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(54) **VALVE LIFT ADJUSTMENT ARRANGEMENT FOR A MECHANICALLY CONTROLLABLE VALVE DRIVE ARRANGEMENT, AND METHOD FOR ALIGNING AN INTERMEDIATE LEVER ARRANGEMENT**

(71) Applicant: **KOLBENSCHMIDT PIERBURG INNOVATIONS GMBH**, NECKARSULM (DE)

(72) Inventors: **Rudolf Flierl**, Hirschau (DE); **Frederic Lauer**, Oberriexingen (DE)

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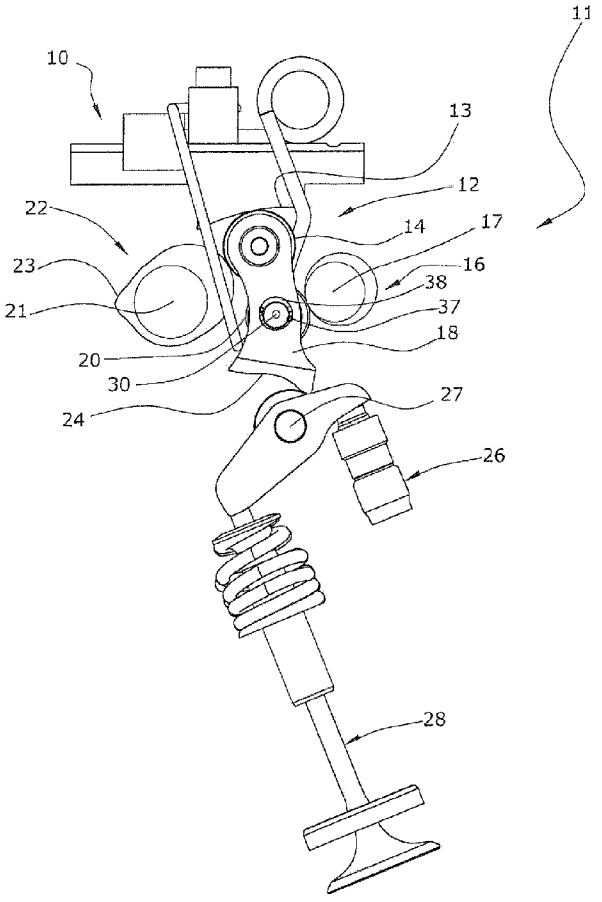
(57) **ABSTRACT**

A valve lift adjustment arrangement for a mechanically-controllable valve drive arrangement includes a bearing shaft, a first roller, a second roller arranged on the bearing shaft, a camshaft arrangement, a valve lift adjustment device comprising a rotatable eccentric shaft, an intermediate lever arrangement, and a device. The intermediate lever arrangement comprises an intermediate lever with a working curve. The intermediate lever is mounted via the first roller to be movable in a slotted-guide track and to be operatively connected to the camshaft arrangement and to the valve lift adjustment device. The device is configured so that the second roller is eccentrically mounted. The device comprises a tool engagement point which aligns the second roller and thereby the intermediate lever arrangement. The camshaft arrangement acts, via the first roller, on the intermediate lever arrangement. The rotatable eccentric shaft is acts, via the second roller, on the intermediate lever arrangement.



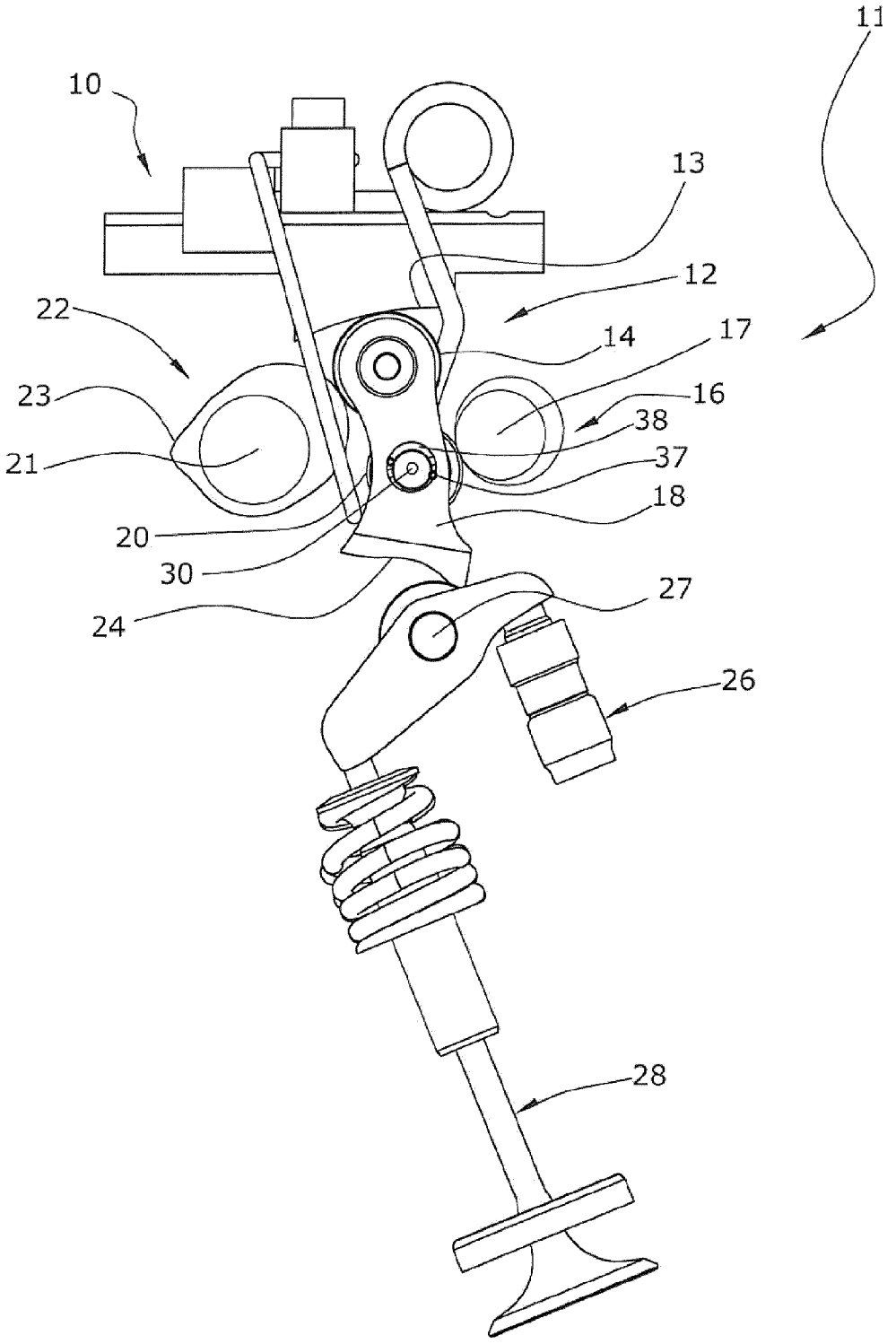


Fig. 1

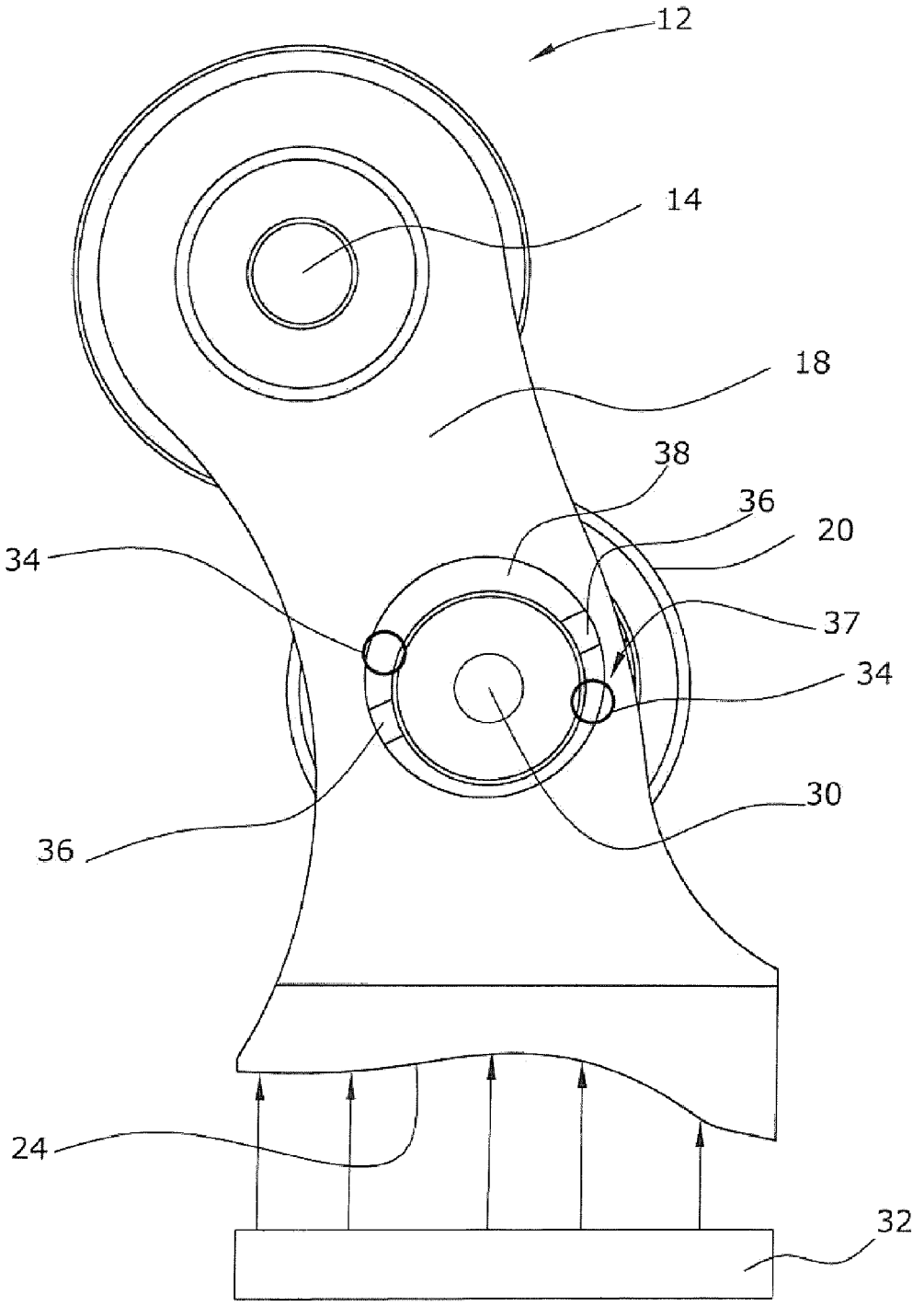


Fig. 2

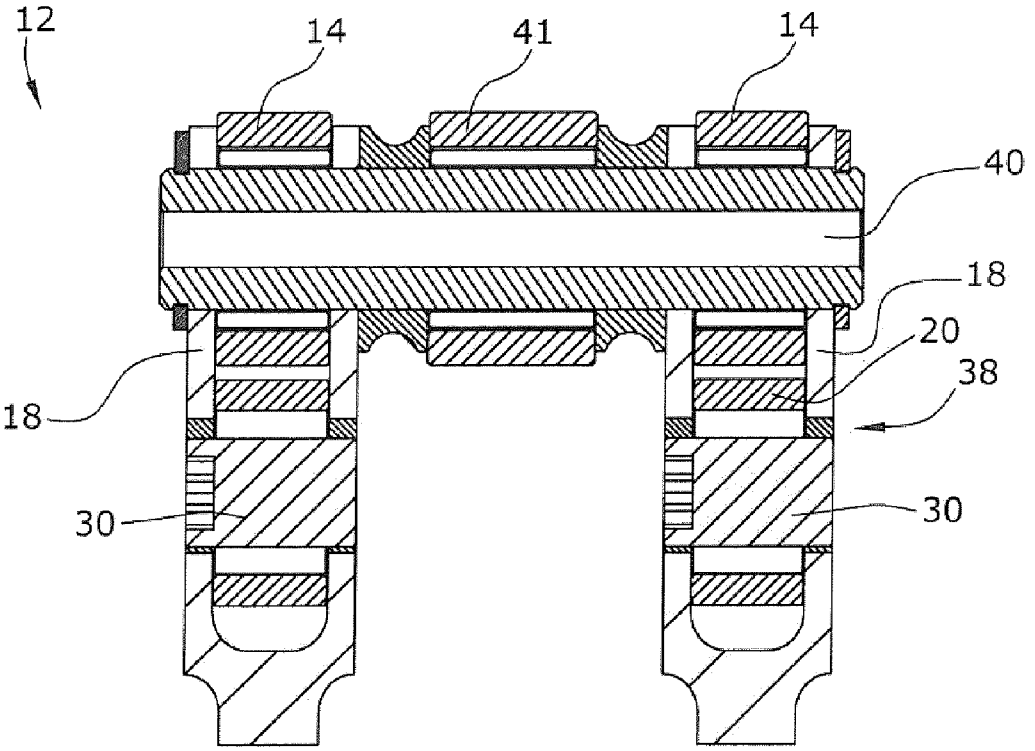


Fig. 3

VALVE LIFT ADJUSTMENT ARRANGEMENT FOR A MECHANICALLY CONTROLLABLE VALVE DRIVE ARRANGEMENT, AND METHOD FOR ALIGNING AN INTERMEDIATE LEVER ARRANGEMENT

CROSS REFERENCE TO PRIOR APPLICATIONS

[0001] This application is a U.S. National Phase application under 35 U.S.C. §371 of International Application No. PCT/EP2012/074306, filed on Dec. 4, 2012 and which claims benefit to German Patent Application No. 10 2012 001 633.6, filed on Jan. 30, 2012. The International Application was published in German on Aug. 8, 2013 as WO 2013/113429 A1 under PCT Article 21(2).

FIELD

[0002] The present invention relates to a valve lift adjustment arrangement for a mechanically-controllable valve drive arrangement of an internal combustion engine comprising at least one intermediate lever arrangement, wherein the intermediate lever arrangement has at least one intermediate lever with a working curve, the lever being movably mounted, at least by way of a first roller, in a slotted-guide track and being operatively connected to a camshaft arrangement and to a valve lift adjustment device, wherein the camshaft arrangement acts, by way of a roller, on the intermediate lever arrangement, and wherein the valve lift adjustment device has a rotatable eccentric shaft which acts, by way of a second roller, on the intermediate lever arrangement.

[0003] The present invention further relates to a method for aligning an intermediate lever arrangement of the valve lift adjustment arrangement, as well as to a method for assembling a valve lift adjustment arrangement, i.e., an intermediate lever arrangement, on a pivot lever arrangement.

BACKGROUND

[0004] Such arrangements have previously been described in the field of internal combustion engines. They specifically serve to adjust the combustion process to the respective load requirements via valve lift height, and thus the filling degree of the cylinders of the internal combustion engine, and to accordingly provide a combustion that is as efficient and thus also as low in emission as possible.

[0005] DE 10 2006 033 559 A1 and DE 10 2007 022 266 A1, for example, describe valve drive arrangements with an adjustable lift of a respective gas exchange valve. For this purpose, both valve drive arrangements provide an intermediate lever arrangement which is connected to a camshaft in order to periodically move the gas exchange valve and which comprises an engagement member via which the maximum or minimum possible lift can be adjusted. All these valve drive arrangements have the disadvantage, however, that after manufacture and subsequent assembly, the valve drive arrangements do not have the exactly-desired valve lift due to manufacturing tolerances. If an exactly-preset valve lift is required for all valves and cylinders, this can result in a dissatisfactory operating performance of the engine, particularly for small valve lifts. Reasons therefor can be found in the structure and the cooperation of the valve lift adjustment arrangement per se, as well as in the final assembly of the valve lift adjustment arrangement and the pivot lever arrangement.

[0006] An overall structure of an adjustable valve drive arrangement is on the whole obtained that can be manufactured only with great effort and which is therefore expensive.

SUMMARY

[0007] An aspect of the present invention was provide a valve lift adjustment arrangement for a mechanically-controllable valve drive arrangement, a method for aligning an intermediate lever arrangement of the valve lift adjustment arrangement, and a method for the assembly of a valve lift adjustment arrangement which avoids the above-described disadvantages.

[0008] In an embodiment, the present invention provides a valve lift adjustment arrangement for a mechanically-controllable valve drive arrangement which includes a bearing shaft, a first roller, a second roller arranged on the bearing shaft, a camshaft arrangement, a valve lift adjustment device comprising a rotatable eccentric shaft, at least one intermediate lever arrangement, and a device. The at least one intermediate lever arrangement comprises at least one intermediate lever comprising a working curve. The at least one intermediate lever is mounted, at least via the first roller, so as to be movable in a slotted-guide track and to be operatively connected to the camshaft arrangement and to the valve lift adjustment device. The device is configured so that the second roller is eccentrically mounted. The device comprises a tool engagement point configured to align the second roller and thereby the at least one intermediate lever arrangement so that a circumferential point of the second roller, in the case of a rotation through an angle α, describes an arc shape which deviates from a circular arc. The camshaft arrangement is configured to act, via the first roller, on the at least one intermediate lever arrangement. The rotatable eccentric shaft is configured to act, via the second roller, on the at least one intermediate lever arrangement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present invention is described in greater detail below on the basis of embodiments and of the drawings in which:

[0010] FIG. **1** shows an embodiment of the device of the valve lift adjustment arrangement according to the present invention;

[0011] FIG. **2** shows a perspective view of an embodiment of a distance measuring device according to the present invention; and

[0012] FIG. **3** shows a sectional view of an intermediate lever arrangement.

DETAILED DESCRIPTION

[0013] In an embodiment of the present invention, the second roller, which acts on the intermediate lever arrangement through the valve lift adjustment arrangement, is eccentrically supported on a bearing shaft by way of a means. A tool engagement point is further provided for a correct alignment of the second roller and thus of the intermediate lever arrangement. When rotated through an angle α, a circumferential point of the second roller thereby describes an arc shape deviating from a circular arc. The present configuration of such a valve lift adjustment arrangement makes it possible to adjust a valve drive arrangement in the pre-assembled state in a simple manner with regard to the correct alignment of the intermediate lever arrangement on the pivot lever arrange-

ment. Manufacturing tolerances or flaws can thus already be recognized before the final assembly and the first operation, and can thereby possibly be compensated or remedied. The simple alignment of the means fastened eccentrically on the bearing shaft further provides a simple form of aligning in the pre-assembled state.

[0014] In an embodiment of the present invention, the means can, for example, comprise an eccentrically-supported bearing shaft. A particularly simple and economic valve lift adjustment arrangement is thereby provided.

[0015] In an embodiment of the present invention, the valve lift adjustment arrangement can, for example, provide a sleeve. This sleeve is provided on both sides of the bearing shaft and provides the eccentric arrangement of the bearing shaft. This arrangement is an economic variant. The optimal alignment of the sleeve is performed during the assembly using a special tool. The sleeve has a tool engagement point for an optimal alignment.

[0016] The means can, for example, be provided in the form of a step. Such a step is provided on both sides of the bearing shaft so that each is eccentric with respect to the bearing shaft, while being arranged within the intermediate lever. The steps are different in size so that an assembly can be made from the side, whereas the roller is inserted into the intermediate lever from the front.

[0017] In an embodiment of the present invention, the tool engagement point can, for example, be configured as a polygonal connection geometry through the sleeve for the eccentric adjustment of the second roller on the bearing shaft. The tool engagement point can, for example, be configured so that the sleeve has a polygonal geometry for engagement with the tool. This embodiment offers the advantage that the engagement member can be mass produced in a simple manner. It can, for example, be advantageous under aspects of assembly and production technology for the engagement member to be integrally formed.

[0018] The valve lift adjustment arrangement has reference marks to provide a clear orientation of the valve adjustment arrangement with respect to the pivot lever arrangement.

[0019] These reference marks on the intermediate lever arrangement serve to cooperate with corresponding reference marks of the pivot lever arrangement during a final assembly and thereby provide an optimum alignment.

[0020] The present invention further provides a method for aligning an intermediate lever arrangement in a valve lift adjustment arrangement, wherein a distance measuring device with a control unit is provided outside the valve lift adjustment arrangement. The intermediate lever is moved relative to the distance measuring device and the working curve is thus traveled along. The measured values obtained by means of the distance measuring device are compared with reference values in the control unit. If the measured values detected by the distance measuring device deviate from the reference values, an adjustment of the intermediate lever arrangement is made via the tool engagement point of the sleeve by turning the means or the second roller on the bearing shaft.

[0021] In an embodiment, the present invention provides a fixation means so that, after adjustment, the position of the second roller is fixed by means of the fixation means.

[0022] Fixation means that act in a form fitting and/or a force locking manner can be advantageous. These fixation means may be realized, for example, in the form of bolts and/or grooves. It can, for example, be advantageous under aspects of assembly and manufacturing technology if the connection is detachable in the event of a component failure and if the defective component can be replaced in a simple manner.

[0023] In an embodiment of the present invention, the fixation means can, for example, be a bonding means, for example, welding or soldering points. Bonding fixation means are advantageous because they represent a simple, secure and stable fixation.

[0024] A conventionally used distance measuring devices can be used to detect the distance between the contour of the working curve of the intermediate lever and the reference values of the pivot lever arrangement. The distance measuring device can, for example, be provided in the form of a capacitive distance sensor, an inductive distance sensor, a measuring sensor with a glass scale, a measuring sensor with a resistance potentiometer, a measuring sensor with inductive detection, a measuring sensor with LVDT (position sensor) detection, or a measuring device based on laser interferometry. Such measuring methods have proven to be extraordinarily useful in practice because of their precision.

[0025] In an embodiment of the method of the present invention for the assembly of the valve lift adjustment arrangement, i.e., of an intermediate lever arrangement on a pivot lever arrangement, a match of the reference marks of the intermediate lever arrangement with the reference marks of the pivot lever arrangement is provided. The final assembly of the intermediate lever arrangement and the pivot lever arrangement is performed after a match of the reference marks has been achieved.

[0026] The following is a detailed explanation of the present invention with reference to the drawings.

[0027] The following mechanical valve drive is generally known by the name "Univalve". Reference is made to EP 1 618 293 B1 where the structure and the functioning of such a valve drive is described.

[0028] An embodiment of a valve lift adjustment arrangement **10** for a mechanically controllable valve drive arrangement **11** is shown in FIG. **1**. The valve lift adjustment arrangement **10** for a piston stroke engine substantially comprises an intermediate lever arrangement **12** and a pivot lever arrangement/cam follower arrangement **26**. The intermediate lever arrangement **12** comprises an intermediate lever **18** which is slidably supported in a slotted guide track **13** that is stationarily arranged in a cylinder head (not illustrated herein). The shape of the slotted-guide track is defined by a circular arc extending around an axial center of a third roller **27**. A camshaft arrangement **22** is provided in the region of the first roller **14**. The camshaft arrangement **22** comprises a camshaft **21** which can be displaced directly or indirectly by a first cam **23**, thereby driving a gas exchange valve **28**. Using the camshaft **21**, the gas exchange valve **28** is opened and closed cyclically if an operative connection exists between the working curve **24** and the third roller **27** of the cam follower arrangement **26**. Alternative embodiments of intermediate levers are of course also covered by the present invention. Two intermediate levers can thus be arranged on one shaft with one roller, the roller then being guided in a slotted-guide track. Reference is thereby made to DE 10 140 635 A1.

[0029] A valve lift adjustment arrangement **16** with a second roller **20** is arranged coaxially to the first roller **14** and approximately centrally between the slotted-guide track **13** and the working curve **24**. The valve lift adjustment arrangement **16** is used to adjust the absolute stroke of the gas

exchange valve **28** and the opening times of the valve. The valve lift adjustment arrangement **16** comprises an eccentric shaft **17** therefor.

[0030] At the end opposite the slotted-guide track **13**, the intermediate lever **18** comprises the working curve **24** with a zero stroke section, an adjustment stroke section, and a valve lift standstill section.

[0031] The intermediate lever **18** is furthermore in an operative connection with a cam follower arrangement **26** via the third roller **27**. Various valve lift positions of the gas exchange valve **28** can be controlled via this operative connection. The cam follower arrangement **26** is supported on a tolerance compensation element, for example, a hydraulic valve tolerance compensation element, and cooperates with the gas exchange valve **28**. The gas exchange valve **28** and the valve tolerance compensation element are mounted in the cylinder head (not illustrated herein).

[0032] FIG. **2** shows a detail of the valve lift adjustment arrangement **10**. In FIG. **2**, the intermediate lever arrangement **12** is illustrated with the distance measuring device **32** of the present invention. The distance measuring device **32** is arranged below the working curve **24** since the working curve **24** is to be measured by the distance measuring device **32**.

[0033] In the shown embodiment, the tool engagement point **36** is integrated in the sleeve **38** and has two slot-shaped recesses. By turning the sleeve **38** through an operation of the tool engagement point **36**, the bearing shaft can be adjusted to a defined rotational position in which it can thereafter be fixed. By simply turning the eccentrically supported bearing shaft **30** during pre-assembly, it is now possible to adjust the valve lift of the associated gas exchange valve **28**, and in this way, it is possible to detect manufacturing inaccuracies and to perform a correct alignment of the intermediate lever **18**. The shown embodiment provides for a maximum in flexibility during the adjustment of the valve lift height and the position of the intermediate lever **18**. The position is fixed by a fixation means **37**, a welding point **34**, in the region of the second roller **20** following the correct alignment of the intermediate lever **18**.

[0034] FIG. **3** illustrates an intermediate lever arrangement **12** with two intermediate levers **18** arranged on a common connecting shaft **40**. On the side opposite the working curve **24**, first rollers **14** are arranged by which the intermediate lever arrangement **12** is operatively connected with the camshaft **21**. A fourth roller **41** is here arranged on the connecting shaft **40** between the first rollers **14**, which roller serves as a guide roller and rolls in the slotted guide **13** (see FIG. **1**). Reference is made to DE 10 140 635 A1 regarding the function and the operation of such a transmission arrangement. It is noted that an intermediate lever arrangement **12** can have one, as well as two, intermediate levers, wherein, in the embodiment having one intermediate lever, a roller situated opposite the working curve **24** is operatively connected with the camshaft **21** and also provides the guiding in the slotted guide **13**.

[0035] An embodiment of the bearing of the bearing shaft **30** of an intermediate lever **18** is shown wherein the support is achieved with sleeves **38** arranged on both sides of the bearing shaft **30**. An optimum alignment of the sleeves **38** is made by means of a corresponding tool. The sleeves are arranged on the right and on the left of the bearing shaft **30**, respectively.

[0036] An embodiment differing therefrom, but not illustrated in detail, is a step **39** provided on the right and the left eccentrically with respect to the bearing shaft **30**. This step **39** is supported in the intermediate lever **18**. The eccentrically arranged steps **39** may be different in size so that an assembly from the side is possible, whereas the roller **20** can be inserted into the intermediate lever **18** from the front.

[0037] The present invention is not limited to embodiments described herein; reference should be had to the appended claims.

What is claimed is:

1-12. (canceled)

13. A valve lift adjustment arrangement for a mechanically-controllable valve drive arrangement, the valve lift adjustment arrangement comprising:

a bearing shaft;

a first roller;

a second roller arranged on the bearing shaft;

a camshaft arrangement;

a valve lift adjustment device comprising a rotatable eccentric shaft;

at least one intermediate lever arrangement comprising at least one intermediate lever comprising a working curve, the at least one intermediate lever being mounted, at least via the first roller, so as to be movable in a slotted-guide track and to be operatively connected to the camshaft arrangement and to the valve lift adjustment device; and

a device configured so that the second roller is eccentrically-mounted, the device comprising a tool engagement point configured to align the second roller and thereby the at least one intermediate lever arrangement so that a circumferential point of the second roller, in the case of a rotation through an angle α, describes an arc shape which deviates from a circular arc,

wherein,

the camshaft arrangement is configured to act, via the first roller, on the at least one intermediate lever arrangement, and

the rotatable eccentric shaft is configured to act, via the second roller, on the at least one intermediate lever arrangement.

14. The valve lift adjustment arrangement as recited in claim **13**, wherein the device further comprises an eccentrically-supported bearing shaft.

15. The valve lift adjustment arrangement as recited in claim **14**, further comprising a sleeve arranged on both sides of the bearing shaft so as to provide an eccentric arrangement thereof.

16. The valve lift adjustment arrangement as recited in claim **14**, further comprising a step arranged on both sides of the bearing shaft so as to be eccentric with respect thereto.

17. The valve lift adjustment arrangement as recited in claim **13**, wherein the tool engagement point further comprises a polygonal connection geometry.

18. The valve lift adjustment arrangement as recited in claim **13**, wherein the valve lift adjustment arrangement comprises reference marks configured to provide an orientation with respect to a pivot lever arrangement.

19. A method for aligning an intermediate lever arrangement of a valve lift adjustment arrangement as recited in claim **13**, the method comprising:

providing a distance measuring device comprising a control unit comprising reference marks outside the valve lift adjustment arrangement;

moving the at least one intermediate lever relative to the distance measuring device so as to travel along the working curve so that the distance measuring device obtains a measured value;

comparing the measured value with the reference values in the control unit so as to determine if the measured value deviates from the reference values; and

adjusting the intermediate lever arrangement via the tool engagement point by turning the second roller if the measured value deviates from the reference values.

20. The method as recited in claim **19**, wherein, after the adjusting, the method further comprises fixing a position of the second roller using a fixation.

21. The method as recited in claim **20**, wherein the fixation is formed by at least one of a form-fitting means/device and a force-locking means/device.

22. The method as recited in claim **21**, wherein the at least one of a form-fitting means/device and a force-locking means/device is at least one of a bolt and a groove.

23. The method as recited in claim **20**, wherein the fixation is a bond.

24. The method as recited in claim **23**, wherein the bond is at least one of a welding point or a soldering point.

25. The method as recited in claim **19**, wherein the distance measuring device is:

a capacitive distance sensor,

an inductive distance sensor,

a measuring sensor comprising a glass scale,

a measuring sensor comprising a resistance potentiometer,

a measuring sensor comprising an inductive detection,

a measuring sensor comprising an LVDT (position sensor) detection, or

a measuring device based on laser interferometry.

26. A method for an assembly of a valve lift adjustment arrangement as recited in claim **18** to a pivot lever arrangement, the method comprising:

providing a valve lift adjusting arrangement as recited in claim **18**;

providing a pivot lever arrangement comprising reference marks; and

matching the reference marks of the intermediate lever arrangement with the reference marks of the pivot lever arrangement prior to a final assembly.

* * * * *