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(72) Inventor: **Cooke, Michael P.**
Gillingham Kent ME7 1DR (GB)

(74) Representative: **Hopley, Joanne Selina et al**
David Keltie Associates,
Fleet Place House,
2 Fleet Place
London EC4M 7ET (GB)

(30) Priority: **13.01.2004 EP 04250133**

(71) Applicant: **Delphi Technologies, Inc.**
Troy, MI 48007 (US)

(54) **Fuel injector**

(57) A fuel injector for use in an internal combustion engine includes a valve needle (10) which is engageable with a valve needle seat (16) to control fuel injection through an injector outlet (21). An actuator (20), typically in the form of a piezoelectric actuator stack (22), is arranged to control fuel pressure within a control chamber (50) and a surface associated with the valve needle (10) is exposed to fuel pressure within the control chamber. A load transmission means (36), preferably in the form of a motion inverter, transmits movement of the actuator (20, 22) to the valve needle (10). The load transmission means includes a bellows arrangement (42) which is compressible and expandable in response to said actuator movement so as to vary fuel pressure within the control chamber (50), thereby to control movement of the valve needle (10) relative to the valve needle seat (16). A piezoelectrically operable injector is operable in an energise-to-inject mode to provide efficient opening of the valve needle (10) and to enable rapid closure of the valve needle (10).

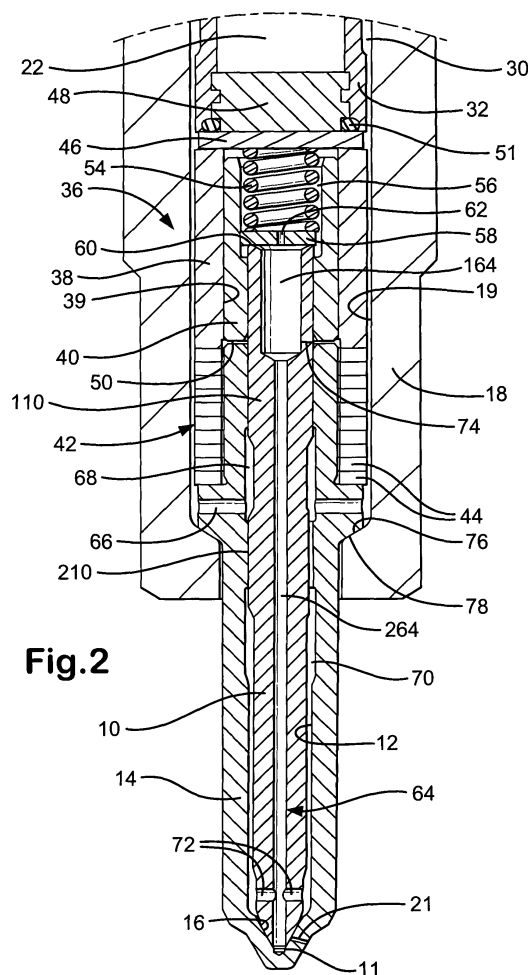


Fig.2

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EUROPEAN SEARCH REPORT

Application Number
EP 05 25 0097

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| The present search report has been drawn up for all claims | | | |
| Place of search Munich | | Date of completion of the search 30 May 2005 | Examiner Jackson, S |
| CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document | | | |

EPO FORM 1503 03.82 (P04C01)



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| Place of search Munich | | Date of completion of the search 30 May 2005 | Examiner Jackson, S |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p> | | | |

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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- ☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:



The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-19,28

Independent claim 1 describes a fuel injector with a load transmission device which converts movement of a piezoelectric stack into movement of the valve needle. This transmission device takes the form of deformable bellows which change the pressure in a control chamber.

2. claims: 20-24

Independent claim 20 describes a fuel injector with a fuel communication means from the control chamber to a valve needle chamber.

3. claims: 25-27

Independent claim 25 describes a fuel injector with constructional features of the nozzle body and the actuator housing which define an internal seating surface.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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