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D E C I S I O N
of 26 September 1995

Case Number: T 0586/91 - 3.2.4

Application Number: 88310979.5

Publication Number: 0317364

IPC: F01L 9/02

Language of the proceedings: EN

Title of invention:
Valve operating system for internal combustion engine

Applicants:
HONDA GIKEN KOGYO KABUSHIKI KAISHA

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"
"Closest state of the art"
"Scope of the claim"

Decisions cited:
T 0229/85

Catchword:
-

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Case Number: T 0586/91 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 26 September 1995

Appellants: HONDA GIKEN KOGYO KABUSHIKI KAISHA
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Decision under appeal: **Decision of the examining division of the European Patent Office dispatched on 8 March 1991 refusing European patent application No. 88 310 979.5 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: C. A. J. Andries
Members: M. G. Hatherly
J. C. M. de Preter

Summary of Facts and Submissions

I. European patent application No. 88 310 979.5, published under the publication No. 0 317 364, was refused by a decision of the first instance dispatched on 8 March 1991.

II. In this decision it was found that the subject-matter of the independent claim 1 filed with the letter of 3 October 1990 was novel but not inventive.

It was argued in the decision that the selection of an orifice to give the required performance was usual design procedure and that it was unnecessary to mention viscosity effects in the prior art since they were general engineering knowledge.

Two prior art documents were mentioned in the decision:

D1 DE-C-751 538
D2 US-A-3 257 999

A further prior art document had been mentioned in the earlier communication of the examining division:

D3 CH-A-243 908

III. An appeal was lodged against this decision on 6 May 1991, the appeal fee was paid on the same day. The statement of grounds of appeal was received by facsimile on 15 July 1991.

Following communications from the board, the appellants submitted amended patent documents with the letter of 29 June 1995.

The independent claim 1 is as follows:

"A valve-operating system for an internal combustion engine, comprising a valve-driving piston (13) slidably received in a cylinder body (12) and operatively connected at one end thereof to an engine valve (5) which is spring-biased in a closing direction, a check valve (41, 60, 70) interposed in a first passage (53, 52, 44, 51; 62; 85) connecting between hydraulic pressure generating means (10) for generating an oil pressure for causing opening of the engine valve and a damper chamber (39) defined between the cylinder body (12) and the valve-driving piston (13), said check valve being capable of permitting the supply of oil pressure from the hydraulic pressure generating means (10) to the damper chamber (39) through the first passage upon opening of the check valve, a further passage (53, 52) provided for connecting said hydraulic pressure generating means (10) with said damper chamber (39) independently of said first passage, said further passage (53, 52) being opened or enlarged in response to a predetermined amount of movement of the valve-driving piston (13) in the opening direction of the engine valve (5) so as to supply oil from the hydraulic pressure generating means (10) to the damper chamber (39) and thereby to increase the oil supplied to the damper chamber, and said further passage (53, 52) being closed or reduced in size in response to a predetermined amount of movement of the valve-driving piston (13) in the closing direction of the engine valve (5), and an orifice means (45, 61, 68, 72, 79, 82, 84) between the hydraulic pressure generating means (10) and the damper chamber (39) for restricting returning flow of the working oil from the damper chamber to the hydraulic pressure generating means for controlling the valve closing,

characterised in that said orifice means comprises a hole having a constant length in the direction of oil flow, said hole being sufficiently short in the flow direction to substantially reduce an influence on the flow of the working oil through the hole caused by viscosity variations of the working oil whereby the valve closing speed characteristic is substantially the same under any oil viscosity variations."

IV. The appellants' request is that the decision be set aside and that a patent be granted on the basis of the following set of application documents:

Claims 1 to 15 filed with the letter dated 29 June 1995;

Description:

- pages 3, 4, 7 to 9, 12, 13 and 15 to 21 as originally filed;

- pages 1, 5, 6, 10, 11 and 14 filed with the letter dated 3 October 1990; and

- pages 2 and 2a filed with the letter of 29 June 1995; and

Figures 1 to 17 as originally filed.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

2.1 Claim 1

The present version of claim 1 includes all the features of claim 1 as originally filed except for two points. Firstly, the term "orifice" has been changed to "orifice means" which is allowable in view of the latter term's use in the originally filed independent claim 11. Secondly, the wording "sufficiently small" has been changed to "sufficiently short in the flow direction". The originally filed independent claim 11 contains the wording "small length in the direction of oil flow as compared with the cross-sectional flow area". Since a length cannot be compared with an area, it is acceptable to use just part of the wording of the originally filed independent claim 11 when clarifying the originally filed claim 1.

The Figures and accompanying description are the basis for stating there are first and further passages connecting the hydraulic pressure generating means and the damper chamber, and that the further passage is opened or enlarged (Figure 7) upon valve-driving piston movement in the opening direction of the engine valve.

That the hole has a constant length in the direction of oil flow can be unequivocally seen on Figures 2, 4 to 8, 12 to 15 and 17 of the drawings as originally filed.

The functional restriction that the valve closing speed characteristic is substantially the same under any oil viscosity variations is a clarification of the originally filed independent claim 11 using Figure 16 and the accompanying description.

2.2 Dependent claims

The present claims 2, 4 to 6 and 8 to 11 correspond essentially to the originally filed claims 2 to 5, 7 and 13 to 15 respectively. The present claim 3 is derivable from eg Figures 4 and 5. The present claim 7 is based on the originally filed claim 6 and Figure 15. The present claim 12 is derivable from Figures 4, 5, 7, 13, 14 and 17. The present claims 13 to 15 are derivable from Figure 2 and page 4, line 36 to page 5, line 26 of the originally filed description.

2.3 The present **description** is merely an adaptation of the originally filed description to take account of changes to the claims and to acknowledge the prior art.

2.4 The **drawings** are as originally filed.

2.5 Thus the board has no objection under Article 123 EPC to the present version of the patent application.

3. *Novelty*

After examination of the cited documents, the board is satisfied that none of them discloses a valve-operating system having all the features set out in claim 1. The subject-matter of claim 1 is thus to be considered as novel within the meaning of Article 54 EPC.

4. *The different rates of flow of oil to and from the damper chamber*

As specified in claim 1, in the opening phase of the engine valve, oil is supplied to the damper chamber between the cylinder body and the valve-driving piston via a check valve. The downwards movement of the valve-driving piston causes a further passage for oil flow to the damper chamber to be opened or enlarged so that the oil flow rate is increased to open the engine valve. Thus oil is supplied at different rates during the engine valve opening phase.

During the closing phase of the engine valve, the oil leaves the damper chamber firstly via the further passage ie rapidly. Subsequently the only exit is via the orifice means because the check valve is closed. Thus the engine valve is slowed in the final part of the valve closing phase. Thus the oil leaves the damper chamber at different rates during the engine valve closing phase.

The different oil flow rates both during the valve opening and the valve closing phases are important features of the claimed system to achieve both fast opening of the engine valve and fast closing which nevertheless ends with a deceleration of the valve prior to its seating.

5. *The closest prior art*

5.1 Document **D1** discloses various valve-operating systems for an internal combustion engine, each with a check valve 5 between a source of pressurised fluid 6 and a working chamber 9, 14, 16. In the systems of Figures 1 and 2 the only route from the pressurised fluid source to the working chamber is via the check valve, ie there

is no further passage as specified in the present claim 1. In the system of Figure 3, although there is a further passage 22, this is always open and moreover is a narrow bypass line (see document D1, page 3, lines 20 to 23) which could not supply fluid at the rate required during engine valve opening (see the originally filed description, page 9, line 32 to page 10, line 4).

When the engine valve is to be closed, the final part of the upward movement of the piston is slowed because the fluid in the working chamber 9, 14, 16 must leave through a restricted passage, in Figure 1 between the piston 1 with its groove 8 and the body 2 with its hole 7, in Figure 2 the throttling line 13, and in Figure 3 either the bypass line 22 or the throttle hole 21.

5.2 Document **D2** discloses a valve-operating system for an internal combustion engine, with a check valve 3 in a first passage 2, 3, 4 between a pump 1 and a chamber 5 above a valve-driving piston 6. A further passage 11, 9 is opened when the piston 6 moves downwardly to expose the lateral bore 10 but this further passage is downstream of the check valve 3 and includes a throttle 12 so that it does not supply liquid during engine valve opening.

For controlling the valve closing, the throttle 12 restricts flow of the working liquid from the chamber 5 (column 4, lines 5 to 12) to a drain.

5.3 Also document **D3** discloses a valve-operating system for an internal combustion engine. A first passage from pressurised oil pipe 2 leads downwards, transversely into piston 1, up through piston 1 and via check valve 11 into braking chamber 7. As the piston moves downwardly to cause the engine valve to open, the oil can additionally begin to pass from pipe 2 around the

piston 1 to the braking chamber 7, through the annular space 8 (surrounding the dotted line piston) and then, as the piston continues to move downwardly, over the end of the piston (solid line piston). Thus there is also a further passage which is opened in response to a predetermined amount of movement of the valve-driving piston 1 in the opening direction of the engine valve so as to increase the oil supplied to the damper chamber 7 for rapid engine valve opening.

When the engine valve is to be closed, initially oil can leave the damper chamber over the end of the piston but subsequently the final part of the upward movement of the piston is slowed because the oil in the braking chamber 7 must leave through the annular space 8 which becomes narrower and narrower as the piston rises.

In view of the two stage flow of oil both to and from the damper chamber, the board concludes that this system is closer than that of either document D1 or D2 to the invention.

5.4 Although the system according to document **D4** provides different rates of oil flow both to and from the damper chamber 27 for valve opening and valve closing respectively, it is less relevant than that of document D3 because of the absence of a check valve and the presence of a bore 17, 22 in the push rod 15, 20 which needs to be opened and closed.

5.5 The Japanese patent publication JP-B-52-35813 cited in the description adds nothing to the teaching of the above documents (in particular Figure 3 of document D3).

5.6 The starting point for the present invention could not be the skilled person's general knowledge. Each item of prior art being examined for inventive step has not only

features in common with the invention but also other features which are different to those of the invention. The presence of these differing features may render an obviousness argument implausible eg if two prior art teachings between them possess all the claimed features but cannot be combined because of basic incompatibility. To start from the skilled person's general knowledge would entail a risk of inadvertently mosaicing several prior art items into an imaginary item with more similarities and less differences to the invention than is justified by the really existing prior art. Thus the starting point for the assessment of inventive step should be, as a general rule and certainly in the present case, a clearly defined item of the prior art.

5.7 Thus the board finds that the closest prior art system, or starting point for the present invention, is disclosed by document D3.

6. *Differentiating features, problem and solution*

6.1 The features differentiating the claimed system from that known from document D3 are set out in the characterising portion of claim 1, in summary that the orifice means is a hole of constant length which is sufficiently short to make the valve closing speed characteristic substantially the same under any oil viscosity variations.

6.2 Starting from the valve-operating system disclosed by document D3, the board sees the objective problem addressed by the invention as being to improve operation under actual service conditions. To state, for example, that the problem is concerned with viscosity effects in the orifice means would be to fix the attention thereon and so impermissibly to point to the solution (see decision T 229/85, OJ EPO 1987, 237).

6.3 The board is satisfied that the objective problem can be solved by the features of the present claim 1 and in particular by the features of its characterising portion.

Once the skilled person has read this claim, he would be well able to select an orifice to give the required performance (as acknowledged in paragraph 4 of page 3 of the examining division's decision). Since the invention could not be defined more precisely without unduly restricting the scope of the claim, and in view of the available prior art, the board considers that, in this particular case, the definition of part of the system by the result to be achieved is allowable.

7. *Inventive step - from document D3*

7.1 On pages 3 and 4 of the examining division's decision it is argued that the skilled engineer designing a hydraulic system would take account of viscosity, would be aware of its effects, either from his general engineering knowledge or from simple trials, and would then select an orifice to give the required performance, this being no more than usual design procedure. It is added that, while the prior art does not mention viscosity effects, they are general engineering knowledge.

7.2 However the board considers that while the skilled person could be expected to realise that the system shown in the closest prior art document D3 does not function optimally under actual service conditions, he would not immediately appreciate that the cause is the viscosity of the working oil and in particular the changes in its viscosity due to changes in its temperature.

7.3 The inventor of the embodiment disclosed in document D3 - although certainly a person skilled in the art - apparently did not take account of the viscosity problem. Although it is common knowledge in hydraulic engineering that the movement of a piston at the end of its stroke can be damped or cushioned by a restricting opening (throttling effect), the inventor of the embodiment disclosed in document D3 saw it as necessary to explain this commonly known effect in the description of document D3 (see page 2, lines 25 to 36) for the annular space 8 which becomes narrower and narrower as the piston rises. On the other hand, he made no mention of a change of the working oil's viscosity or of constancy of the valve closing characteristic. The purpose of the tapering annular space was solely linked to the cushioning or damping effect, and the board sees no hint either to a change of the working oil's viscosity, or for instance to some other parameter such as atmospheric pressure, or to a problem or a solution linked to one of these parameters.

7.4 The person skilled in the art would need to find out where in the hydraulic circuit the problem occurs, why the problem occurs and what could be modified to overcome the problem. Only after determining that the orifice is at fault is he in a position to apply his knowledge of orifices. In the absence of hints to viscosity changes at the orifice in the cited prior art, the board sees no incentive for him to proceed in this way. Thus the recognition of the problem of oil viscosity changes at the orifice means constitutes part of the inventive step.

7.5 Even if he were to see a problem at the tapering annular gap which has a substantial axial length, the board does not see how the skilled person could replace it by a

short constant length hole without fundamentally changing the whole structure of the document D3 system. Such a change would not be obvious.

8. *Other theoretical starting points*

8.1 If, despite the reasoning in Section 5.3 above, the person skilled in the art were to start from the valve-operating system of document **D1** then he would need both to add the further oil supply passage which is opened or enlarged when the piston moves downwardly and to change the length of the throttle passages. Even though the definition of the length of the hole in the present claim 1 relies on the result to be achieved rather than being expressed is absolute terms, it is clear that the hole of Figure 1 of document D1 is not of constant length and the throttling line 13 of Figure 2 and the bypass line 22 of Figure 3 could by no means be termed short. The throttle hole 21 in Figure 3 might be termed short but, as with document D3, document D1 explains the commonly known damping effect (page 1, line 6; page 2, lines 4 to 8 and 19) but does not mention viscosity or changes thereof and therefore gives the skilled person no incentive to proceed in the direction of the invention to achieve substantially the same valve closing speed characteristic under any oil viscosity variations.

For essentially the same reasons as those given in Sections 7.2 to 7.4 above, even if one were to start from the system disclosed by document D1 the board sees no logical chain of argumentation as to why the skilled person would be led in an obvious manner to alter the orifices in such a way as to arrive at a system satisfying the present claim 1.

8.2 Also if one were to start from the system of document **D2** it would be necessary both to add a "further passage" and to carefully consider the disclosure of the document concerning the throttle 12 which appears to be a hole in a plate.

It seems to the board that a hole in a plate must have a constant length in the direction of oil flow and indeed that a hole in a plate must be short. If a plate with a hole were provided to damp the oil flow, then the decisive point would be whether it substantially reduced viscosity variations and made the valve closing substantially constant ie whether the effect had already been achieved. The decisive point would **not** be whether it had been recognised as desirable to provide a short hole.

This said, the disclosure of document D2 must be carefully examined. Lines 5 to 12 of column 4 state that during the final stage of valve closing the control fluid is compelled to pass through the by-pass pipe 11 and the throttle installed therein causing a considerable damping. Thus the description does not mention a throttle plate but only a throttle. It is clear that throttles can take various forms and the Figure is plainly a schematic representation of the hydraulic circuit, the check valve 3 is not really constructed as shown and other components also are schematic. The board thus cannot conclude that the throttle 12 really comprises a pipe 11 into which is inserted an oversized plate 12 with a hole therein. The teaching of document D2 seems in this respect merely to be a throttle in general terms.

The lack of a discussion of the viscosity effects in document D2 has of course never been in dispute, and, for similar reasons to those of Sections 7.2 to 7.4

above, the board does not see any reason why the skilled person would be led in an obvious manner to modify the system of document D2 to arrive at a valve operating system satisfying the present claim 1.

8.3 Document D4 is plainly less relevant than documents D1 to D3 and would in no way be a suitable starting point.

9. The board thus finds that the available prior art documents, taken singly or in combination, are not prejudicial to the valve-operating system of claim 1.

The valve-operating system according to claim 1 thus involves an inventive step within the meaning of Article 56 EPC.

10. The subject-matter of claim 1 is thus patentable as required by Article 52 EPC. A patent may therefore be granted based on the allowable independent claim 1, dependent claims 2 to 15 which concern preferred embodiments of the valve-operating system according to claim 1, the amended description and the drawings.

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 in the version set out in Section IV above.

The Registrar: The Chairman:

N. Maslin C. Andries