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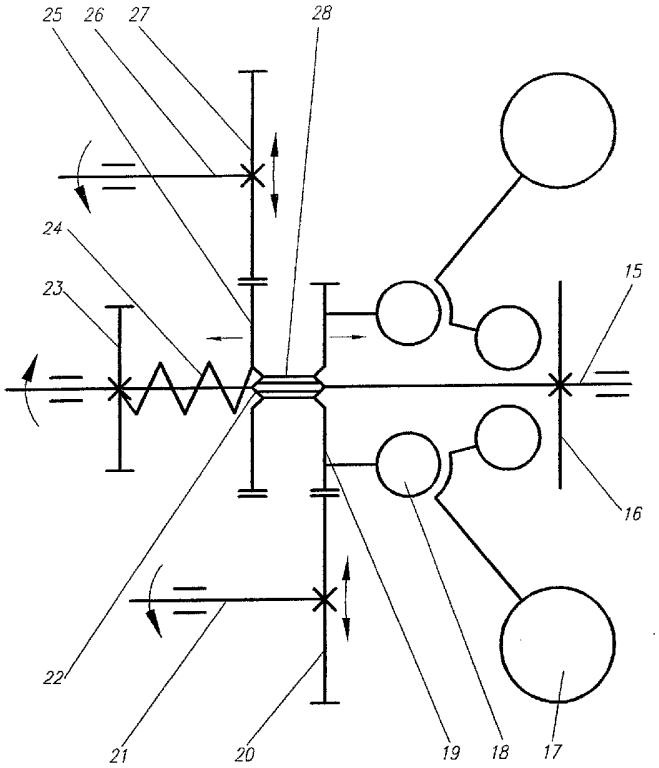
(54) **Title:** GAS-DISTRIBUTING MECHANICAL ARRANGEMENT AUTOMATICALLY CHANGING INJECTION AND EXHAUST GAS VALVE TIMING



(57) **Abstract:** The invention refers to the mechanical engineering industry, more properly to the internal combustion engine gas-distributing device configuration improvement. In the proposed device for the internal combustion engine the injecting and exhausting gas valve timing occurs in automatic mode in relation to the load applied to the engine shaft and the shaft speed. Several alternatives of the invention realization are proposed.. In the most preferred embodiment of the invention (fig.3b and fig.5) the camshafts cams 30 and 31 operates through the rocker arms 33, mounted on the axle 32, at that each cylinder has four distributing valves two admission 10 and two emission 11 valves disposed in mutually antithetic position, as well as two camshafts 21 and 26, which are similar by construction with those installed in the two camshafts engines each cylinder has one admission and one emission camshaft. In such a rocker arms 33 and cams 30 and 31 interaction with admission 10 and emission 11 valves there are one intake and one discharge manifolds on the cylinder flow head opposite sides.

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Gas-distributing mechanical arrangement automatically changing injection and exhaust gas valve timing

Description of invention

The invention refers to the mechanical engineering industry, more properly to the internal combustion engine gas-distributing device configuration improvement. In the proposed mechanical arrangement for the internal combustion engine the injecting and exhausting gas valve timing occurs in automatic mode in relation to the load applied to the engine shaft and the shaft speed.

The gas valve timing mechanism function is in timed injection of the fuel-air mixture or air in the engine cylinders and the flue gas extraction from them. The mechanism configuration and parameters varies depending on the number of cylinders, their volume or the mode of engine use. The vehicle engines are generally equipped with the valve mechanism, which assure complete gas exchange at a high engine speed, when the engine is reaching the maximal power.
The injection and the exhaustion processes are the result of the consistent valves, driving mechanism and camshaft operation. The gas valve timing mechanism efficiency is evaluated in case of the multi cylinder engine by the coefficient of admission and the uniformity of each cylinder admission. To obtain the better cylinder admission and flue gas emission, both the admission and the emission valves should be opened and closed before or after the piston changes its stroke in the dead centers. The valves opening and closing angle is assigned depending on the crankshaft rotation angle.

The maximal values of the piston stroke and the orifice area, as well as valve timing do not specify in complete mode the valves performance and the valve timing mechanism operation. Such a parameter as time cross-section , which specify as orifice area, as well as duration of the flow passage can be used for more complete evaluation purpose.

Generally known internal combustion engine valve timing mechanisms are presented on the fig.1, where: a, b, c and d - are the mechanisms with overhead camshaft and valves; e - mechanisms with overhead valves and underneath camshaft; f - mechanisms with lower valves. The fig.1 positions are as follows: 1 - camshaft with cams; 2 - valve; 3 - spring; 4, 5, 6 - cross member; 7 - pushrod; 8 - cylindrical pusher.

The valve timing mechanism is known (fig. 2a), where fore each cylinder there are four gas distribution valves, at that there is a couple of camshafts in the flow head. One of the two is intended for simultaneous closing and opening for the defined time of the two admission ports 9 by means of two valves 10 situated on the same side of the combustion chamber 14. Using the generally known devise, placed with its driven gear at the camshaft leading end, fast simultaneous closing and opening of the admission valves 10 is assured with the engine speed increase.

The invention scope is:

- reduce the idle speed limit, within that the engine operates steadily without vibrations;
- prevent the engine overheating, typical for the combustion engines at low speed from 0 to 1200 rpm;
- get the engine peak output not only at the high speed, but assure corresponding peak output for each valve timing condition;
- obtain better air and fuel mixing, thus assuring more complete fuel-air mixture combustion, fuel saving, as well as abate the air pollution.
- obtain different cylinder coefficient of admission in correspondence to the engine speed and the same fuel-air mixture final compression pressure as can be obtained with automatic degree of compression change.

The declared scope has been reached by substitution of the generally known valve timing mechanism with other one, which automatically modify the admission and emission valves timing in function of the load applied to the engine and its speed, at that:

- admission 9 and emission 12 ducts, as well as admission 10 and emission 11 valves all are situated in the engine flow head;
- the power drive from the crankshaft to the gear 23 is made by the mechanism shaft 15, gear 22 and slide bushing 28, with built-in crosspiece 18, but the gears 19 and 25 teeth have opposite spiral direction;
- the gear 19 drive the gear 20 and the camshaft 21, but the gear 25 drive the gear 27 and the camshaft 26;
- the gears 19 and 20 have opposite with the gears 25 and 27 teeth spiral direction.

The invention essence is evidenced in the following drawings:

- the fig. 2b shows the admission 9 / 10 and emission 12 / 11 ducts / valves arrangement for one cylinder and the gas flows directions according to the invention, to assure the automatic valve timing adjustment;
- the fig.3a and 3b show rocker arms 33 arrangement on the axles 32 and 34, as well as the admission 30 and emission 31 cams arrangement on the camshaft and their interaction with the admission 10 and emission 11 valves;
- the fig.4 and fig.5 show the proposed device kinematic diagrams for two possible versions of the device realization;
- the fig.6a, b, c, d show the proposed device admission and emission phase plain state changes during the engine operation in relation to the engine load and speed: a - idle run, b - low speed, c - high speed, d - extremely high speed.

The following notations are used on the mentioned figures: 9 - admission duct; 10 - emission duct; 11 - admission valve; 12 - emission valve; 13 - fuel or electric spark infeed opening; 14 - combustion chamber; 15 - governor driven shaft; 16 - arresting fin; 17 - governor weight; 18 - crosspiece; 19 - the gear with one teeth spiral direction built-in in the crosspiece; 20 - the gear coupling with the gear 19; 21 - left-side camshaft; 22 - governor driven shaft gear; 23 - the crankshaft driven gear; 24 - spring; 25 - the gear with teeth spiral direction opposite to the gear 19, built-in in the crosspiece; 26 - right-side camshaft; 27 - the gear coupling with the gear 25; 28 - the slide bushing with internal gear teeth; 29 - the built-in in the crosspiece gear with two

teeth spiral directions, which in the version of the device realization shown in the fig.5 substitutes two gears 19 and 25 with opposite teeth spiral directions; 30 - the camshaft cam for the admission valve opening and closing; 31 - the camshaft cam for the emission valve opening and closing; 32 and 34 - axles; 33 - rocker arms fixed on the axle.

Detailed invention description

In the proposed valve timing mechanism governor (fig.4 and fig.5) gear 23 is driven by the crankshaft. The gear 20 and the camshaft 21, as well as the gear 27 and the camshaft 26 rotate in the opposite direction to the governor shaft 15. The gear 23 through the shaft 15 drives the gear 22, which is all-the time coupled with gear type slide bushing 28. The gears 19 and 25 are placed at the definite distance one from another and together with the crosspiece 18 can move along the gear 22 in axial direction depending on the weight 17 position. As at the engine low speed the weight 17 centrifugal force is relatively low, the valve timing corresponds to the state, shown in the fig. 6a.

With the engine speed increase, the weight 17 centrifugal force also increases and overcoming the spring 24 resistance shifts the gears 19 un 25, which in their turn pivot the gears 20 and 27, and camshafts 21 and 26 each in its direction owing to the opposite teeth spiral. This occurs because of the slide bushing 28 with internal teeth slip along the gear 22, thus, additionally pivoting the gear 20 and the camshaft 21 in one direction, and the gear 27, driven by the gear 25, in the opposite. In this way, thanks to the gears 19, 20, 25 and 27 interaction, the cams of the camshafts 21 and 26 turn in the opposite directions, thus causing more wide admission and emission valve timing. The valve timing, in this case, corresponds to the state, shown in the fig. 6b. The valve timing state at higher speeds is illustrated in the fig. 6c and fig. 6d.

The speed of the overloaded engine decreases, causing the weight 17 centrifugal force decreasing. So, the spring 24 through the gears 19 and 25 get the camshafts 21 and 26 back in the initial position, causing gradual valve timing transfer from the state as in the fig. 6d to the lower 6c- state and further to the still lower 6b- and 6a- states. The governor returns the gas timing in the initial (stopping down) position at the engine stop

Depending on the proposed valve timing device application, for example in the street or in the racing car, the gear 23 drive and driven ratio should be chosen correspondingly i=1:1 and 1:2.

Gradual transfer from the state like in the fig. 6a to the state 6b is more proper for the engine intended for city use, but for the sport cars the transfer from the 6b to the 6c state and further to the 6d state is more advisable. More over, in the case of extreme norms of the operating engines take place transfer to the state 6d and still higher states. The effective use of the obtained advantage, as well as the fuel saving can be achieved by the proper choose of the change gear, with more favorable gears ratios, and the tire size.

In the first version of the invention realization (see fig. 4 and claim articles 1 to 4) the valve timing governor configuration (fig. 4) kinematic diagram is built like four helical gears 19, 20, 25 and 27 all-time coupling, where the gear couples 19 and 20,

and 25 and 27 have opposite teeth spiral directions. The weight 17 centrifugal force, compressing the governor spring 24 and causing the slide bushing 28 slip over the gear 22, induce the gears 19 and 25 axial displacement with corresponding pivoting of the gears 20 and 27, and relative camshafts 21 and 26, each in opposite directions, inducing in such a way more wide admission and emission valve timing.

In the second version of the invention realization (see fig. 5 and claim articles 5 to 8) relative to the fig. 4, the gears 19 and 25 are substituted with one gear 29, which from one side has the teeth spiral direction like the gear 19 and from the other like the gear 25.

In the both above mentioned versions of the invention realization the admission 10 and emission 10 valves of the engine combustion chamber are disposed as in the fig. 2b. The two camshafts 21 and 26 similar by design to those used on the engine of two camshaft types, that is one for the admission valves and the other for the emission valves per cylinder. Such type of the valves arrangement (fig. 2b) at the inlet creates the turbulent flow, favoring the fuel-air mixing and its combustion process. At the same time at the emission valve opening occurs the better condition for the exhaust gas exit.

In the third version of the invention realization (see fig. 3a and claim article 9) the valve timing mechanism used to drive the gas-distributing device (fig. 4 or fig. 5). There are admission 30 and emission 31 cams on each of the camshafts 21 and 26, which through the axle 32 and the rocker arm 33 operate the admission 10 and emission 11 valves. The camshafts 21 and 26 are pivoted in the opposite directions when the engine reaches the certain speed. This pivoting results in the admission cam 30 on the camshaft 21 through the rocker arm 33, fixed on the axle 32 acts on one of the admission valves 10. The second admission valve 10 is acted upon through the rocker arm 33 by the admission cam 30, fixed on the second camshaft 26, which, driven by the governor (fig. 4 or fig.5), is pivoted in the direction opposite to the camshaft 21. In this way the cams 30 displacement in the opposite directions is realized, thus giving wider valve timing on admission. The camshaft 26 emission cam 31 through the rocker arm 33 acts on one of the emission valves 11, at that the other emission valve 11 is acted upon through the rocker arm 33, fixed on the axle 32, by the cam 31 fixed on the camshaft 21. The gearbox (fig. 4 or fig. 5) turns the camshafts 21 and 26 in the opposite directions. In this way the cams 31 displacement in the opposite directions is realized, thus giving wider valve timing on emission.

In the fourth version of the invention realization (see fig. 3b and claim article 10) the valve timing mechanism also used to drive the gas-distributing device (fig. 4 or fig. 5). There are admission 30 and emission 31 cams on each of the camshafts 21 and 26, which through the axle 34 and the rocker arm 33 operate the admission 10 and emission 11 valves. The camshafts 21 and 26 are pivoted in the opposite directions when the engine reaches the certain speed. This pivoting results in the admission cam 30 on the camshaft 21 acts on one of the admission valves 10. The second admission valve 10 is acted upon through the rocker arm 33 by the admission cam 30, fixed on the second camshaft 26, which, driven by the governor (fig. 4 or fig.5), is pivoted in the direction opposite to the camshaft 21. In this way the cams 30 displacement in the opposite directions is realized, thus giving wider valve timing on admission. The

camshaft 26 emission cam 31 acts on one of the emission valves 11, at that the other emission valve 11 is acted upon through the rocker arm 33, fixed on the axle 34, by the cam 31 fixed on the camshaft 21. The gearbox (fig. 4 or fig. 5) turns the camshafts 21 and 26 in the opposite directions. In this way the cams 31 displacement in the opposite directions is realized, thus giving wider valve timing on emission.

The advantages of the proposed gas-distributing device are as following:

- the device can be made on the base of the existing gas distributing mechanisms elements;
- it is possible to reduce the engine idle run speed up to 400 rpm and even lower, at that the engine works steadily without vibrations;
- in the city traffic regime the fuel consumption, as well as air pollution are reduced;
- more complete gas exchange occurs at various engine speeds, resulting in the engine power increase and enhancing its operation dynamics.

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Claims

1. Gas-distributing device (fig. 4), which automatically change the admission and emission valves timing in relation to the load, applied to the engine shaft and the shaft speed, **characterized in that** is configured as four all-time coupled helical gears 19, 20, 25 and 27, where the gears 19 and 20 teeth spiral direction is opposite to the gears 25 and 27 teeth spiral direction. At that the weight 17 centrifugal force, compressing the governor spring 24 and causing the slide bushing 28 slip over the gear 22, induce the gears 19 and 25 axial displacement with corresponding pivoting of the gears 20 and 27, and relative camshafts 21 and 26, each in opposite directions, thus inducing more wide admission and emission valve timing.

2. Gas-distributing device, as in the Claim 1, where the gear 19 commands the gear 20 and the camshaft 21, but the gear 25 commands the gear 27 and camshaft 26.

3. Gas-distributing device, as in the Claim 1 or in the Claim 2, where the power transmission from the crankshaft to the gear 23 is realized by the governor axle 15, gear 22 and slide bushing 28 with built-in crosspiece 18 and gears 19 and 25 with opposite teeth spiral directions.

4. Gas-distributing device, as in any of the aforesaid Claims, where the admission 9 and emission 12 ducts, as well as admission 10 and emission 11 valves all are disposed in the engine head, at that each cylinder has four gas distributing valves, disposed cross wisely relative to each other (fig. 2b): two admission 10 and two emission 11 valves and two camshafts 21 and 26. As a result the camshafts cams interferes directly with admission 10 and emission 11 valves. In such a camshafts cams and camshafts interaction there are one intake and one discharge manifolds attached to the corresponding admission 9 and emission 12 ducts on the each side of the cylinder flow head.

5. Gas-distributing device (fig. 5) which automatically change the admission and emission valves timing in relation to the load, applied to the engine shaft and the shaft speed, **characterized in that** is configured as three all-time coupled helical gears 20, 27 and 29, where the gears 19 and 25, described in the Claim 1 are substituted with one gear 29, where its part 19' has teeth spiral direction as the gear 19, but the part 25' has teeth spiral direction as the gear 25, at that, the part 19' and gear 20 teeth spiral direction is opposite to the part 25' and gear 27 teeth spiral direction. The weight 17 centrifugal force, compressing the governor spring 24 and causing the slide bushing 28 slip over the gear 22, induce the gear part 19' and 25' axial displacement with corresponding pivoting of the gears 20 and 27, and relative camshafts 21 and 26, each in opposite directions, thus inducing more wide admission and emission valve timing.

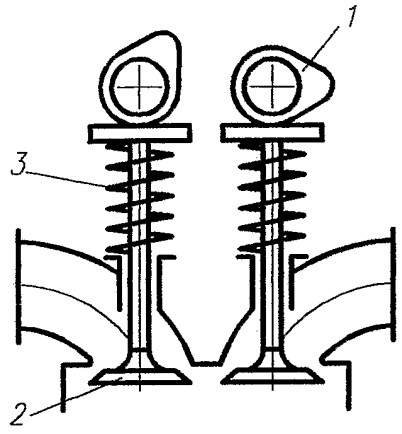
6. Gas-distributing device, as in the Claim 5, where the gear part 19' commands the gear 20 and the camshaft 21, but the gear part 25' commands the gear 27 and camshaft 26.

7. Gas-distributing device, as in the Claim 5 or in the Claim 6, where the power transmission from the crankshaft to the gear 23 is realized by the governor axle 15, gear 22 and slide bushing 28 with built-in crosspiece 18 and gear parts 19' and 25' with opposite teeth spiral directions.

8. Gas-distributing device, as in any of the aforesaid Claims from 5 to 7, where the admission 9 and emission 12 ducts and admission 10 and emission 11 valves all are disposed in the engine head, at that each cylinder has four gas distributing valves, disposed cross wisely relative to each other (fig. 2b): two admission 10 and two emission 11 valves and two camshafts 21 and 26. As a result the camshafts cams interferes directly with admission 10 and emission 11 valves. In such a camshafts cams and camshafts interaction there are one intake and one discharge manifolds attached to the corresponding admission 9 and emission 12 ducts on the each side of the cylinder flow head.

9. Gas-distributing device which automatically change the admission and emission valves timing in relation to the load, applied to the engine shaft and the shaft speed, **characterized in that** is configured (fig. 3a) in a way where the camshafts cams 30 and 31 operates through the rocker arms 33, mounted on the axle 32, at that each cylinder has four distributing valves two admission 10 and two emission 11 valves disposed in mutually antithetic position, as well as two camshafts 21 and 26, which are similar by construction with those installed in the two camshafts engines each cylinder has one admission and one emission camshaft. In such a rocker arms 33 and cams 30 and 31 interaction with admission 10 and emission 11 valves there are one intake and one discharge manifolds on the cylinder flow head opposite sides.

10. Gas-distributing device which automatically change the admission and emission valves timing in relation to the load, applied to the engine shaft and the shaft speed, **characterized in that** is configured (fig.3b) in a way where the admission cam 30 on the camshaft 21 acts on one of the admission valves 10, but the other admission valve 10 is acted upon by admission cam 30 on the camshaft 26 through the rocker arm 33 fixed on the axle 34; in its turn the emission cam 31 on the camshaft 26 acts on one of the emission valves 11, but the other emission valve 11 is acted upon by the emission cam 31 on the camshaft 21 through the rocker arm 33 fixed on the axle 34, at that there are four distributing valves oppositely arranged two admission 10 and two emission 11 valves and two camshafts, similar by design to those installed on the two camshafts engines by one admission and emission camshaft for the cylinder. As a result at such a rocker arm 33 arrangements on the axle 34 and cams 30 and 31 interaction with admission 10 and emission 11 valves the engine spark plug 13or fuel mixture are placed in the combusting chamber center.



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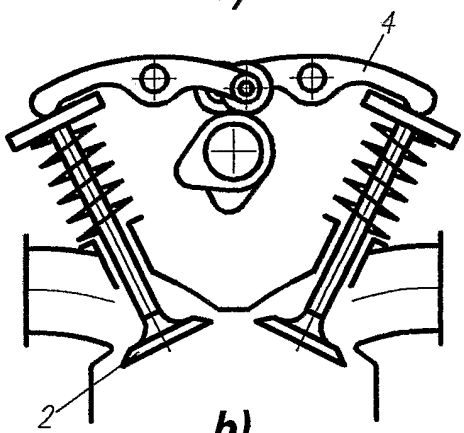

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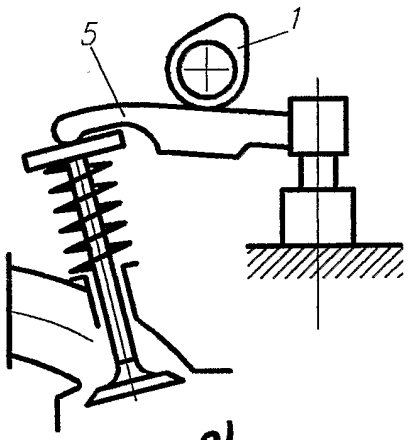

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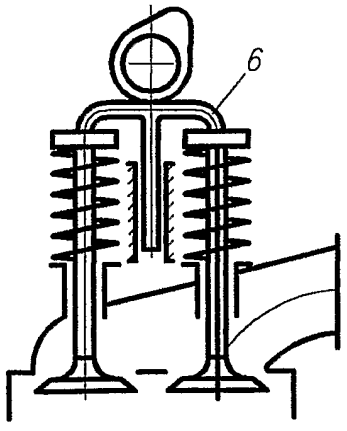

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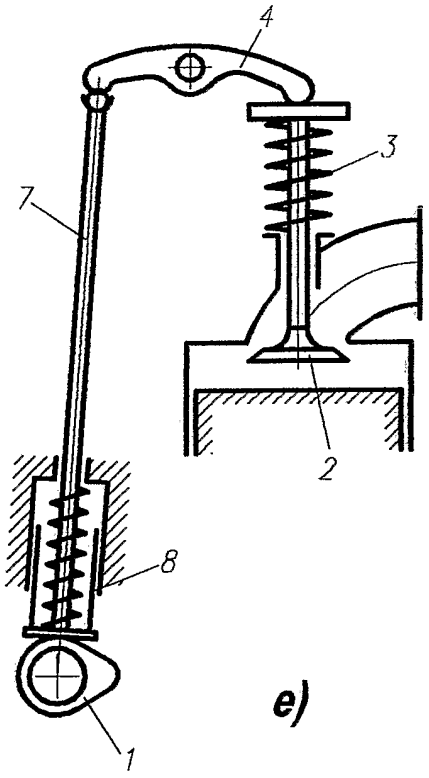

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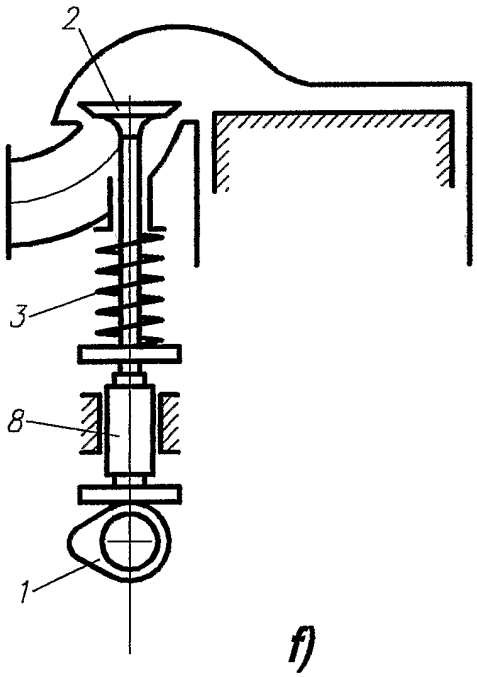

f)

Fig.1 *Prior art*

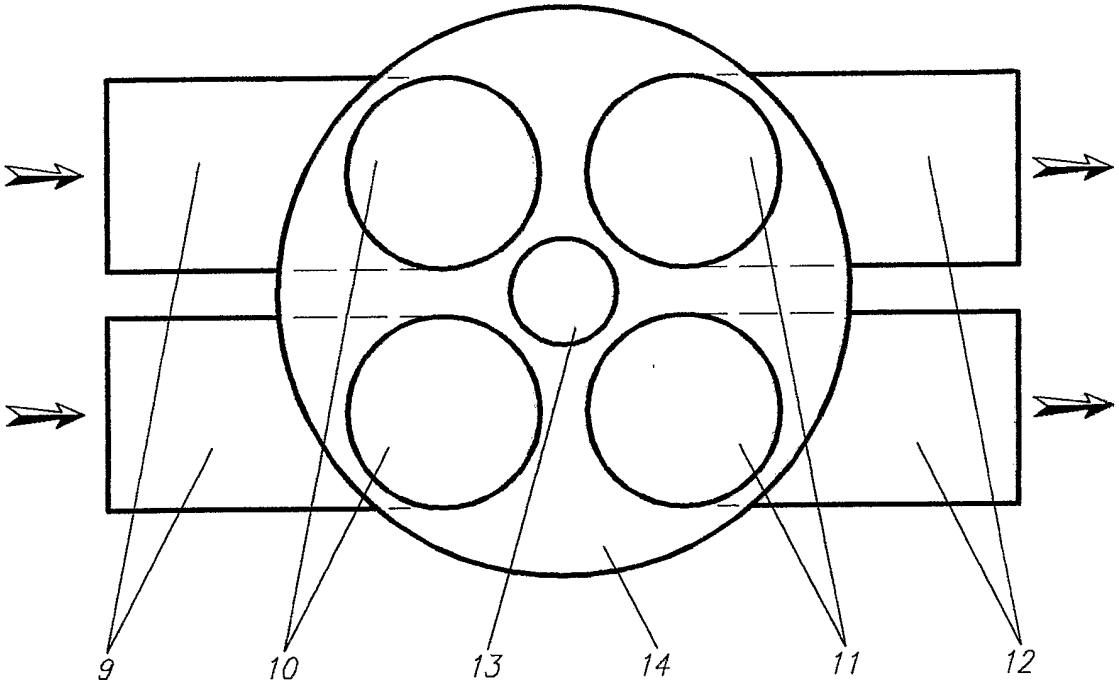

Fig.2a Prior art

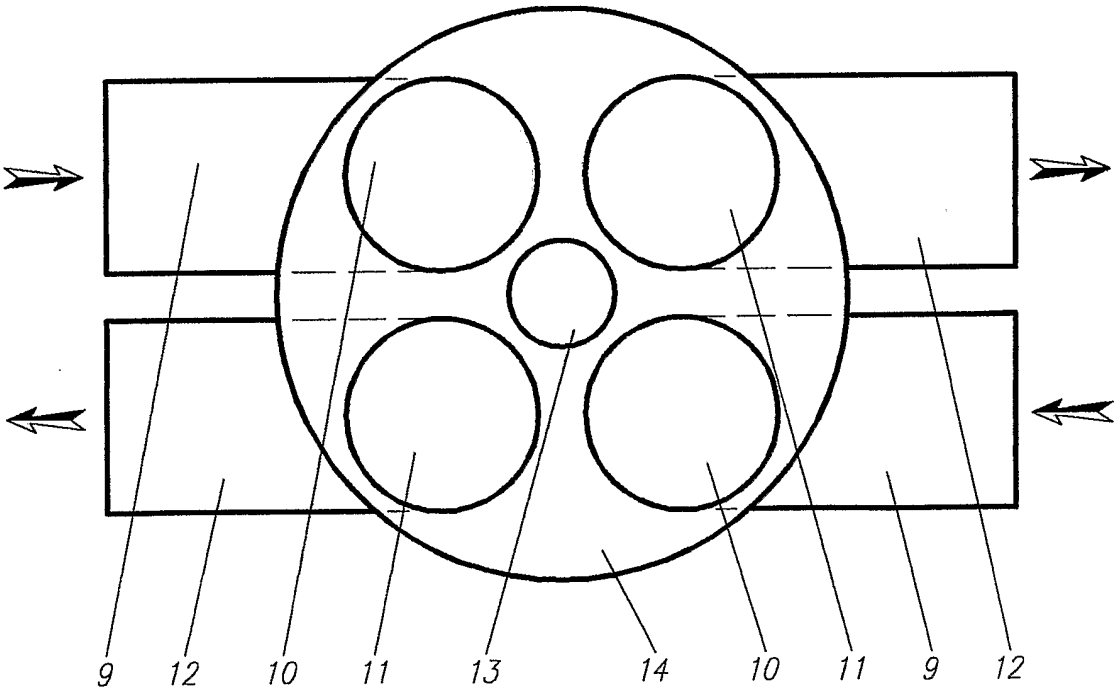

Fig.2b

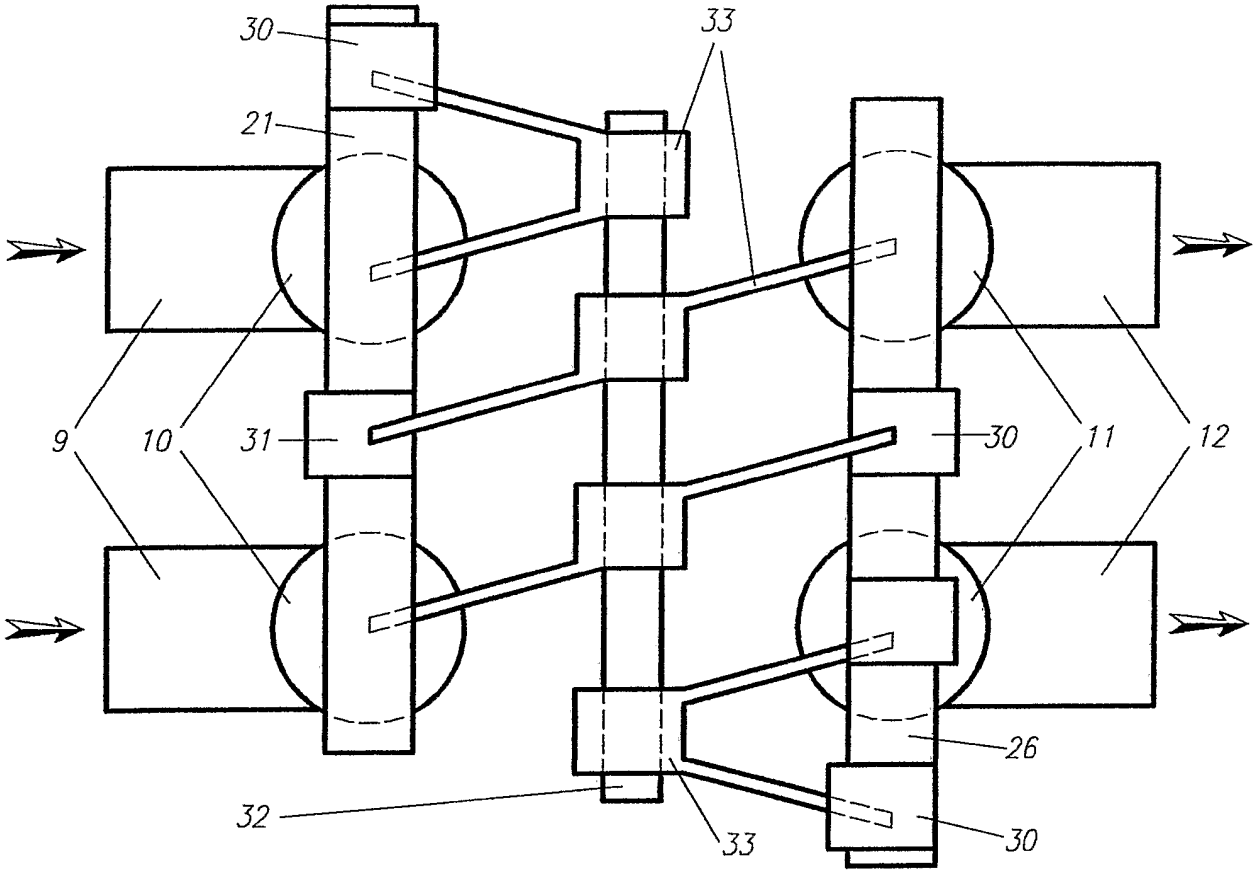
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Fig.3a

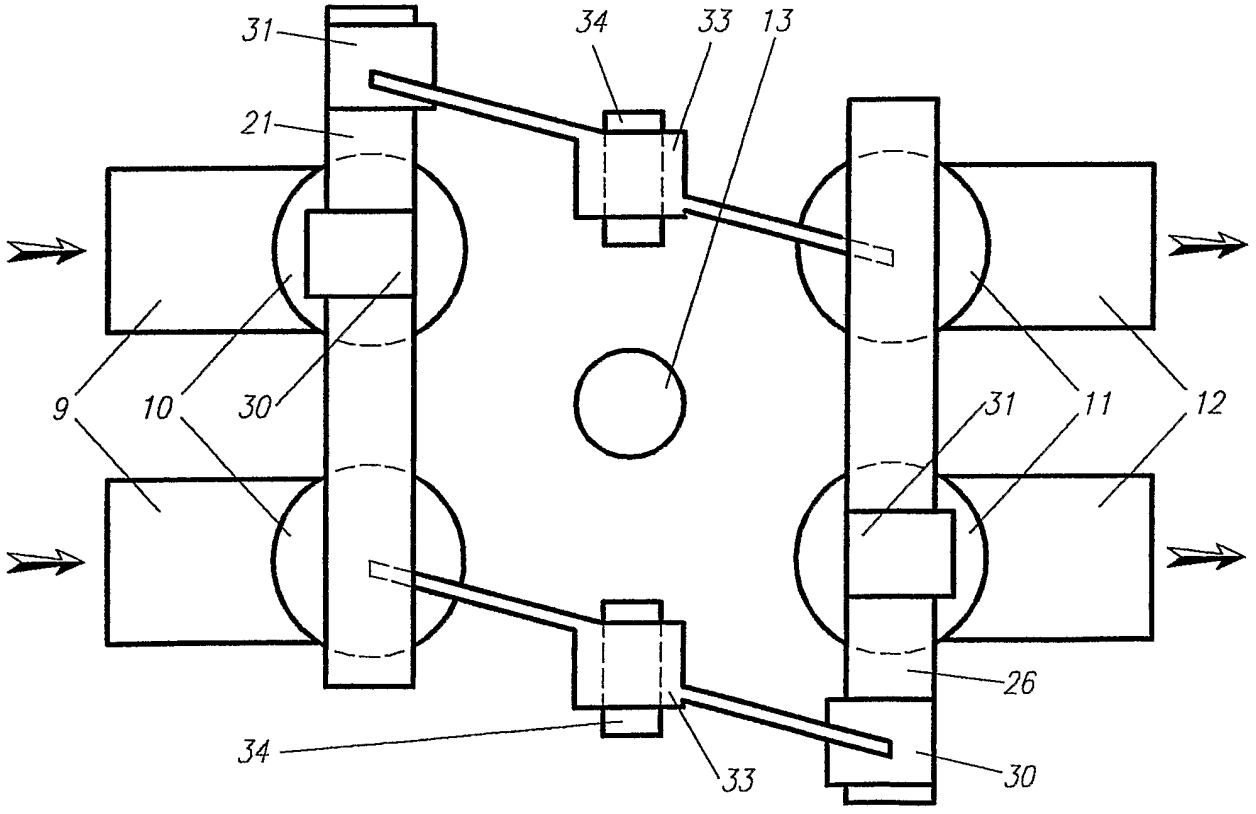
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Fig.3b

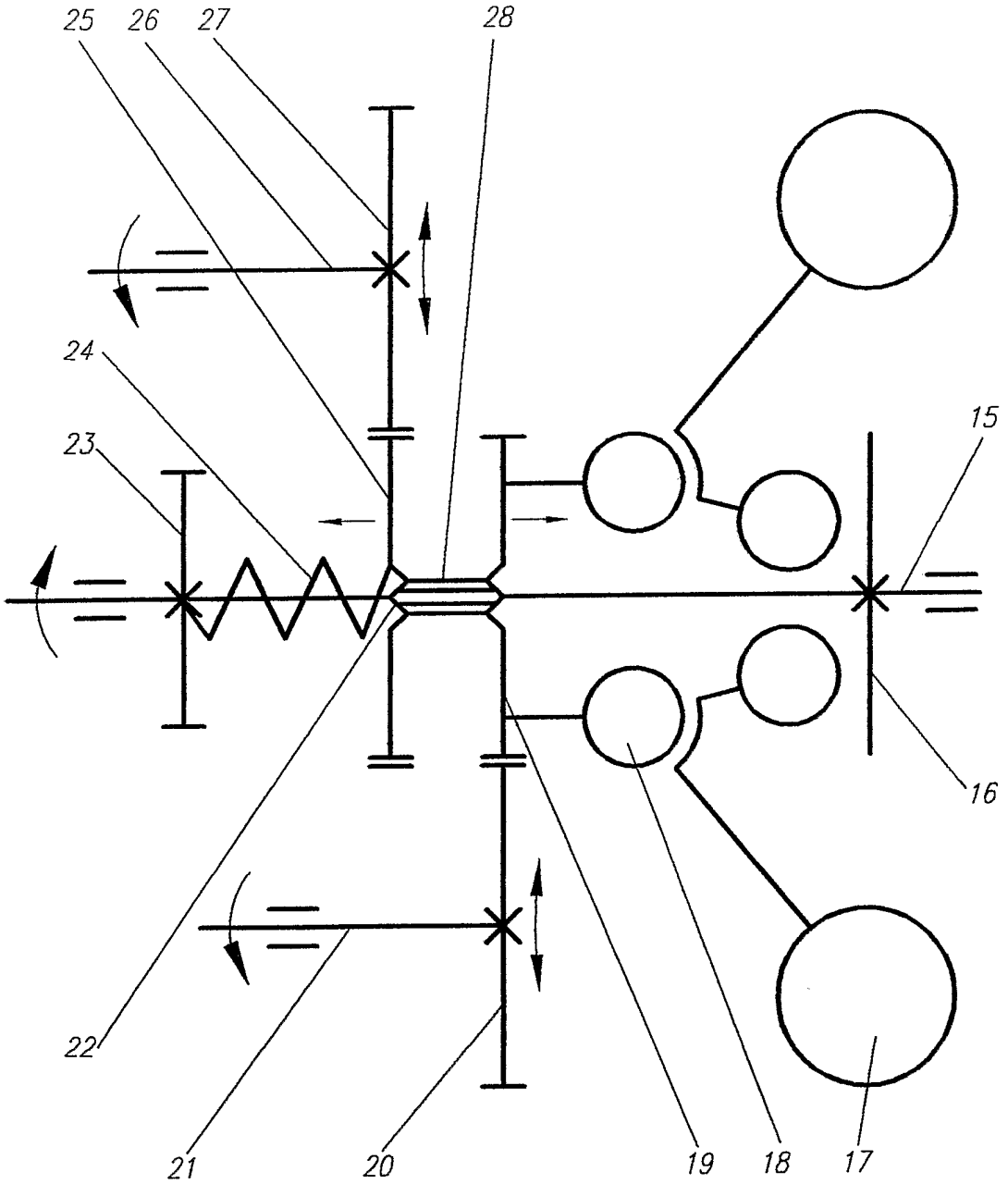

Fig.4

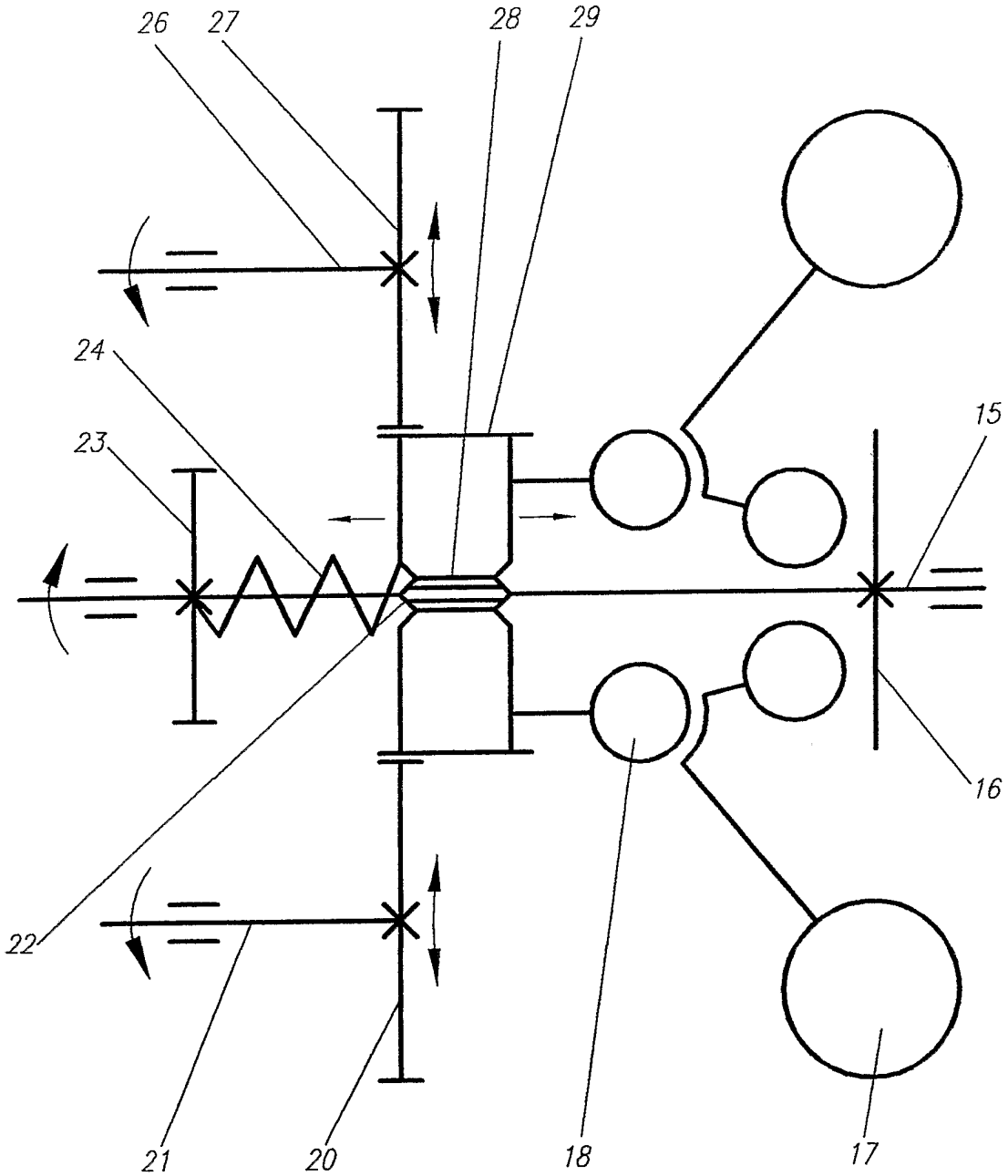

Fig.5

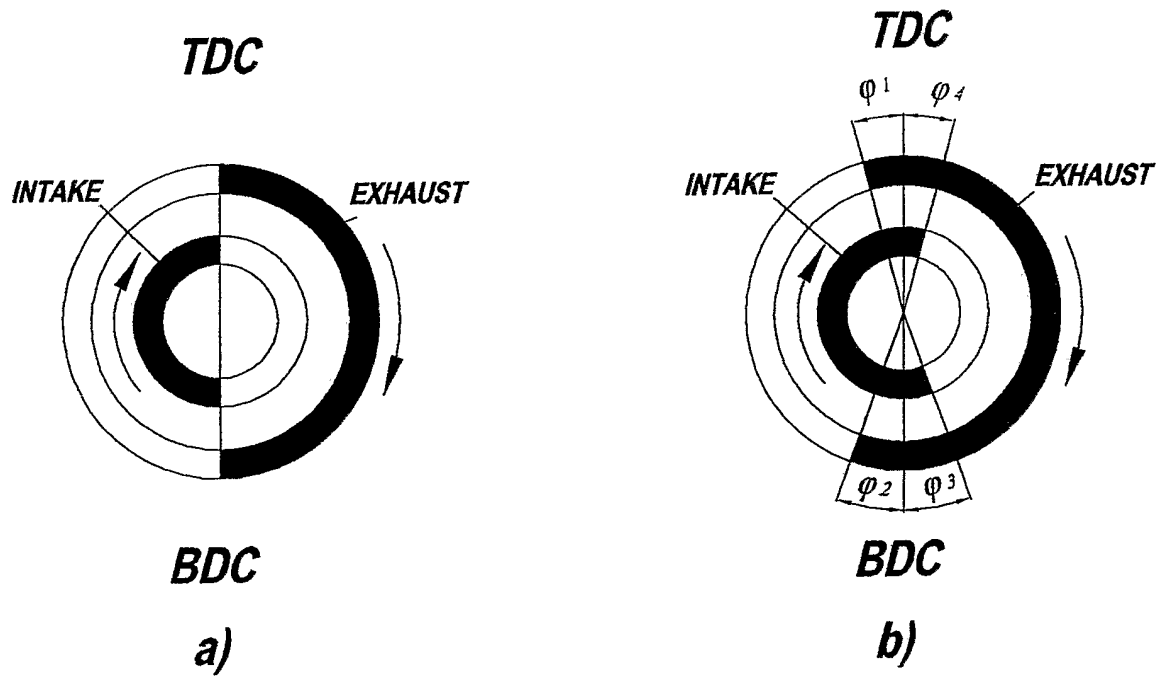
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Fig.6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/LV2005/000006

A. CLASSIFICATION OF SUBJECT MATTER
F01L1/34 F16D3/06 F02D13/02 F01L1/18 F01L1/053

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)
F01L F16D F02P F02D

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, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 04, 30 April 1996 (1996-04-30) & JP 07 332050 A (YUTAKA TANAKA), 19 December 1995 (1995-12-19) abstract figures	1-8
A	US 4 570 581 A (TITOLO ET AL) 18 February 1986 (1986-02-18) abstract figures	1-8
A	FR 2 587 417 A (BOSCH GMBH ROBERT) 20 March 1987 (1987-03-20) abstract figures	1-8

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 December 2005	13. 01. 2006

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Paulson, B

Form PCT/ISA/210 (second sheet) (January 2004)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 41 32 967 A1 (DIECK, MICHAEL, 2839 SIEDENBURG, DE) 14 May 1992 (1992-05-14) abstract figures	1-8
A	US 1 635 314 A (DOIGNON LOUIS ABEL) 12 July 1927 (1927-07-12) abstract figures	1-8
A	US 4 409 941 A (HAUBENHOFER ET AL) 18 October 1983 (1983-10-18) abstract figures	1-8
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A	PATENT ABSTRACTS OF JAPAN vol. 010, no. 265 (M-515), 10 September 1986 (1986-09-10) & JP 61 087911 A (SHOICHI YAMAMOTO), 6 May 1986 (1986-05-06) abstract figures	1-8
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C.(Continuation) 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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A	US 4 649 874 A (SONODA ET AL) 17 March 1987 (1987-03-17) abstract figures	9,10
A	US 4 969 427 A (HAMADA ET AL) 13 November 1990 (1990-11-13) abstract figures	9,10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/LV2005/000006

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-8

Claims 1 to 8 refer to an apparatus for varying the valve timing with a centrifugal regulator.

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2. claims: 9,10

Claims 9 and 10 refer to different layouts of rocker arms in the cylinder head on an internal combustion engine.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/LV2005/000006

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
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