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D E C I S I O N
of 12 June 2003

Case Number: T 0247/02 - 3.2.4

Application Number: 99830065.1

Publication Number: 0939205

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Language of the proceedings: EN

Title of invention:
Internal combustion engine with variable hydraulic valve actuating system

Applicant:
C.R.F. Società Consortile per Azioni

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0247/02 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 12 June 2003

Appellant: C.R.F. Società Consortile per Azioni
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 7 September 2001 refusing European application No. 99830065.1 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: C. A. J. Andries
Members: T. Kriner
M.-B. Tardo-Dino

Summary of Facts and Submissions

I. The Appellant (Applicant) lodged an appeal on 2 November 2001 against the decision of the Examining Division, posted on 7 September 2001, refusing the European patent application No. 99 830 065.1. The fee for the appeal was paid simultaneously and the statement setting out the grounds of appeal was received on 7 January 2002.

II. The Examining Division had held in the decision under appeal that the application did not meet the requirements of Article 52(1) EPC in conjunction with Article 56 EPC in view of the disclosure of documents:

D1: JP-A-5-256 115 (Patent Abstract)

D2: EP-A-0 317 371.

In addition to these documents, the following documents have been cited in the search report, in the application and during the examining procedure:

D3: DE-A-19 604 455

D4: US-A-2 827 884

D5: EP-A-0 196 441

D6: EP-A-0 803 642.

III. The appellant requested that the decision under appeal be set aside and a patent be granted on the basis of the following documents:

Claims: 1 to 3, filed with letter of 28 May 2003;

Description: pages 1 to 4, 11, 12 filed with letter of 28 May 2003;
pages 5 to 10 as originally filed;

Drawings: Figures 1 to 3 as originally filed.

IV. Claim 1 of the main request reads as follows:

"Internal combustion engine, comprising:
- at least one intake valve (7) and at least one exhaust valve (27) for each cylinder, each provided with respective spring means (9) biassing the valve to the closed position, for controlling the communication between the respective intake and exhaust conduits (4, 5, 6) and the combustion chamber (2),
- camshaft means (11, 28) for actuating the intake and exhaust valves (7, 27) of the engine cylinders through respective tappets (16, 29), each intake valve (7) and each exhaust valve (27) being driven by a cam (14, 28) of said camshaft means (11, 28),
- wherein at least one of said tappets (16) drives the respective intake or exhaust valve (7), against the action of said biassing spring means (9), through the interposition of hydraulic means including a chamber (c) of fluid under pressure,

- said hydraulic means further comprises a piston (21) associated with the stem (8) of the valve (7) and slidably mounted within a guiding cylinder (22), said piston (21) facing a variable volume chamber (34) defined thereby within said guiding cylinder (22), said variable volume chamber (34) being in communication with the chamber (c) of fluid under pressure through a connecting aperture (35) formed at one end of said guiding cylinder (22), said piston (21) having an end nose (38) adapted to be introduced within said connecting aperture (35) during the final portion of the travel of the piston (21) corresponding to the closing of the valve (7), for reducing the communication port between said variable volume chamber (34) and said chamber (c) of fluid under pressure, so as to brake the travel of the valve (7) in proximity of its closed position,
- wherein said hydraulic means including said chamber (c) of fluid under pressure, said piston (21) and said guiding cylinder (22) are all provided in the body (19) of a pre-assembled unit (20),
- said engine comprising means (43 - 50) for providing an additional communication between said variable volume chamber (34) and said chamber (c) of fluid under pressure, so as to eliminate or reduce the braking effect at the end of the closing travel of the valve (7),
- said means for providing the above mentioned additional communication between the variable volume chamber (34) and the chamber (c) of fluid under pressure comprising a valve element (43) movable between a first position in which it provides said communication and a second position in which this communication is interrupted,

- said valve element (43) being rotatably mounted within a cylindrical cavity (44) where two conduits (48, 49) open, respectively communicated to said variable volume chamber (34) and said chamber (c) of fluid under pressure, said valve element (43) defining a passage (46) adapted to come into communication with both said conduits (48, 49) when the valve element is in its first position,
- said passage (46) being defined by a longitudinal slot formed on a surface of the valve element (43), said conduits (48, 49) opening at two spaced areas, which are longitudinally aligned,

characterised in that:

- said chamber (c) of fluid under pressure is adapted to be connected through a solenoid valve (24) to an outlet channel (23), in order to uncouple the valve (7) from the respective tappet (16) and cause the quick closing of the valve (7), under the action of the respective biassing spring means (9), said solenoid valve (24) being provided in the body of the pre-assembled unit,
- said valve element (43) is rotatable about an axis offset and orthogonal with respect to the axis of said piston (21), and said cylindrical cavity is formed in said body (19) of the pre-assembled unit (20) as a separate cavity with respect to the cavity where said guiding cylinder (22) is mounted,
- the longitudinal slot is formed on the outer surface of the valve element (43),
- said conduits (48, 49) open at two spaced areas of the cylindrical wall of the cavity (44) wherein the valve element (43) is rotatably mounted."

V. In support of his request, the Appellant relied essentially on the following submissions:

The present invention as defined in claim 1 referred to an internal combustion engine comprising hydraulic means for controlling the movement of the intake and exhaust valves. This hydraulic means allowed a quick closing of the valves, and had simple and inexpensive means for reducing the braking effect at the end of the closing travel of the valves. These advantages were achieved by a combination of features which was neither known nor suggested by the available state of the art.

Therefore, the subject-matter of claim 1 was new and based on an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

The features of claim 1 are disclosed in originally filed claims 1, 2, 3, 6, in Figure 2, and in the description on page 6, lines 3 to 10.

Claims 2 and 3 correspond to the originally filed claims 4 and 5.

The description has been adapted to the wording of claim 1. Moreover D1 and D2 have been cited.

Therefore, all amendments meet the requirements of Article 123(2) EPC.

3. *State of the art*

3.1 D1 discloses an internal combustion engine, comprising:

- at least one intake valve (6) and at least one exhaust valve (implicit) for each cylinder, each provided with respective spring means (see abstract) biassing the valve to the closed position, for controlling the communication between the respective intake and exhaust conduits and the combustion chamber,

- camshaft means for actuating the intake and exhaust valves of the engine cylinders through respective tappets, each intake valve and each exhaust valve being driven by a cam of said camshaft means (see abstract),

- wherein at least one of said tappets drives the respective intake or exhaust valve, against the action of said biassing spring means, through the interposition of hydraulic means including a chamber (chamber between oil supplying passage 25 and chamber 14) of fluid under pressure,

- said hydraulic means further comprises a piston (11) associated with the stem of the valve and slidably mounted within a guiding cylinder (10), said piston facing a variable volume chamber (14) defined thereby within said guiding cylinder, said variable volume chamber being in communication

with the chamber of fluid under pressure through a connecting aperture (on the left hand side of said guiding cylinder),

said engine comprising means (36) for providing an additional communication between said variable volume chamber and said chamber of fluid under pressure, so as to eliminate or reduce the braking effect at the end of the closing travel of the valve,

said means for providing the above mentioned additional communication between the variable volume chamber and the chamber of fluid under pressure comprising a valve element (48) movable between a first position in which it provides said communication and a second position in which this communication is interrupted.

However,

- the connecting aperture is not formed at one end of said guiding cylinder,

- the piston has no end nose adapted to be introduced within said connecting aperture during the final portion of the travel of the piston corresponding to the closing of the valve,

- the hydraulic means is not provided in the body of a pre-assembled unit,

- the valve element is not rotatably mounted within a cylindrical cavity and does not define a passage for communicating two conduits, and

- the engine does not comprise a solenoid valve for uncoupling the intake or exhaust valve from the respective tappet.

3.2 D2 discloses an internal combustion engine as described in the pre-characterizing portion of claim 1, namely an internal combustion engine comprising:

- at least one intake valve (5) and at least one exhaust valve (implicit) for each cylinder, each provided with respective spring means (7) biassing the valve to the closed position, for controlling the communication between the respective intake and exhaust conduits (3) and the combustion chamber (1),

- a camshaft means (8) for actuating the intake and exhaust valves of the engine cylinders through respective tappets (13, 14), each intake valve and each exhaust valve being driven by a cam (9) of aid camshaft means,

- wherein at least one of said tappets drives the respective intake or exhaust valve, against the action of said biassing spring means, through the interposition of hydraulic means including a chamber (27) of fluid under pressure,

- said hydraulic means further comprises a piston (12) associated with the stem of the valve and slidably mounted within a guiding cylinder (11), said piston facing a variable volume chamber (26) defined thereby within said guiding cylinder, said variable volume chamber being in communication with the chamber of fluid under pressure through a connecting aperture (25) formed at one end of said guiding cylinder, said piston having an end nose (31) adapted to be introduced within said connecting aperture during the final portion of the travel of the piston corresponding to the closing of the valve, for reducing the communication port between said variable volume chamber and said chamber of fluid under pressure, so as to brake the travel of the valve in proximity of its closed position (see column 4, lines 52 to 56),

- wherein said hydraulic means including said chamber of fluid under pressure, said piston and said guiding cylinder are all provided in the body (S) of a pre-assembled unit,

- said engine comprising means (57, see Figure 4) for providing an additional communication between said variable volume chamber and said chamber of fluid under pressure, so as to eliminate or reduce the braking effect at the end of the closing travel of the valve,

- said means for providing the above mentioned additional communication between the variable volume chamber and the chamber of fluid under

pressure comprising a valve element (51) movable between a first position in which it provides said communication and a second position in which this communication is interrupted,

- said valve element being rotatably mounted within a cylindrical cavity (17') where two conduits (58, 59) open, respectively communicated to said variable volume chamber and said chamber of fluid under pressure, said valve element defining a passage (60) adapted to come into communication with both said conduits when the valve element is in its first position,

- said passage being defined by a longitudinal slot formed on a surface of the valve element, said conduits opening at two spaced areas, which are longitudinally aligned.

However, D2 does not disclose any of the features of the characterizing portion of claim 1.

3.3 D3 and D4 each refer to a valve of an internal combustion engine, the valve having a piston and a pneumatic or hydraulic actuator. The actuator comprises a valve element which is rotatable about an axis offset and orthogonal with respect to the axis of the piston.

However, the valve element according to D3 and D4 has nothing in common with the valve element described in the present claim 1.

3.4 Each of D5 and D6 (both cited in the application) discloses an internal combustion engine, comprising:

- at least one intake valve (D5: 15, 18 / D6: 7) and at least one exhaust valve (D5: implicit / D6: 27) for each cylinder, each provided with respective spring means (D5: 13, 66 / D6: 9) biassing the valve to the closed position, for controlling the communication between the respective intake and exhaust conduits (D5: 70 / D6: 4, 6) and the combustion chamber,

- camshaft means (D5: 34 / D6: 11, 28) for actuating the intake and exhaust valves of the engine cylinders through respective tappets (D5: 24 / D6: 15, 16), each intake valve and each exhaust valve being driven by a cam (D5: 33 / D6: 14) of said camshaft means,

- wherein at least one of said tappets drives the respective intake or exhaust valve, against the action of said biassing spring means, through the interposition of hydraulic means including a chamber (D5: 12 / D6: C) of fluid under pressure,

- said hydraulic means further comprises a piston (D5: 22 / D6: 21) associated with the stem of the valve and slidably mounted within a guiding cylinder (D5: 20 / D6: 22), said piston facing a variable volume chamber (D5: 54 / D6: see Figure 1) defined thereby within said guiding cylinder, said variable volume chamber being in communication with the chamber of fluid under pressure through a connecting aperture (D5: 53 /

D6: see Figure 1) formed at one end of said guiding cylinder, said piston having an end nose (D5: see Figure 2 / D6: see Figure 1) adapted to be introduced within said connecting aperture during the final portion of the travel of the piston corresponding to the closing of the valve, for reducing the communication port between said variable volume chamber and said chamber of fluid under pressure, so as to brake the travel of the valve in proximity of its closed position,

wherein said hydraulic means including said chamber of fluid under pressure, said piston and said guiding cylinder are all provided in the body (D5: 11 / D6: 19) of a pre-assembled unit,

- wherein said chamber of fluid under pressure is adapted to be connected through a solenoid valve (D5: 39 / D6: 24) to an outlet channel (D5: 38, 41, 28, 46, 47 / D6: 23), in order to uncouple the valve from the respective tappet and cause the quick closing of the valve, under the action of the respective biassing spring means, said solenoid valve being provided in the body of the pre-assembled unit.

However, the engines according to D5 and D6 do not comprise any means for eliminating or reducing the braking effect at the end of the closing travel of the intake or exhaust valve as defined in claim 1.

3.5 In view of the assessments above, the subject-matter of claim 1 is novel.

4. *Inventive step*

4.1 The most relevant state of the art is represented by D2 which has not only the most features in common with the subject-matter of claim 1, but additionally, like the present application, is directed to a combustion engine which overcomes the problem of an excessive braking effect at the end of the closing travel of a valve when the working fluid has a high viscosity.

4.2 Starting from D2 the object underlying the present application may be regarded (see page 4, line 17 to page 5, line 4 of the description) as to provide an internal combustion engine wherein the valves can be quickly closed without causing damages as a result of a too strong impact of the valves against their seats, and wherein the means for reducing the braking effect at the end of the closing travel of the intake or exhaust valve are simple and inexpensive.

4.3 This object is achieved by the provision of an internal combustion engine as defined in the pre-characterising portion of claim 1 which additionally comprises the following features:

(a) the chamber of fluid under pressure is adapted to be connected through a solenoid valve to an outlet channel, in order to uncouple the valve from the respective tappet and cause the quick closing of the valve, under the action of the respective biassing spring means, said solenoid valve being provided in the body of the pre-assembled unit;

(b) the valve element is rotatable about an axis offset and orthogonal with respect to the axis of said piston, and the cylindrical cavity is formed in the body (19) of the pre-assembled unit as a separate cavity with respect to the cavity where the guiding cylinder is mounted;

(c) the longitudinal slot is formed on the outer surface of the valve element;

(d) the conduits open at two spaced areas of the cylindrical wall of the cavity wherein the valve element is rotatably mounted.

4.4 The provision of feature a is suggested by each of D5 and D6 and may therefore be regarded as obvious.

However, as shown above in section 3, there is no suggestion to design a means for reducing the braking effect at the end of the closing travel according to features b - d. Consequently, the provision of these features in an engine according to D2 cannot be regarded as obvious.

4.5 With respect to the above findings, the subject-matter of claim 1 also involves an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent on the basis of the following documents:

   Claims: 1 to 3, filed with letter of 28 May 2003;

   Description: pages 1 to 4, 11, 12 filed with letter of 28 May 2003;
   pages 5 to 10 as originally filed ;

   Drawings: Figures 1 to 3 as originally filed.

The Registrar: The Chairman:

G. Magouliotis C. Andries