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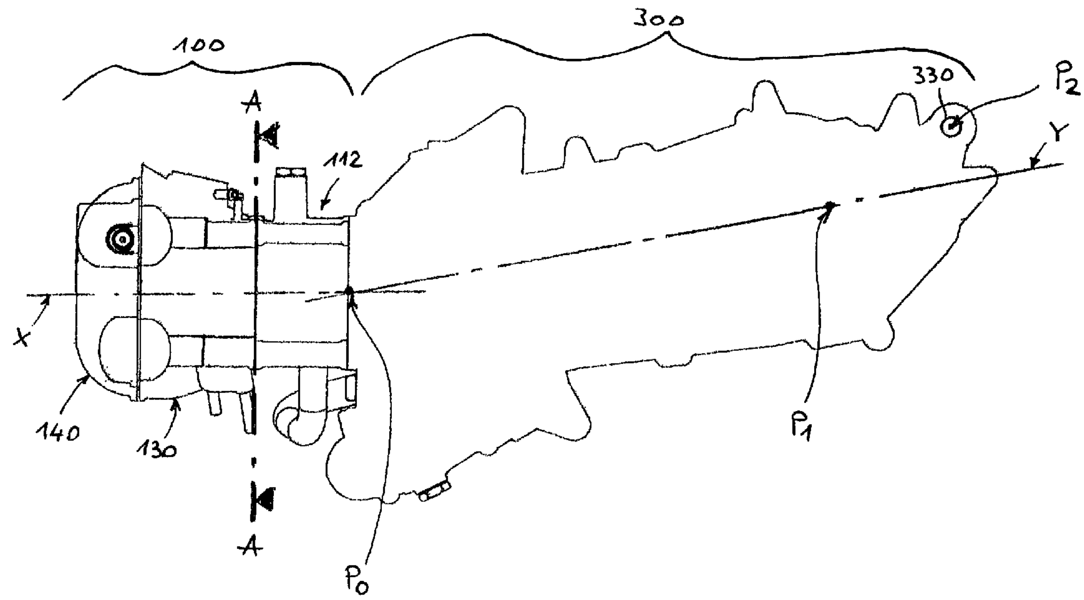
(54) Title: FAMILY OF POWER UNITS COMPRISING INTERNAL COMBUSTON ENGINES OF STANDARDIZED DIMENSIONS AND 2- AND 3-WHEELED VEHICLES EQUIPPED WITH SAID UNITS



(57) Abstract: Family of power units, each one of which consists essentially of an internal-combustion engine (100, 200) comprising one or two cylinders (112), the related head (130) with two shafts of the cams (133, 137) and an upper cover (140), and furthermore of an associated speed-variation (300, 500) and/or power transmission (400), wherein all engines (100, 200) in said family of power units share the same ratios of a number of characteristic dimensions to each other. USE: Propulsion of two-wheel or three-wheel vehicles.

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FAMILY OF POWER UNITS COMPRISING INTERNAL COMBUSTION ENGINES OF STANDARDIZED DIMENSIONS AND 2- AND 3-WHEELED VEHICLES EQUIPPED WITH SAID UNITS.

DESCRIPTION

The present invention refers to a family of power units that are essentially constituted by internal-combustion engines and related transmission and/or change gears for two-wheeled and three-wheeled vehicles.

Companies in which engines are manufactured on a large-scale basis have since a long time now considered the opportunity of using common component parts and/or modular-construction systems and sub-assemblies to manufacture engines having different power and piston-displacement ratings - see for instance the patent publications GB-A-2 344 378 and EP-A-597 263. In particular, the latter patent, which is focused on engines intended for motor-scooter or medium-to-low powered vehicle applications, provides for the possibility of joining together a plurality of so-to-say "basic" engines, i.e. single-cylinder engines, by inserting one or more modules constituted by complementary parts in the cylinder block thereof, so as to be able to obtain so-to-say "derived" engines, i.e. multi-cylinder engines, which may also be of a different architecture (in-line or V-shaped cylinder arrangement, etc.) and have higher power ratings. However, in this litterature not too much attention is paid to the power units considered as a whole, the definition of which is closely connected to the different types of vehicle where they are intended to be used.

Also the present invention tackles the above-cited problems and aims at taking into a different account the needs and the requirements of both the manufacturers and the users, thence also of the various power units used on two-wheeled and three-wheeled vehicles.

In this connection, let us for instance consider motor-scooters, which are enjoying an increasing and favourable acceptance thanks also to the fact that they are very easy to drive since they are provided with power units that comprise a continuously-variable transmission. Their manufacturers have to take into due account several requirements, such as the possibility of adopting engines having different power and piston-displacement ratings, the adoption of wheels of a different diameter (eg. 13-in. and 16-in. wheels) and the need for an adequate surface to be anyway provided for the feet of the driver to rest upon.

On the other hand, users of the so-called "standard" motor-cycles normally require higher performance levels than those permitted by the motor-scooters and accept a more demanding driving style, so that multi-speed instead of continuously-variable transmissions are used in their power units. As a consequence, the companies manufacturing any typology of two- and/or three-wheeled vehicles must therefore be able to avail themselves of many typologies of power unit. The final results are long development times, low benefits from a scale effect and an understandable complexity in the management of materials and parts in the production lines.

It is a main object of the present invention to provide a family of power units that is capable of meeting in the best possible manner and at the highest level the above mentioned needs and requirements of both users and manufacturing companies of two-wheeled and three-wheeled vehicles.

Therefore, the present invention consists of a family of power units comprising engines having a medium-to-low piston-displacement volume (not in excess of 250 cu.cm, indicatively), which are essentially intended for use in two-wheeled and three-wheeled vehicles, which are characterized by a highly standardized and modular construction as recited and defined in the appended claims.

The engines of this family of power units, on which the Applicant has carried out an extensive research and development activity that enabled optimum values to be defined as far as the sizing of the head is concerned, enable the above stated object of the present invention to be reached along with further objects, as this will become apparent from the following description of some non-limiting examples of embodiment of the present invention that is given with reference to the accompanying drawings, in which:

- Figure 1 is a side overall view of a power unit for use on a motor-scooter, which comprises a four-stroke single-cylinder engine according to the present invention in combination with a continuously-variable transmission, the latter being only shown schematically;

- Figure 2 is a partially cutaway overall view of the same power unit, which also shows a number of construction details of the above mentioned continuously-variable transmission;

- Figure 3 is a view of the head of the cylinder of the same engine, starting from the plane whose intersection with the sheet of the drawing is the straight line A-A indicated in Figure 1;

- Figure 4 is a view of the same head along the section line X-X of Figure 3;

- Figure 5 is a partially cross-sectional view along the line B-B of Figure 2 of the rear portion of the continuously-variable transmission;

- Figure 6 is a partially cross-sectional view along the line C-C of Figure 2 of the rear portion of the same continuously-variable transmission;

- Figure 7 is a side overall view of a power unit for use on a motor-cycle, which comprises the same single-cylinder engine as the one shown in the preceding Figures, and a different multi-speed, i.e. discretely-variable transmission gear, the latter being only shown schematically owing to its being of a per se known traditional construction;

- Figure 8 is a side overall view of a power unit for use on a motor-cycle, which comprises a four-stroke engine with two cylinders provided in a V-arrangement combined to a different multi-speed discretely-variable transmission gear, the latter being only shown schematically owing to the same reason as cited in Figure 7.

It should be noticed that, for the sake of greater simplicity, a number of items and parts, which are of traditional construction or, anyway, are certainly well known to those skilled in the art and, furthermore, not actually relevant to the present invention, will not be described here, although they are actually shown in the accompanying drawings.

Whereas all engines considered in the present invention are of the four-stroke cycle, double overhead camshaft kind (commonly known under the acronym DOHC), the power units illustrated in Figures 1, 2 and 7 make use of single-cylinder engines that are indicated generally at 100, while the power unit illustrated in Figure 8 makes use of an engine with two cylinders in a V-arrangement that is indicated generally at 200. As this has already been indicated earlier in this description, all engines being considered here have unitarily, i. e. for each cylinder, a medium-to-low piston-displacement volume that does not exceed approx. 250 cu.cm.

A continuously-variable transmission, which is indicated generally at 300, is comprised in the power unit of Figures 1 and 2 and will be described further on with reference to greater details illustrated in Figures 5 and 6, while a first kind of a multi-speed discretely-variable transmission, which is indicated generally at 400, is comprised in the power unit illustrated in Figure 7 while a second kind of multi-speed discretely-variable transmission, which is generally indicated at 500, is comprised in the power unit illustrated in Figure 8. It shall be anyway appreciated that the present invention also covers power units that comprise the single-cylinder engine 100 in conjunction with a discretely-variable transmission 500 or the two-cylinder engine 200 in conjunction with the continuously-variable transmission 300 or, again, the two-cylinder engine 200 in conjunction with the discretely-variable transmission 400.

From the illustration in Figure 2 it can be noticed that the engine 100 comprises a block 110 and a single cylinder 112 with the associated piston 114 driven by the crankshaft 116 via the connecting-rod 118. In turn, the continuously-variable transmission 300, which will be described in greater detail further on with special reference to Figures 5 and 6, is enclosed in a casing 301 equipped with a removable cover 302, and comprises : a driving pulley 304 on the front side; a driven pulley 310; a gearbox 320; the axle 330 of the driving wheel on the rear side; a driving belt 308 linking the pulleys 304 and 310 with each other. Shown in Figures 1 and 2 is also the ring 330, the axis of which is indicated at P_2, for the attachment of the rear shock-absorbing strut (not shown) to the power unit when the latter is used on a motor-scooter.

The crankshaft 116 of the engine 100, the axis of rotation of which is indicated at Z in Figure 4, is firmly joined to a rectilinear shaft 120, the axis of rotation of which is indicated at P_0 in Figure 2, for the support of the driving pulley 304 of the continuously-variable transmission 300. As an alternative thereto, the shaft 120 may be a direct prolongation of the crankshaft 116, outside of the block 110, so that mentioned axes Z and P_0 may also be coincident.

As this is best shown in Figure 1, in accordance with a design option that is rather common in the field of motor-scooters, the axis X of the cylinder 112 forms a quite small angle, typically in the order of 10 to 20°, with the plane that contains the axis P_0 of the driving pulley 304 and the axis P_1 of the driven pulley 310. At Y in Figure 1 there is indicated the straight line that is formed by the intersection of this plane with the plane of the drawing.

Further to the above listed parts and the other parts and auxiliary components that, due to the previously mentioned reason, are not described, but merely shown in Figure 2 (such as for instance the engine starter, the carburettor, the cooling water pump, etc), the engine 100 comprises a head 130, in which there are to be found some of the main features of the present invention, and a removable cover 140 for closing from the top the same head 130.

Four stud bolts are used to fasten the head 130 to the cylinder 112, as this is best shown in Figure 3 by the corresponding holes 131, 142, 143 and 144. Further bolts, some of which are shown in Figure 2 where they are indicated at 151, 152, 153, are in turn used to fasten the cover 140 on to the head 130.

The head 130 (in which there are provided, in a per se well-known manner, the induction manifolds 132 and the exhaust manifolds 136, along with the flowpaths of lubrication oil and cooling water, as well as the seat 139 - shown in Figure 3 - of the spark plug, not shown) forms the housing for the whole timing system of the engine 100. As already mentioned, this timing system is of the DOHC type and comprises, among other things : a first shaft (not shown, for sake of simplicity) for the actuation of two suction valves 131 by means of corresponding cams 133 and springs 134, and a second shaft (also not shown) for the actuation of two exhaust valves 135 by means of corresponding cams 137 and springs 138, the second axis of the said shafts being parallel to one another - see Figures 3 and 4.

According to a major feature of the present invention, the dimensional characteristics of the head and of the timing system are the same not only for the whole family of power units of the invention, i.e. for the entire range of piston-displacement volumes and horsepower ratings, but also for both the single-cylinder engine 100 described hitherto and the two-cylinder engine 200 that will be described further on with special reference to Figure 8. In particular, the following dimensions, which appear in best evidence in Figures 3 and 4, are the same throughout the range :

- the height A of the head 130 starting from the lower plane 117 interfacing with the cylinder 112, up to the upper plane 119 interfacing with the cover 140,

- the centre-to-centre distance B between the axis of the above mentioned camshafts,
- the angle of inclination C of the suction valves 131, and
- the angle of inclination D of the exhaust valves 135 with respect to the axis of the spark plug;
- the centre-to-centre distance N between the suction valves 131 and
- the centre-to-centre distance R between the exhaust valves 135, as measured on the interface plane 117 between the head 130 and the cylinder 112.

Furthermore, if:

- S indicates the distance between the axis of rotation Z of the crankshaft 116 and the interface plane 119 between the head 130 and the cover 140 (which coincides with the plane containing the axes of the two shafts of the cams 133 and 137 - see Figure 4),
- L indicates the horizontal centre-to-centre distance and
- M indicates the vertical centre-to-centre distance between the four bolts that are used to fasten the head 130 on to the cylinder 112,

then, for the unitary piston-displacement volumes of the engines in the family of power units developed by the Applicant (i.e. up to approx. 250 cu.cm), according to the present invention the ratios of the above mentioned dimensions to each other are the same and unvaried throughout the family of power units, particularly when said ratios are selected from within variation ranges that are delimited by following minimum and maximum values :

Table 1

Size ratios	min	max
A/S	0.25	0.30
A/B	1.05	1.30
B/L	0.9	1.05
B/M	0.9	1.1
B/N	2.5	3.3
B/R	2.5	3.2

According to the present invention, also the values of the angle of inclination C of the suction valves 131 and the angle of inclination D of the exhaust valves 135 are preferably the same throughout the family of power units when they are selected from within variation ranges that are delimited by following minimum and maximum values:

Table 2

Angle values	min	max
C	13°	17°
D	16°	20°

Clearly apparent are at this point the advantages that derive to the manufacturer from being capable of relying on same unitary values for the above mentioned linear and angular dimensions throughout the family of power units, in particular as far as

- the simplification/shortening of the time required for new models of two-wheeled and three-wheeled vehicles to reach the market,
- the reduction in the number of component parts, and related part numbers, to handle and manage both at the factory and the after-sales service level

are concerned.

In fact, also the single-cylinder engine that is part of the power unit comprising the multi-speed discretely-variable transmission 400 illustrated in Figure 7 and the two-cylinder engine 200 that is part of the power unit comprising the multi-speed discretely-variable transmission 500 illustrated in Figure 8 have the same characteristics as regards their linear and angular dimensions.

In a preferred embodiment of the present invention the continuously-variable transmission 300 - attached to the rear suspension of the vehicle through the fixation ring 330 at a position defined by the axis P_2 which lies in a rear position with respect to the axis P_1 of the driven pulley 310, as this is best shown in Figure 1 - features some characteristics that are best illustrated in Figures 5 and 6.

Noticed in Figure 5 can be the driven pulley 310 of the transmission 300, which is enclosed between the casing 301 and a removable cover 302 and consists of a first idle part 312 and a second part 314 that rotates jointly with the shaft 316, along with the driving belt 308. The shaft 316 carries also the driving gearwheel (not shown) of the gearbox 320 and extends all along the afore cited axis P_1. According to another feature of the present invention, the shaft 316 of the driven pulley

310 is provided with three supports, i.e. one support more than in traditional continuously-variable transmissions. While two of such supports (only one of them being shown here, as indicated at 315, for sake of a greater simplicity) are in a traditional manner kept in position by the casing 310, the third support 318 is constituted by a bearing that is situated at the free end portion 317 of the shaft 316 (i.e. on the opposite side with respect to the gearbox associated to the same shaft). The third support 318 is kept in position by the cover 302 by means of a bush 319 that – according to another feature of the invention – is made of a plastic material or, alternatively, by a spring ring.

The above described continuously-variable transmission 300 features the following advantages as compared with a traditional construction, which is typically disclosed in US-A-4 475 893 and US-A-4 567 958 :

- the overall construction of the continuously-variable transmission 300 is simplified thanks to a reduction in the parts list, since the cover 302 is used here not only as a means for closing the casing 301, but also to perform a structural task;

- since the cover 302 is subject to periodical removal in order to allow for the belt 308 to be replaced, the use of a plastic bush 319 or of a spring ring enables for assembly clearances to be effectively compensated for;

- the elastic deformability of the bush 319 (or, alternatively, of the afore mentioned spring ring) also contributes to dampening the vibrations of the whole power unit.

A further feature of the present invention relates to the cooling of the driving pulley 304 of the continuously-variable transmission 300, which rotatably drives the belt 308. The driving pulley 304 comprises a so-called moving disk 306, which is slidable on the shaft 120, and a so-called fixed ring 307, which is fastened to the same shaft (which, as already told earlier in this description, may also be omitted and directly replaced by a cantilever extension of the crankshaft 116, in which case the axis P_0 coincides with the axis Z). As this is shown in Figure 6, the casing 301 is provided with a preferably removable cover 305, which is provided with a large aperture 325 exactly in front of the fixed disk 307, whereas the outer face 309 of the fixed disk 307, i.e. the face thereof which lies on the opposite side with respect to the engine of the power unit, is configured as a centrifugal fan. Around the pulley 304 and in a forward direction, i.e. towards the side which is opposite to the side on which the belt 308 lies, the casing 301 is closed in such a manner to create in its interior a flowpath 303 for the cooling air, which completely surrounds the pulley 304 - as indicated by the arrows F_1 to F_6 appearing in Figure 6 - and extends both in front of and behind the belt 308. The latter is in this way stressed to a lower extent and has a longer durability, with a clear advantage in terms of overall reliability of the power unit.

From the above description it can be readily appreciated that the family of power units according to the present invention actually meets the expectations of both manufacturers and users and, furthermore, ensures an improved overall reliability thanks to a whole set of construction improvements.

Although the above description refers to a currently preferred embodiment of the present invention, other embodiments and variants thereof may be developed without departing from the scope of the appended claims.

CLAIMS

1. Family of power units, each one of which consisting essentially of an internal-combustion engine (100, 200) that comprises one or two cylinders (112), the related head (130) with two shafts of the cams (133, 137) and an upper cover (140), and furthermore of an associated speed-variation and/or power transmission, wherein all engines (100, 200) in said family of power units share the same ratios of following dimensions to each other:

- (A/S), where (A) is the height of the head (130), as measured from the plane (117) interfacing with the cylinder (112) up to the plane (119) interfacing with the cover (140), and (S) is the distance of the axis of rotation of the crankshaft (116) from said plane (119) interfacing with the cover (140);

- (A/B), where (A) is the said height of the head (130) and (B) is the centre-to-centre distance between the shafts of the cams (133, 137);

- (B/N), where (B) is the said centre-to-centre distance between the camshafts and (N) is the centre-to-centre distance between the suction valves (131) as measured on the interface plane (117) between the engine head (130) and the cylinder (112);

- (B/R), where (B) is again the centre-to-centre distance between the camshafts and (R) is the centre-to-centre distance between the exhaust valves (135), aòso measured on the said interface plane (117).

2. Family of power units according to claim 1, wherein the values of said size ratios are selected from within these variation ranges : (A/S) from 0.25 to 0.30; (A/B) from 1.05 to 1.30; (B/N) from 2.5 to 3.3; (B/R) from 2.4 to 3.3.

3. Family of power units according to claim 1 or 2, wherein all engines (100, 200) also share the same angle of inclination (C) of the suction valves (131) and the same angle of inclination (D) of the exhaust valves (135).

4. Family of power units according to claim 3, wherein the values of said angles of inclination of the valves are selected from within these variation ranges : (C) from 13° to 17° and (D) from 16° to 20°.

5. Family of power units according to any of the preceding claims, wherein all engines (100, 200) also share the same ratio (B/M), where (B) again is the dimension of the centre-to-centre distance (B) between the camshafts and (M) is the dimension of the centre-to-centre distance between the means used to fasten the head (112) on to the cylinder (112).

6. Family of power units according to any of the preceding claims, comprising two-cylinder engines (200) in a V-shaped arrangement.

7. Family of power units according to any of the preceding claims and used in a two-wheeled or three-wheeled vehicle, wherein the engines (100) are in combination with a continuously-variable transmission (300) enclosed in a casing (301).

8. Family of power units according to claim 7, wherein, when the engine (100) is a single-cylinder engine, the axis (P_0) of the driving pulley (304) of the continuously-variable transmission (300) is parallel to or even coincident with the axis of rotation (Z) of the crankshaft (116), and wherein the plane formed by said axis (P_0) of the driving pulley (304) and the axis (P_1) of the driven pulley (310) forms an angle comprised between 10° and 20° with the axis (X) of the engine (100).

9. Family of power units according to claim 7 or 8, wherein the shaft (316) of the driven pulley (310) is provided with a third support element (318) at the end portion thereof, the said third support element (318) lying on the opposite side with respect to the gearbox (320) that is associated to the said shaft (316).

10. Family of power units according to claim 7, wherein said third support element (318) of the shaft (316) of the driven pulley (310) is held in position onto a removable cover (302) of the casing (301) by means of a bush (319) made of plastic material or a spring ring.

11. Family of power units according to any of the preceding claims 7 to 10, wherein inside the casing (301) there is provided a flowpath (303) of the cooling air, which starts with an aperture (325) in the same casing located, preferably on a preferably removable cover (305), that is in front of the driving pulley (304), and extends both in front of and behind the belt (308) of the continuously-variable transmission (300).

12. Family of power units according to claim 11, wherein the face (309) of the disk (307) of the driving pulley (304) that lies behind said aperture (325) of the casing (301) is provided in the form of a centrifugal fan.

13. Family of power units according to any of the preceding claims 1 to 6 and used in a two-wheeled or three-wheeled vehicle, wherein the engines (100) are associated to a multi-speed discretely-variable transmission (400, 500).

14. Engines (100, 200) having a unitary piston-displacement volume not exceeding approx. 250 cu.cm and being part of the family of power units according to claims 1 to 13.

15. Two-wheel or three-wheel vehicles that make use of a power unit belonging to the family of power units according to claims 1 to 13.

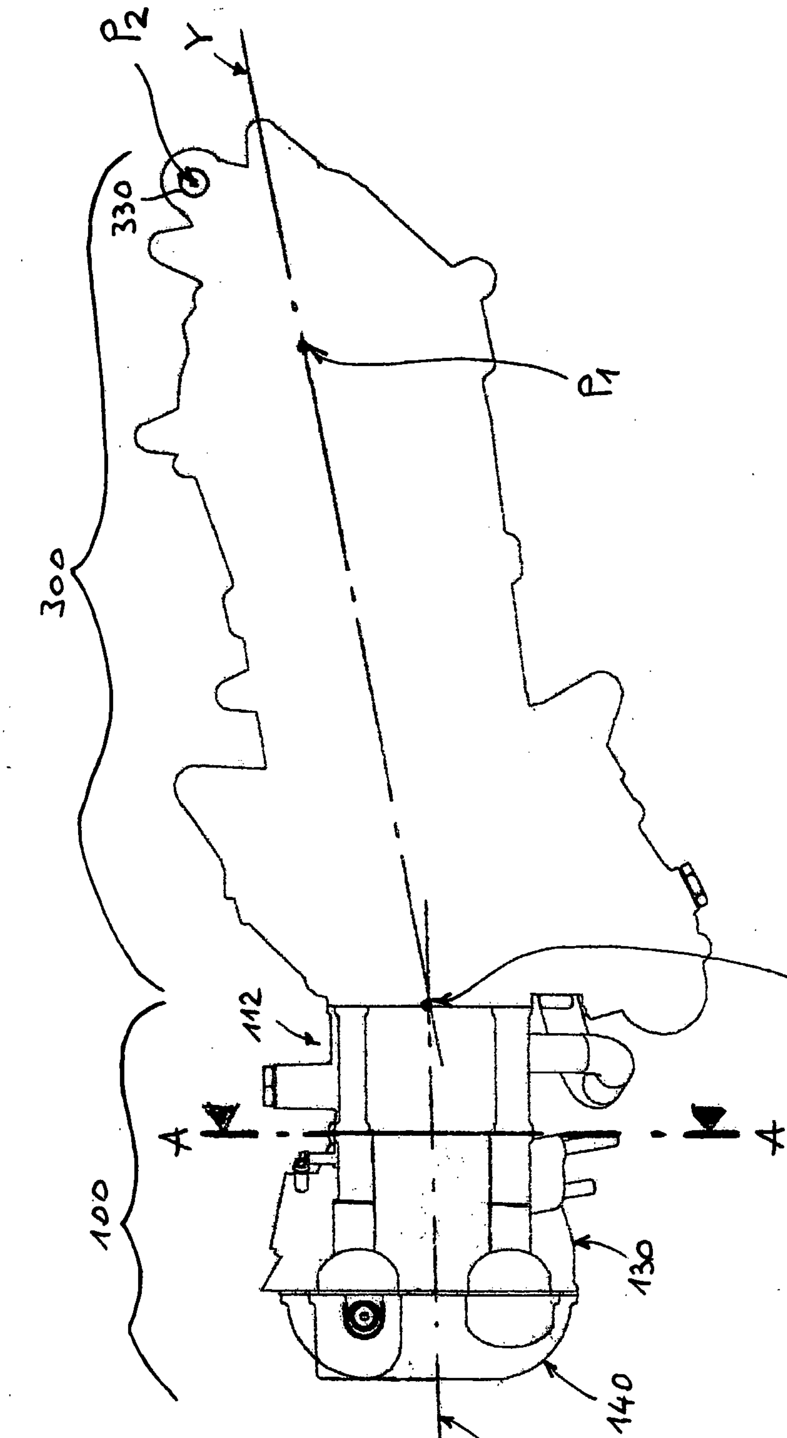
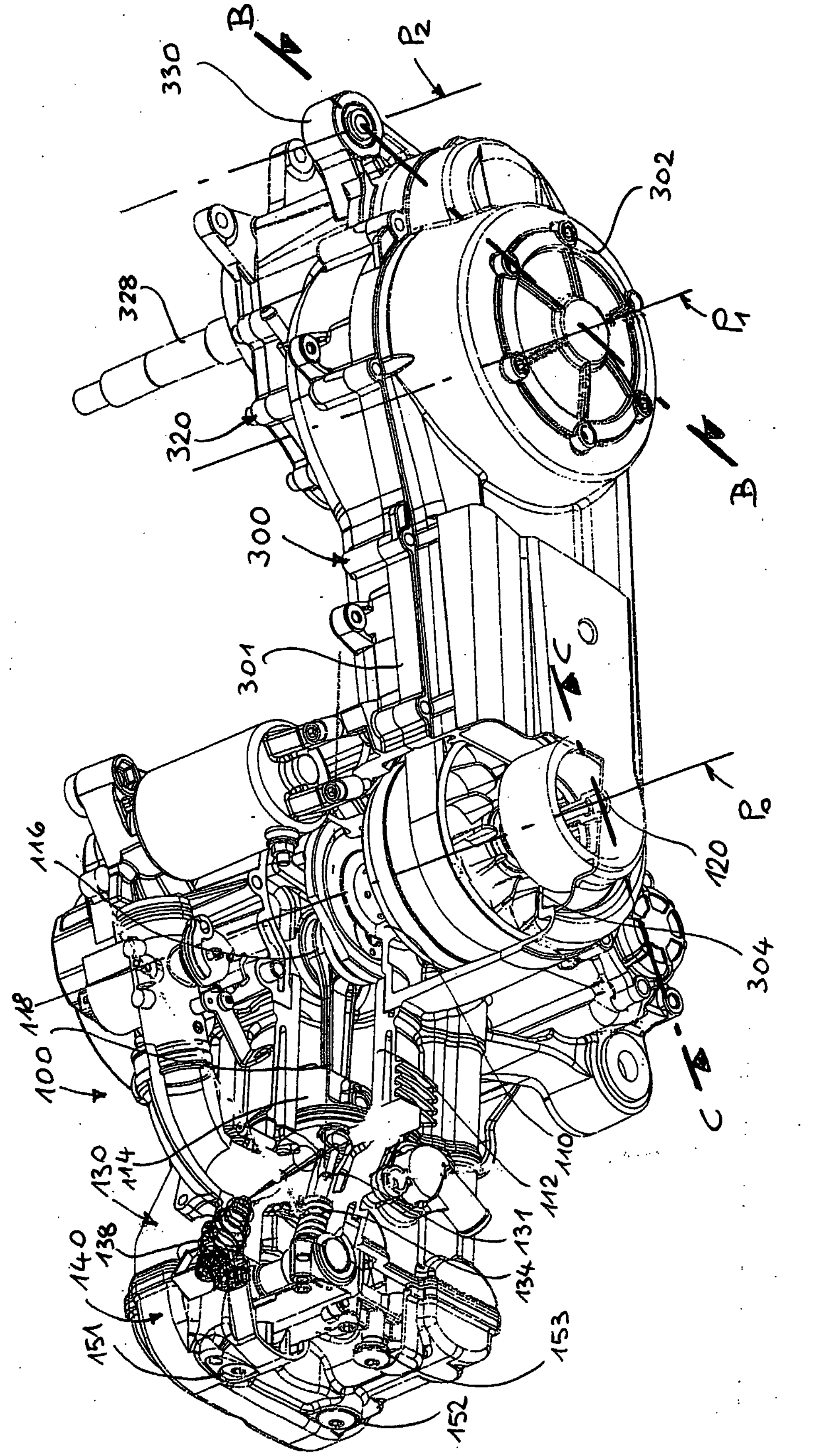


FIG. 1


B
330
302
328
320
300
301
C
116
118
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304
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C
B

FIG.2

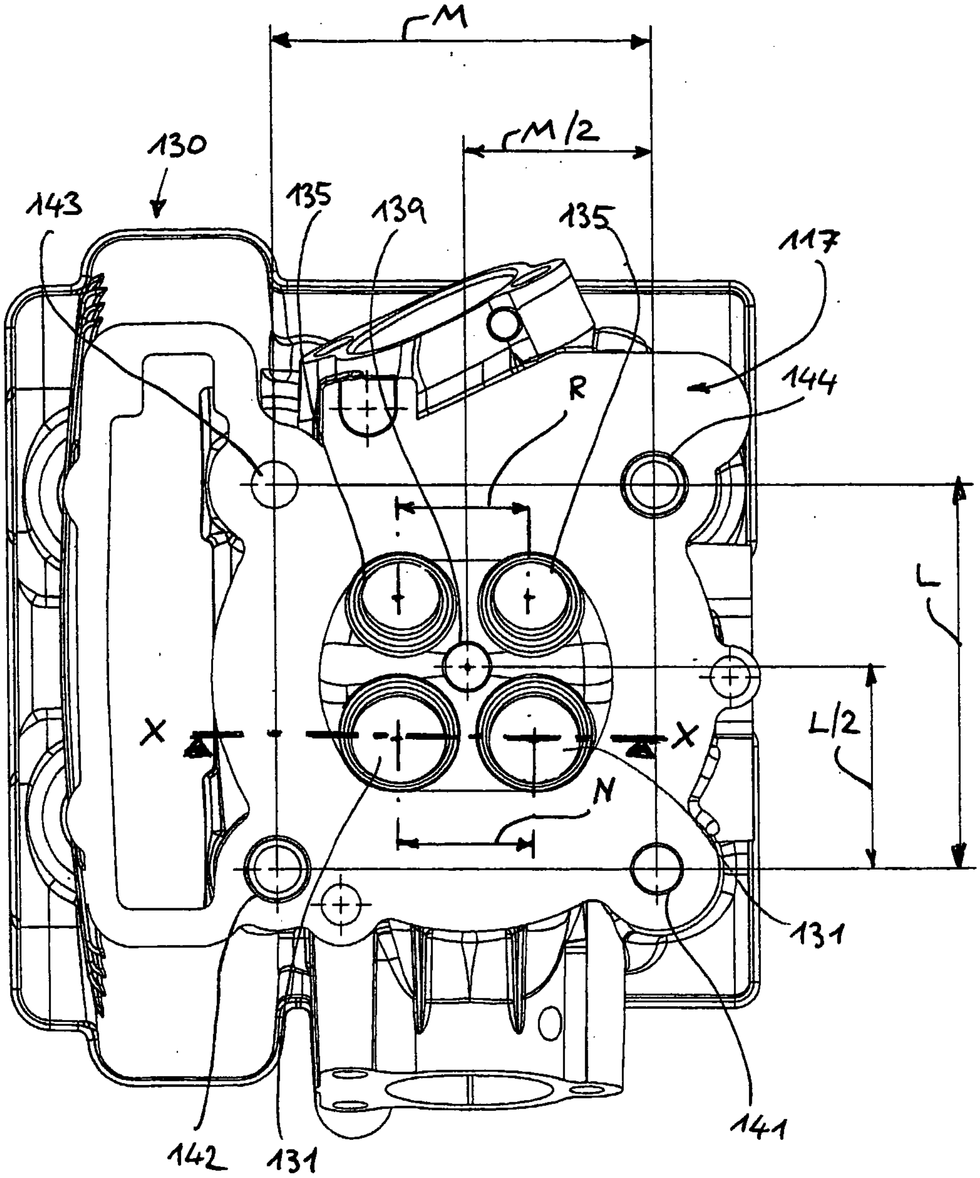

FIG.3

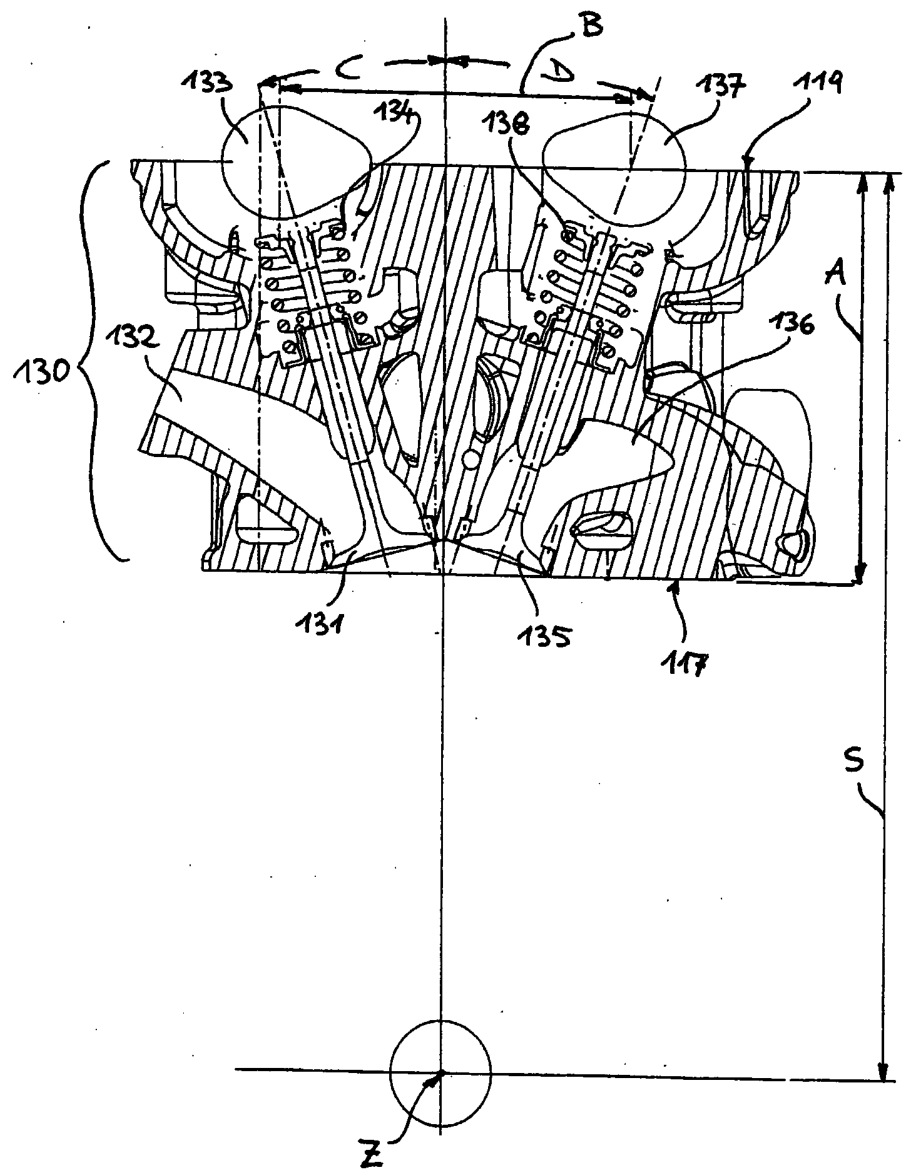

FIG.4

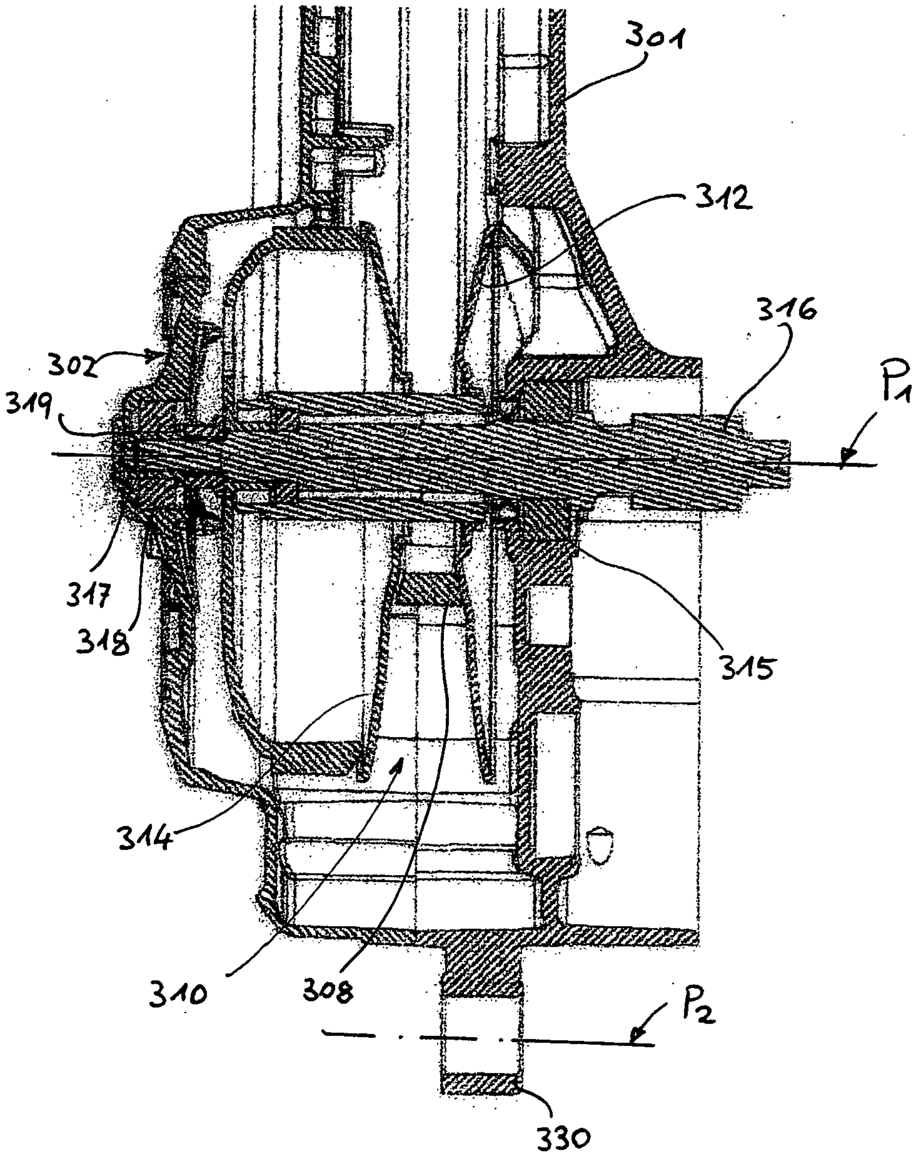

FIG. 5

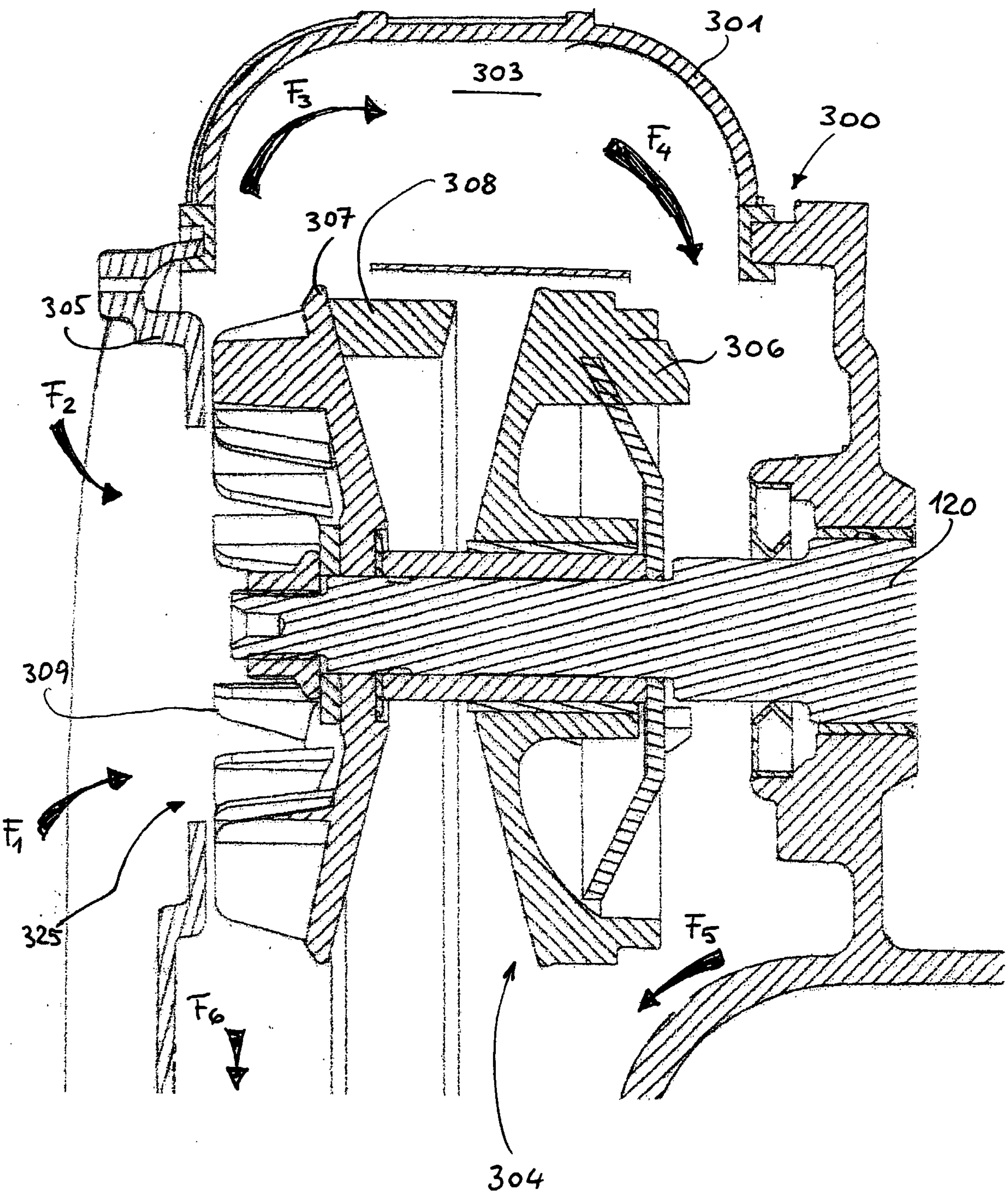

FIG. 6

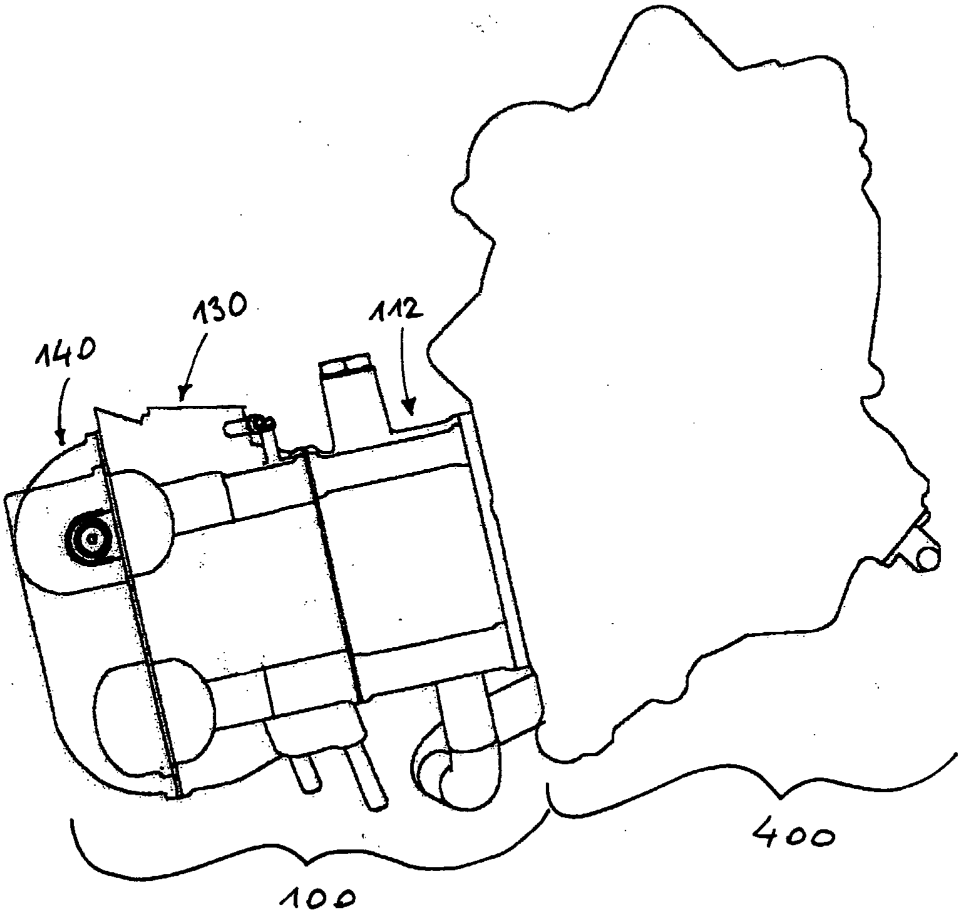

FIG. 7

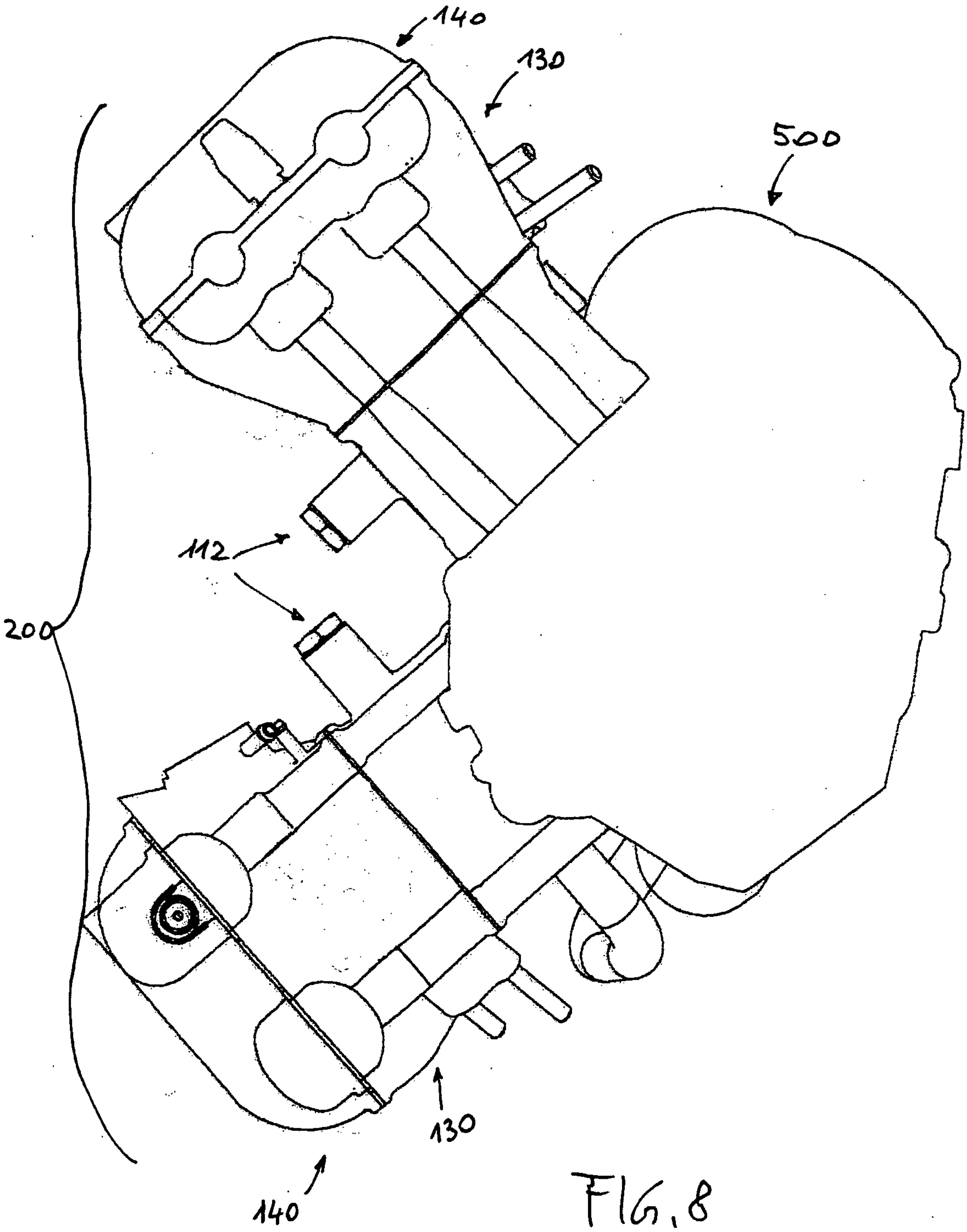

FIG. 8

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 02/00544

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F02F7/00 F01B1/12 F02F1/42 F02B61/02 B62K7/00

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)
IPC 7 F02F F01B F02B B62K B62M

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GALE A. PRAGUE: "PARTS INTERCHANGEABLE IN PACKARD LINE" SAE JOURNAL, 10 September 1948 (1948-09-10), page 80 XP002228764	1
A	figure 1 table 1	2
X	US 2002/011222 A1 (BILEK ANDREAS ET AL) 31 January 2002 (2002-01-31)	1,6
A	figures 1-6 abstract claims 1-55	2

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in 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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INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 02/00544

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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