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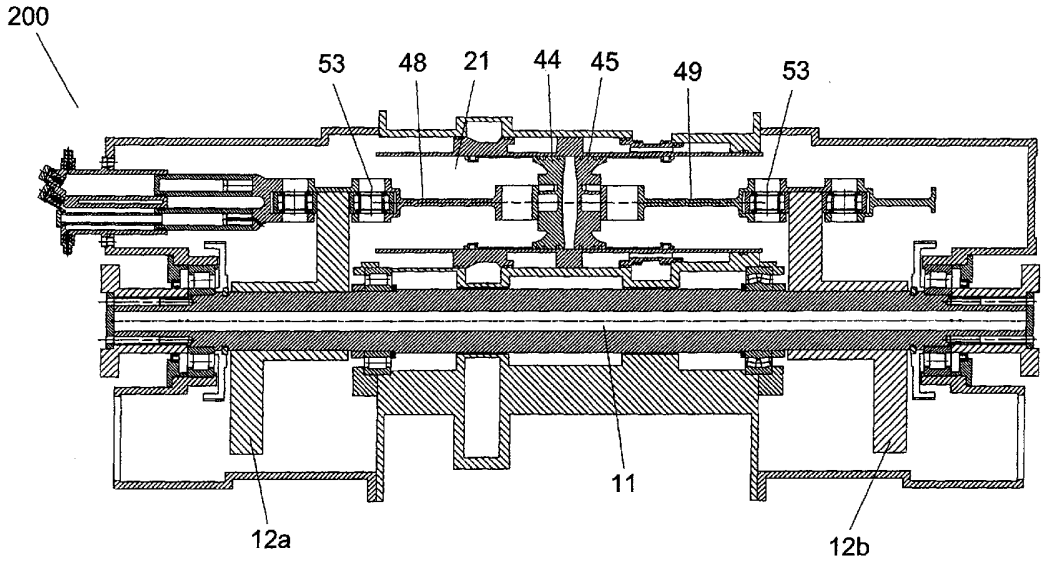
(54) Title: ARRANGEMENT IN A TWO CYCLE COMBUSTION ENGINE




(57) Abstract: Device for a two-stroke combustion engine (10) with internal combustion, comprising a number of engine cylinders (21; 21-1 -21-5), where each cylinder encompasses a pair of pistons (44, 45) which can move to and from each other and for each piston pair a common, intermediate working chamber (K), while each piston (44, 45) is equipped with its own axially moveable piston rod (48, 49), the outer end of which, by way of a support roller, pushes against its respective curve-shaped, i.e. sine curve shaped, cam guide assembly (12a, 12b). A pump system (200), comprising a piston - and a cylinder arrangement is arranged to one or both of the outer ends of the axially moveable piston rods (48, 49).

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# Arrangement in a two cycle combustion engine

The present invention relates to a device for a two-stroke combustion engine as described in the preamble of the independent claim 1.

The invention is a further development of the applicant's own Norwegian Patent NO 305619 that is incorporated here by reference.

Vibration and noise are problems with many engines, especially two-stroke engines. Even if the engine as described in NO 305619 functions satisfactorily in the main, there is still room for improvements related to the mentioned vibration and noise. To improve these, it is suggested in the present invention to integrate a hydraulic motor in the form of a pump system, which also functions as a vibration dampener system, and which comprises a piston arrangement and a cylinder arrangement.

A second and further object of the invention is to provide a system that can provide further energy from the mentioned engine. For example, this can be done in that both fluid under low pressure and/or fluid under high pressure can be drawn out from the pump system, which thereafter can be used to drive other applications, either internally in the engine and/or in external applications.

Advantages with the present solution are that there are no transmissions such as gear, chain or belt. Thus power losses through friction and several moving parts are avoided, and this also provides a dampening system.

The objects according to the present invention are achieved by a pump system which is arranged in connection with axially movable piston rods in the engine. The invention is further characterized by the characteristic part of the independent claim 1. Alternative embodiments are characterized by the dependent claims.

The invention shall now be described further with reference to the enclosed figures, in which:

Fig. 1 shows a vertical cross-section of an engine according to the invention.

Fig. 2 shows in a section corresponding to fig. 1, vital parts of the engine.

Fig. 3 shows schematically illustrated and spread out in the plane of the drawing a more detailed movement pattern for the two pistons of each cylinder, shown in different angle positions in relation to the rotating movement of the drive shaft, shown in connection with a five-cylindered engine.

Fig. 4 shows in a corresponding view to fig. 3, the pistons in their respective positions in relation to the associated cylinders, in a subsequent working position.

Fig. 5 shows a pump system according to the invention connected to a piston rod.

Fig. 6 shows a pump system corresponding to fig. 5, shown as an example on one side in an alternative embodiment of an engine.

Generally, in connection with fig.1, reference will be made to a two-stroke combustion engine 10 with internal combustion. In particular, an engine 10 adapted according to a so-called sine concept is described. Shown in particular in fig. 1, is a combustion engine 10 according to the invention, depicted in cross-section and in a schematic way.

In the embodiment example shown in fig. 1, a drive shaft 11 is shown in the form of a drive stump shaft, that runs through the engine 10, axially and centrally.

The drive shaft 11 is equipped at its one end with a radially outwardly extending first head section 12a, which forms a first cam guide assembly. At its other end, the drive shaft 11 is equipped with a corresponding radially outwardly extending second head section 12b, which forms a second cam guide assembly.

In the embodiment example shown, the head sections/cam guide assemblies 12a, 12b are presented separately and each is individually connected to the drive shaft 11 with their own securing means.

The cam guide assembly 12a encloses the drive shaft 11 at its one end 11a and forms an end support against the

end plate 11b of the drive shaft 11 by way of a fastening flange 12a' and is permanently secured to the drive shaft by way of securing screws 12a''.

The cam guide assembly 12b encloses a thickened section 11c of the drive shaft 11 at its opposite end section 11d. The cam guide assembly 12b is not secured directly to the drive shaft 11, as is the cam guide assembly 12a but, in contrast, is arranged so that it can be moved axially a limited extent axially along the drive shaft 11, especially with respect to be able to regulate the compression ratio in the cylinders 21 of the engine 10 (only one of a number of cylinders is shown in fig. 1).

The end section 11d of the drive shaft 11 (see fig. 1) forms a radially graduated sleeve section, fastened to which is a dish-formed carrying member 13. The carrying member 13 is equipped with a fastening flange 13' which is secured to the end section 11d of the drive shaft 11 with securing screws 13''. An oil pressure chamber 13b is situated between the upper end plate 13a of the carrying member 13 and an opposite shoulder plate 11e in the drive shaft 11. A compression adjuster 12b', in the form of a piston-forming guiding flange, is received in the oil pressure chamber 13b so that it can glide, and which extends from the inside of the cam guide assembly 12b radially inwards in the oil pressure chamber 13b to abut such that it can glide against the outer surface of the end section 11d.

To prevent mutual rotation between the cam guide assembly 12b and the carrying member 13 and the drive shaft 11, respectively, a series of guiding pins 12', which are anchored in individual bores in the end section 13a of the carrying member 13 in the shoulder plate 11e of the drive shaft 11, respectively, runs through the guiding flange 12b'.

The oil pressure chamber 13b is supplied with pressure oil and drained of pressure oil, respectively, by way of transverse-running channels 11f and 11g through the end section 11d of the drive shaft 11.

An oil-feeding means 14, which is plunged axially inwards into the mutually running axial bores in the end section 11d of the drive shaft 11 and in the fastening flange 13' of the carrying member 13, respectively, ensures that the pressure oil and return oil, respectively, are led to and from the channels 11f and 11g by way of separate guiding channels 14a and 14b and adjoining annular grooves 14a'and 14b' in the oil-feeding means 14, respectively.

Control of pressure oil and return oil to and from the oil pressure chamber 13b on opposite sides of the compression adjuster 12b' of the cam guide assembly 12b is carried out from a remote, not further shown, ordinary control device, in a way not further shown.

The drive shaft 11, as shown in fig.1, is connected at opposite ends with corresponding drive shaft sleeves 15a and 15b. The sleeve 15a is fastened to the cam guide assembly 12a with securing screws 15a', while the sleeve 15b is fastened to the carrying member 13 with securing screws 15b'. The sleeves 15a and 15b are rotatably mounted in one of two opposite main journal bearings 16a, 16b, which are fastened at the opposite ends of the engine 10 in one of the end covers 17a and 17b, respectively.

The end covers 17a and 17b are correspondingly secured, as shown in fig.1, to an intermediate engine block 17 with the aid of securing screws 17'.

Inside the engine 10, a first lubricating oil chamber 17c is defined between the end cover 17a and the engine block 17 and a second lubricating oil chamber 17d between the end cover 17b and the engine block 17. An extra oil jacket 17e in connection with the end cover 17b and an external oil tube 17f between the lubricating oil chamber 17c and the oil jacket 17e is shown. Also shown is a suction strainer 17g in connection with a lubricating oil tube 17h that forms communication between the lubricating oil chamber 17d and an external lubricating oil arrangement (not further shown).

The oil-feeding means 14 is equipped with a cover-forming head section 14c which is secured to the end cover 17b of the engine 10 with securing screws 14c'. The cover-forming head section 14c makes a seal in relation to the lubricating oil chamber 17c outside the journal bearing 16b. Correspondingly, to the end cover 17a is secured a sealing cover 14d with corresponding sealing ring 14e outside the journal bearing 16a.

Consequently, the engine 10 is generally built up of a driven part, i.e. a rotatory part, and a driving component, i.e. a non-rotating part. The driven component comprises the drive shaft 11 of the engine and the carrying member 13 of the drive shaft and drive shaft sleeves 15a, 15b as well as cam guide assemblies 12a and 12b, which are connected to the drive shaft 11. The driving, non-rotating component comprises the cylinders 21 of the engine with associated pistons 44, 45.

A regulation of the compression ratio of the engine is ensured by carrying out an internal regulation, i.e. mutually between the different items in the driven component. More specifically, the one cam guide assembly 12b is axially displaced to and fro in relation to the drive shaft 11, i.e. within the bound movement space in the mentioned oil pressure chamber 13a, which is given by the guiding flange 12b' and the sub-chamber of the oil chamber 13a on the opposite sides of the guiding flange 12b'.

In practice, this amounts to a regulation length of a few millimetres for smaller engines and a few centimetres for larger engines. However, the respective volume differences in the associated working chambers have a corresponding compression effect in the different engines.

For example, a stepwise or stepless regulation of the compression ratio according to need can be imagined, for example adjusted with graded control of the cam guide assembly 12b to the respective positions in relation to the drive shaft 11. The control can, for example, be automatic with the aid of in itself known electronics, based on different temperature sensor equipment, etc.

Alternatively, the control can be by manual control by way of suitable regulating means, which are not further shown here.

By carrying out the regulating of the cam guide assembly 12b connected to the driven component of the engine, one avoids influencing the general control of the arrangement for the associated piston 44, piston rod 48, main support wheel 53 and auxiliary wheel 55, i.e. one avoids influencing the mechanical connection itself between the driving component and the driven component.

On the other hand, one obtains by such a regulation of the cam guide assembly 12b, an axial regulation inside the driving component, in such a way that the arrangement of piston 44, piston rod 48, main support wheel 53 and auxiliary wheel 55 can be moved together by way of the cam guide assembly 12b in relation to the associated cylinder 21, independent of the actual compression regulation in practice.

In figs. 1 and 2, the dotted line indicates a centre distance 44' between the piston heads in the pistons 44,45 at normal compression ratio when the cam guide assembly 12b takes up the position shown in fig.1. The solid line indicates a centre distance 44'' between the piston heads in the pistons 44,45 when the guiding flange 12b' of the cam guide assembly 12b is fully pushed up towards the shoulder plate 11e in the piston rod 11.

The engine 10 is shown divided into three stationary main components, i.e. a middle section which makes up the engine block 17 and the two cover-forming housing members 17a,17b, which are arranged at the respective ends of the engine 10. Consequently, the housing members 17b,17c are adapted to cover their respective cam guide assembly 12a,12b, support wheels 53 and 55 and their associated mounting in the respective piston rods 48,49 at their respective ends of the engine block 17. Therefore, all of the driving and driven components of the engine are effectively housed in the engine 10 and received in an oil

bath in the associated lubricating oil chambers 17c and 17d.

In the engine block 17 there is in the shown embodiment example, used in connection with a three-cylinder engine, correspondingly formed with three circumferentially separated engine cylinders 21. Only one of the cylinders 21 is shown in figs. 1 and 2.

The three cylinders 21, which are placed around the drive shaft 11 with a mutual angle distance of 120°, are according to the shown embodiment example, shaped as separate cylinder-forming inserted members, which are placed in a corresponding bore in the engine block 17.

A sleeve-formed cylinder bushing 23 is inserted into each cylinder/cylinder part 21. Formed in the bushing 23 are an annular series of scavenging ports 24 at the one end of the bushing 23 and a annular series of exhaust ports 25 at the other end of the bushing 23.

Correspondingly, scavenging nozzles 26 are arranged in the wall 21a of the cylinders 21, which run radially with the scavenging ports 24 of the bushing 23, while exhaust ports 27, which run radially with the exhaust ports 25 of the bushing, are correspondingly formed in the cylinder wall 21a.

In fig. 1, an annular inlet channel 28 for scavenging air is shown, which encases the scavenging ports 26, and a radially, externally lying scavenging air inlet 29.

Furthermore, shown in fig.1 is an annular exhaust outlet channel 30 that surrounds the exhaust ports 27 as well as a radially, outwardly extending exhaust outlet 31.

In the following, with reference to figs. 3 and 4, a preferred embodiment example of the sine concept in connection with a five cylinder, two-stroke combustion engine with two associated, mutually diverging cam guide curves 8a and 8b, shall be described in more detail.

In figs. 3 and 4, the five cylinders 21-1, 21-2, 21-3, 21-4 and 21-5 of the engine and associated two curves 8a and two curves 8b, respectively, are presented schematically, shown folded out in a schematically

illustrative way in one and the same plane. The five cylinders 21-1, 21-2, 21-3, 21-4 and 21-5 are shown in their respective angle positions with a mutual angle interval of 72°, i.e. in positions that are evenly distributed around the axis of the rotation shaft 11.

For an engine with five cylinders, such as shown in figs. 3 and 4, for each 360° rotation, a sine curve with two sine tops and two sine bottoms and between-lying four inclined planes, i.e. two sine planes arranged after each other in each cam guide assembly 12a,12b, is used, so that one obtains four strokes for each of the two pistons of the five cylinders for each rotation.

In the embodiment example shown, the support rollers for the pistons are placed with correspondingly equal angle intervals, i.e. in the corresponding rotating angle positions along the sine curve, so that they in turn are subjected to corresponding piston movements in corresponding positions along the respective sine planes.

The engine power is consequently transferred in turn from the different pistons 44,45 by way of the support rollers 53 in the axial direction to the drive shaft 11 by way of respective sine curves with their own sine planes, and the drive shaft 11 is thereby subjected to a forced rotation around its axis. This takes place in that the piston rods of the engine are moved in parallel with the longitudinal direction of the drive shaft and the support rollers of the piston rods are forced to roll along the sine planes. Thereby, the power of the engine is transferred in the axial direction from the support rollers of the piston rods to the sine planes, which are forced to rotate together with the drive shaft 11 around it axis. In other words, one obtains transmission of driving power from one oscillating piston movement to a rotational movement in the drive shaft, in that the driving power is transmitted directly from the respective large roller of the piston rods to the sine plane of the drive shaft.

Figure 5 shows a pump system 200 according to the invention, rigidly arranged to the outer end of the

axially moveable piston rod 48. The pump system shall preferably be a hydraulic pump system, but a pneumatic pump system or a pump system that uses other fluids can also be used. The pump system comprises a piston- and a cylinder arrangement that can comprise a low-pressure piston 202 with associated low-pressure cylinder 204 and a high-pressure piston 206 with associated high-pressure cylinder 208. Also arranged to each of the cylinder chambers 204,208 are respective nipples/valves 210, 212, 214, 216. Control of the nipples/valves is performed in accordance with the piston rods and thus, also the cycle of the engine system.

As mentioned previously, at the end of the piston rod 48, a support wheel 53 and possibly an auxiliary support wheel 55 are arranged, which abut the cam guide assembly 12. This is shown to the right in figure 5. To connect the lower part of the piston rod 48 to the pump system 200, a connecting means 218 (a guide slip) can be used. The connecting means is arranged to provide a rigid connection between the pump system and the lower part of the piston rod, so that the axial power of motion of the piston is transmitted directly to the pistons 202, 206 of the pump system. In the drawing, the connecting means 218 is shown placed between the support wheels 53, but the piston rod 48 with associated components, the connecting means 218 and the lower part 220, can also be cast in one piece, possibly also with the pistons 202, 206.

During operation of the engine 10, the piston rod 48 is driven in an axial direction, in a cycle that is described earlier. This implies that both the low-pressure piston 202 and the high-pressure piston 206 are correspondingly driven in the same cycle. It shall be mentioned that, off course, more pistons/cylinders can be placed in the pump system than that which is shown in figures 5 and 6.

The shape and manner of operation of the pump system 200 is apparent from figures 5 and 6. The cylinder unit, including the cylinders 204, 206 can be permanently

secured to the end covers 17a, 17b, or possibly to the engine block 17. When the low-pressure piston 202 is driven into the low-pressure cylinder 204, a low pressure is built up in the fluid that is in the cylinder 204. This build up of pressure can thereafter be led out through the nipple/valve 210, so that the led out low-pressure fluid can be used to drive other applications. Correspondingly, the high-pressure piston 206 will be driven into the high-pressure cylinder 208, whereupon a high pressure is built up in the fluid that is in the cylinder 208. This build-up of pressure can thereafter be led out through the nipple/valve 212, so that the led out high-pressure fluid can be used to drive other applications. The applications that are driven can be external in relation to the engine, or internal in the engine.

The high-pressure valve 212 and the low-pressure valve 210 can, for example, be shaped as a high-pressure nipple with a ball valve and a low-pressure nipple with a ball valve, respectively. For controlled supply of fluid to the cylinders 204, 208, control valves 214, 216 can be used, which, for example, can be shaped as banjo valves with ball valve.

In the high-pressure cylinder 208, a pipe 224 can be arranged in the same axial direction as the cylinder, to reduce the volume of the cylinder. To prevent build-up of too high pressure inside the pipe 224, it will be natural to provide a discharge channel 222, either in connection to the piston 206 or in connection to the pipe 224.

In the figures, the low-pressure piston 202 is shown with a circular, cylindrical form and the high-pressure piston 206 is shown in the shape of a pipe, but other geometric shapes can also be used. Furthermore, sealing rings of a common, known type are provided, either externally at the ends of the pistons 202, 206, or internally in the cylinders 204, 208 at their open ends, to provide a fluid-tight connection between the mentioned pistons and cylinders.

In addition to that the pump system 200 can be used to provide further tapping of energy from the engine, the pump system will also contribute to an improved vibration and noise reduction in the whole engine system. This is obtained both with the aid of regulation of the valves-/nipples, and also because of the dampening which is achieved in the pipe 224 with the associated discharge channel 222.

The invention is not limited to that which is described in this application, but the pump system can be modified by an expert within the frame of what is given in the enclosed claims.

## Claims

1. Device for a two-stroke combustion engine (10) with internal combustion, comprising a number of engine cylinders (21; 21-1 - 21-5), which are arranged in an annular series around a common, middle drive shaft (11) and having the cylinder axes running in parallel with the drive shaft, with each cylinder containing a pair of pistons (44,45) that can move to and from each other and for each pair of pistons, a common, intermediate working chamber (K), while each piston (44,45) is equipped with its own axially moveable piston rod (48,49), the outer end of which, by way of a support roller (53,55), pushes against their own curve-shaped, i.e. sine curve shaped, cam guide assembly (12a,12b), which is arranged at the opposite ends of each respective cylinder (21;21-1 -21-5), and which control the movements of the piston in relation to the associated cylinder, and where the two pistons (44,45) in each cylinder (21; 21-1 -21-5) has mutually diverging piston phases, which are controlled by the mutually diverting cam guide assemblies (12a,12b), with the cam guide assemblies (12a,12b) being shaped with corresponding mutually diverging sine planes (8a,8b), characterised in that a pump system (200), comprising a piston- and cylinder arrangement, is arranged to one or both of the outer ends of the axially moveable piston rods (48,49).

2. Device in accordance with claim 1, characterised in that the pistons (202, 206) of the pump system (200) are rigidly joined to the outer end of said piston rods (48,49), and that the cylinder unit of the pump system (200), comprising the cylinders (204, 208) is permanently secured to, for example, the end covers 17a, 17b or the engine block 17.

3. Device in accordance with claim 2, characterised in that the pistons (202, 206) are arranged to be driven, in accordance with the cycle of the engine system, into and out of the cylinders (204, 208), whereby a low pressure and high pressure are created in the cylinders, respectively.

4. Device in accordance with claim 3, characterised in that the pump system (200) comprises a high-pressure valve (212) and a low-pressure valve (210) formed as a high-pressure nipple with a ball valve and a low-pressure nipple with a ball valve, respectively.

5. Device in accordance with claim 3, characterised in that control valves (214, 216) are provided for controlled supply of fluid to the cylinders (204, 208), and that the control valves can be formed, for example, as banjo valves with ball valve.

6. Device in accordance with claim 4, characterised in that the high-pressure cylinder (208) comprises a pipe (224) in the same axial direction as the cylinder, arranged to reduce the volume of the cylinder.

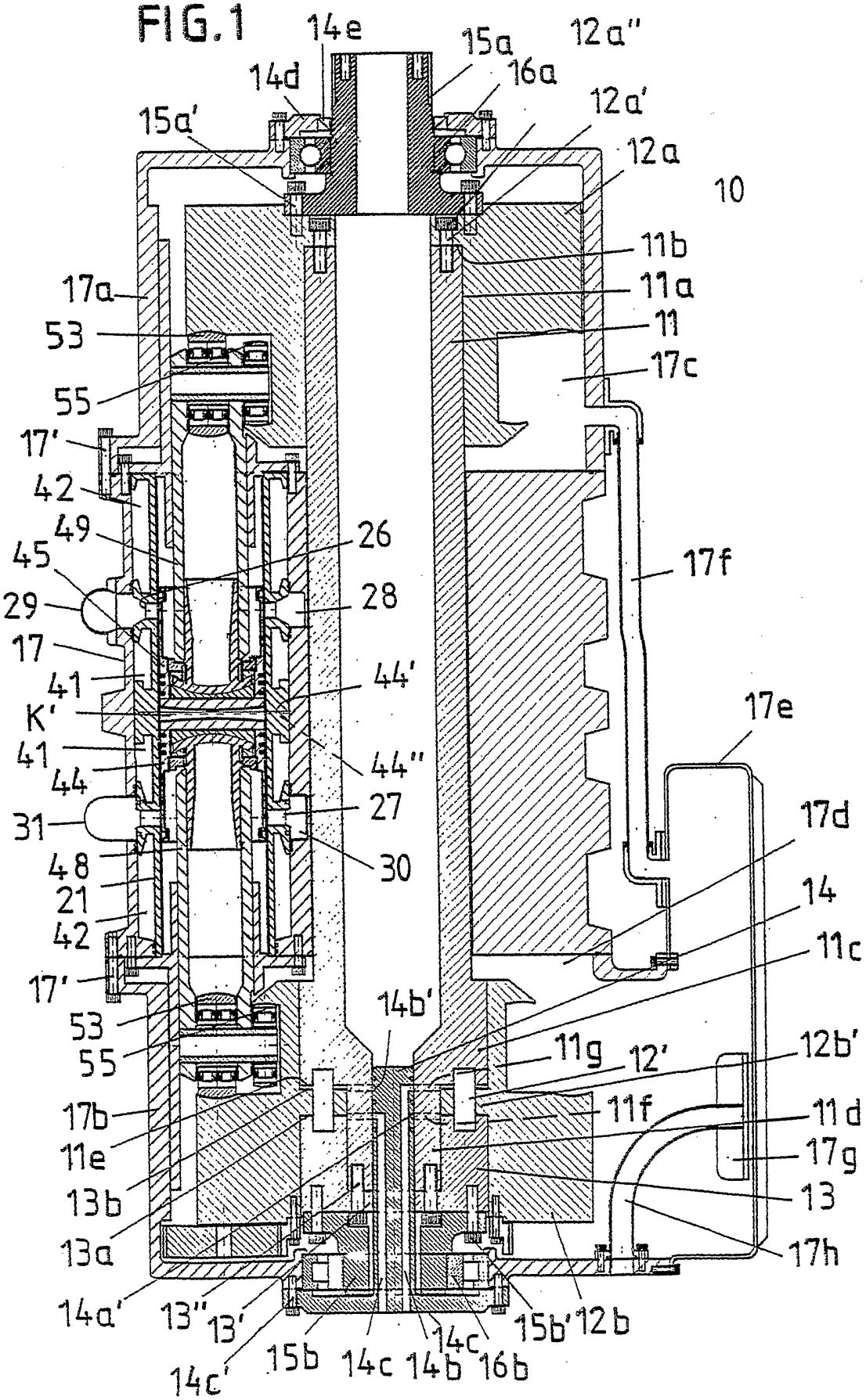
7. Device in accordance with claim 6, characterised in that a discharge channel (222) is provided either in connection to the piston (206) or in connection to the pipe (224), arranged to prevent that too high pressure is built up inside the pipe (224).

8. Device in accordance with claim 1, characterised in that a support wheel (53), and possible an auxiliary support wheel (55), which lies against the cam guide assembly (12), and a connecting means (218) fitted between the support wheels (52) are arranged at the end of the piston rod (48) to connect the lower part of the piston rod (48) with the pump system (200).

9. Device in accordance with claim 8, characterised in that the connecting means (218) is arranged to provide a rigid connection between the pump system (200) and the lower part of the piston rod (48), so that the axial power of motion of the piston is transmitted directly to the pistons (202, 206) of the pump system.

10. Device in accordance with claim 8, characterised in that the piston rod (48) with associated components, connecting means (218) and the lower part (220) are cast as one piece, possibly also with the pistons (202, 206).

FIG.1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11a
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17f
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14c

FIG. 2

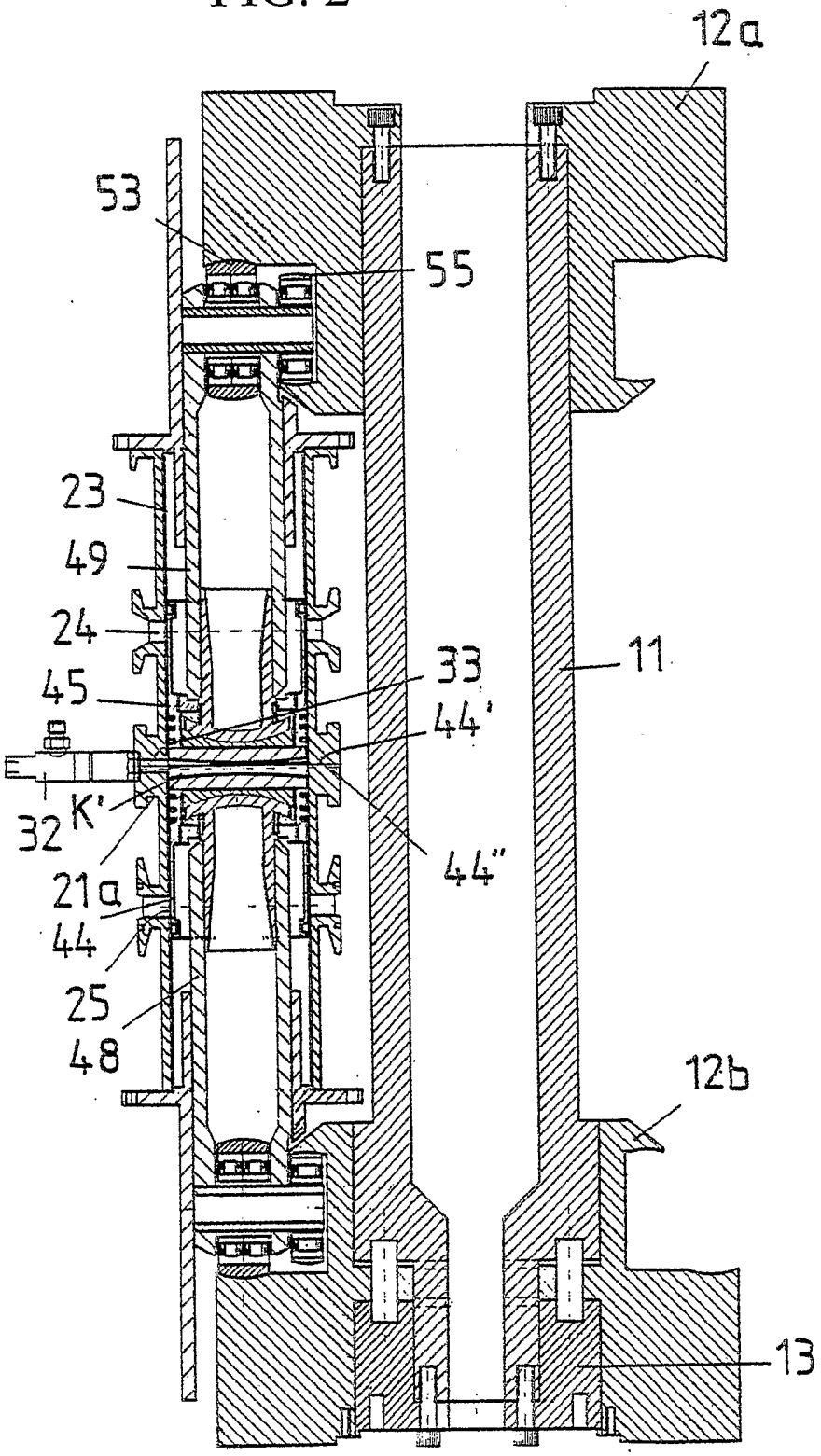
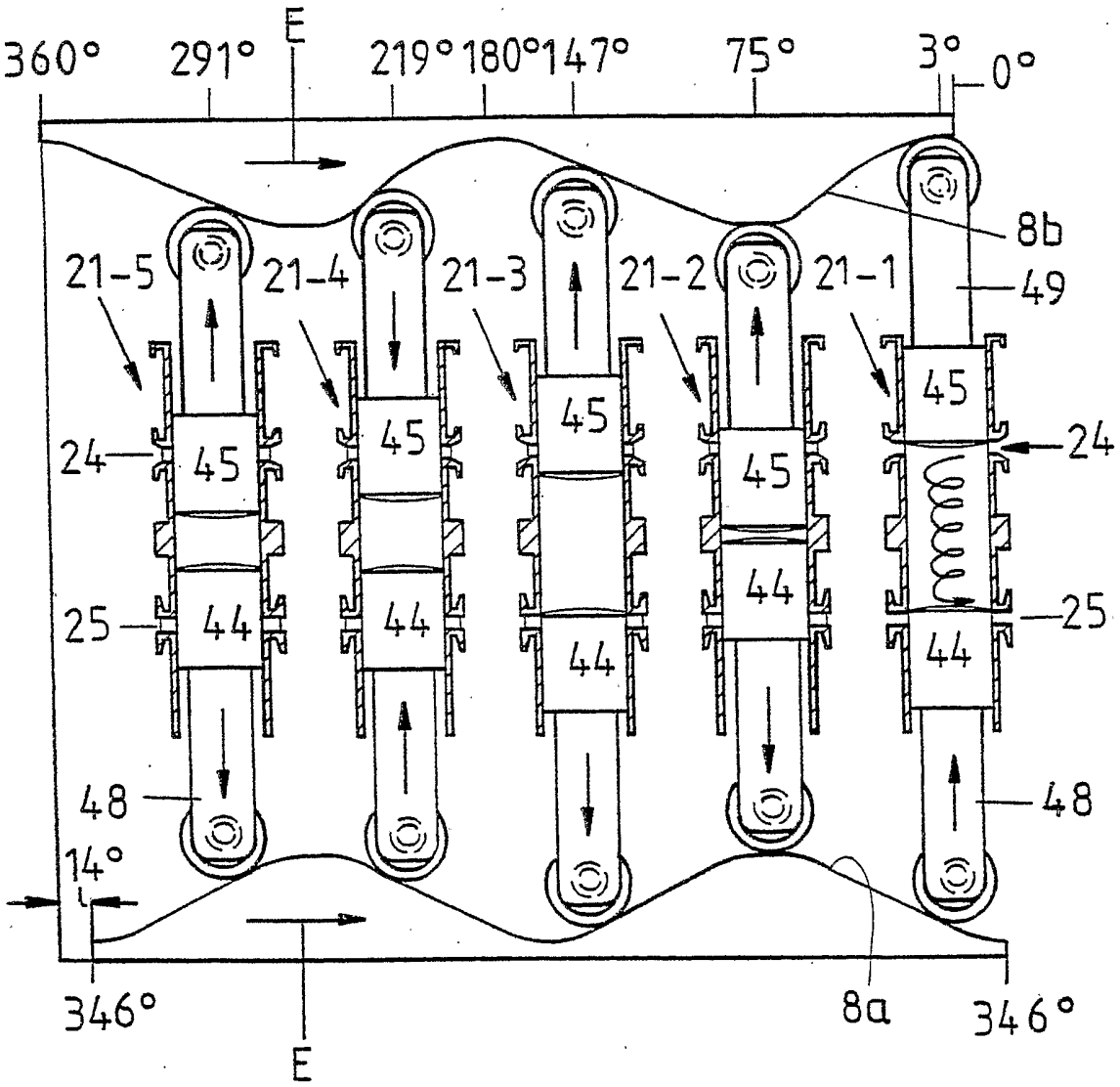


FIG. 3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219°
180°
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44
48
14°
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8a
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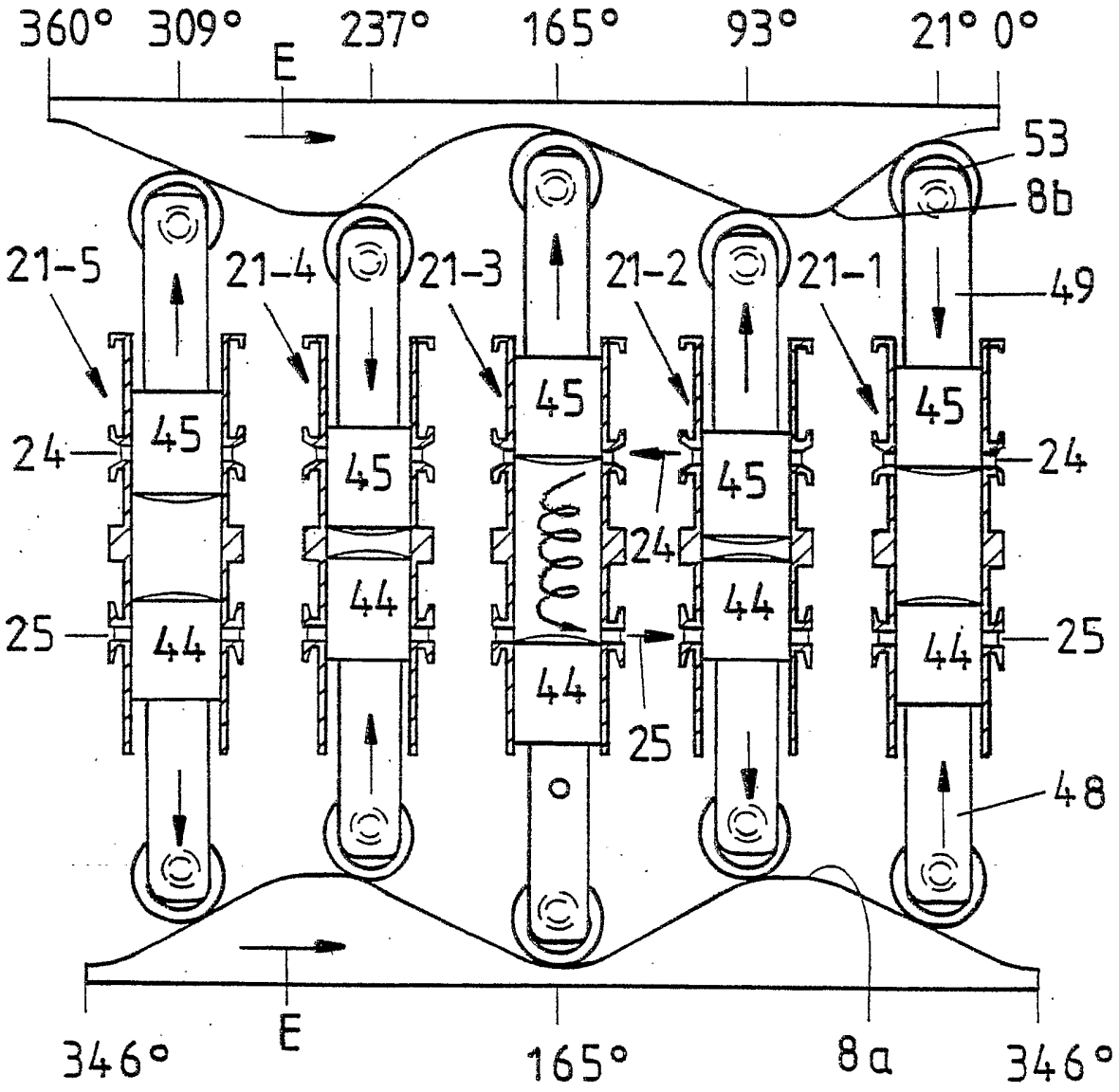
E

FIG. 4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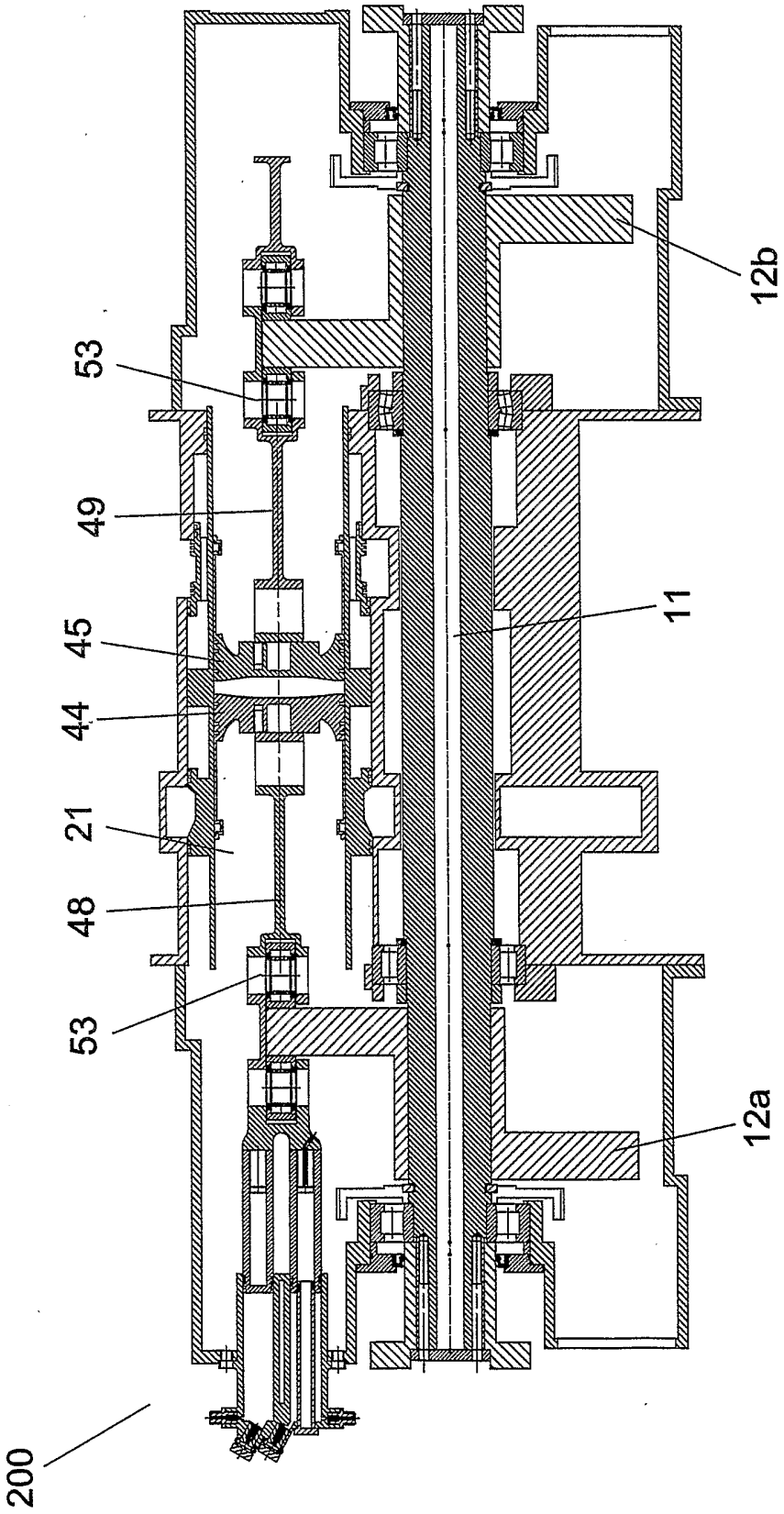


FIG. 5

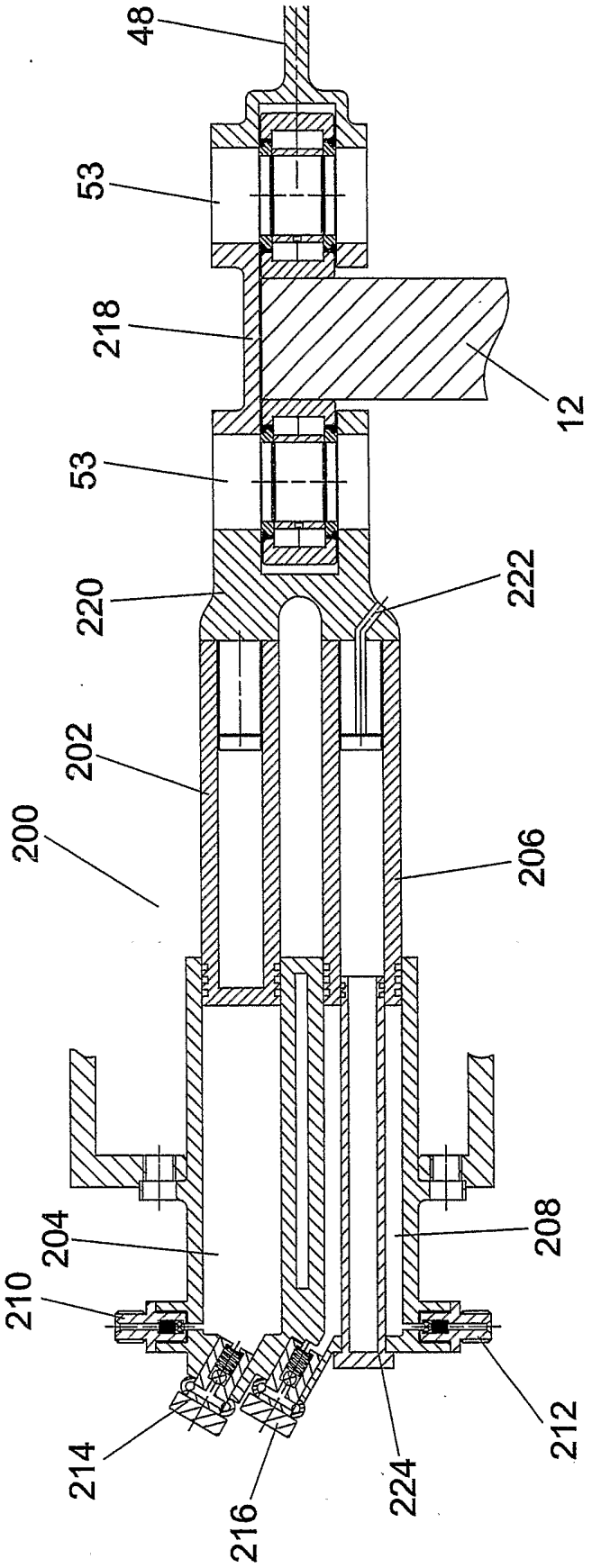


FIG. 6

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 02/00480

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F02B 75/26
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F01B, F02B

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

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
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| 10 March 2003 | 11 -03- 2003 |
| Name and mailing address of the ISA/<br>Swedish Patent Office<br>Box 5055, S-102 42 STOCKHOLM<br>Facsimile No. +46 8 666 02 86 | Authorized officer<br>Björn Kallstenius / JA A<br>Telephone No. +46 8 782 25 00 |

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