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[Continued on next page]

(54) Title: FUEL INJECTOR AND METHOD FOR CONTROLLING FUEL INJECTORS

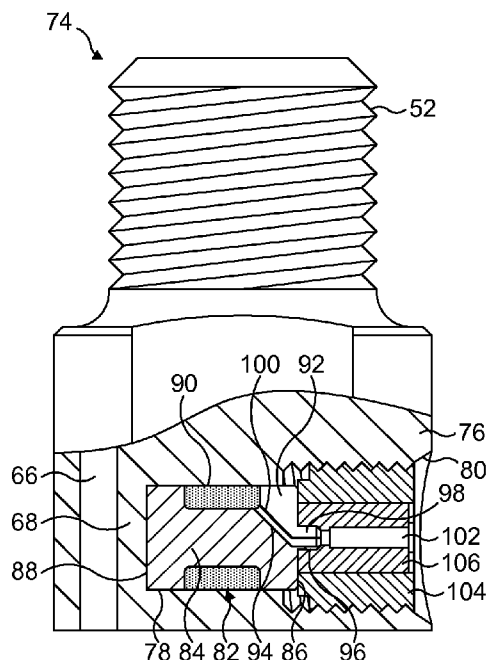


FIG. 4

(57) Abstract: A fuel injector for an internal combustion engine, the fuel injector comprising an injector body, a fuel supply passage defined in the injector body, the fuel supply passage containing fuel under high pressure in use of the injector, a pressure sensor for measuring the pressure of fuel in the passage in use, wherein the pressure sensor is situated within the injector body and is separated from fuel in the passage in use, and a method of fuel injection, comprising constructing an hydraulic behaviour profile by fuel pressure measurement, using the hydraulic behaviour profile to predict fuel pressure that will prevail in a fuel injector during an injection event, and supplying a control signal to the fuel injector to control the amount of fuel injected during the injection event in accordance with the predicted fuel pressure. By predicting the fuel pressure that will prevail during an injection event, the fuel delivered during the injection event can be accurately controlled.



— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

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INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER

INV. F02M61/16

ADD. F02M63/00

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)

F02M

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 438 496 A (OHIE TOMONORI [JP]) 20 March 1984 (1984-03-20) column 6, lines 42-56 figure 7	1-4,7,8, 10, 12-14,16
Y		11,21, 28,31
Y	US 2003/111049 A1 (LEWIS STEPHEN R [US]) 19 June 2003 (2003-06-19) paragraph [0013] figure 1	11
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents :

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document but published on or after the international filing date

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.

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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.
X	US 2003/121501 A1 (BARNES TRAVIS E [US] ET AL) 3 July 2003 (2003-07-03) paragraphs [0007], [0016], [0018], [0019]	24-27, 29, 30, 32-41
Y	figures 1-5	28, 31
X	EP 1 424 480 A (ST MICROELECTRONICS SRL [IT]) 2 June 2004 (2004-06-02) paragraphs [0021], [0042], [0046], [0050], [0056], [0058], [0065], [0082], [0083]	24-27, 29, 30, 32-37
A	US 6 085 727 A (NAKANO FUTOSHI [JP]) 11 July 2000 (2000-07-11) the whole document	24-41
P,Y	EP 1 854 993 A (DELPHI TECH INC [US]) 14 November 2007 (2007-11-14) paragraph [0051] figures 2,4	21
A	US 6 622 549 B1 (WLODARCZYK MAREK T [US] ET AL) 23 September 2003 (2003-09-23) the whole document	18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2008/053171

Box No. 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 No. 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 allsearchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search reportcovers only those claims for which fees were paid, specifically claims Nos.:
1-41
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 and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ 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: 1-23

A fuel injector for an internal combustion engine, comprising an injector body, a fuel supply passage defined in the injector body and a pressure sensor for measuring the pressure of fuel in the fuel supply passage, wherein the pressure sensor is situated within the injector body and is separated from fuel in the fuel supply passage.

2. claims: 24-41

A fuel injection system for an internal combustion engine, comprising a plurality of fuel injectors, an accumulator, at least one pressure sensor and a control unit arranged to predict the fuel pressure that will prevail in an injector during an injection event and to supply control signals, and an associated method of predicting a fuel pressure in a fuel injector.

3. claims: 42-50

A method of compensating for an error in the output of a fuel pressure sensor, comprising determining an average output of the fuel pressure sensor, comparing the average output of the fuel pressure sensor with a reference value and applying a compensation offset to the output of the fuel pressure sensor.

4. claims: 51-57

A method of calibrating a fuel injector having a pressure sensor, comprising measuring an output value of the pressure sensor, determining the pressure of a fluid in a supply passage corresponding to the output value, recording the pressure of fluid corresponding to the output value as a sensor characteristic of the injector and encoding the sensor characteristic.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2008/053171

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4438496	A	20-03-1984	DE 3122553 A1	04-03-1982
			JP 1477158 C	27-01-1989
			JP 57005526 A	12-01-1982
			JP 63028230 B	07-06-1988
US 2003111049	A1	19-06-2003	DE 60219411 T2	03-01-2008
			EP 1321660 A2	25-06-2003
US 2003121501	A1	03-07-2003	NONE	
EP 1424480	A	02-06-2004	US 2004154593 A1	12-08-2004
US 6085727	A	11-07-2000	DE 69826092 D1	14-10-2004
			DE 69826092 T2	29-09-2005
			EP 0916831 A1	19-05-1999
			JP 3834918 B2	18-10-2006
			JP 10246144 A	14-09-1998
			WO 9839561 A1	11-09-1998
EP 1854993	A	14-11-2007	AT 399935 T	15-07-2008
			EP 2021619 A1	11-02-2009
US 6622549	B1	23-09-2003	NONE	