being shrunk on with its inner periphery. The hollow-cylindrical sleeve can be closed on the front face at one end by the fact that it engages over the end of the valve stem in a cap-like manner.

Alternatively, the outer helical toothing can also be formed directly on the valve stem, so that a hollow-cylindrical sleeve as a separate component can be avoided.

The length of the outer helical toothing corresponds in its axial extension at least to the length of the opening lift of the valve plus the minimum engagement length of the helical toothing.

In contrast, a toothing portion which is much shorter in the axial direction suffices for the inner helical toothing.

Such an inner helical toothing can be produced on a relatively short inner ring in a straightforward manner by machining down. To advantage, the inner ring is mounted at its outer periphery on an axial ball-bearing inside a recess of a housing cover of the valve housing and comprises at its outer periphery a ratchet toothing which interacts with the ratchet elements of the neutral device.

To advantage, the neutral device comprises an annular disc, in the inner periphery whereof the ratchet elements are in each case mounted in a spring-loaded manner, the annular disc being secured with the axial ball-bearing on the inside to the housing cover.

Examples of embodiment of the invention are explained below with the aid of the drawing; in the figures:

Fig. 1 shows a partial axial cross-section through a valve housing for a two-stroke diesel engine with a valve rotating device,

Fig. 2 shows a section of fig. 1 in an enlarged representation,

Fig. 3 shows a cross-section through III-III of fig. 1,

Fig. 4 shows an axial cross-section through a valve housing for a four-stroke diesel engine,

- Fig. 5 shows an enlarged section of fig. 4,
- Fig. 6 shows a cross-section through VI-VI of fig. 5,
- Fig. 7 shows an axial longitudinal cross-section through another embodiment of a valve housing for a four-stroke diesel engine,
- Fig. 8 shows a section of fig. 7 in an enlarged representation,
- Fig. 9 shows a cross-section through IX-IX of fig. 8,
- Fig. 10 shows an axial longitudinal cross-section through a further embodiment of a valve housing for a four-stroke diesel engine,
- Fig. 11 shows an enlarged section of fig. 10 and
- Fig. 12 shows a cross-section through XII-XII of fig. 11.

Figure 1 shows an axial cross-section through a section of a valve housing of a two-stroke diesel engine for a marine drive in the region of the upper end of valve spindle 1 in its closed position. A housing cover 4 is placed on valve housing 2. Valve stem 3 is mounted in a sliding bearing (not represented) in the valve housing.

Provided on valve housing 2 is a compressed-air cylinder 5, in which a compressed-air piston 18 is guided. Valve stem 3 is accommodated in a central bore of compressed-air piston 18 such as to be torsion-resistant by means of a clamping part in the form of a conical sleeve 48 and axially keyed by means of a bulge 55 of conical sleeve 48, said bulge protruding inwards. Bulge 55 engages in an annular groove of valve stem 3 of valve spindle 1. Conical sleeve 48 is

axially secured by means of a lock ring 44 by the screwed coupling thereof with compressed-air piston 18.

A valve stem end 24 turned down with respect to remaining valve stem 3 has a hollow-cylindrical sleeve 23 pressed thereon. Lower cylindrical end 12 thereof sits gap-free on an annular stop face 46, which is formed by a recess of valve stem 3 on the end face.

The upper end of sleeve 23 is closed apart from an assembly bore 47. End face 49 thereof abuts, in the shown closed position of valve spindle 1, against a pressure plate 70 accommodated in hydraulic piston 21 of hydraulic cylinder 6, said pressure plate interacting with a guide sleeve 52 via a helical spring 54. Guide sleeve 52 is under the pressure of the hydraulic oil from oil pressure line 22. During the opening lift of valve spindle 1, the latter, when acted upon by hydraulic piston 21, is conveyed downwards together with compressed-air piston 18 until the oil pressure in cylinder chamber 26 corresponds to the pressure in compressed-air cylinder 5. The closing of valve spindle 1 is then effected by the compressed air in cylinder chamber 25 of compressed-air cylinder 5, compressed-air cylinder 18 being conveyed upwards again together with valve spindle 1 until it reaches the uppermost position represented in figure 1.

A neutral device described in greater detail in figures 2 to and 3 interacts with a ratchet toothing 57 at the outer periphery of an inner ring 13, which comprises an inner helical toothing 14 at its inner periphery. Inner helical toothing 14 interacts with an outer helical toothing 16 at the outer periphery of sleeve 23.

Whereas inner helical toothing 14 corresponds in the axial direction at least to its minimum engagement length with

outer helical toothing 16, the latter further extends at least by the length of the opening lift of valve spindle 1.

The neutral device is devised in such a way that it rotates valve spindle 1 either during the closing movement or the opening movement thereof and releases the rotation of inner ring 13 in the respective counter direction. In the case of a movement of valve spindle 1, when inner ring 13 is blocked, in the direction of the closing movement of the valve spindle, i.e. upwards according to figure 1, a rotation of the valve spindle corresponding to the helical toothing results and thus a grinding-in of the valve seats when closing of the valve occurs; in the reverse case, this grinding effect occurs at the moment of the opening of valve spindle 1 until the latter has left the valve seat. In terms of design, the two cases differ solely in the selection of the blocking direction of ratchet toothing 57 against ratchet elements 41 acting thereon, which are mounted in an annular disc 38 of the neutral device, said annular disc being rigidly fixed in the housing.

The lubricating oil supply for the helical toothing and the neutral device is provided by means of a system of lubricating oil bores 34, 53 in housing cover 4. The lubricating oil flowing away passes via an annular space 27 between housing cover 4 and compressed-air cylinder 5 through a discharge bore 28 in the cylinder wall of valve housing cover 4 to the exterior.

Figure 2 shows, as an enlarged section from figure 1, the lower end of sleeve 23, which sits on annular face 46 of valve spindle 1. At its outer peripheral face, sleeve 23 comprises an outer helical toothing 16, which interacts with inner helical toothing 14 of inner ring 13. Inner ring 13 comprises a central recess 56, which ensures that the lubricating oil can supply unhindered the toothing region of the helical toothing.

Inner ring 13 comprises at its outer periphery a ratchet toothing 57, the teeth whereof interact with ratchet elements 41, eight whereof are mounted distributed over the periphery in an annular disc 38 of the neutral device (see fig. 3). Each ratchet element 41 is held with its locking pawl in the blocking position by a pressure ram 43 loaded by a ratchet spring 42. This blocking position prevents rotation of inner ring 13 with respect to annular disc 38 in a direction of rotation according to arrow P1, with the consequence that the valve spindle is rotated according to arrow P2 corresponding to the helical toothing of the counter direction. On the other hand, however, a rotation of inner ring 13 is possible in the opposite direction, i.e. according to arrow P2 against the spring action of pressure ram 43 of ratchet elements 41, i.e. the neutral device releases the rotation of inner ring 13, a rotation of the valve spindle during its lift movement not occurring.

If it thereby involves a lift movement downwards in the opening direction of the valve spindle driven by hydraulic piston 21, the helical toothing causes a rotation of inner ring 13 according to arrow P2, while the valve spindle moves linearly downwards, so that the valve disc moves away from the valve seat in the opening direction.

If, conversely, valve spindle 1 is moved upwards in the direction of the closing position after the depressurisation of the hydraulic cylinder and under the action of compressed-air piston 18, the helical toothing causes a rotation of valve spindle 1 directed against the direction of rotation according to arrow P2, since a rotation of inner ring 13 is blocked by the neutral device, i.e. the valve spindle rotates opposite to arrow P1 in the direction according to arrow P3. At the moment when the valve seat is reached, this rotation causes a grinding-in

of the seating region of the valve disc against the valve seat on the housing side, the seating areas being mutually ground off in a desired manner. The mutual valve seating areas forming the valve seat are thus smoothed, so that a valve seat with a large surface contact is achieved.

If, on the other hand, a rotation of the valve spindle is caused not during the closing of the valve, but in the opposite direction during the opening of the valve, this can easily be brought about without changing the helical toothing by the fact that a neutral device with opposite directions of action is used.

Figures 4 to 6 show a modified embodiment of a valve housing 2 with a housing cover 4.

In contrast with the embodiment according to figures 1 to 3, the upper drive element is formed, instead of by a hydraulic cylinder, by a valve cam (not shown) for controlling the opening lift of valve spindle 1 and the lower drive element is formed, instead of by a compressed-air cylinder, by a spring element comprising helical valve springs 58, which are used under compressive pretensioning between the upper side of valve housing 2 and the lower side of a support ring 59 secured at the upper end of valve stem 3. In order not to hinder a rotation of valve spindle 1, a ball-bearing 60 is arranged between support ring 59 and an end disc 61 of valve springs 58.

The lower portion of housing cover 4 is represented enlarged in figure 5. Outer helical toothing 16 is formed directly on valve stem 3, e.g. by means of a machining-down procedure. Inner ring 13 with inner helical toothing 14 sits on an axial ball-bearing 62, which on the other side is supported against a guide bush 63 of valve housing 2. Ratchet elements 41 of the neutral device sit in

corresponding recesses of housing cover 4, as shown in figure 6.

As represented in figure 6, inner ring 13 carries ratchet toothing 57 at its outer periphery and inner helical toothing 14 at its inner periphery. Outer helical toothing 16 is cut directly on stem 3 of the valve spindle.

Figures 7 to 9 represent a further embodiment, which is very similar to that according to figures 4 to 6. There is however a difference in that axial ball-bearing 62 for bearing inner ring 13 sits above the neutral device and is supported on upper end face 64 of guide bush 63. As for the rest, the corresponding reference numbers denote the same objects as in the embodiment according to figures 4 to 6.

The neutral device shown in figure 9 corresponds to the view through cross-sectional plane IX-IX of figure 8, i.e. the directions of rotation for blocking (arrow P1) and ratcheting (arrow P2) run in opposite directions. This results from the fact that, in the embodiment according to figure 5, cross-section VI-VI is represented in figure 6 in plan view, whilst in figure 8 cross-section IX-IX of figure 9 is represented in the view from beneath.

Figure 9 also represents the cross-sectional course represented in figure 7 through cross-sectional plane VII-VII broken off at an angle. Figures 1 and 4 also show cross-sectional planes similarly broken off at an angle; only according to figure 10 does the cross-sectional plane run unbroken, as can be seen from a comparison of figures 11 and 12.

The embodiment according to figures 10 to 12 differs from the two embodiments according to figures 4 to 9, which also each show valve controls for four-stroke diesel engines actuated by cams and valve springs, essentially in that the

neutral device is housed at the upper end of housing cover 4. As in the case of the variant according to figures 7 to 9, axial ball-bearing 62 is arranged above the neutral device. The supporting of axial ball-bearing 62, however, takes place - unlike the two previously described four-stroke variants - against housing cover 4. In the present variant, components comparable with all the other variants are also denoted by the same reference numbers.

Figure 11 shows the distinctive feature that seating ring 59 is extended downwards by a toothed sleeve 64. Toothed sleeve 64 carries outer helical toothing 16 at its outer periphery; the transmission of the turning moment from sleeve 64 to valve stem 3 takes place via conical sleeve 48.

A cylindrical sleeve 65 is also pulled on over housing cover 4, said cylindrical sleeve terminating at the top with an inner flange 66, in order to fix axial ball-bearing 62 therewith, and comprising at the bottom an outer flange 67 for a screwed connection with housing cover 4.

CLAIMS

1. A valve rotating device for exhaust valves of internal combustion engines, in particular marine diesel engines, said device being arranged on a valve housing for the valve spindle (1) beside a first drive element for opening the valve and a second drive element for closing the valve, with a neutral device which rotates the valve spindle (1) during the closing movement or the opening movement thereof and releases the rotation in the counter direction and, in order to transmit the rotational movement to the valve spindle, an outer helical toothing (16) is provided on the valve stem (3) of the valve spindle (1) and the associated inner helical toothing (14) is provided on an inner ring (13) supported by means of the neutral device, wherein the outer helical toothing (16) corresponds, in the axial direction, at least to the length of the opening lift of the valve spindle (1) plus the minimum engagement length of the helical toothing,

characterised in that

the inner ring (13) is mounted on an axial ball-bearing (62) inside a recess of a housing cover (4) of the valve housing (2) and comprises, at its outer periphery, a ratchet toothing (57) which interacts with ratchet elements (41) of the neutral device.

2. The valve rotating device according to claim 1, characterised in that an annular disc (38) of the neutral device is provided, in the inner periphery whereof the ratchet elements (41) are in each case mounted in a spring-loaded manner, and the annular disc (38) is secured with the axial ball-bearing (62) to the housing cover (4).

3. The valve rotating device according to claim 1, characterised in that the outer helical toothing (16) is formed directly on the valve stem (3).
4. The valve rotating device according to claim 1, characterised in that the outer helical toothing (16) is formed on a hollow-cylindrical sleeve (23), which is secured on a corresponding seat of the valve stem (3) by being shrunk on with its inner periphery.