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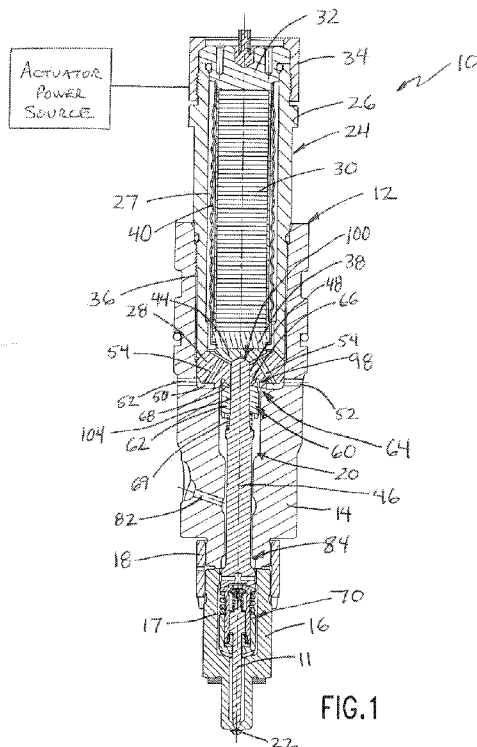
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[Continued on next page]

(54) Title: PIEZOELECTRIC DIRECT ACTING FUEL INJECTOR WITH HYDRAULIC LINK

(57) Abstract: A piezoelectric-actuated fuel injector for injecting fuel into a combustion chamber of an internal combustion engine is provided which includes a piezoelectric actuator movable to expand in a first direction and movable to contract in a second direction opposite the first direction, and a hydraulic link assembly disposed within a nozzle cavity formed in a nozzle housing containing a nozzle valve element. The hydraulic link assembly is positioned close to the injector orifices to minimize needle valve element length and mass, thereby reducing seat impact forces and enhance response time. A refill valve operates to move into an open position to refill a hydraulic link chamber. An actuator power source operates to vary voltage to cause multiple injection pulses and to selectively maintain the voltage above a predetermined lower level between injection pulses to maintain the refill valve in a closed position to prevent refilling of the hydraulic link chamber.



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EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,  
LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK,  
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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 51/06; B05B 1/08; F02M 47/02; B05B 3/00; F02M 37/04; F02M 37/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) &amp; Keywords: injector, piezo, stack, needle, plunger, hydraulic

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,390,385 B1 (HARDY et al.) 21 May 2002 See column 7, line 3 - column 8, line 67; figures 1,3.	1-20
A	US 7,073,730 B2 (HAAG et al.) 11 July 2006 See column 3, line 20 - column 6, line 6; claim 1 and figures 1,3.	1-20
A	US 7,140,353 B1 (RAUZNITZ et al.) 28 November 2006 See column 8, line 23 - column 9, line 51; claims 2, 11 and figures 1-5.	1-20
A	US 7,353,806 B2 (GANT, GARY L.) 08 April 2008 See column 5, line 8 - column 11, line 34; claims 1,11 and figures 1-3.	1-20

 Further documents are listed in the continuation of Box C. See patent family annex.

\* Special categories of cited documents:

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

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