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D E C I S I O N
of 1 March 2002

Case Number: T 0083/00 - 3.2.4

Application Number: 93202978.8

Publication Number: 0602692

IPC: F02D 41/22

Language of the proceedings: EN

Title of invention:
Method and apparatus for controlling a vehicle engine

Applicant:
Delco Electronics Corp.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 54

Keyword:
"Novelty - (yes) after amendments"
"Remittal for furthr prosecution"

Decisions cited:
-

Catchword:
-

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Case Number: T 0083/00 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 1 March 2002

Appellant: Delco Electronics Corp.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 21 September 1999 refusing European patent application No. 93 202 978.8 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: C. A. J. Andries
Members: T. Kriner
C. Holtz

Summary of Facts and Submissions

I. The Appellant (Applicant) lodged an appeal on 15 November 1999, against the decision of the Examining Division, dispatched on 21 September 1999, refusing the European patent application No. 93 202 978.8. The fee for the appeal was paid simultaneously and the statement setting out the grounds of appeal was received on 23 December 1999.

II. The Examining Division held that the application did not meet the requirements of Article 52(1) EPC in conjunction with Article 54 EPC in view of documents:

D1: GB-A-2 201 247 and

D2: FR-A-2 637 652.

In addition to these documents the following documents have been cited in the search report:

D3: EP-A-0 497 237 (also cited during the examining proceedings)

D4: GB-A-2 217 782

D5: WO-A-82/00888

D6: EP-A-0 204 985.

III. The Appellant requested full reversal of the decision to refuse the application on the basis of the following documents:

Claims: No. 1, 8 and 11 filed with letter of 6 September 2000;
No. 2 to 7, 9 and 10 as originally filed;
No. 12 to 16 filed with letter of 9 April 1999.

Description: Pages 1 and 3 to 28 as originally filed, with the amendments on pages 4 and 28 requested with letter of 6 September 2000;
Pages 2, 2a filed with letter of 28 July 1999.

Drawings: Figures 1 to 6b as originally filed.

IV. The independent claims 1, 8 and 11 read as follows:

"1. A method of controlling the timing of engine operating events in an engine comprising crankshaft sensing means (52,56) adapted to sense the position of the engine crankshaft (54); camshaft sensing means (10,50) including a camshaft wheel (10) rotatable with the engine camshaft (12) and a camshaft wheel sensor (50) adapted to produce a first signal indicative of whether the engine is in a first half of an engine cycle or a second half of the engine cycle and a second signal including signal transitions in first and second directions indicative of the approach of respective pistons to their top dead centre position; and processing means (60) operable to determine the timing of engine operating events on the basis of the engine position; the method comprising the steps of determining whether the crankshaft sensing means is faulty or otherwise unreliable; and

determining the position and speed of the engine and controlling the timing of engine operating events (a) on the basis of the crankshaft sensing means and the level of the first signal from the camshaft sensing means when the crankshaft sensing means is determined not to be faulty or otherwise unreliable, and (b) when the crankshaft sensing means is determined to be faulty or otherwise unreliable, on the basis of the piston positions determined from said signal transitions in the first and second directions obtained from the second signal from the camshaft sensing means."

"8. Apparatus for controlling the timing of engine operating events comprising crankshaft sensing means (52,56) operable to sense the position of the engine crankshaft (54); camshaft sensing means (10,50) including a camshaft wheel (10) rotatable with the engine camshaft (12) and operable to indicate whether the engine is in a first half or a second half of an engine cycle, the camshaft wheel including a plurality of edges for indicating that an individual piston is approaching top dead centre during an engine cycle and a separate synchronising edge, and a camshaft wheel sensor operable to produce a first signal indicative of whether the engine is in the first or second half of a cycle, a second signal providing signal transitions in first and second directions indicative of the approach to top dead centre of a respective piston, and a separate synchronising signal transition in said first direction; and processing means (60) operable to determine whether the crankshaft sensing means is faulty or otherwise unreliable, and to determine the engine position and to control the timing of engine operating events on the basis of (a) the sensed crankshaft position and the signal level of the first

signal from the camshaft wheel sensor when the crankshaft sensing means is not deemed to be faulty or otherwise unreliable, and (b) the first and second transitions of the second signal from the camshaft wheel sensor when the crankshaft sensing means is deemed to be faulty or otherwise unreliable."

"11. A camshaft wheel adapted to be fitted to an engine camshaft for rotation therewith and to be used with an engine control unit to control the timing of engine operating events, comprising a first circumferential portion (20) shaped to indicate that the engine is in a first half of the engine cycle; a second circumferential portion shaped to indicate that the engine is in a second half of the engine cycle; a plurality of indicating edges (22 to 25) of first and second type spaced substantially regularly around the camshaft wheel, each indicating edge being operable to indicate the position of an engine piston; and a synchronising edge (28) separate from the indicating edges for use in synchronising the engine control unit to the indicating edges."

V. In support of its requests, the Appellant relied essentially on the following submissions:

None of the documents cited by the Examining Division disclosed all features of the present independent claims. D1 did not show any means for providing an indication of whether the engine was in a first half or a second half of a cycle, and the camshaft wheel of D1 could not identify pistons on the basis of signal transitions in first and in second directions. The camshaft wheel shown in Figure 3 of D2 could not be used in the manner detailed in claim 11, and D3 did not

disclose that the engine speed was determined on the basis of the signal transitions in first and second directions, when the crankshaft sensing means was determined to be faulty or otherwise unreliable.

Reasons for the Decision

1. The appeal is admissible

2. *Amendments*

2.1 The present independent claims 1, 8 and 11 are based on originally filed independent claims 1, 8 and 12. In comparison with these claims the present claims 1, 8 and 11 have been clarified and supplemented by the following additional features:

Claim 1:

(a) the second signal is indicative of the approach of respective pistons to their top dead centre position;

(b) the timing of the engine operating events is controlled amongst others on the basis of the level of the first signal (when the crankshaft sensing means is determined not to be faulty or otherwise unreliable);

(c) the timing of the engine operating events is controlled on the basis of the piston positions determined from the signal transitions in the first and second directions (when the crankshaft sensing means is determined to be faulty or

otherwise unreliable).

Claim 8:

(d) the camshaft wheel includes a plurality of edges for indicating that an individual piston is approaching top dead centre during an engine cycle;

(e) the second signal provides signal transitions in first and second directions indicative of the approach to top dead centre of a respective piston;

(f) the camshaft wheel sensor is operable to produce a separate synchronising signal transition in the first direction;

(g) the processing means is operable to control the timing of the engine operating events amongst others on the basis of the signal level of the first signal (when the crankshaft sensing means is not deemed to be faulty or otherwise unreliable);

(h) the processing means is operable to control the timing of the engine operating events on the basis of the first and second transitions of the second signal from the camshaft wheel sensor (when the crankshaft sensing means is deemed to be faulty or otherwise unreliable).

Claim 11:

(i) the portions to indicate that the engine is in a first and a second half of the engine cycle are

circumferential portions;

(j) the means for indicating the position of an engine piston are indicating edges of first and second type;

(k) the camshaft wheel comprises a synchronising edge separate from the indicating edges.

2.2 Features a and d are supported by the statements on page 9, lines 14 to 20 of the originally filed description, and features b and g by the statements on page 9, line 29 to page 10, line 17. Features c, e and h are based on the explanations on page 9, lines 14 to 20 and page 12, lines 11 to 16 of the originally filed description, and features f and i to k are disclosed in Figure 1 in conjunction with the corresponding description on page 6, lines 19 to 33, and on page 8, line 25 to page 9, line 28 of the originally filed documents.

2.3 The dependent claims 2 to 7, 9 and 10 have not been amended, and dependent claims 12 to 16 correspond to originally filed claims 13 to 17. Aditionally claims 12 to 14 have been clarified.

The present description is the originally description brought in line with the present claims, and the drawings are as originally filed.

2.4 Consequently, the amendments of the application do not give a reason to objections under Article 123(2) EPC.

3. Novelty

3.1 Document D1

3.1.1 D1 discloses:

a method of controlling the timing of engine operating events in an engine (see page 1, lines 5 to 10) comprising crankshaft sensing means (2, 4) adapted to sense the position of the engine crankshaft (1); camshaft sensing means (3, 5) including a camshaft wheel (3) rotatable with the engine camshaft (8) and a camshaft wheel sensor (5) adapted to produce a signal including signal transitions in first and second directions indicative of the approach of respective pistons to their top dead centre (see Figure 5, cam signal M_2); and processing means (10) operable to determine the timing of engine operating events on the basis of the engine position (see page 7, lines 11 to 18); the method comprising the steps of determining whether the crankshaft sensing means is faulty or otherwise unreliable (see Figure 8, steps S3 and S4); and determining the position and speed of the engine and controlling the timing of engine operating events (a) on the basis of the crankshaft sensing means and the level of the first signal from the camshaft sensing means when the crankshaft sensing means is determined not to be faulty or otherwise unreliable (see Figure 5), and (b) when the crankshaft sensing means is determined to be faulty or otherwise unreliable, on the basis of the piston positions determined from said signal transitions in the first and second directions obtained from the second signal from the camshaft sensing means (see Figure 6);

an apparatus for controlling the timing of engine operating events comprising crankshaft sensing

means (2, 4) operable to sense the position of the engine crankshaft (1); camshaft sensing means (3, 5) including a camshaft wheel (3) rotatable with the engine camshaft (8), the camshaft wheel including a plurality of edges (3_1, 3_2, 3_3, 3_4) suitable for indicating that an individual piston is approaching top dead centre during an engine cycle, and a camshaft wheel sensor (5) operable to produce a signal (M_2) providing signal transitions in first and second directions indicative of the approach to top dead centre of a respective piston, and processing means (10) operable to determine whether the crankshaft sensing means is faulty or otherwise unreliable, and to determine the engine position and to control the timing of engine operating events on the basis of (a) the sensed crankshaft position and the signal level of the first signal from the camshaft wheel sensor when the crankshaft sensing means is not deemed to be faulty or otherwise unreliable, and (b) the first and second transitions of the second signal from the camshaft wheel sensor when the crankshaft sensing means is deemed to be faulty or otherwise unreliable; and

a camshaft wheel (3) adapted to be fitted to an engine camshaft (8) for rotation therewith and to be used with an engine control unit (10) to control the timing of engine operating events, comprising a plurality of indicating edges (3_1, 3_2, 3_3, 3_4) of first and second type spaced substantially regularly around the camshaft wheel, each indicating edge being operable to indicate the position of an engine piston.

3.1.2 The Board does not share the Appellant's opinion that the camshaft wheel of D1 could not identify pistons on the basis of signal transitions in first and second

directions. Each of the toothed portions 3_1, 3_2, 3_3, and 3_4 of the camshaft disk 3 (see Figure 4) provides signal pulses which inevitably include signal transitions in first and second directions (see Figures 5 and 6, cam signal M2). In accordance with the description on page 8, lines 20 to 25, the signal pulses are used to identify the top dead centre of each cylinder. Consequently the camshaft disk does identify pistons on the basis of signal transitions in first and second directions.

3.1.3 It is however correct that D1 does not disclose any means for providing an indication of whether the engine is in a first half or in a second half of a cycle. The disk (2) for sensing the position of the crankshaft (1) comprises a number of notches (2_1, 2_2, 2_3, 2_4) which correspond to the number of cylinders of the engine and which are positioned so that they represent compression top dead centres of the cylinders (see page 5, lines 14 to 19). The camshaft wheel (3) comprises exactly the same number of toothed portions (3_1, 3_2, 3_3, 3_4) which are designed so that each portion represents a predetermined cylinder (see page 5, line 26 to page 6, line 8). The combination of the signals caused by the notches of the crankshaft disk and by the toothed portions of the camshaft wheel enables an exact determination of each cylinder and of the position of its piston (see page 6, lines 18 to 26). Consequently it is neither intended nor necessary to use the camshaft wheel sensor in the system of D1 to produce a signal indicative of whether the engine is in a first half of an engine cycle or a second half of the engine cycle.

Furthermore the camshaft wheel shown in D1 does not

comprise a separate synchronising edge and the camshaft sensing means does not provide a separate synchronising signal.

3.1.4 Therefore D1 does not disclose that

the camshaft wheel sensor is adapted to produce a signal indicative of whether the engine is in a first half of an engine cycle or a second half of the engine cycle (compared to claim 1);

the camshaft sensing means are operable to indicate whether the engine is in the first or second half of an engine cycle, the camshaft wheel comprises a separate synchronising edge, the camshaft wheel sensor is operable to produce a separate synchronising signal transition in said first direction (compared to claim 8);

the camshaft wheel comprises a first circumferential portion shaped to indicate that the engine is in a first half of the engine cycle, and a second circumferential portion shaped to indicate that the engine is in a second half of the engine cycle, and a synchronising edge separate from the indicating edges for use in synchronising the engine control unit to the indicating edges (compared to claim 11).

3.2 Document D2

3.2.1 D2 discloses:

a method of controlling the timing of engine operating events in an engine (see page 1, lines 7 to 12) comprising crankshaft sensing means (1, 3) adapted to

sense the position of the engine crankshaft (14); camshaft sensing means (2'', 4) including a camshaft wheel (2'', Figure 3) rotatable with the engine camshaft (15) and a camshaft wheel sensor (4) adapted to produce a first signal indicative of whether the engine is in a first half of an engine cycle or a second half of the engine cycle (see page 7, lines 11 to 35) and a second signal including signal transitions in first and second directions (see Figure 6: B) indicative of the position of individual pistons during an engine cycle (see page 9, lines 10 to 13); and processing means (5) operable to determine the timing of engine operating events on the basis of the engine position; the method comprising the steps of determining whether the crankshaft sensing means is faulty or otherwise unreliable (implicit, see page 10, lines 7 to 10); and determining the position and speed of the engine and controlling the timing of engine operating events (a) on the basis of the crankshaft sensing means and the level of the first signal from the camshaft sensing means when the crankshaft sensing means is determined not to be faulty or otherwise unreliable (see page 9, lines 13 to 31, and Figure 6: A, B), and (b) when the crankshaft sensing means is determined to be faulty or otherwise unreliable (see page 8, lines 10 to 18), on the basis of the piston positions determined from the second signal from the camshaft sensing means,

an apparatus for controlling the timing of engine operating events comprising crankshaft sensing means (1, 3) operable to sense the position of the engine crankshaft (14); camshaft sensing means (2, 4) including a camshaft wheel (2) rotatable with the engine camshaft and operable to indicate whether the

engine is in a first half or a second half of an engine cycle, the camshaft wheel including a plurality of edges (10', 11', 12', 13') suitable for indicating that an individual piston is approaching top dead centre during an engine cycle, and a camshaft wheel sensor (4) operable to produce a first signal indicative of whether the engine is in the first or second half of a cycle, a second signal providing signal transitions in first and second directions indicative of the position of individual pistons during an engine cycle; and processing means (5) operable to determine whether the crankshaft sensing means is faulty or otherwise unreliable, and to determine the engine position and to control the timing of engine operating events on the basis of (a) the sensed crankshaft position and the signal level of the first signal from the camshaft wheel sensor when the crankshaft sensing means is not deemed to be faulty or otherwise unreliable, and (b) transitions of the second signal from the camshaft wheel sensor when the crankshaft sensing means is deemed to be faulty or otherwise unreliable; and

a camshaft wheel (2'', Figure 3) adapted to be fitted to an engine camshaft for rotation therewith and to be used with an engine control unit (5) to control the timing of engine operating events, comprising a first circumferential portion (13) shaped to indicate that the engine is in a first half of the engine cycle; a second circumferential portion (portion between edges 10' and 11') shaped to indicate that the engine is in a second half of the engine cycle (see page 9, lines 13 to 21); a plurality of indicating edges (10', 11', 12', 13') spaced substantially regularly around the camshaft wheel, each indicating edge being operable to indicate the position of an

engine piston (see page 9, lines 10 to 13).

3.2.2 The second signal indicates exactly the top dead centre position of the respective pistons or a fixed position which is shifted with respect to the top dead centre position (see page 9, lines 10 to 13). As shown in Figure 6 (signal B) these positions are determined exclusively from signal transitions in a single direction caused by the rising edges (10', 11', 12', 13') of the camshaft wheel.

A separate means for producing a separate synchronising signal is not provided on the camshaft wheel according to D2.

3.2.3 Consequently D2 does not disclose that

the second signal indicates the approach of respective pistons to their top dead centre position (which is a selection of the possibilities disclosed in D2), the position and speed of the engine is determined on the basis of the piston positions determined from said signal transitions in first and second directions obtained from the second signal, when the crankshaft sensing means is determined to be faulty or otherwise unreliable (compared to claim 1);

the camshaft wheel comprises a separate synchronising edge, the second signal produced by the camshaft wheel sensor is indicative of the approach to top dead centre of a respective piston, the camshaft wheel sensor is operable to produce a separate synchronising signal transition in a first direction; and the position and speed of the engine is not determined on the basis of the piston positions determined from said signal

transitions in the first and second directions obtained from the second signal, when the crankshaft sensing means is determined to be faulty or otherwise unreliable (compared to claim 8);

the camshaft wheel comprises indicating edges of a first and of a second type, and a synchronising edge separate from the indicating edges for use in synchronising the engine control unit to the indicating edges (compared to claim 11).

3.3 Document D3

3.3.1 D3 discloses:

a method of controlling the timing of engine operating events in an engine (see column 1, lines 1 to 10) comprising crankshaft sensing means (108, 107) adapted to sense the position of the engine crankshaft; camshaft sensing means (109, 112) including a camshaft wheel (109) rotatable with the engine camshaft (see column 1, lines 56 to 58) and a camshaft wheel sensor (112) adapted to produce a first signal indicative of whether the engine is in a first half of an engine cycle or a second half of the engine cycle (see column 3, line 39 to column 4, line 23, and Figure 4) and a second signal including signal transitions in first and second directions (produced by raising and trailing edge of tooth 136, trailing edge of first tooth 135 and raising edge of second tooth 135, see Figures 2 and 4) indicative of the position of individual pistons during an engine cycle (see Figure 4), and processing means (see Figure 3) operable to determine the timing of engine operating events on the basis of the engine position; the method

comprising the steps of determining whether the crankshaft sensing means is faulty or otherwise unreliable (see Figure 3, block 151); and determining the position and speed of the engine and controlling the timing of engine operating events (a) on the basis of the crankshaft sensing means and the level of the first signal from the camshaft sensing means when the crankshaft sensing means is determined not to be faulty or otherwise unreliable (see column 5, lines 3 to 26), and (b) when the crankshaft sensing means is determined to be faulty or otherwise unreliable, on the basis of the piston positions determined from said signal transitions in the first and second directions obtained from the second signal from the camshaft sensing means (see column 5, lines 1,2 and lines 26 to 35);

an apparatus for controlling the timing of engine operating events comprising crankshaft sensing means (108, 107) operable to sense the position of the engine crankshaft; camshaft sensing means (109, 112) including a camshaft wheel (109) rotatable with the engine camshaft and operable to indicate whether the engine is in a first half or a second half of an engine cycle, the camshaft wheel including a plurality of edges for indicating the position of individual pistons and suitable for indicating that an individual piston is approaching top dead centre during an engine cycle, and a camshaft wheel sensor (112) operable to produce a first signal indicative of whether the engine is in the first or second half of a cycle, a second signal providing signal transitions in first and second directions indicative of the position of a respective piston, and a synchronising signal transition in said first direction (see Figure 4: a, b, the signal at 0°); and processing means operable to determine whether the

crankshaft sensing means is faulty or otherwise unreliable, and to determine the engine position and to control the timing of engine operating events on the basis of (a) the sensed crankshaft position and the signal level of the first signal from the camshaft wheel sensor when the crankshaft sensing means is not deemed to be faulty or otherwise unreliable, and (b) the first and second transitions of the second signal from the camshaft wheel sensor when the crankshaft sensing means is deemed to be faulty or otherwise unreliable; and

a camshaft wheel (109) adapted to be fitted to an engine camshaft for rotation therewith and to be used with an engine control unit (102) to control the timing of engine operating events, comprising a first circumferential portion (portion between the trailing edge of tooth 136 and the raising edge of second tooth 135) shaped to indicate that the engine is in a first half of the engine cycle (0° to 360° see Figure 4); a second circumferential portion (portion between the raising edge of the second tooth 135 and the trailing edge of tooth 136) shaped to indicate that the engine is in a second half of the engine cycle (360° to 720°, see Figure 4); a plurality of indicating edges (trailing edge of the first tooth 135, raising edge of the second tooth 135, raising and trailing edge of tooth 136) of first and second type spaced substantially regularly around the camshaft wheel, each indicating edge being operable to indicate the position of an engine piston (see Figure 4, and column 3, line 39 to column 4, line 13).

3.3.2 The Appellant's argumentation according to which D3 did not disclose that the engine speed was determined on

the basis of the signal transitions in first and second directions, when the crankshaft sensing means was determined to be faulty or otherwise unreliable, is not convincing. During normal operation of the apparatus of D3, the crankshaft sensor (107) detects the position [see Figure 4: a)] and the speed of the engine (see column 2, lines 49 to 51). Both the detected speed and the detected position are used for determining the fuel supply to the engine (see column 3, lines 8 to 11, and column 5, lines 2 to 7). As agreed by the Appellant (see letter of 6 September 2000, page 1, paragraph 4), the camshaft sensor (112) takes over when the crankshaft sensor fails. In this event, the fuel supply is determined on the basis of the signal from the camshaft sensor (see column 5, lines 1, 2 and 26 to 35) which signal includes signal transitions in first and second directions (see Figure 4: b, c). Since during normal operation the fuel supply is determined on the basis of the position and the speed of the engine detected by the crankshaft sensor, it is obvious that the fuel supply is determined in analogy on the basis of the position and the speed detected by the camshaft sensor when the crankshaft sensor fails, in particular as the camshaft sensor is suitable to detect both the position and the speed of the engine. Therefore D3 at least implicitly discloses that the engine speed is determined on the basis of the signal transitions in first and second directions, when the crankshaft sensing means was determined to be faulty or otherwise unreliable

3.3.3 However, since the second signal produced by the camshaft wheel sensor according to D3 indicates exactly the top dead centre position of the respective pistons (see Figure 4), and the trailing edge of tooth 136 is

used for synchronisation purposes (see column 4, lines 24 to 35, and Figure 4), D3 does not disclose that

the second signal produced by the camshaft wheel sensor is indicative of the approach to top dead centre of a respective piston, the camshaft wheel has a separate synchronising edge, the synchronising signal produced by the camshaft wheel sensor is a separate signal (compared to claim 1);

the edges of the camshaft wheel are provided for indicating that an individual piston is approaching top dead centre during an engine cycle, the camshaft wheel includes a separate synchronising edge, the second signal is indicative of the approach to top dead centre of a respective piston (compared to claim 8); and

the camshaft wheel comprises a synchronising edge separate from the indicating edges for use in synchronising the engine control unit to the indicating edges (compared to claim 11).

3.4 Documents D4, D5 and D6

D4, D5 and D6 are less relevant than D1, D2 and D3 and cannot anticipate the novelty of the subject-matter of the present claims.

3.5 In view of the assessments above, the Board comes to the conclusion that the subject-matter of independent claims 1, 8, 11 and of dependent claims 2 to 7, 9, 10 and 12 to 16 is novel.

4. *Procedural matter*

The Examining Division rejected the present application exclusively on the ground of lack of novelty.
Since this objection has been overcome by the present claims, the case is remitted to the first instance for the examination of the further requirements of the EPC.

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 for further prosecution on the basis of the following documents:

Claims: No. 1, 8 and 11 filed with letter of 6 September 2000;
No. 2 to 7, 9 and 10 as originally filed;
No. 12 to 16 filed with letter of 9 April 1999.

Description: Pages 1 and 3 to 28 as originally filed, with the amendments on pages 4 and 28 requested with letter of 6 September 2000;
Pages 2, 2a filed with letter of 28 July 1999.

Drawings: Figures 1 to 6b as originally filed.

The Registrar: The Chairman:

G. Magouliotis C. Andries