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- (54) **Készülék összekapcsolt bütyköstengelyek relatív elfordulási szöghelyzetének állítására**

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.

Device for Adjusting the Relative Rotational Angular Position of Nested Cam Shafts

The invention relates to a device for adjusting the relative rotational angular position of nested cam shafts in a combustion engine and to a cam shaft phase setter which can be assembled, as an assembly unit for adjusting the relative rotational angular position, on an axial end of a shaft arrangement which comprises the cam shafts, or which is already assembled when the device in accordance with the invention is formed.

A phase setter for adjusting the relative rotational angular position of nested cam shafts is already known from US 1,527,456 which concerns a phase setter which has an axial design and is an integrated constituent part of the shaft arrangement. A stator of the phase setter also simultaneously serves to rotationally mount the mutually nested cam shafts.

US 7,469,670 B2 discloses a vane-cell phase setter which is assembled on nested cam shafts. The phase setter comprises a stator, which is non-rotationally connected to the outer shaft, and a rotor which is non-rotationally connected to the inner shaft. The stator is also non-rotationally connected to a drive wheel of a traction drive via which the stator is driven by the crankshaft of the combustion engine. When rotary-driven, the stator slaves the rotor. The rotor can however be pivoted hydraulically relative to the stator about their common rotational axis. The rotor is fastened to the inner shaft by means of a central, axially extending screw. Assembling the phase setter requires a plurality of process steps. The stator is screwed onto the outer shaft, and the rotor is fastened to the inner shaft in a force fit by means of the central screw. Between these two steps, the drive wheel is adjusted in terms of its rotational angular position relative to the stator and is fixedly connected to the stator in the adjusted rotational angular position by means of a plurality of screws. Only then is the rotor fixed on the inner shaft by tightening the central screw. In one variant, the rotor is screwed onto the outer shaft, and the stator is fixedly fastened to the inner shaft in a force fit by means of a central connecting screw once the rotational angular position of the drive wheel has been adjusted.

WO 2006/081789 A1 likewise discloses an arrangement comprising nested cam shafts which can be rotated relative to each other by means of an assembled phase setter. The stator and rotor of the phase setter are fixedly connected to the respectively assigned cam shaft and abut

against the front-facing side of the respectively assigned cam shaft, thus sealing off hydraulic channels which lead through the front-facing ends.

EP 0 686 754 B1 describes nested cam shafts comprising an axial-adjustment phase setter. The phase setter comprises a stator, which can be rotary-driven by the crankshaft, and a rotor which is in a toothed engagement -- comprising a helical toothed gearing -- with the stator and which can be rotated relative to the stator in said toothed engagement. The rotor is connected to one of the cam shafts in a prismatic joint, such that it is secured against rotating but can be axially moved. The stator together with a drive wheel is fixedly connected to the other cam shaft at a plurality of points using screws in a connecting flange. For setting the rotational angular position in the connecting flange, the stator is provided with slot-shaped openings which extend in the circumferential direction and through which the screws extend. The stator forms a cup which is open towards the cam shafts on the front-facing side and in which the rotor can be axially moved back and forth when the helical toothed gearings are in engagement. For adjusting, the rotor is charged with hydraulic pressure on a front-facing side which faces away from the cam shafts. The hydraulic pressure is countered by a restoring spring which is supported on one of the cam shafts and on the rotor. During assembly, the restoring spring has to be arranged between the rotor and the cam shaft, and biased as it is assembled, before the rotor is pushed on and the stator is fastened. In order to fluidically seal the cup formed by the stator, a flange component is attached to the front-facing end of the assigned cam shaft.

DE 10 2009 041 873A1 relates to a cam shaft phase adjuster for the inner cam shaft in a concentric cam shaft assembly. The phase adjuster comprises a rotor and a stator. The rotor is connected to the inner cam shaft via an intermediate screw assembly. The screw assembly comprises a central bore in which a valve assembly is located in order to control a rotation of the rotor relative to the stator. A valve drive pinion is arranged on the stator and connected to the crankshaft of the internal combustion engine via a valve drive chain.

GB 2 433 974 A relates to fastening a cam shaft to a machine using a cam shaft phaser. The cam shaft consists of an inner shaft and a sleeve which surrounds the shaft. The inner shaft is connected to a first set of cams; a second set of cams is formed on the outer sleeve. The inner shaft and the outer sleeve can be rotated relative to each other. The phaser comprises a pinion which is driven by the crankshaft.

DE 10 2008 019 746 A relates to a device for variably setting the control times of gas exchange valves in a combustion engine, comprising a drive element which is in a drive connection with the crankshaft via a traction drive or toothed wheel drive.

GB 2 467 333 A relates to a cam shaft comprising a cam shaft phaser. The phaser comprises a stator which comprises an outer toothed gearing via which a crankshaft drives the phase setter.

GB 2 369 175 A relates to a variable phase coupling for outputting from a crankshaft onto two sets of cams. The coupling comprises a drive element, which is driven by the crankshaft, and two driven elements, each for connecting to one of the sets of cams. Each of the driven elements is hydraulically coupled to the drive element, such that each of the two driven elements can assume an angular position independently of the other.

It is an object of the invention to facilitate the assembly of a phase setter on nested cam shafts of the type described, in particular for a phase setter which is preferably embodied to have a vane-cell design.

The invention correspondingly proceeds from a device for adjusting the relative rotational angular position of nested cam shafts in a combustion engine, comprising a shaft arrangement comprising a first cam shaft and a second cam shaft, one of which extends in the other, and which can be rotated relative to each other. In particular, one of the cam shafts can be an outer shaft and the other can be an inner shaft which extends through the outer shaft. However, it is in principle also conceivable for one shaft to extend on the inside in some sections and on the outside in other sections and for the other shaft to correspondingly extend on the outside in some sections and on the inside in other sections. The device also comprises a phase setter which is assembled as an assembly unit on an axial end of the shaft arrangement and comprises a stator, which is non-rotationally connected to the first cam shaft, and a rotor which can be rotary-driven by the stator and can be adjusted in terms of its rotational angular position relative to the stator and which in this sense can be adjusted in its rotational angle. The phase setter is fastened to the shaft arrangement, preferably axially fixed on the shaft arrangement, by means of a connecting device. The connecting device connects the rotor non-rotationally to the second cam shaft. Another constituent part of the device is a drive wheel which is non-rotationally connected to the first cam shaft and the stator, for rotary-driving the

first cam shaft and the stator. Where a component is "rotationally fixed" or "non-rotationally connected" to another component, this means that the components which are rotationally fixed to each other cannot be rotated relative to each other in relation to a common rotational axis. The components can be formed in one piece or can also be formed separately from each other and non-rotationally joined to each other, wherein the subsequent join connection can be a positive-fit, force-fit or material-fit connection. The word "or" is understood here, as elsewhere, by the invention in its usual logical sense of "inclusive or", i.e. it encompasses the meaning of "and" as well as the meaning of "either ... or", unless only one of these two meanings can exclusively follow from the respectively specific context. In relation to the rotationally fixed positive-fit, force-fit or material-fit connection, this means for example that the respective components can be connected to each other in a positive fit only in a first variant, in a force fit only in a second variant, and in a material fit only in a third variant. In other variants, the respective components can be connected to each other by means of one of the three possible combinations of just two of these types of connection; and lastly, all three types of connection can be realised in a final variant.

In accordance with the invention, a cam shaft engaging structure, which is rotationally fixed to the first cam shaft, and a phase setter engaging structure which is rotationally fixed to the stator are pushed axially into each other and thus in a rotational blocking engagement with each other, namely a rotationally secured axial translatory engagement, which connects the stator, secured against rotating, to the first cam shaft in a positive fit. The rotational blocking engagement in accordance with the invention maintains a connection between the stator and the first cam shaft which transmits the torque in the circumferential direction in a positive fit and maintains the ability of the phase setter to be axially assembled. Where a rotationally secured connection or a rotational blocking engagement are mentioned, this means that the components which are connected to each other in this way are connected to each other, secured against rotating, in at least a positive fit. In preferred variants, the respective rotationally secured connection is based on a positive fit only; in alternative variants, it is based on a combination of a positive fit and a force fit. A material fit in addition to a solely positive fit or in addition to a positive and force fit is not to be excluded; preferably, however, there is no material fit in the rotational blocking engagement.

In preferred first embodiments, the engaging structures can be formed as crown wheels and can be pushed axially into each other. The cam shaft engaging structure or the phase setter

engaging structure can also comprise one or more axial recesses, for example one or more holes, on the front-facing end, and the other engaging structure in each case can comprise one or more and in particular a corresponding number of axial projections, for example pin-shaped or bolt-shaped projections, which are correspondingly adapted in their shape; these are pushed axially into each other when the phase setter is assembled and thus form the rotational blocking engagement. In preferred second embodiments, one of the engaging structures surrounds the other at least partially and preferably completely around the rotational axis of the stator. During assembly, the engaging structures together form a prismatic joint which exhibits the common rotational axis of the stator and the first cam shaft as its joint axis. The engaging structures themselves can also be able to be axially moved relative to each other in the rotational blocking engagement when assembled. In particular in embodiments in which the phase setter is a vane-cell phase setter and/or swivel-vane phase setter, such mobility – though advantageous – need not necessarily be provided. As already mentioned, the rotational blocking engagement can also feature a force fit in addition to the positive fit, such that the engaging structures together form a plug connection when the phase setter is assembled. The phase setter or at least the stator can be axially fixed relative to the shaft arrangement by the rotational blocking engagement; more preferably, however, there is no axial fixing in the rotational blocking engagement, and axial fixing is preferably effected via the rotor of the phase setter by means of the connecting device.

In embodiments in which the engaging structures extend around the rotational axis, preferably completely around the rotational axis, i.e. circumferentially over 360° , and one of the engaging structures surrounds the other at least partially and preferably completely in the circumferential direction, the engaging structures can be adapted to each other in shape, each as a mono- or polyhedron or other rotationally asymmetrical shape, wherein they can certainly exhibit 1-fold or manifold and in general terms n-fold rotational symmetry. In such embodiments, they also need not comprise any planar engaging surfaces which effect the positive fit. The surface of the respective engaging structure which effects the positive fit or the plurality of surfaces of the respective engaging structure which jointly effect the positive fit can certainly be curved; the cross-sections which together form the positive fit are however at least not circular. In preferred embodiments, the engaging structures comprise toothed gearings which are in a positive fit with each other. The toothed gearings can exhibit a uniform tooth pitch as viewed over the circumference, though this is not in principle required. The toothed gearings can be pronounced, i.e. can exhibit a large tooth depth; in principle,

however, flat milled edges are also sufficient, as long as only the positive fit can be securely effected and the required torque can be transmitted with no slipping.

The rotational blocking engagement can preferably be released again, such that the phase setter engaging structure can easily be axially removed from the first cam shaft in order to disassemble the phase setter.

The invention facilitates the assembly of the phase setter, since by means of the connecting device, the rotor can be non-rotationally connected to the second cam shaft and the phase setter is thus fastened to the shaft arrangement and, when positioning on the axial end of the shaft arrangement, the phase setter engaging structure can be pushed into the rotational blocking engagement with the cam shaft engaging structure by a simple axial translatory movement. Where a translatory engagement is mentioned, or it is mentioned that the engaging structures are pushed into each other or pushed into each other during assembly, this does not necessarily mean that the engaging structures slide on or onto each other in the process, although this is preferred. If the engaging structures are for example embodied as crown toothed gearings, such engaging structures can also pass into mutual contact for the first time right at the end of assembly. However, a relative axial linear movement – in this sense, an axial translatory movement – is sufficient for establishing the rotational blocking engagement.

In preferred embodiments, the stator is a rotationally fixed constituent part of a phase setter housing which surrounds the rotor at its outer circumference and axially encloses it on both front-facing sides. The phase setter housing is preferably axially fixed on the shaft arrangement by means of the connecting device, wherein advantageously, the rotor is axially fixed on the second cam shaft by means of the connecting device, and the phase setter housing is axially fixed on the shaft arrangement by fixing the rotor. In order to avoid redundancy, there is preferably no additional axial fixing in the rotational blocking engagement; rather, the engaging structures can at least in principle also be axially moved relative to each other in the rotational blocking engagement, in order to be able to compensate as applicable for any tolerances or differences in thermal expansion between the shaft arrangement and the phase setter.

One particularly favourable set of circumstances is when the stator is a rotationally fixed constituent part of a phase setter housing and the phase setter engaging structure is provided

on the phase setter housing. The phase setter engaging structure, which for simple assembly is accessible from without, i.e. accessible for the cam shaft engaging structure, can for example be formed on the phase setter housing as for example an axial recess or axial projection or as a plurality of axial recesses or projections, as already mentioned, and can as applicable also be realised by a combination of different shaped elements. The phase setter engaging structure can also be formed separately and subsequently joined non-rotationally to the phase setter housing. It can in particular be provided on a cover on the front-facing side of the phase setter housing. The shape and arrangement of the phase setter engaging structure is at any rate such that when the phase setter is assembled, the rotational blocking engagement can be established by an axial movement of the phase setter housing relative to the first cam shaft and thus relative to the cam shaft engaging structure.

In embodiments in which the stator is a rotationally fixed constituent part of a phase setter housing, as is preferred, at least one or preferably more than one early setting chamber and at least one or preferably more than one late setting chamber which act/s counter to the early setting chamber(s) are advantageously formed between the stator and the rotor in the phase setter housing. The early setting chamber(s) serve/s to generate a torque which acts on the rotor relative to the stator in a leading direction. The late setting chamber(s) serve/s to generate a torque which acts on the rotor relative to the stator in a trailing direction. In order to generate the respective torque, the setting chambers can be charged with a pressure fluid in order to be able to adjust the rotational angular position of the rotor relative to the stator. The pressure which prevails in either the early setting chamber(s) or the late setting chamber(s) or as applicable both types of setting chamber preferably acts on the rotor in the circumferential direction.

In preferred embodiments, the phase setter is a hydraulic phase setter. It can in particular be a vane-cell phase setter or swivel-vane phase setter, wherein the two terms are understood to be synonymous. In such embodiments, the rotor comprises at least one rotor vane which the at least one early setting chamber adjoins in one circumferential direction and the at least one late setting chamber adjoins in the other direction. The rotor vane divides a pressure space, which is delineated in the circumferential direction by the stator, into the two setting chambers. The rotor preferably comprises a plurality of rotor vanes, in a distribution about its rotational axis, which sub-divide pressure spaces, which are delineated in the circumferential direction by the stator, into an early setting chamber and a late setting chamber, respectively. Due to the

invention, such a phase setter can be provided in a particularly simple way as a prefabricated assembly unit and can be assembled on the shaft arrangement.

With regard to the drive wheel via which the shaft arrangement and the phase setter are rotary-driven, it is advantageous if, in first variants, the first cam shaft can be rotary-driven via the drive wheel and outputs onto the stator in the rotational blocking engagement or, in alternative second variants, the stator can be rotary-driven via the drive wheel and outputs onto the first cam shaft in the rotational blocking engagement. In the first variants, the phase setter engaging structure which is rotationally fixed to the stator serves as a rotational slaving means for the stator; in the second variants, the cam shaft engaging structure which is rotationally fixed to the first cam shaft serves as a rotational slaving means for the cam shaft.

The drive wheel advantageously comprises a toothed gearing, circumferentially around its rotational axis, for being driven, fixedly in terms of torque, by the crankshaft, wherein "fixedly in terms of torque" means that the drive wheel is in a predefined rotational speed relationship to the crankshaft. The drive wheel can for example form a spur wheel gear system, preferably a toothed spur wheel gear system, with an output wheel which outputs onto the drive wheel. Alternatively, however, the drive wheel can for example also be a sprocket or toothed belt wheel of a corresponding traction drive.

The drive wheel directly forms the cam shaft engaging structure. In such embodiments, it comprises said toothed gearing circumferentially around its rotational axis for rotary-driving and also comprises the engaging structure on the circumference or on a front-facing side. The cam shaft engaging structure can be provided in addition to the toothed gearing on the drive wheel. It can also be formed in part directly by the toothed gearing, wherein in such cases, the toothed gearing is axially longer than would be necessary for rotary-driving the cam shaft, such that the toothed gearing comprises, axially alongside each other, a portion for rotary-driving and another portion which forms the cam shaft engaging structure. Although embodiments in which the drive wheel fulfils both the function of absorbing torque from outside the device in accordance with the invention and the function as an engaging structure are advantageous, the drive wheel can instead, in other embodiments, equally advantageously also fulfil the rotary-driving function for the device only. The cam shaft engaging structure which is rotationally fixed to the first cam shaft and the phase setter engaging structure which is rotationally fixed to the phase setter are then formed differently: the cam shaft engaging

structure is for example formed directly on the cam shaft or another component which is non-rotationally joined to the first cam shaft.

If the phase setter is embodied as a hydraulic phase setter, it comprises an inlet and an outlet for a pressure fluid, for rotationally adjusting the rotor hydraulically. The pressure fluid can in particular be a lubricating oil which serves to lubricate the combustion engine. The phase setter can be supplied with the pressure fluid via a machine housing of the combustion engine, for example a cylinder head or cylinder head cover, or via the shaft arrangement, preferably via the second cam shaft which is rotationally fixed to the rotor. In alternative embodiments, the phase setter can be supplied with the pressure fluid from without via an attachment housing which is fastened to the machine housing. Said supply paths can also be combined with each other, for example in such a way that the pressure fluid reaches the shaft arrangement via the machine housing, such as for example a cylinder head or cylinder head cover, and reaches the phase setter via the shaft arrangement, or also for example in such a way that the pressure fluid is initially fed to said attachment housing and from the latter directly to the phase setter or also indirectly from the attachment housing via the machine housing or the shaft arrangement. The attachment housing can comprise a pressure storage, arranged upstream of the phase setter in the supply cycle, for ensuring a pressure level which is sufficient for the phase setter. As an alternative to or preferably in addition to a pressure storage, a non-return means such as for example a reflux valve can be arranged upstream of the phase setter, preferably in the attachment housing, and prevent the pressure fluid within the feed line to the phase setter from flowing off back, away from the phase setter, when there is a drop in pressure upstream. If the attachment housing comprises a pressure storage, the optional blocking means is arranged upstream of the pressure storage and preferably in the attachment housing. As an alternative to or in addition to said functions, the attachment housing can also serve to mount the electromagnetic part of a control valve which can be electromagnetically actuated and through which the phase setter is operated in a controlled way using the pressure fluid. As an alternative to or in addition to a non-return means arranged upstream of the pressure storage, a non-return means can be arranged downstream of the pressure storage in the fluid feed line to the phase setter, i.e. between the pressure storage and the phase setter, preferably between the pressure storage and a control valve of the phase setter, wherein said non-return means prevents backflow from the phase setter towards the pressure storage.

In preferred embodiments of a hydraulic phase setter, an outlet for the pressure fluid extends through the region of the rotational blocking engagement and between the engaging structures, such that the rotational blocking engagement is used in a dual function for relieving the phase setter of pressure. If the fluid is drained from the phase setter via the rotational blocking engagement, the drained fluid can advantageously also provide for lubrication in the rotational blocking engagement and so counteract fretting. This is advantageous in particular when the engaging structures together form a prismatic joint in the rotational blocking engagement, i.e. can at least in principle be axially moved relative to each other.

In preferred embodiments, the engaging structures each comprise a toothed gearing circumferentially around a common rotational axis, and the toothed gearings are in the rotational blocking engagement with each other. The toothed gearings preferably exhibit a uniform tooth pitch, wherein one or more teeth can however be omitted in order for example to form an outlet. The toothed gearings can advantageously be embodied, each as a crown toothed gearing, on mutually facing front-facing sides of the engaging structures. Instead, or in principle also additionally, one of the engaging structures can comprise an outer toothed gearing on an outer circumference, and the other can comprise an inner toothed gearing on an inner circumference. It would in principle be sufficient if one of the engaging structures comprised an engaging groove and the other comprised an engaging spline co-operating with the engaging groove, such that the rotational blocking engagement would be embodied in the manner of a tongue-and-groove connection. It would also be possible to provide just one axial recess and just one axial projection co-operating with the axial recess as an engaging element and engaging counter element on each of mutually facing front-facing sides of the engaging structures, wherein the projection protrudes into the recess in the rotational blocking engagement and thus effects the rotational slaving in the rotational blocking engagement. Circumferential toothed gearings or at least a plurality of engaging grooves and engaging splines or a plurality of recesses and projections in a preferably uniform distribution about the rotational axis, are however preferred. Strictly in principle, the rotational block could also be established by a blocking element which can be axially inserted, for example a pin, a parallel key, a disc spring or the like, which however would necessitate an additional process step during assembly. One alternative, which is likewise advantageous with regard to being simple to assemble by being axially pushed on, would be engaging structures, one of which surrounds the other about the rotational axis, wherein the cross-sections of the engaging structures which together effect the positive fit deviate from a circular shape and are for

example polygonal. Forming the rotational blocking engagement using mutually adapted toothed gearings which encircle the rotational axis is however a particularly space-saving variant which is also suitable for transmitting high torques. Furthermore, a force-fit engagement would also be conceivable, wherein one of the engaging structures, which surrounds the other, could be formed as a tensing sleeve. A force-fit rotational blocking engagement can however effect an undesirable redundancy or can also necessitate an additional assembling step, if for example such a tensing sleeve, once pushed on, had to be tensed by means of a tensing means in order to establish the rotational blocking engagement. Since every additional process step in series production, in particular mass production such as for example motor vehicle production – the preferred area of application for the invention – is repeated thousands or even millions of times depending on the size of the series, any simplification in assembly represents a significant advantage.

If, as is preferred, the phase setter is embodied as a hydraulic phase setter, a control valve which controls the relative rotational angular position of the rotor can advantageously be arranged centrally, i.e. centrally in relation to the rotor and the stator and preferably also in relation to the cam shafts. A central control valve can in particular also protrude into the second cam shaft. In such embodiments, the second cam shaft is provided with a central hollow space which is open on the front-facing end facing the phase setter and into which the central control valve protrudes and in which it can be fixedly connected to the second cam shaft, so as to fasten the phase setter to the shaft arrangement.

In embodiments in which the phase setter comprises a control valve, which is central in relation to the stator and the rotor, for fluidically adjusting the rotational angular position of the rotor, the control valve can advantageously form a connecting member of the connecting device, expediently a screw element, and protrude into a hollow space of the second cam shaft and be fixedly connected – expediently, screwed – to the second cam shaft in the hollow space. A central connecting member, such as for example a screw element, which protrudes through the rotor and into the second cam shaft, is advantageous for non-rotationally connecting the rotor and the second cam shaft and for fastening the phase setter, both as a whole and also when such a connecting member is not a constituent part of a control valve.

A control valve which is also advantageous for the purposes of the invention is disclosed in DE 10 2010 002 713, to which reference is made for advantageous embodiments of the control valve.

In preferred embodiments, the phase setter comprises a latching device which fixes the rotor mechanically, preferably in a positive fit, in a particular rotational angular position relative to the stator in a releasable latching engagement and switches to a release state, which allows the rotational angular position of the rotor to be adjusted, when it is charged with a pressure fluid. The latching engagement is preferably established when the phase setter is assembled. Latching devices such as can also be advantageously realised within the framework of the invention are disclosed in DE 10 2011 004 539 and DE 10 2010 053 685, to which reference is made with respect to the latching device, in relation to the control valve and also with respect to advantageous features of a pressure storage, including adjusting a latching device and a pressure storage to each other.

The phase setter can comprise a torsion spring which tenses the rotor relative to the stator towards a rotational angular end position. The torsion spring can advantageously be provided additionally or also instead of a latching device.

It has already been stated that the engaging structures which are in the rotational blocking engagement when the phase setter is assembled can in particular be mutually adapted spur toothed gearings or also crown toothed gearings. If they are crown toothed gearings, then during assembly, the crown-toothed engaging structure of the phase setter is moved into the rotational blocking engagement with the correspondingly crown-toothed cam shaft engaging structure in accordance with a claw coupling or radial tooth coupling. The invention understands a crown toothed gearing to be any type of toothed gearing comprising a plurality of teeth which axially project on a front-facing side in a distribution about the rotational axis of the phase setter, for example a Hirth toothed gearing or any other type of face toothed gearing. The toothed gearings of the engaging structures can also be inclined towards the rotational axis, i.e. can project in both the axial and radial direction. One engaging structure can then comprise teeth which project radially outwards obliquely on a conical front-facing side, and the other engaging structure can correspondingly comprise teeth which protrude radially inwards obliquely on a facing conical front-facing side. Crown toothed gearings or face toothed gearings comprising teeth which project at least substantially axially only are

however preferred. Crown toothed gearings in the narrower sense, in which the teeth correspondingly project on the respective front-facing side at least substantially axially only, can be manufactured, i.e. shaped, in a simple way. A rotational blocking engagement comprising crown-toothed or face-toothed engaging structures in which the teeth project from front-facing sides at least substantially axially only also has the advantage that no additional design space is required for the rotational blocking engagement as viewed radially with respect to the rotational axis. As compared to spur-toothed engaging structures, which themselves necessarily require a certain radial design space due to the shaft-socket arrangement, it is possible to improve or at least facilitate sealing off the pressure chambers of the phase setter at otherwise identical dimensions of the phase setter.

In the sense that a small design space requirement in the radial direction is to be sought, engaging structures in which the engaging elements and engaging counter elements, which are in the rotational blocking engagement when the phase setter is assembled, project at least substantially axially only on front-facing sides which face each other axially are in principle advantageous. In view of the torque load which the engaging structures have to withstand, such engaging elements are preferably the axially projecting teeth of toothed gearings which encircle the rotational axis, preferably completely, i.e. over 360° .

The phase setter housing which encompasses the stator can be rotationally mounted on the rotor or in the rotational blocking engagement with the cam shaft engaging structure and can otherwise comprise no other rotational mounting, in particular in embodiments in which the first cam shaft outputs onto the stator, i.e. in which the phase setter engaging structure acts as a rotational slaving means for the stator. Instead, however, the phase setter housing which encompasses the stator can also be rotationally mounted in an outer rotary bearing, i.e. in a rotary bearing which is external in relation to the rotational blocking engagement and the arrangement consisting of the rotor and the stator, and thus independently of the cam shaft arrangement. The phase setter housing can then be supported in the outer rotary bearing, for example on the machine housing, such as for example on a cylinder head or cylinder head cover. Supporting it in an outer rotary bearing is in particular advantageous for embodiments in which the drive wheel rotary-drives the first cam shaft via the stator, i.e. in which the phase setter housing outputs onto the first cam shaft, such that the cam shaft engaging structure acts as a rotational slaving means for the cam shaft. In such embodiments, the drive wheel is preferably connected non-rotationally to the stator, for example fixedly joined to the phase

setter housing or as applicable formed in one piece directly on the stator or on a lateral cover of the phase setter housing.

In preferred embodiments, the connecting device – which fastens the phase setter to the shaft arrangement in relation to the axial direction and connects the rotor non-rotationally to the second cam shaft – comprises a cam shaft hollow space which extends on the axial end of the shaft arrangement in the second cam shaft which faces the phase setter and is open towards the phase setter. The connecting device also comprises a connecting member, i.e. a central connecting member such as for example a central fastening screw, which protrudes into said hollow space and is fixedly connected to the second cam shaft in the hollow space when assembled. As already mentioned, the central connecting member can form the housing of a central control valve of the phase setter. Instead, however, the control valve can also be arranged outside the arrangement consisting of the rotor and stator. In such embodiments, however, the pressure fluid of the preferably hydraulic phase setter is also advantageously guided centrally into the pressure chambers of the phase setter via the region of the cam shaft hollow space, i.e. through the cam shaft hollow space and feed lines which are formed in the rotor of the phase setter. In such embodiments, the central connecting member is not a valve housing but rather only substantially fulfils the function of immovably connecting the rotor to the second cam shaft.

A first connecting channel can extend axially in the region of the cam shaft hollow space in order to guide the pressure fluid radially between the second cam shaft and the connecting member, wherein the pressure fluid can be fed to the at least one or preferably more than one early setting chamber of the phase setter or also to the at least one or preferably more than one late setting chamber through the first connecting channel. The pressure fluid can expediently also be drained again from the corresponding type of chamber, i.e. either an early setting chamber or a late setting chamber, through the first connecting channel when the phase setter is switched. Providing an axially extending connecting channel radially between the connecting member and the cam shaft which surrounds the connecting member in the region of the hollow space is in particular advantageous for embodiments in which the control valve is not arranged centrally in relation to the phase setter and/or the cam shaft but rather outside the arrangement consisting of the rotor and stator.

A sleeve structure can be arranged on the end of the second cam shaft facing the phase setter and can be connected to the second cam shaft such that it cannot be rotated and preferably also such that it cannot be axially moved. The second cam shaft and the sleeve structure can together delineate a second connecting channel through which the pressure fluid can be fed to the at least one early setting chamber or also to the at least one late setting chamber. If both the axially extending first connecting channel and the axially extending second connecting channel are provided, these connecting channels are fluidically separated, i.e. one of these connecting channels is connected to the early setting chamber or chambers only, and the other is connected to the late setting chamber or chambers only. The sleeve structure can extend partially or completely in the cam shaft hollow space, in order to fluidically separate the first connecting channel and second connecting channel from each other in the hollow space. In such embodiments, the sleeve structure serves as a separating sleeve. Instead, however, the sleeve structure can also be arranged on the outer circumference of the second cam shaft, such that the second connecting channel on the outer circumference of the second cam shaft is formed between the second cam shaft and the sleeve structure which in this case is an outer sleeve structure.

The first connecting channel or second connecting channel, respectively, can in particular be an annular space which extends circumferentially and completely around the rotational axis of the phase setter.

In embodiments in which the first connecting channel is formed radially between the central connecting member and a surrounding casing portion of the second cam shaft, the cam shaft hollow space can advantageously exhibit a variable hollow space width and can in particular be formed as a stepped bore. In such embodiments, the stepped hollow space exhibits, adjoining each other, a larger width on its end facing the phase setter and a comparatively smaller width in an axially adjoining portion further away from the phase setter. The fixed connection to the connecting member, for example a screw connection, is established in the portion which exhibits the smaller width, when the phase setter is assembled. The first connecting channel extends in the comparatively widened hollow space portion. In a preferred development of such an arrangement, the aforesaid sleeve structure is then also provided as an outer sleeve structure in order to form the second connecting channel on the outer circumference of the second cam shaft between the second cam shaft and the outer sleeve structure.

The invention relates not only to the shaft arrangement comprising the assembled phase setter but also to a phase setter which is suitable for being assembled on nested cam shafts. The phase setter comprises a stator and a rotor which is arranged such that it can be adjusted in its rotational angle relative to the stator about a rotational axis within a predefined angular range. The stator is a rotationally fixed constituent part of a phase setter housing in which the rotor is accommodated such that it can be rotationally adjusted. Since the stator rotates together with a first cam shaft of the nested cam shafts when the phase setter is assembled, the phase setter housing is rotationally symmetrical in relation to the rotational axis of the stator. The phase setter also comprises a connecting member for non-rotationally fastening the rotor to another, second cam shaft of the nested cam shafts. If, as has already been described with respect to the device, the phase setter comprises a central control valve, a valve housing of the control valve can advantageously form the connecting member. In accordance with the invention, the phase setter comprises a phase setter engaging structure which is rotationally fixed to the phase setter housing and comprises at least one and preferably more than one axially extending engaging element for establishing a rotational blocking engagement which is based on a positive fit. When assembled within the device described, the phase setter engaging structure forms the engaging structure of the phase setter which is in the rotational blocking engagement. The phase setter engaging structure is provided on the phase setter housing and adapted in shape in such a way that when assembled, and together with an engaging counter element of the cam shaft assigned to the stator — the cam shaft engaging structure — it connects the stator, secured against rotating, to the first cam shaft in a positive fit. The phase setter engaging structure is shaped such that it can be pushed axially into or onto a cam shaft engaging structure which is rotationally fixed to the first cam shaft, when the phase setter is assembled, in order to establish the rotational blocking engagement. The phase setter engaging structure is preferably shaped such that it can be moved into the rotational blocking engagement by an axial linear movement of the phase setter relative to the first cam shaft.

In order to form the phase setter engaging structure, an axially projecting ring can be formed on the phase setter housing or joined to the phase setter housing, wherein a front-facing side or equally preferably an inner or outer annular circumference of said ring is for example provided with a toothed gearing, advantageously a toothed gearing which encircles the rotational axis of the stator. The ring preferably extends circumferentially, over 360°, but can in principle also be formed as a partial ring only. This also applies to the toothed gearing, i.e.

it can be provided such that it partially or preferably completely encircles the rotational axis. A phase setter engaging structure comprising engaging elements which project at least substantially axially, such as in particular a crown toothed gearing, can however also advantageously be formed directly on a front-facing side of a lateral cover of the phase setter housing which faces the shaft arrangement. Such a phase setter engaging structure can also be formed in a recess formed on the front-facing side of the cover, for example a circumferential groove on the front-facing side or a collar which radially faces the shaft arrangement directly, radially on the inside of the cover, in order to reduce the design space required in the axial direction for the rotational blocking engagement.

Where features of the components of the phase setter, such as in particular the stator, the phase setter housing, the rotor, the connecting member and the phase setter engaging structure, are disclosed in connection with the device, i.e. the phase setter when assembled, the statements made in this respect also apply in relation to the phase setter itself. The phase setter is preferably provided for use within the device in accordance with the invention.

Other advantageous features are also disclosed in the sub-claims and combinations of them.

An example embodiment of the invention is described below on the basis of figures. Features disclosed by the example embodiment, each individually and in any combination of features, advantageously develop the subject-matter of the claims as well as the embodiments described above. There is shown:

- Figure 1 a phase setter of a first example embodiment, which is arranged on an axial end of nested cam shafts in order to adjust their rotational angle, in a longitudinal section;
- Figure 2 the phase setter in a cross-section;
- Figure 3 a cross-section in which the phase setter is in a rotationally secured, axial translatory engagement with one of the cam shafts;
- Figure 4 the cam shafts and the phase setter in another longitudinal section;
- Figure 5 the phase setter together with a shaft arrangement which comprises a modified cam shaft;
- Figure 6 the phase setter itself;
- Figure 7 a phase setter of a second example embodiment, in a longitudinal section;

- Figure 8 the end of the cam shaft arrangement of the second example embodiment which faces the phase setter;
- Figure 9 a phase setter of a third example embodiment, in a longitudinal section;
- Figure 10 an example of an engaging structure comprising teeth which axially project on a front-facing side; and
- Figure 11 another example embodiment of an engaging structure comprising teeth which axially project on a front-facing side.

Figure 1 shows a first example embodiment of a device in accordance with the invention comprising nested cam shafts 1 and 2 and a cam shaft phase setter S which is arranged on an axial end of the shaft arrangement formed by the cam shafts 1 and 2 and serves to vary the rotational angular position which the cam shafts 1 and 2 exhibit relative to each other. The first cam shaft 1 forms an outer shaft in the shaft arrangement or at least comprises an outer shaft portion at the axial end at which the phase setter S is arranged. The second cam shaft 2 forms an inner shaft, which extends at least substantially within the first cam shaft 1, in the shaft arrangement or at least comprises an inner shaft portion, which extends in the outer shaft portion of the cam shaft 1, at the axial end of the shaft arrangement at which the phase setter S is arranged. The cam shafts 1 and 2 can be jointly rotated about a common rotational axis R relative to each other within a rotational angular range which is predefined by the phase setter S, in order to be able to vary the control times of cams of the cam shaft 1 as compared to cams of the cam shaft 2 and thus the assigned valves. The device is a constituent part of a combustion engine, for example a drive motor of a motor vehicle. The shaft arrangement is rotationally mounted in or on a machine housing M of the combustion engine, for example in or on a cylinder head.

The phase setter S comprises a stator 3, which together with a stator cover 4 and a stator cover 5 forms a phase setter housing 3, 4, 5, and a rotor 9 which can be rotated back and forth about the rotational axis R relative to the phase setter housing 3, 4, 5. The stator 3 is joined to the stator covers 4 and 5 on its front-facing sides fixedly, i.e. immovably relative to the respective stator cover 4 and 5. The stator 3 and/or the phase setter housing 3, 4, 5 is rotary-driven about the rotational axis R by a crankshaft of the combustion engine, via a gear system and in a predefined rotational speed relationship to the crankshaft, and slaves the rotor 9 when it is rotary-driven. In order to vary the relative rotational angular position of the cam shafts 1 and 2, the rotational angular position of the rotor 9 relative to the stator 3 can however be adjusted.

The rotor 9 is non-rotationally connected to the cam shaft 2 and – as is preferred but merely by way of example – also connected to the cam shaft 2 such that it is axially fixed, i.e. axially immovably relative to the cam shaft 2. In a rotational blocking engagement, the stator 3 is connected to the cam shaft 1, secured against rotating, i.e. cannot be rotated about the rotational axis R relative to the first cam shaft 1.

Figure 2 shows the phase setter in a cross-section. The stator 3 is formed as a hollow ring comprising stator jaws which project inwards, towards the rotational axis R. The rotor 9 correspondingly comprises a rotor hub and rotor vanes which project outwards from the rotor hub. The stator jaws delineate pressure spaces for a hydraulic pressure fluid in the circumferential direction. The rotor vanes each protrude outwards between two adjacent stator jaws and each sub-divide one of the pressure spaces delineated by the stator jaws into an early setting chamber K_1 and a late setting chamber K_2 . If the early setting chambers K_1 are pressurised and the late setting chambers K_2 are relieved, the rotor 9 rotates relative to the stator 3, clockwise in Figure 2, at most up to the early position assumed in Figure 2. If the late setting chambers K_2 are pressurised and the early setting chambers K_1 are relieved of pressure, the rotor 9 rotates anticlockwise, at most up to a late position. Charging the early setting chambers K_1 with pressure adjusts the cam shaft 2 relative to the cam shaft 1 in a leading or "early" direction, due to its rotationally fixed connection to the rotor 9. A relative rotational adjustment in the other rotational direction corresponds to a delay or adjustment of the cam shaft 2 in a trailing or "late" direction. The early position and the late position are each predefined by an abutting contact. In each of the two endpositions, at least one of the rotor vanes is preferably in an abutting contact with one of the stator jaws. In preferred embodiments, the rotor 9 can not only be rotationally adjusted back and forth between these two rotational angular end positions relative to the stator 3 but can also be hydraulically fixed in any intermediate position by correspondingly charging both the early setting chambers K_1 and the late setting chambers K_2 with pressure.

The phase setter S comprises a control valve 20 which is central in relation to the stator-rotor arrangement 3, 9 and comprises a valve housing 21 and a valve piston 22 which is arranged in the valve housing 21 such that it can be axially adjusted back and forth. The valve piston 22 is hollow and comprises an axially extending hollow space 23. The control valve 20 comprises a valve inlet P_a on an end facing the cam shaft 2, and a piston outlet which leads radially through a casing of the valve piston 22 which surrounds the hollow space 23. The other axial

end of the valve piston 22, which faces away from the inlet P_a , comprises a coupling member 25 for coupling to a setting member which axially adjusts the valve piston 22. The coupling member 25 acts as an operating plunger of the valve piston 22. The coupling member 25 protrudes through a front-facing closure wall 26 of the valve housing 21. The front-facing closure wall 26 surrounds the coupling member 25 in a tight fit and provides for a fluid-proof closure of the valve housing 21 despite the coupling member 25 being able to be moved back and forth. The setting member is by way of example, and as is preferred, an electromagnetic setting member-- in the example embodiment, an axial stroke electromagnet -- comprising a coil 27 through which current can be passed and an anchor 28 which the coil 27 surrounds. The coil 27 is non-rotationally connected to the machine housing M of the combustion engine. In the example embodiment, the coil 27 is non-rotationally connected to an attachment housing 18 which is assembled on the machine housing M and covers the phase setter S. The anchor 28 can be axially moved relative to the coil 27. The anchor 28 and the coupling member 25 are in a coupling engagement which is formed as an axial pressure contact. When current is passed through the coil 27, a setting force which is directed axially towards the coupling member 25 acts on the anchor 28 and -- in the coupling engagement, which is a solely axial pressure contact -- on the coupling member 25 and thus on the valve piston 20.

The control valve 20 comprises a spring member 24, the spring force of which counters the setting force of the electromagnetic setting member. The spring member 24 is directly supported on the valve housing 21 and supported in the direction of the electromagnetic setting member on the valve piston 22. The electromagnetic setting member is actuated, i.e. current is passed through it, by a controller of the combustion engine. It is preferably actuated using a characteristic diagram which is stored in a memory of the machine controller, for example as a function of the rotational speed of the crankshaft, the load or other or additional parameters which are relevant to the operation of the combustion engine.

Pressure fluid for controlling the phase setter S can be fed centrally and in the axial direction to the control valve 20 via the inlet P_a . The pressure fluid is guided via the shaft arrangement into the central hollow space 2a, from where it flows axially through the valve inlet P_a into the piston space 23. The fluid can in particular be a lubricating oil which serves to lubricate the combustion engine and can also for example serve to lubricate a pivot bearing of the shaft arrangement. Via apertures 23a formed in the casing of the valve piston 22, the pressure fluid flows from the piston space 23 either to the early setting chambers K_1 via feed channels 9.1 or

to the late setting chambers K_2 via feed channels 9.2 (Figure 2), depending on the axial position of the valve piston 22. The valve housing 21 comprises ports, which lead through its casing, for feeding the pressure fluid to the setting chambers K_1 and K_2 and draining the pressure fluid from the setting chambers K_1 and K_2 . An outlet 8 serves the purpose of draining, as will be described below. Further details and advantageous features of the control valve 20 are described in the aforesaid German patent application DE 10 2010 002 713 and also in the two other applications mentioned, i.e. DE 10 2011 004 539 and DE 10 2010 053 685, to which reference is made in this respect.

In the example embodiment, the pressure fluid is fed via the machine housing M. The attachment housing 18 comprises a pressure storage 29 for the phase setter S which is connected to the pressure fluid feed line of the machine housing M via a fluid channel 19 formed in the attachment housing 18. If the phase setter S does not have a pressure storage of its own, the fluid channel 19 in the attachment housing 18 can be omitted. In a modification, the pressure fluid for the phase setter S can be fed to the attachment housing 18 which for this purpose would comprise a pressure fluid port and preferably also a blocking member upstream of the pressure storage. Instead of an external port on the attachment housing 18, however, the pressure fluid could in another modification also be fed via the machine housing M, initially via the blocking member to the pressure storage and from the latter centrally back via the machine housing and the shaft arrangement, as is preferred, to the control valve 20.

The phase setter S is connected to the second cam shaft 2, non-rotationally and— as is preferred, but merely by way of example — also such that it is axially fixed, by means of a connecting member 21. A front axial portion of the connecting member 21 protrudes into a central hollow space 2a of the cam shaft 2, where it is fixedly connected to the cam shaft 2 by means of a screw connection 14. The connecting member 21 presses the rotor 9, axially fixed, against a front-facing wall of the cam shaft 2 and thus provides the rotationally fixed as well as axially fixed connection between the rotor 9 and the cam shaft 2.

The stator 3 is connected, secured against rotating, to the first cam shaft 1 in a positive fit. For the positive-fit connection, an engaging structure 6 of the phase setter S which is rotationally fixed to the stator 3 and an engaging structure 12 which is rotationally fixed to the first cam shaft 1 are in a rotational blocking engagement, which is based on a positive fit, with each other. The phase setter engaging structure 6 is provided on the phase setter housing 3, 4, 5. It

encircles the rotational axis R . The cam shaft engaging structure 12 is likewise circumferential and, in the rotational blocking engagement, overlaps axially with the phase setter engaging structure 6. The engaging structures 6 and 12 can mesh in a positive fit and a force fit in the rotational blocking engagement, in order to form a plug connection with each other; more preferably, however, the rotational blocking engagement is based on a positive fit only or at least most predominantly on a positive fit, such that the engaging structures 6 and 12 together form a prismatic joint, with the rotational axis R as the joint axis. The screw connection 14 with the cam shaft 2 provides for the axial fixing. In such embodiments, small axial relative movements between the engaging structures 6 and 12 which may be required can occur in the prismatic joint between the engaging structures 6 and 12.

The phase setter engaging structure 6 is formed on the phase setter housing 3, 4, 5 as an axially projecting ring on the front-facing side which faces the shaft arrangement, wherein said ring is formed – as is preferred but merely by way of example – in one piece on the stator cover 5 which faces the cam shafts 1 and 2. The cam shaft engaging structure 12 is formed by the drive wheel 10, on an outer circumference of the drive wheel 10 in the example. By reversing the set of circumstances, however, it would also be possible to form the engaging circumferential surface as an outer circumferential surface of the phase setter engaging structure 6 and, correspondingly, the engaging circumferential counter surface as an inner circumferential surface of the drive wheel 10 or other corresponding structure which is rotationally fixed to the cam shaft 1. Preferably, the engaging structures 6 and 12 are axially short and shaped as stubs; in principle, however, other geometries are also conceivable. In a modification, the engaging circumferential surface of the engaging structure 6 could also be formed in the axial region of the disc-shaped stator cover 5 instead of on an axially projecting ring. Forming the engaging structure 6 on a ring which axially projects on the outside or on a comparable projection does however have the advantage that in the disc-shaped region of the stator cover 5, pressure fluid can be drained towards a pressure fluid reservoir, for example an oil sump, via the hollow space which arises around the shaft arrangement at the axial level of the stator cover 5. The pressure fluid which flows off from the phase setter S is drained via an outlet 8 which extends between the engaging structures 6 and 12 in the rotational blocking engagement, i.e. the outlet 8 serves to relieve the phase setter S of pressure.

Figure 3 shows the rotational blocking engagement in a cross-section. The circumferential surfaces of the engaging structures 6 and 12 which are in the rotational blocking engagement,

i.e. the engaging circumferential surface and the engaging circumferential counter surface, are each provided with a toothed gearing which encircles the rotational axis R — the phase setter engaging structure 6 with an inner toothed gearing 7, and the cam shaft engaging structure 12 with an outer toothed gearing 13. At least one tooth or more preferably more than one tooth of one or optionally both of the toothed gearings 7 and 13 is levelled, preferably down to the root circle of the respective toothed gearing, such that gaps which extend axially through the rotational blocking engagement formed solely as a slaving engagement, or at least one such gap, is/are maintained and form/s the outlet 8. In order to form the outlet 8, and as is preferred but merely by way of example, only the toothed gearing 7 of the phase setter engaging structure 6 is provided with one or more levelled teeth and/or one or more elongated tooth gaps, in order to form the outlet 8.

In a second and/or dual function, the drive wheel 10 forms the cam shaft engaging structure 12. Its primary function is that of a drive wheel for the shaft arrangement. The shaft arrangement comprising the cam shafts 1 and 2 is rotary-driven from outside the shaft arrangement via the drive wheel 10 which is rotationally fixed to the cam shaft 1. In the example embodiment, the set of circumstances is such that an additional cam shaft 15 or cam shaft arrangement for controlling other valves of the combustion engine is rotationally mounted in parallel alongside the cam shafts 1 and 2. The cam shaft 15 or shaft arrangement 15 is rotary-driven by the crankshaft and outputs onto the drive wheel 10 via an output wheel 16 which is rotationally fixed to the cam shaft 15 or additional shaft arrangement. The wheels 10 and 16 are outer-toothed spur wheels which roll off on each other in toothed engagement via their spur toothed gearing 11 and 17. In modifications of the drive arrangement, it would for example be conceivable to provide the phase setter engaging structure 6 with an outer toothed gearing instead of the rotational blocking engagement in accordance with the invention, in order to drive the stator 3 directly from the output wheel 16 in a rolling engagement. For this purpose, the outer toothed gearing 17 of the output wheel 16 would merely have to be elongated into axial overlap with the engaging structure 6. Rotary-driving the phase setter S using a non-rolling slaving engagement — the rotational blocking engagement in accordance with the invention — does however have significant advantages. There is solely a transmission of torque, without any rolling engagement. The radial tolerance chain is shorter, hence tolerance problems are fewer. In another modification, the output wheel 16 could output onto the phase setter S only in the rolling engagement, the engaging structure of which could likewise be provided with an outer toothed gearing for this purpose,

in order to output onto the cam shaft 1 via the rotational blocking engagement, as in the example embodiment. Due to said disadvantages, namely the rolling engagement of the phase setter S and the elongated radial tolerance chain, such a modification would however also appear inferior to outputting onto the shaft arrangement only and to the transmission of torque onto the phase setter S solely in the non-rolling slaving engagement. Another disadvantage would be the more difficult assembly of the phase setter S.

For it is possible, due to the invention, to simplify assembling a phase setter on an axial end of a shaft arrangement of nested cam shafts 1 and 2 and consequently reduce costs. The phase setter S is assembled on the shaft arrangement largely as an assembly unit. The assembly unit comprises the phase setter housing 3, 4, 5 together with the engaging structure 6, the rotor 9 which is accommodated in the phase setter housing 3, 4, 5, and optionally the central control valve 20 together with the valve housing which forms the central connecting member 21. As can already be seen from Figure 1, this assembly unit is positioned on the end of the shaft arrangement by pushing the phase setter engaging structure 6 into the rotational blocking engagement with the cam shaft engaging structure 12. Once it is positioned, the connecting member 21 is fixedly connected, for example screwed, to the cam shaft 2. If the connecting member 21 is correspondingly shaped, the rotor 9 is pressed, axially fixed, against the cam shaft 2 during when connected and is thus connected, rotationally and axially fixed, to the cam shaft 2. The assembly unit as a whole is therefore also completely assembled. It then merely remains for the attachment housing 18 to be fastened to the machine housing M. Fastening the attachment housing 18 also simultaneously assembles the electromagnetic part of the control valve 20, and the phase setter S is complete. In order to reinforce the frictional fit between the cam shaft 2 and the rotor 9, a friction disc which increases the frictional moment can be arranged between the axial front-facing surfaces which are in the frictional fit. Alternatively, the frictional moment can also be increased by filling with a frictional mixture which contains solid particles – hard material particles which embed themselves in the front-facing surfaces which axially face each other. Suitable mixtures and frictional composites are described in DE 10 2010 003 574.2, to which reference is made in this respect.

Figure 4 shows the device in another longitudinal section. As in Figure 2, a latching device 30 can be seen in the longitudinal section. The stator 3 and the rotor 9 are mechanically fixed in a particular rotational angular position relative to each other by means of the latching device 30, in order in particular to prevent oscillations of the rotor 9 relative to the stator 3 in starting

phases of the combustion engine. In the example embodiment, the rotor 9 is latched in the early position. Latching in the early position, though preferred, is merely by way of example. The latching device 30 comprises a first latching member 31, for example in the form of a latching pin which is guided by the rotor 9 such that it can be linearly moved axially back and forth, and a second latching member 32, for example an engaging opening, which is rotationally fixed to the stator 3. The latching member 32 is formed in the phase setter housing 3, 4, 5 – in the example, in the stator cover 5 – on a front-facing side axially facing the latching member 31. In the latching engagement, the latching members 31 and 32 co-operate in a positive fit. The latching member 31 is tensed into the latching engagement by a spring member 33 and can be moved in the opposite direction, out of the latching engagement, by being charged with pressure fluid. The latching engagement is expediently established when the phase setter S is assembled.

Figure 5 shows the device in a modification in which the engaging structure 12 is formed on an end piece 1a of the cam shaft 1. The end piece 1a is a sleeve body which is joined, rotationally and axially fixed, to a pipe portion of the cam shaft 1, preferably in a material fit. The material-fit connection is denoted by 1b. It is preferably a welded connection; a soldered connection would also be conceivable. The shaft end piece 1a also directly forms the drive wheel 10 in one piece with the engaging structure 12.

Figure 6 shows the assembly unit which comprises the phase setter housing 3, 4, 5, the rotor 9 and the control valve 20. As shown, the assembly unit can be positioned on the end of the shaft arrangement and moved along the rotational axis R towards the front-facing end of the shaft arrangement by an axial translatable movement, wherein the engaging structure 6 can be moved into the rotational blocking engagement with the cam shaft engaging structure 12. The stator-rotor arrangement already protrudes through the control valve 20 in Figure 6, such that when the engaging structure 6 is pushed on, the connecting member 21 and/or valve housing 21 is also directly moved into the central hollow space 2a of the cam shaft 2. The control valve 20 and/or the connecting member 21 formed by it can however also only be advanced into and through the stator-rotor arrangement 3, 9, up to the hollow space 2a, once the rotational blocking engagement has already been established. A connecting portion of the valve housing and/or connecting member 21 is denoted by 21a and is formed as a threaded portion in the example embodiment. The thread is not however illustrated in Figure 6. The rotational symmetry of the phase setter housing 3, 4, 5 can also be seen in Figure 6.

Figure 7 shows a shaft arrangement together with a phase setter S in a second example embodiment. The phase setter is again a fluidic swivel-vane phase setter comprising a stator 3 and a rotor 9 which form early and late setting chambers, as has been described with respect to the first example embodiment. One of the early setting chambers K_1 as well as one of the feed lines 9.1 to the early setting chambers K_1 and one of the feed lines 9.2 to the late setting chambers K_2 can be seen in the section in Figure 7. The feed lines 9.1 and 9.2 guide the pressure fluid from a central inner region of the device outwards to the assigned early and late setting chambers. Lateral stator covers 4 and 5 of the stator 3 again form the phase setter housing 3, 4, 5.

Unlike the first example embodiment, the rotational blocking engagement between the stator 3 and the first cam shaft 1 is not formed by means of spur toothed gearings but rather by co-operating crown toothed gearings or face toothed gearings 43 and 47. As in the first example embodiment, the toothed gearings 43 and 47 can encircle the rotational axis R completely, i.e. over 360° , in a uniform pitch. The toothed gearing 47 is provided on a phase setter engaging structure 46 formed on the cover 5, and the toothed gearing 43 is provided on a cam shaft engaging structure 41 which is non-rotationally arranged on the outer circumference of the cam shaft 1. When the phase setter S is assembled, these two engaging structures 41 and 46 co-operate by means of their toothed gearings 43 and 47 in the manner of a claw coupling or radial tooth coupling. Establishing the rotational blocking engagement by means of teeth – or in more general terms, projections – which project at least substantially axially has the advantage that the stator cover 5 which forms the engaging structure 46 can form a longer sealing gap 5a with the rotor 9 which protrudes between the covers 4 and 5, at otherwise identical dimensions in the radial direction, than if the rotational blocking engagement is established by means of spur toothed gearings which project radially on circumferential surfaces. A sealing gap which is comparably long radially could only be realised with spur toothed gearings by manufacturing the cover 5 with a more complicated geometry. Axially projecting engaging elements such as for example the teeth of the toothed gearing 47 can also be formed in a particularly simple way, for example by compacting and sintering.

The toothed gearing 47 is formed in a recess of the cover 5 which faces the shaft arrangement 1, 2 and encircles the rotational axis R. In the example embodiment, the recess is a collar which encircles the rotational axis R and opens axially towards the cam shaft engaging

structure 41 and radially inwards, i.e. towards the rotational axis R. Since the face toothed gearing 47 or otherwise configured engaging surface is formed with axial projections in a recess and/or axially recessed region of the phase setter housing 3, 4, 5, the phase setter S can be kept to a design which is axially short in the region of the rotational blocking engagement.

The phase setter S of the second example embodiment comprises a control valve 35 which is arranged eccentrically in relation to the arrangement consisting of the stator 3 and the rotor 9. The control valve 35 is arranged near the phase setter S in the machine housing M, for example a cylinder head or cylinder head cover. In the second example embodiment, the pressure fluid is again fed to the early setting chambers and late setting chambers – and also drained from these pressure chambers again when the pressure is relieved – through the region of the central hollow space 2a of the cam shaft 2, as controlled by means of the control valve 35.

Feed channels 36 and 37 are formed on the shaft end of the cam shafts 1 and 2 and connect the control valve 35 to axially extending connecting channels 48 and 49. The feed channels 36 and 37 are both shown in continuous lines. The feed channels 36 and 37 are however actually offset axially with respect to each other in the axial direction of the control valve 35, i.e. as viewed perpendicular to the plane of representation. The connecting channel 48 extends in the hollow space 2a of the cam shaft 2 up to the feed lines 9.1, i.e. it connects them to the control valve 35. The connecting channel 48 extends, as viewed radially, between a central connecting member 45 – which, due to the eccentric arrangement of the control valve 35 in the second example embodiment, only fulfils the function of fastening the phase setter S – and a casing portion of the cam shaft 2 which surrounds the connecting member 45. The connecting channel 49 extends, as viewed radially, between the outer circumference of the cam shaft 2 and a sleeve structure 42 which is immovably joined to the cam shaft 2 on the outer circumference. Each of the two connecting channels 48 and 49 is formed as an annular space encircling the rotational axis R.

The hollow space 2a is formed in the cam shaft 2 as a stepped bore and comprises one larger-diameter hollow space portion which is near the phase setter S and open towards the phase setter S, and one smaller-diameter hollow space portion which is distanced from the phase setter S. The connection between the cam shaft 2 and the connecting member 45 is established in the smaller-diameter hollow space portion. The connecting channel 48 extends in the

larger-diameter hollow space portion. In the example embodiment, the connecting member 45 also comprises a stem portion in the overlap region with the connecting channel 48, wherein the diameter of said stem portion is smaller than the diameter of an adjoining stem portion in the region of which the connection to the cam shaft 2 is established. Since the hollow space portion facing the phase setter S is widened, however, it is not necessary required for the connecting member 45 to additionally also comprise a smaller-diameter stem portion in the overlap region.

A shaft seal, which is denoted by 44, is arranged between the machine housing M and the phase setter housing 3, 4, 5 in order to seal off a space which remains around the rotational blocking engagement between the phase setter housing 3, 4, 5 and the machine housing M. In order to drain pressure fluid which has entered this space, i.e. in order to be able to relieve the space of pressure, one or more relieving channels can be provided in the machine housing M and port into the space.

The cam shaft 1 is supported, such that it can be rotated, on the machine housing M via the engaging structure 41, for which purpose the engaging structure 41 forms a rotary slide bearing 38 with the machine housing M. Instead of a rotary slide bearing 38, the cam shaft 1 could also advantageously be supported on the machine housing M in a roll bearing via the engaging structure 41. A rotary bearing, for example a roll bearing, could be provided instead of or in addition to the shaft seal 44 in order to support the phase setter housing 3, 4, 5 of the second example embodiment radially on the machine housing M by means of a rotary bearing and thus relieve the engaging structures 41 and 46 in the rotational blocking engagement.

Another difference with respect to the first example embodiment is that in the second example embodiment, a drive wheel 40 is non-rotationally connected to the stator 3 and, as is preferred but merely by way of example, is also arranged in axial overlap with the stator 3, such that the shaft arrangement 1, 2 is rotary-driven via the phase setter S. The stator 3 outputs onto the cam shaft 1 in the rotational blocking engagement and also onto the cam shaft 2 via the rotor 9.

Figure 8 shows the end of the shaft arrangement 1, 2 which faces the phase setter S, without the phase setter S, i.e. before it has been assembled, such that the stepped cam shaft hollow space 2a can clearly be seen. The sleeve-shaped casing portion of the cam shaft 2 which

surrounds the connecting channel 48 once assembled and extends over the axial length of the larger-diameter hollow space portion is denoted by 2b. The connecting channels 48 and 49 are fluidically separated from each other in the region of the cam shaft 2 in a particularly simple design by this casing portion 2b which is formed in one piece directly by the cam shaft 2.

Aside from the differences described, the device of the second example embodiment can correspond to that of the first example embodiment, such that reference is made in this respect to the statements made with respect to the first example embodiment.

Figure 9 shows a shaft arrangement 1, 2 comprising a phase setter S of a third example embodiment. Similarly to the second example embodiment, a drive wheel 50 drives the cam shaft 1 via the stator 3 and the rotational blocking engagement between engaging structures 51 and 56. The engaging structure 51 forms a rotational slaving means for the cam shaft 1. A control valve 35 is arranged in the machine housing M, in accordance with the second example embodiment. A shaft seal, which seals off a space which remains around the rotational blocking engagement between the machine housing M and the phase setter housing 3, 4, 5, is denoted by 54. As in the second example embodiment, the phase setter housing 3, 4, 5 thus forms a rotating cover which seals off a fluidic part of the device at the axial end of the cam shafts 1 and 2. One or more pressure relieving channels can be provided in the machine housing M in order to relieve the space sealed off by means of the shaft seal 54 of pressure.

The cam shaft 1 is supported on the machine housing M such that it can be rotated, in its axial end region near the phase setter S, by means of a rotary bearing 39. The rotary bearing 39 is a roll bearing, for example a needle roll bearing. Instead of the roll bearing 39, the cam shaft 1 could however also form a rotary slide bearing with the machine housing M, as in the second example embodiment. Instead or in addition, a rotary bearing could be arranged axially alongside the shaft seal 54, in order to support the rotary-driven stator 3 and/or the phase setter housing 3, 4, 5 on the machine housing M. Details concerning the seal at 54 and the fixed connection between the stator 3 and the drive wheel 50 can be seen in Figure 9. As also in the second example embodiment before, the rotational blocking engagement is effected by means of crown toothed gearings or face toothed gearings 53 and 57 which are formed on front-facing sides of the stator cover 5 which face each other and – unlike the second example embodiment – directly on the cam shaft 1. An engaging structure 56 which comprises the toothed gearing 57 is provided in the form of an annular stub on the side of the cover 5,

radially on the inside, while the toothed gearing 53 is formed directly on the front-facing side of the casing of the cam shaft 1 which faces it. The end of the casing of the cam shaft 1 forms the cam shaft engaging structure 51.

In the third example embodiment, the eccentric control valve 35 is again connected to the early setting chambers and late setting chambers of the phase setter S via connecting channels 58 and 59 which axially extend in the region of the hollow space 2a of the cam shaft 2. Unlike the second example embodiment, a sleeve structure 52 which fluidically separates the connecting channels 58 and 59 from each other within the hollow space 2a is arranged in a portion of the cam shaft hollow space 2a which is widened in terms of its diameter. The connecting channels 58 and 59 can advantageously be formed as annular spaces which extend circumferentially around the rotational axis R. In the third example embodiment, the inner connecting channel 58 extends between the connecting member 55, which corresponds to the connecting member 45 of the second example embodiment, and the inner sleeve structure 52. The connecting channel 59 extends between the sleeve structure 52 and the surrounding casing portion of the cam shaft 2. As in Figure 7, the feed channels 36 and 37 which lead to the connecting channels 58 and 59 are again shown by continuous lines in Figure 9, although the two feed channels 36 and 37 are offset with respect to each other in the axial direction of the control valve 35, i.e. exhibit a distance from each other as viewed perpendicular to the plane of representation.

Figure 10 shows an example of a preferred embodiment of an engaging structure comprising axially extending engaging elements. In the example, this is a crown toothed gearing. It is assumed in the example that this is the engaging structure 46 or 56 of the phase setter S of the second or third example embodiment. The toothed gearing itself is correspondingly denoted by 47 or 57, respectively.

Figure 11 shows another example of engaging structures comprising axial projections. In the example of Figure 11, these are Hirth toothed gearings which are in the rotational blocking engagement, wherein the reference signs of the second and third example embodiment are again used by way of example. Only the face toothed gearing 47 or 57 of the phase setter engaging structure 46 or 56 can be seen, which is in the rotational blocking engagement with the corresponding face toothed gearing 43 or 53 of the respective cam shaft engaging

structure 41 or 51, respectively. As mentioned, the toothed gearings 43, 53, 47 and 57 are for example Hirth toothed gearings.

It should be noted that the engaging structures 6 and 12 of the first example embodiment can be replaced with engaging structures comprising axial projections and recesses, in particular crown toothed gearings or face toothed gearings, such as for example the toothed gearings shown in Figures 10 and 11. In the second or third example embodiment, the eccentric control valve 35 can conversely be replaced with a centrally arranged control valve corresponding to the control valve 20 of the first example embodiment. In such modifications, the connecting member 45 or 55 would be replaced by the valve housing 21. In particular when the control valve is centrally arranged, it is advantageous if, as is described for example with respect to the first example embodiment, an outlet for the pressure fluid extends between the engaging structures 41 and 46 of the second example embodiment or the engaging structures 51 and 56 of the third example embodiment. The connecting channels 48, 49, 58 and 59 would be omitted, since the required connections would be established via the central control valve. As can be seen in Figure 9, the phase setter engaging structure 51 could also be provided on the drive wheel of the phase setter S – in this case, by way of example, on the drive wheel 50 – i.e. on a bearing structure of the drive wheel 50 instead of on the stator cover 5.

Reference signs:

- 1 first cam shaft
- 1a shaft end piece
- 1b join connection
- 2 second cam shaft
- 2a hollow space
- 2b casing portion
- 3 stator
- 4 stator cover
- 5 stator cover
- 6 phase setter engaging structure
- 7 toothed gearing
- 8 outlet
- 9 rotor

- 9.1 feed channel
- 9.2 feed channel
- 10 drive wheel
- 11 toothed gearing
- 12 cam shaft engaging structure
- 13 toothed gearing
- 14 screw connection
- 15 cam shaft
- 16 output wheel
- 17 toothed gearing
- 18 attachment housing
- 19 fluid channel
- 20 control valve
- 21 valve housing
- 21a connecting portion
- 22 valve piston
- 23 piston space
- 24 spring member
- 25 coupling member
- 26 front-facing closure wall
- 27 coil
- 28 anchor
- 29 pressure storage
- 30 latching device
- 31 latching member
- 32 latching member
- 33 spring member
- 34 —
- 35 control valve
- 36 feed channel
- 37 feed channel
- 38 rotary bearing
- 39 rotary bearing
- 40 drive wheel

- 41 cam shaft engaging structure
- 42 sleeve structure
- 43 toothed gearing
- 44 shaft seal
- 45 connecting member
- 46 phase setter engaging structure
- 47 toothed gearing
- 48 first connecting channel
- 49 second connecting channel
- 50 drive wheel
- 51 cam shaft engaging structure
- 52 sleeve structure
- 53 toothed gearing
- 54 shaft seal
- 55 connecting member
- 56 phase setter engaging structure
- 57 toothed gearing
- 58 first connecting channel
- 59 second connecting channel

- K_1 early setting chamber
- K_2 late setting chamber
- M machine housing, cylinder head cover, cylinder head
- P_s valve inlet
- R rotational axis
- S phase setter

SZABADALMI IGÉNYPONTOK

1. Készülék belsőégésű motor összekapcsolt bütyköstengelyei relatív elfordulási szöghelyzetének állítására, amely készülék magában foglal:

(a) egy tengely-egységet egy első bütyköstengellyel (1) és egy második bütyköstengellyel (2), amelyek közül az egyik legalább egy tengelyirányú tengelyszakaszon a másikon terjed ki, és amelyek egymáshoz képest elforgathatók,

(b) egy fázisállítót (S), amely a tengely-egység egy tengelyirányú végén szerelési egységként van szerelve, és van egy, az első bütyköstengellyel (1) együttforgó módon összekötött állórésze (3) és egy az állórész (3) által forgással hajtott, az állórészhez (3) képest az elfordulási szög tekintetében állítható forgórésze (9),

(c) egy összekötő berendezést (2a, 14, 21; 2a, 14, 45; 2a, 14, 55), amely a fázisállítót (S) tengelyirányban a tengely-egységen rögzíti, és a forgórészt (9) együttforgó módon összeköti a második bütyköstengellyel (2), és

(d) egy az első bütyköstengellyel (1) és az állórésszel (3) együttforgó hajtókereket (10; 40; 50) az első bütyköstengely (1) és az állórész (3) forgóhajtásához,

(e) ahol egy, az első bütyköstengellyel (1) együttforgó bütyköstengely-bekapcsoló szerkezet (12; 41; 51) és egy az állórésszel (3) együttforgó fázisállító-bekapcsoló szerkezet (6; 46; 56) elfordulásbiztos kapcsolódásban tengelyirányban egymásba van csúsztatva, és alakzárás révén elfordulásbiztosan össze van kötve az első bütyköstengellyel (1),

azzal jellemezve, hogy

(f) a hajtókerék (10) képezi a bütyköstengely-bekapcsoló szerkezetet (12).

2. Az 1. igénypont szerinti készülék, azzal jellemezve, hogy az állórész (3) egy fázisállító-háznak (3, 4, 5) az együttforgó alkotórésze, a fázisállító-ház (3, 4, 5) az összekötő berendezés (2a, 14, 21; 2a, 14, 45; 2a, 14, 55) segítségével a tengely-egységen tengelyirányban van rögzítve, és a fázisállító-bekapcsoló szerkezet (6) a fázisállító-házban (3, 4, 5) áll rendelkezésre, ahol egy előnyös kivitelben a fázisállító-bekapcsoló szerkezet (6; 46; 56) a fázisállító-házon (3, 4, 5) kívülről hozzáférhetően van elhelyezve, úgyhogy a fázisállító (S) a fázisállító-háznak (3, 4, 5) az első

bütyköstengelyhez (1) képest történő tengelyirányú mozgásával előállítható az elfordulásbiztos kapcsolódás.

3. Az előző igénypontok szerinti készülék, azzal jellemezve, hogy

- az állórész (3) egy fázisállító-háznak (3, 4, 5) az együttforgó alkotórésze,
- a fázisállító-házban (3, 4, 5) ki van alakítva egy korai állító kamra (K_1) a forgórészre (9) az állórészhez (3) képest előresietési irányban ható forgatónyomaték létrehozásához és egy utóállító kamra (K_2) a forgórészre (9) az állórészhez (3) képest késési irányban ható forgatónyomaték létrehozásához, továbbá

- a korai állító kamra (K_1) és az utóállító kamra (K_2) a mindenkori forgatónyomaték létrehozásához egy nyomóközeggel terhelhető, hogy a forgórész (9) elfordulási szöghelyzetét az állórészhez (3) képest állítani lehessen,

- ahol a fázisállító-bekapcsoló szerkezet (6; 46; 56) előnyös módon a fázisállító-házban (3, 4, 5) áll rendelkezésre.

4. Az előző igénypontok egyike szerinti készülék, azzal jellemezve, hogy vagy az első bütyköstengely (1) van forgással hajtva a hajtókeréken (10) át, és az elfordulásbiztos kapcsolódásban az állórészre (3) gyakorol hajtást, úgyhogy a fázisállító-bekapcsoló szerkezet (6) egy állórész-forgató menesztőt képez, vagy az állórész (3) van forgással hajtva a hajtókeréken (40; 50) át, és az elfordulásbiztos kapcsolódásban az első bütyköstengelyre (1) gyakorol hajtást, úgyhogy a bütyköstengely-bekapcsoló szerkezet (41; 51) egy bütyköstengely-forgató menesztőt képez.

5. Az előző igénypontok egyike szerinti készülék, azzal jellemezve, hogy a bekapcsoló szerkezetek (41, 46; 51, 56) egyikének a forgástengely (R) körül elosztva több, legalább lényegében tengelyirányban kiemelkedő bekapcsoló eleme, a bekapcsoló szerkezetek (41, 46; 51, 56) másikának pedig a forgástengely (R) körül elosztva több, a bekapcsoló elemekkel komplementer bekapcsoló elleneleme van, és a bekapcsoló elemek az elfordulásbiztos kapcsolódásban legalább lényegében tengelyirányban bekapcsolódnak a bekapcsoló ellenelemekbe vagy ezek közé, amely bekapcsoló elemek és bekapcsoló ellenelemek előnyös módon fogazások (43, 47; 53, 57), például koronakerekes vagy síkkerekes fogazások fogai, illetve fogárkai.

6. Az előző igénypontok egyike szerinti készülék, azzal jellemezve, hogy a hajtókeréknek (10; 40; 50) a hajtókerék (10; 40; 50) forgóhajtásához körben van egy fogazása (11), és a bütyköstengely-bekapcsoló szerkezet (12; 41; 51) vagy ehhez a fogazáshoz (11) áll rendelkezésre kiegészítésként például a hajtókeréken (10),

vagy a fogazásnak (11) van egy tengelyirányú szakasza a forgóhajtás számára, és egy másik tengelyirányú szakasszal a bűtyköstengely-bekapcsoló szerkezetet (12) képezi.

7. Az előző igénypontok egyike szerinti készülék, azzal jellemezve, hogy a fázisállítónak az elfordulási szöghelyzet hidraulikus állítása számára, amely szöghelyzetet a forgórész (9) az állórészhez (3) képest felvesz, van egy bevezetése (P_a) és egy kivezetése (8) egy nyomóközeg számára, és a kivezetés (8) a bekapcsoló szerkezetek (6, 12) között az elfordulásbiztos kapcsolódás területén terjed ki.

8. Az előző igénypontok egyike és a következő jellemzők legalább egyike szerinti készülék:

(i) a bekapcsoló szerkezeteknek (6, 12; 41, 46; 51, 56) egy közös forgástengely (R) körül kiterjedő bekapcsoló felületei (7, 13; 43, 47; 53, 57) vannak, amelyek egymással elfordulásbiztos kapcsolódásban vannak,

(ii) a bekapcsoló szerkezeteknek (6, 12) egy közös forgástengely (R) körül van egy-egy bekapcsoló felülete (7, 13), amelyek közül az egyiket egy kerületi külső felület (13), a másikat pedig a kerületi külső felületet körülvevő kerületi belső felület (7) képezi, amely bekapcsoló felületek keresztmetszetben nézve nem kör alakúak, és egymással elfordulásbiztos kapcsolódásban vannak,

(iii) a bekapcsoló szerkezeteknek (6, 12; 41, 46; 51, 56) egy közös forgástengely (R) körül van egy-egy fogazása (7, 11; 43, 47; 53, 57), és a fogazások (7, 11; 43, 47; 53, 57) előnyös módon egy külső fogazás és egy belső fogazás, vagy koronakerekes vagy síkkerekes fogazások, egymással elfordulásbiztos kapcsolódásban vannak.

9. Az előző igénypontok egyike szerinti készülék, azzal jellemezve, hogy a fázisállító (S) magában foglal egy, az állórészre (3) és a forgórészre (9) vonatkozóan központi szabályozószelepet (20) a forgórész (9) elfordulási szöghelyzetének áramló közeges állítása számára, és a szabályozószelep (20) a tengely-egység tengelyirányú végén elmozdíthatatlanul össze van kötve a második bűtyköstengellyel (2), előnyös módon benyúlik a második bűtyköstengelybe (2), amely szabályozószelep (20) előnyös módon a második bűtyköstengely (2) egy üreges terében (2a) szilárdan össze van kötve, előnyös módon össze van csavarozva a második bűtyköstengellyel (2).

10. Az előző igénypontok egyike szerinti készülék, azzal jellemezve, hogy

- a fázisállító-házban (3, 4, 5) ki van alakítva egy korai állító kamra (K_1) a forgórészre (9) az állórészhez (3) képest előresietési irányban ható forgatónyomaték létrehozására és egy utóállító kamra (K_2) a forgórészre (9) az állórészhez (3) képest késési irányban ható forgatónyomaték létrehozására,

- a korai állító kamra (K_1) és az utóállító kamra (K_2) a mindenkor forgatónyomaték létrehozásához egy nyomóközeggel terhelhető, hogy a forgórész (9) elfordulási szöghelyzetét az állórészhez (3) képest állítani lehessen,

- az összekötő berendezés (2a, 14, 45; 2a, 14, 55) magában foglal egy az egyik végen a második bűtköstengelyben (2) kiterjedő üreges teret (2a) és egy, az üreges térbe (2a) nyúló, az üreges térben (2a) a második bűtköstengellyel (2) szilárdan összekötött összekötő tagot (45; 55), és

- az üreges tér (2a) területén sugárirányban a második bűtköstengely (2) és az összekötő tag (45; 55) között, tengelyirányban egy első összekötő csatorna (48; 58) terjed ki, amelyen át a nyomóközeg a korai állító kamra (K_1) és az utóállító kamra (K_2) közül az egyikhez vezethető,

- amely első összekötő csatorna (48; 58) előnyös módon egy, a forgástengely (R) körül kiterjedő gyűrűs tér.

11. Az előző igénypontok egyike szerinti készülék, azzal jellemezve, hogy

- a második bűtköstengelynek (2) a fázisállító (S) felé néző végén egy perselyes szerkezet (42; 52) van elhelyezve, és együttforgó módon össze van kötve a második bűtköstengellyel (2),

- a második bűtköstengely (2) a perselyes szerkezettel (42; 52) egy második összekötő csatornát (49; 59) határol, amelyen át a nyomóközeg a korai állító kamra (K_1) és az utóállító kamra (K_2) közül az egyikhez vezethető, és

- a perselyes szerkezet (42) körülveszi a második bűtköstengelyt (2), és az első összekötő csatorna (48) sugárirányban a második bűtköstengely (2) és az összekötő tag (45) között terjed ki, vagy a második bűtköstengely (2) körülveszi a perselyes szerkezetet (52), és az első összekötő csatorna (58) sugárirányban a perselyes szerkezet (52) és az összekötő tag (55) között terjed ki.

12. Az előző igénypontok egyike szerinti készülék, azzal jellemezve, hogy az állórész (3) egy fázisállító-háznak (3, 4, 5) az együttforgó alkotórésze, és a fázisállító-ház (3, 4, 5) egy forgócsapágyban (44; 54) a belsőégésű motor motorházán (M) forgathatóan van megtámasztva.

13. Az előző igénypontok egyike szerinti készülék fázisállítója, amely

fázisállító magában foglal:

(a) egy állórészt (3), amely a fázisállító forgástengelyére (R) vonatkozóan forgásszimmetrikus fázisállító-ház (3, 4, 5) képez,

(b) egy, a fázisállító-házban (3, 4, 5) befogadott, a forgástengely (R) körül az elfordulási szög tekintetében az állórészhez (3) képest állítható forgórészt (9),

(c) egy összekötő tagot (21; 45; 55) a forgórésznek (9) a második bűtköstengelyen (2) való, együttforgó rögzítése érdekében,

(d) és egy, a fázisállító-házzal (3, 4, 5) együttforgó, tengelyirányban kiterjedő fázisállító-bekapcsoló szerkezetet (6; 46; 56) egy alakzáráson nyugvó, elfordulásbiztos kapcsolódás előállításához, amely az állórészt (3) az első bűtköstengellyel (1) a fázisállító szerelések elfordulásbiztosan köti össze,

(e) amely fázisállító-bekapcsoló szerkezet (6; 46; 56) úgy van kialakítva, hogy a fázisállító (S) szerelések tengelyirányban az elfordulásbiztos kapcsolódásba tolható egy, az első bűtköstengellyel (1) együttforgó bűtköstengely-bekapcsoló szerkezetben (12; 41; 51) vagy ezen vagy ehhez képest.

14. A 13. igénypont szerinti fázisállító, azzal jellemezve, hogy a fázisállító-bekapcsoló szerkezetnek (6; 46; 56) van egy, a forgástengely (R) körül kiterjedő bekapcsoló felülete (7; 47; 57), amely egy homlokfelület egy legalább lényegében csak tengelyirányú homlokoldali bekapcsolódás számára, vagy egy kerületi felület egy kerületi bekapcsolódás számára, amely bekapcsoló felületet (7; 47; 57) előnyös módon egy legalább két, kerületi irányban egymástól bizonyos távolságra lévő, a fázisállító-bekapcsoló szerkezet (46; 56) egyik homlokoldalán legalább lényegében tengelyirányban kiemelkedő foggal rendelkező fogazás (47; 57), vagy egy, legalább két, kerületi irányban egymástól bizonyos távolságra lévő, a fázisállító-bekapcsoló szerkezet (6) egyik belső vagy külső kerületén sugárirányban kiemelkedő foggal rendelkező fogazás (7) képez.

15. A 14. igénypont szerinti fázisállító, azzal jellemezve, hogy a forgórésznek (9) van legalább egy forgórész-szárnya, amely a forgórész (9) agyától az állórész (3) belső kerületi felületének irányában emelkedik ki, és egy, az állórész (3) által mindkét kerületi irányban határolt kamrát egy korai állító kamrára (K_1) és egy utóállító kamrára (K_2) oszt.

(A meghatalmazott)

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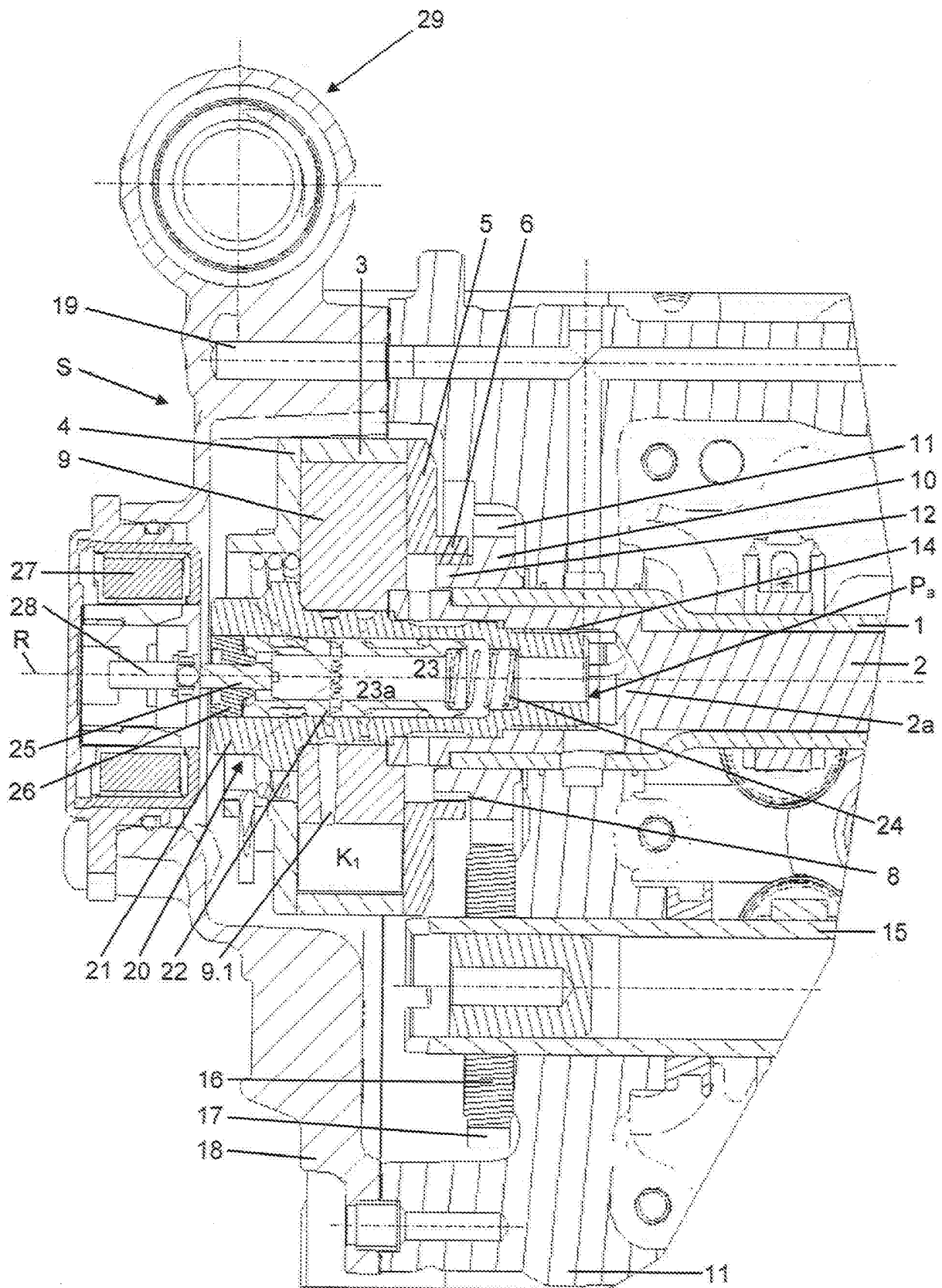


Figure 1

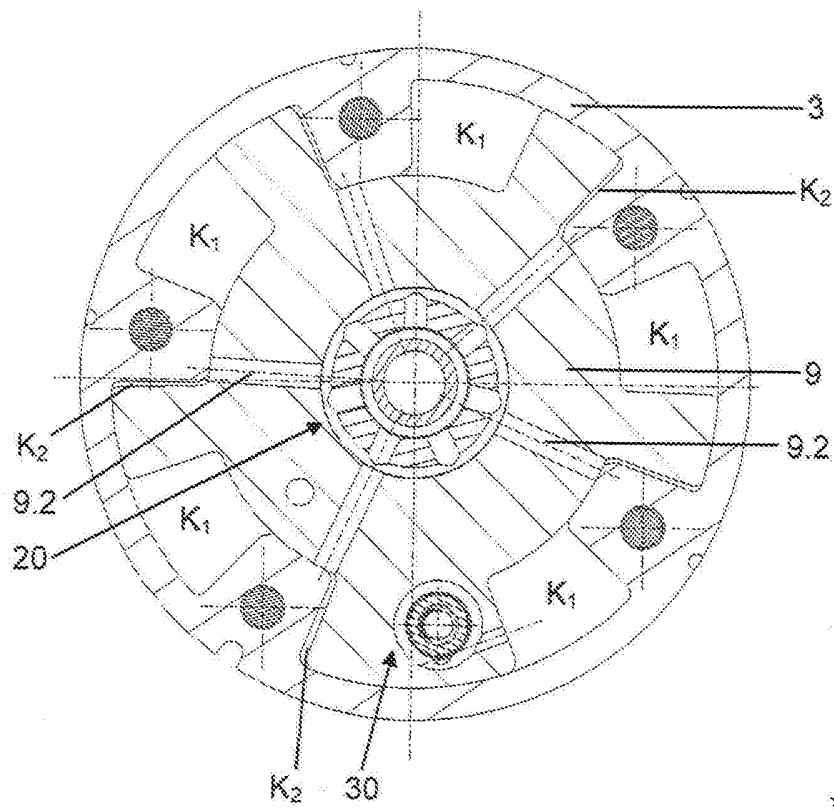


Figure 2

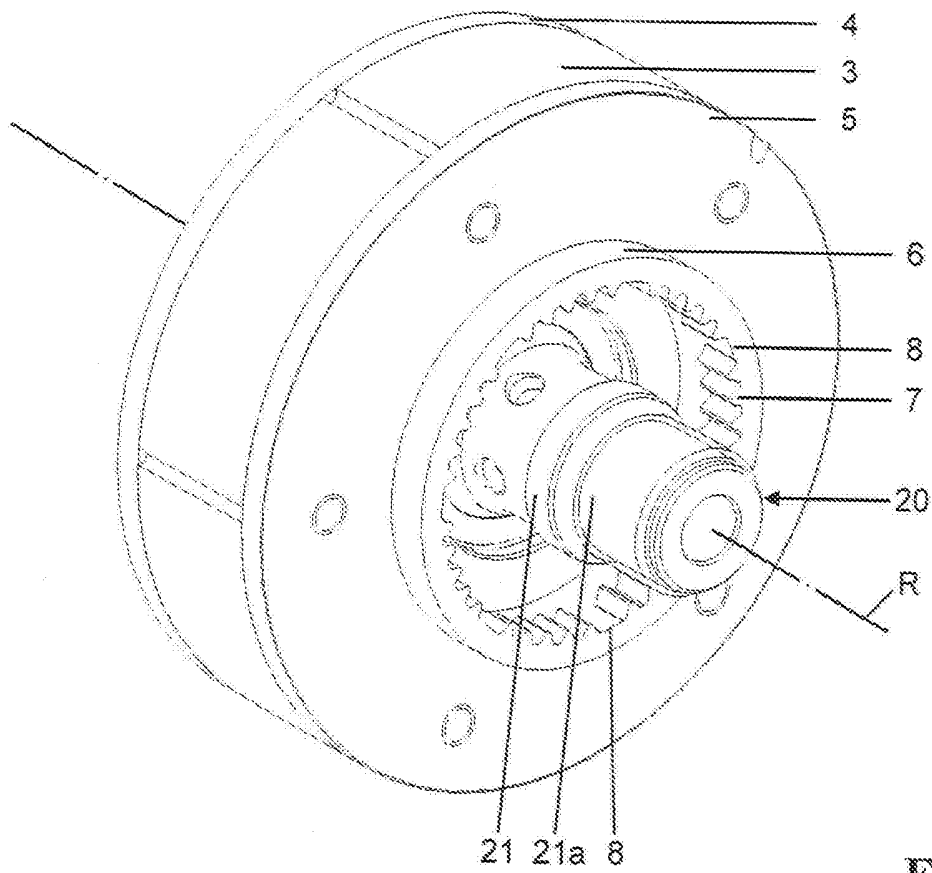
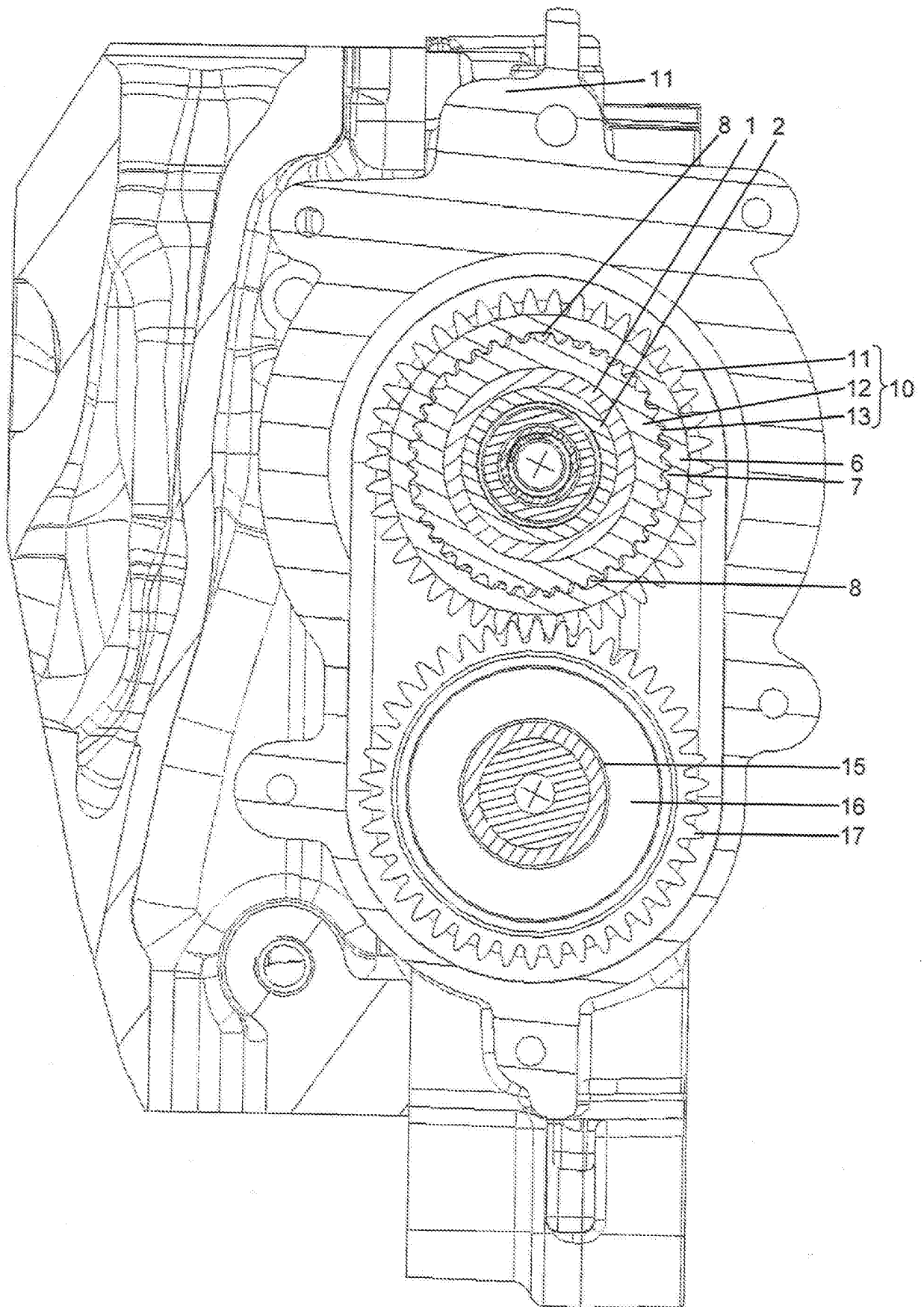


Figure 6

**Figure 3**

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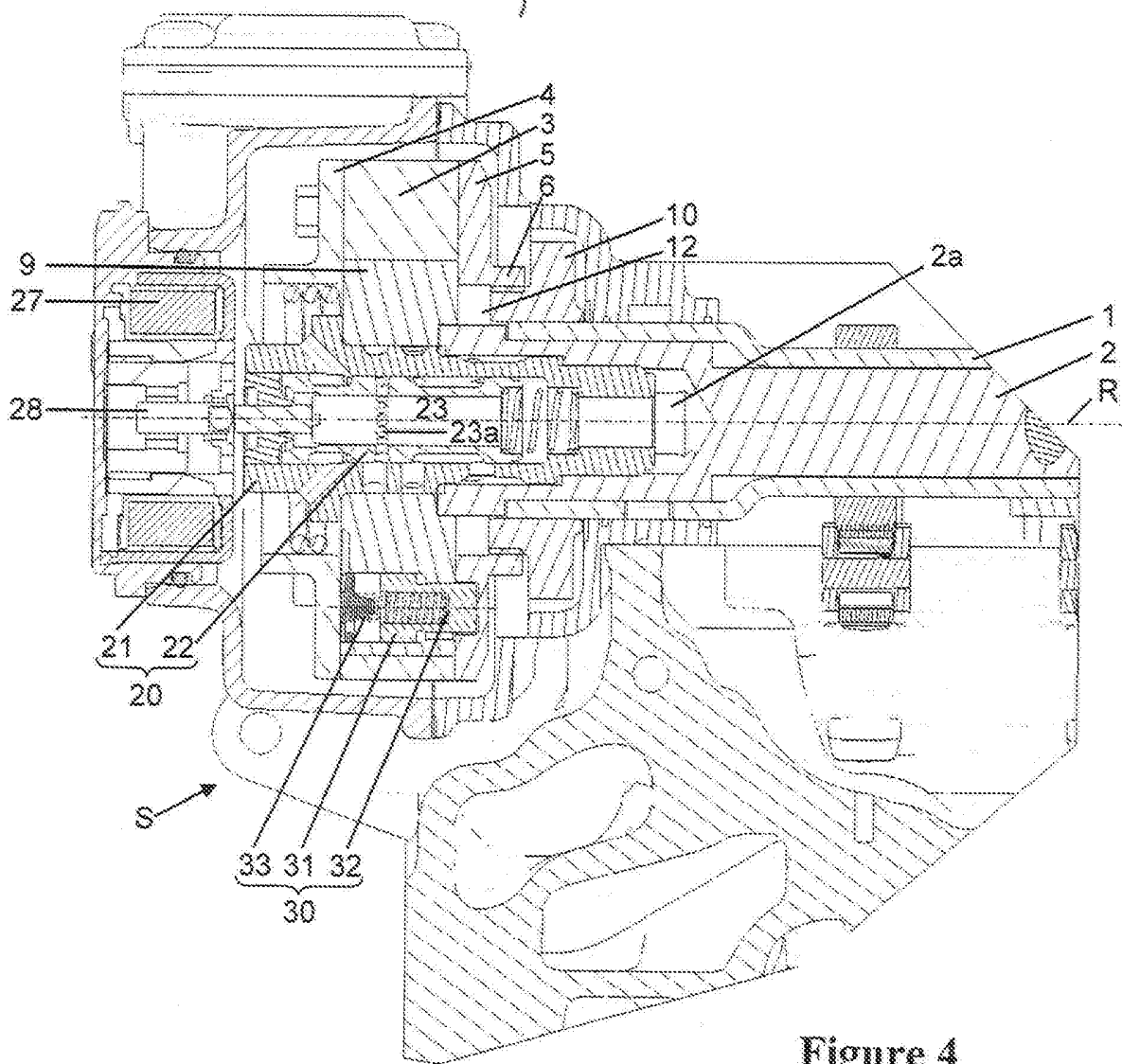


Figure 4

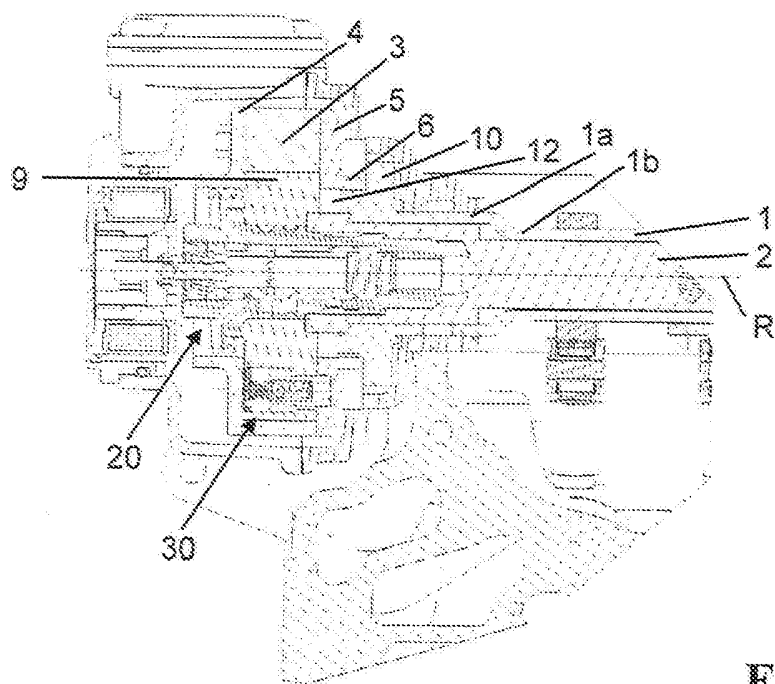


Figure 5

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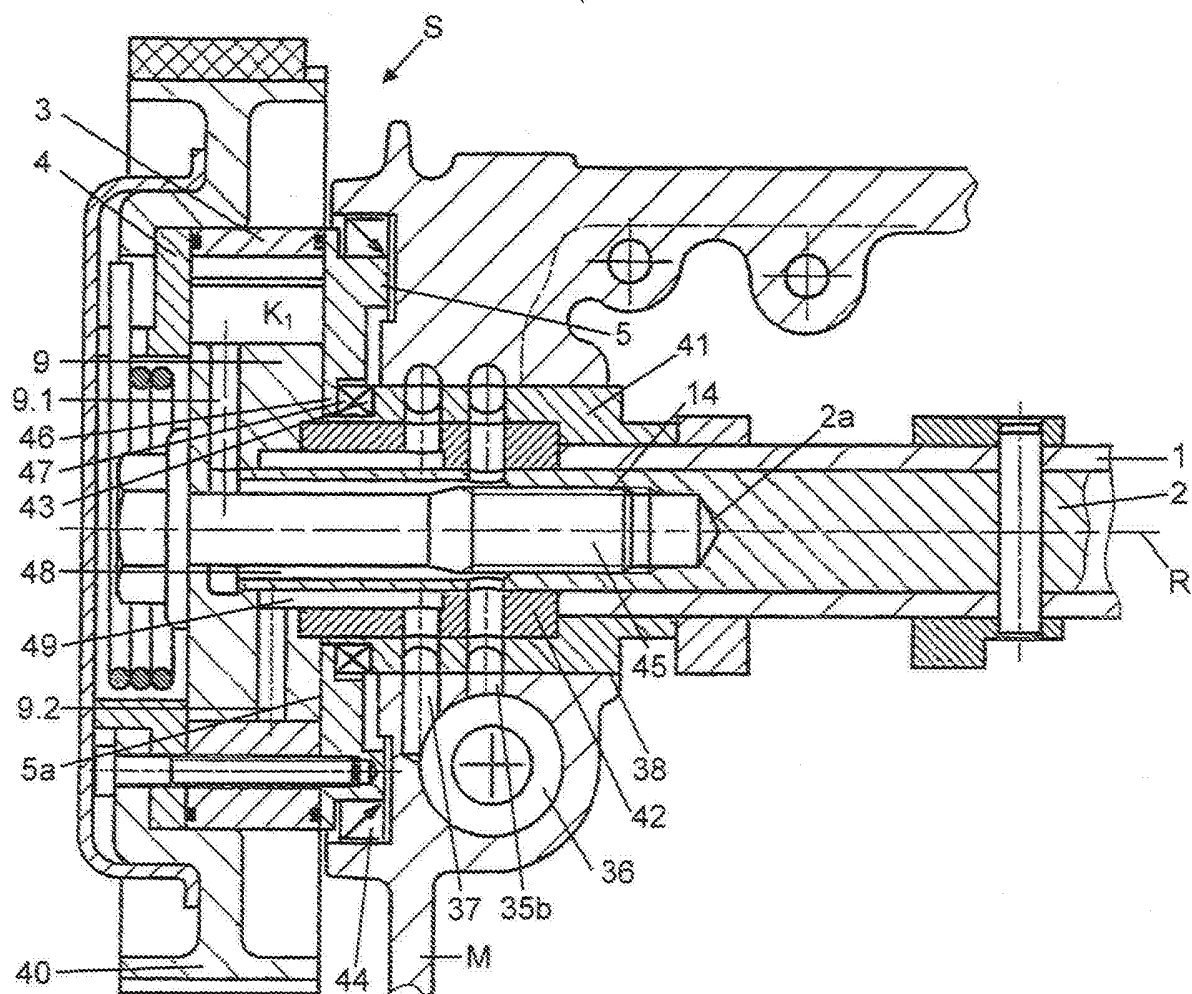


Figure 7

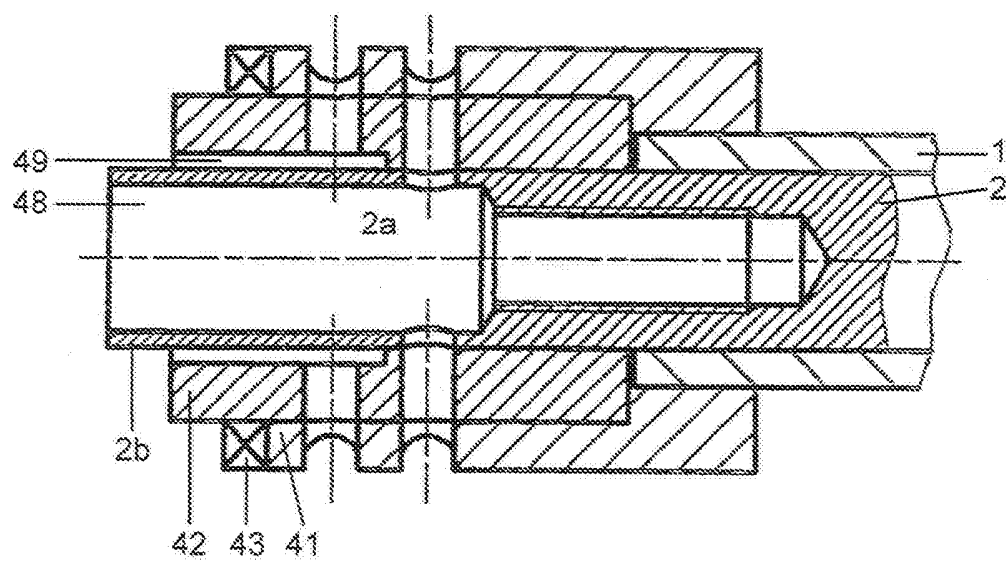


Figure 8

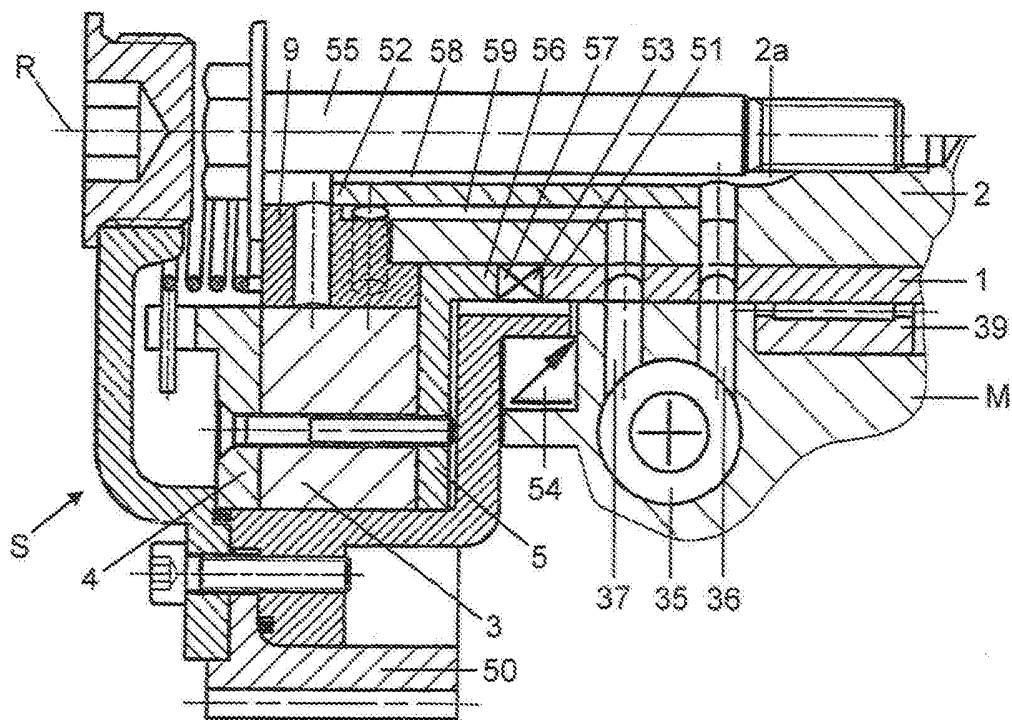


Figure 9

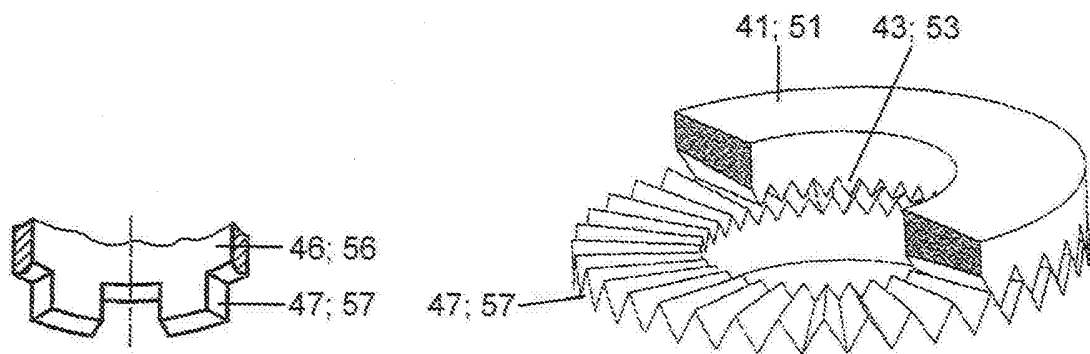


Figure 10

Figure 11