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Datasheet for the decision of 10 June 2022

Case Number: T 0914/20 - 3.2.04

Application Number: 14830900.8

Publication Number: 3077647

IPC: F02D13/02, F02D13/04

Language of the proceedings: EN

Title of invention:
COMBUSTION ENGINE, VEHICLE COMPRISING THE COMBUSTION ENGINE AND METHOD FOR CONTROLLING THE COMBUSTION ENGINE

Patent Proprietor:
Scania CV AB

Opponent:
Daimler Truck AG

Headword:

Relevant legal provisions:
EPC Art. 100(a), 56

Keyword:
Inventive step - (no)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

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Case Number: T 0914/20 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 10 June 2022

Appellant: (Opponent)	Daimler Truck AG 70546 Stuttgart (DE)
Representative:	Hofstetter, Schurack & Partner Patent- und Rechtsanwaltskanzlei PartG mbB Balanstrasse 57 81541 München (DE)
Respondent: (Patent Proprietor)	Scania CV AB 151 87 Södertälje (SE)
Representative:	Thum, Bernhard Thum & Partner Thum Mötsch Weickert Patentanwälte PartG mbB Siebertstr. 6 81675 München (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 5 March 2020 rejecting the opposition filed against European patent No. 3077647 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman	C. Heath
Members:	G. Martin Gonzalez
	C. Kujat

Summary of Facts and Submissions

I. The appeal was filed by the appellant-opponent against the decision of the opposition division to reject the opposition filed against the patent in suit.

II. The Opposition Division held that the the subject-matter of the claims as granted was novel and involved an inventive step.

III. Oral proceedings were held before the Board on 10 June 2022.

IV. The appellant requests that the decision under appeal be set aside and the patent revoked.

The respondent-proprietor requests to dismiss the appeal (main request) or auxiliarily that the decision under appeal be set aside and the patent maintained in amended form according to auxiliary requests 1-4, all filed with their reply to the appeal of 15 October 2020.

V. The wording of claim 1 of this decision's requests is as follows:

(a) Main request (as granted)

"A four-stroke combustion engine comprising
- at least one cylinder (10);
- a piston (12) arranged in each cylinder (10);
- at least one inlet valve (18) arranged in each cylinder (10), which inlet valve (18) is connected with an inlet system (20);

- at least one first camshaft (22) which controls each inlet valve (18);
- at least one exhaust valve (24) arranged in each cylinder (10), which exhaust valve (24) is connected with an exhaust system (26);
- at least one second camshaft (28) which controls each exhaust valve (24); and
- a crankshaft (16) which controls each camshaft (22, 28),

characterised in

- at least one phase-shifting device (34), arranged between the crankshaft (16) and the at least one second camshaft (28), in order to phase-shift the at least one second camshaft (28) in relation to the crankshaft (16), to a state where the at least one exhaust valve (24) is controlled in such a way that it is opened during the engine's expansion stroke and closed during the engine's exhaust stroke, in order to achieve engine-braking via compression in the cylinders (10) during the exhaust stroke, and in that a decompression device is connected to the at least one exhaust valve (24), which decompression device is arranged to open and close the at least one exhaust valve (24) in the transition area between an exhaust stroke and an inlet stroke, when the piston (12) is at a top dead centre in the cylinder (10)."

(b) Auxiliary request 1

Claim 1 as in the main request with the following amendments (emphasis by the Board to indicate added text):

"...in the transition area between an exhaust stroke and an inlet stroke, when the piston (12) is at a top

dead centre in the cylinder (10), wherein the at least one phase-shifting device (34) is also arranged between the crankshaft (16) and the at least one first camshaft (22), in order to phase-shift the at least one first camshaft (22) in relation to the crankshaft (16) to a state, where the at least one inlet valve (18) is controlled in such a way, that it is op ned at a crankshaft angle where the at least one exhaust valve (24) is closed with the decompression device."

(c) Auxiliary request 2

Claim 1 as in auxiliary request 1 with the following amendments (emphasis by the Board to indicate added text):

"...where the at least one exhaust valve (24) is closed with the decompression device, wherein the decompression device is adapted to open and close the at least one exhaust valve (24) in the transition area between an inlet stroke and an exhaust stroke, when the piston (12) is at a top dead centre in the cylinder (10)."

(d) Auxiliary request 3

Claim 1 as in auxiliary request 2 with the following amendments (emphasis by the Board to indicate added text):

"...in the transition area between an exhaust stroke and an inlet stroke, when the piston (12) is at a top dead centre in the cylinder (10), wherein the decompression device is adapted to open the at least one exhaust valve at 40°-80° crankshaft degrees, preferably 60° crankshaft degrees, before the top dead

centre between the exhaust stroke and the inlet stroke, the decompression device is adapted to close at least one exhaust valve (24) at 40°-80°, preferably 60°, after the top dead centre between the exhaust stroke and the inlet stroke, wherein the at least one phase-shifting device (34) is also arranged between the crankshaft (16) and the at least one first camshaft (22), in order to phase-shift the at least one first camshaft (22) in relation to the crankshaft (16) to a state,..."

(e) Auxiliary request 4

Claim 1 as in auxiliary request 3 with the following amendments (emphasis by the Board to indicate added):

"...is adapted to open and close the at least one exhaust valve (24) in the transition area between an inlet stroke and an exhaust stroke, when the piston (12) is at a top dead centre in the cylinder (10), wherein the decompression device is adapted to open the at least one exhaust valve (24) at 50°-90° crankshaft degrees, preferably 70° crankshaft degrees, before the top dead centre between the inlet stroke and the exhaust stroke, and wherein the decompression device is adapted to close the at least one exhaust valve (24) at 20°-60°, preferably 40°, after the top dead centre between the inlet stroke and the exhaust stroke."

VI. In the present decision reference is made to the following documents:

(D5) DE 10 2009 051 261 A1
(D14) US 2012/0024260 A1

VII. The appellant's arguments can be summarised as follows:

Claim 1 of all requests lacks an inventive step over the combination of D14 and D5.

VIII. The respondent's arguments can be summarised as follows:

The subject-matter of the independent claims of all requests involves an inventive step over the cited prior art.

Reasons for the Decision

1. The appeal is admissible.

2. Background

The invention is directed to engine braking in a four-stroke combustion engine. Engine braking is produced by compressing air inside the cylinder during the exhaust stroke. For obtaining this compression action, the exhaust valves are partially closed during the exhaust stroke. This is achieved by advancing their opening/closing times, that is they are phase shifted during engine braking with respect to their crankshaft angle in normal engine operation. To this end a phase-shifting device is arranged between the crankshaft and the exhaust valve camshaft. Since a phase-shifting device can act steplessly, it is possible to regulate the braking torque in a stepless manner, see specification paragraphs [0012]-[0017]. The invention is also concerned with the pressure inside the cylinder at the end of the above described exhaust stroke with compression action. Too high pressure may produce

damage. At the initiation of the ensuing inlet stroke the inlet valves open. The inlet valves or their drive train may be damaged if they must overcome a too high force due to a too high inner cylinder pressure, see specification paragraph [0005]. A decompression device serves to reduce this damage risk. This device controls the exhaust valves so that they additionally open at the end of the exhaust stroke to reduce the pressure inside the cylinder, see specification paragraph [0018].

3. Main request - Inventive step

3.1 Document D14 has been cited as both prejudicial to novelty and inventive step and is indeed considered a suitable starting point for assessing inventive step.

Granted claim 1 requires in its characterizing portion two exhaust valve events. In the first one the valve opens during the expansion stroke and closes during the exhaust stroke. This is represented in figure 3 of the patent by curve A2 where the exhaust valve opens and closes about the 180° crankshaft angle (piston bottom dead center - BDC). This event is also known as brake gas recirculation (BGR). The second one is a compression-release or decompression event. In this event the exhaust valve opens and closes during the transition between the exhaust stroke and the inlet stroke, about the piston top dead centre (TDC) at a 360° crankshaft angle. This event is represented by curve D1 in figure 3 of the patent.

These two events are anticipated by the embodiment of figure 8 of D14. This embodiment is also described in paragraphs [0058]-[0060]. Indeed, figure 8 shows in solid lines an exhaust valve actuation during engine

braking. Event 922 of figure 8 about the BDC - 180° crankshaft angle-, anticipates a BGR as in the contested claim (curve A2 in figure 3 of the patent). Event 920 of figure 8 represents a decompression event as the one claimed and described by curve D1 in figure 3 of the patent. Paragraphs [0004], [0005], [0054] and [0058] of D14 describe these events for figure 8 of D14.

3.2 The claimed engine uses a different valve shifting mechanism than that of D14. D14 uses for the exhaust valve a switching system 10 that alternates between a main rocker arm 200 and a braking rocker arm 100. The main arm 200 provides the regular opening and closing events during motor power. The braking arm 100 provides exhaust fixed valve braking events 920 and 922 as depicted in figure 8. Switching system 10 is described in figures 1-4 and paragraphs [0049]-[0052]. Though not explicitly disclosed, this system appears to have a single camshaft.

3.3 Thus, the claimed engine differs from the known one of D14 in that it has two camshafts, an intake and an exhaust camshaft, and in that a phase-shifting device is arranged between the crankshaft and the exhaust camshaft (second camshaft in the claim language) for obtaining the phase-shifted braking exhaust valve events.

3.4 These differentiating features solve the problem of increasing engine braking efficiency by achieving the effect of allowing a stepless control of the braking torque, see patent specification paragraphs [0012], [0013] and [0017].

3.5 In this respect, document D5 is concerned with stepless engine braking regulation, see paragraph [0003], where its main aim is how to improve that engine braking regulation, see D5, paragraph [0004]. Thus, the skilled person seeking to improve the engine braking efficiency or regulation of D14, would naturally regard the teachings of D5 as very relevant. Paragraph [0031] third sentence of D5 teaches that all actuators influencing the air charge can be used to control the engine braking power in order to realise an almost stepless regulation. This paragraph further teaches camshaft phase-shifting devices ("Phasensteller"), for controlling opening and closing times of the intake and exhaust valves, as one such means to obtain the desired regulation, see paragraph [0031], bridging sentence between pages 4 and 5. In particular a phase-shifting device for the exhaust camshaft and a phase-shifting device for the intake camshaft, note the plural "Phasensteller 60 für Nockenwellen" in the above referred sentence of paragraph [0031] and the explicit description in paragraph [0032] "Auslassnockenversteller beziehungsweise Einlassnockenversteller". In the light of these teachings, the skilled person seeking to improve the engine regulation in D14 would regard the implementation of two camshafts with a phase-shifting device between the crankshaft and the exhaust camshaft for controlling its engine phase-shifted valve events so as to obtain a stepless control of its braking action as an obvious measure.

3.6 The respondent argues that the idea of D14 of controlling the valve events with the switching rocker arms system 10 having a single camshaft is a central one and that therefore the skilled person would not as a matter of obviousness consider departing from it and

the special motor structure that it represents. D14 teaches, so the respondent's argument goes, the engine braking events and effects of figure 8 only on the basis of the switching rocker arms system 10. The Board is not convinced by this argument. D14 also indicates that other means for actuating the exhaust and intake valves to provide engine braking may be used, see paragraph [0065] last sentence. This is also explicitly suggested in paragraph [0045] when describing the system 10: "...in another alternative embodiment of the present invention, it is contemplated that the means for actuating an exhaust valve to provide engine braking 100, and/or the means for actuating an intake valve to provide engine braking 300 may be provided by any lost motion system, or any variable valve actuation system including...". The Board notes that D14 also cites in paragraph [0011] cam phase shifters as commonly known variable valve actuation systems. Thus, contrary to the respondent's arguments, document D14 itself suggests considering different valve actuation systems and, thus, to depart from the engine's structure.

3.7 Nor will the skilled person be deterred from implementing phase-shifters because it would mean a complete overhaul of the engine's design or too complex structural modifications. The suggested two camshafts, instead of one, provided with phase-shifters are well-known structures and devices in the art. Thus, modifying the known engine to implement them is within the routine work and abilities of a person involved in the development of internal combustion engines. These modifications do not represent, in the Board's view, a complete overhaul of the engine's design. Moreover, increasing construction complexity is a known disadvantage of implementing further mechanical

elements and the price to be paid for improving regulation efficiency. The skilled person will accept this known disadvantage, in exchange for braking efficiency. It is part of the routine weighing of available options.

3.8 Finally, the respondent submits that D5 does not teach the claimed specific phase-shifter location. Claim 1 requires it to be arranged between the crankshaft and the camshaft. According to the respondent, the phase-shifting device of D5 could be located between the inlet and the outlet camshafts. In the Board's view, although the word "Phasensteller" in D5 does not specify that it is arranged between the camshaft and the crankshaft, it is the most common arrangement known to the skilled person for a device that adjusts or shifts angles between those two shafts. The claimed arrangement is thus the obvious one when implementing the teachings of D5.

3.9 The Board thus concludes that granted claim 1 does not involve an inventive step over the teachings of D14 and D5, Articles 100(a) and 56 EPC.

4. Auxiliary requests - Inventive step

4.1 All auxiliary requests lack inventive step over D14 combined with the teachings of D5, Article 56 EPC.

4.2 D14 describes in paragraph [0059], in connection with the embodiment of figure 8, a variant where the intake valve opening 934 (in dashed lines) may be retarded so as not to interfere with the compression release event 920 (the decompression event). This anticipates the feature added in auxiliary request 1 to phase-shift the intake valve so that it opens at a crankshaft angle

where the exhaust valve is closed with the decompression device. As discussed above, the obvious combination of the D14 figure 8 embodiments and D5 results in an engine with two crankshafts, including a phase-shifter for the intake camshaft and intake valve phase-shifting events, as claimed.

4.3 D14, figure 8, also discloses the feature added to auxiliary request 2 to open and close the exhaust valve (compression release event 920) between the intake stroke and the exhaust stroke at the two top dead centres of the cylinder TDC - 0° and 360° crankshaft angles, see figure 8.

4.4 Auxiliary requests 3 and 4 specify certain crank degree ranges for opening and closing the exhaust valve. These restrictions are the result of routine design choices or routine optimisation when carrying out the engine braking method of D14, figure 8. When the skilled person puts into practice an engine according to the obvious combination of D14 figure 8 and D5, they would naturally try to realize it with optimum parameters using their routine design abilities. They would thus arrive at the claimed subject-matter as a matter of obviousness.

5. For the above reasons, the Board finds that at least one ground for opposition prejudices the maintenance of the European Patent, Article 101(2) EPC. Thus, the decision was wrong and must be put aside. It also finds for the auxiliary requests that taking into consideration the amendments made by the respondent-proprietor, the patent and the invention to which it relates do not meet the requirements of the Convention. The Board must thus revoke the patent pursuant to Article 101(3)(b) EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

G. Magouliotis C. Heath

Decision electronically authenticated