



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11)

EP 0 999 363 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.05.2000 Bulletin 2000/19

(51) Int Cl.7: **F02M 61/16**

(21) Application number: **99308526.5**

(22) Date of filing: **28.10.1999**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**
Designated Extension States:
AL LT LV MK RO SI

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

(74) Representative: **Pearce, Anthony Richmond**
Marks & Clerk,
Alpha Tower,
Suffolk Street Queensway
Birmingham B1 1TT (GB)

(30) Priority: **06.11.1998 GB 9824272**

(71) Applicant: **Lucas Industries Limited**
London W1Y 4DJ (GB)

(54) **Filter**

(57) A filter comprising a plate (13) arranged to be received within a bore (11) or drilling of a fuel injector, the plate (13) being provided with a plurality of openings (15) whereby fuel can flow from an upstream side of the plate (13) to a downstream side thereof, the openings (15) having been formed using a micro-machining technique.

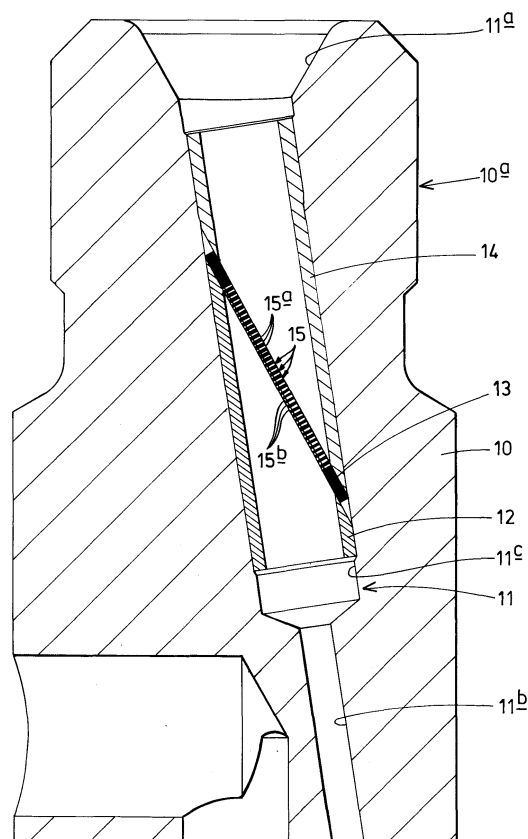


FIG 1

EP 0 999 363 A1

Description

[0001] This invention relates to a filter, and in particular to a filter suitable for use in a fuel injector to remove particulate contaminants from a flow of fuel.

[0002] It is known to provide an edge filter in a fuel injector to separate contaminants from the flow of fuel towards a nozzle of the injector, thereby reducing the risk of damage to the injector, for example as a result of the contaminants causing components of the injector to become jammed in position or causing excessive wear. The filter must be capable of separating small contaminant particles from the flow of fuel, and also be capable of withstanding the impact of large particles.

[0003] It is an object of the invention to provide a filter suitable for use in such applications.

[0004] According to the present invention there is provided a filter comprising a plate arranged to be received within a bore or drilling of a fuel injector, the plate being provided with a plurality of openings whereby fuel can flow from an upstream side of the plate to a downstream side thereof, the openings having been formed using a micro-machining technique.

[0005] Each opening conveniently includes an upstream region of relatively large dimensions and a downstream region of relatively small dimensions. Such an arrangement is advantageous in that the downstream regions ensure that small contaminant particles are removed from the flow of fuel, the upstream regions protecting the downstream regions from being impacted by large contaminant particles.

[0006] A plurality of downstream regions may be associated with each upstream region.

[0007] The invention also relates to a method of manufacturing such a filter comprising micro-machining a plate to form a plurality of openings. The micro-machining operation may take the form of etching the plate to form the openings. Alternatively, the micro-machining operation may involve building up layers of material, conveniently nickel or chromium, to form the plate and the openings using an electroforming technique. It will be appreciated, however, that other micro-machining techniques may be used.

[0008] The invention will further be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a diagrammatic sectional view of a filter in accordance with an embodiment of the invention located within a fuel injector;

Figure 2 is an enlarged perspective view illustrating the embodiment of Figure 1;

Figure 3 is an enlargement of part of Figure 2; and

Figures 4 and 5 are views similar to Figures 2 and 3 illustrating an alternative embodiment.

[0009] Figure 1 illustrates part of the nozzle holder 10 of a fuel injector, the nozzle holder 10 being provided with a region 10a which is externally screw-threaded and arranged to have a pipe connector secured thereto to permit the connection of the injector to a source of fuel under high pressure, for example a common rail charged with fuel to an appropriate pressure by a high pressure fuel pump. The nozzle holder 10 is provided with a stepped bore 11 including an inlet region 11a, and a region 11b of relatively small dimensions. Intermediate the regions 11a and 11b, the bore 11 is shaped to define a filtration region 11c. The region 11c is of stepped form and houses a tubular location member 12, the upstream end of which is angled and arranged to support a filtration member in the form of a plate 13 of elliptical shape. The location member 12 is arranged to seat against a step forming part of the region 11c of the bore 11, the location member 12 being of diameter slightly smaller than that of the adjacent part of the bore to permit the location member 12 to be slid into position. The location member 12 and plate 13 are secured in position by means of a tubular fixing member 14, the downstream end of which is angled similarly to the upstream end of the location member 12, the upstream end of the fixing member 14 being of diameter such that the fixing member 14 is an interference fit within the bore 11.

[0010] The plate 13 is micro-machined to form a plurality of openings 15 which extend from an upstream surface of the plate 13 to a downstream surface thereof. Each opening 15 comprises an upstream region 15a which is of relatively great depth and relatively large dimensions and a downstream region 15b which is of relatively small depth and small dimensions.

[0011] In use, fuel flowing from the inlet region 11a of the bore to the region 11b must flow through the openings 15 of the plate 13. Contaminants carried by the flow of fuel which are of dimensions greater than the upstream regions 15a of the openings 15 are unable to pass through the openings 15, and are thus prevented from continuing with the flow of fuel towards the nozzle of the injector. Contaminant particles which are of dimensions smaller than the upstream regions 15a of the openings 15 are able to enter the upstream regions 15a. If these contaminant particles are of dimensions greater than the downstream regions 15b of the openings 15, then, as these contaminant particles will be unable to flow through the downstream regions 15b, these particles are also prevented from continuing with the flow of fuel towards the nozzle body of the injector. It will therefore be appreciated that only particles of very small dimensions which are able to pass through the downstream regions 15b of the openings 15 are permitted to continue with the flow of fuel towards the nozzle body of the injector. The dimensions of the downstream regions 15b are chosen to be sufficiently small that any particles which are able to pass through the downstream regions 15b will be of sufficiently small dimensions that the risk of significant damage to the injector or of the

injectors performance being impaired is relatively low.

[0012] It will be appreciated that as the plate 13 is angled to the flow of fuel, any contaminant particles flowing with the fuel and incident upon the plate 13 do not impact the plate 13 normal to the plane thereof, thus the risk of damage to the plate 13 is reduced. Further, as the plate 13 is angled relative to the axis of the bore 11, the area of the plate 13 which can be provided with the openings 15 is increased, thus the available filtration area can be increased. A further advantage of the arrangement illustrated in Figure 1 is that only particles of relatively small dimensions are able to pass through the upstream regions 15a of the openings 15, thus the downstream region of the plate 13 which defines the downstream regions 15b, and is relatively fragile, is not impacted by contaminant particles of relatively large dimensions. As a result, the risk of damage to the downstream region of the plate 13 is reduced.

[0013] It is thought that, in use, contaminant particles incident upon the plate 13 are likely to be broken up, in use, and once the particles have broken to a sufficient extent to be able to pass through the downstream regions 15b of the openings 15, then these particles will be able to continue with the flow of fuel towards the nozzle body. It will be appreciated, however, that by this time, as the particles are of small dimensions, the risk of damage to the injector is reduced. If the particulate contaminants are able to break up in this manner, then it will be appreciated that clogging of the filter can be avoided.

[0014] Figures 2 and 3 illustrate the arrangement of Figure 1 in greater detail. As shown most clearly in Figure 3, the upstream regions 15a of the openings take the form of a series of parallel grooves. The downstream regions 15b are defined by a series of slats 16 of small width, the slats 16 defining the downstream regions 15b extending in a direction perpendicular to the grooves defining the upstream regions 15a. As the slats 16 are relatively thin, it will be appreciated that the slats 16 are relatively fragile, and thus it is important to ensure that contaminant particles of relatively large dimensions are removed from the fuel by being unable to pass through the grooves defining the upstream regions 15a of the openings 15. As a result, the relatively large contaminant particles are unable to move into engagement with the slats 16, and are thus unable to cause damage to the slats. It is thought that the provision of slots acting as the upstream regions 15a should be particularly effective at breaking up large contaminant particles.

[0015] Although in the description hereinbefore, the plate 13 is located using a location member 12 and a fixing member 14, the plate 13 not being secured to either of these components, the arrangement may be modified by securing the plate 13 to one or other, or both of these components, if desired.

[0016] Further, if the plate 13 is secured to the fixing member 14, then the provision of the location member 12 may be avoided.

[0017] The embodiment illustrated in Figures 4 and 5 is similar to that described hereinbefore. In the arrangement of Figures 4 and 5, the upstream regions 15a take the form of a matrix of openings of hexagonal form rather than a series of grooves. It will be appreciated, however, that the upstream regions 15a may be of other shapes, for example squares, triangles, circles or any other shape. Each upstream region 15a communicates with a plurality of downstream regions 15b which again take the form of openings. As illustrated in Figure 5, these openings may be of circular cross-section, but again the downstream regions 15b may take the form of a matrix of openings of any suitable shape. Operation of this embodiment is as described hereinbefore and so will not be described in further detail.

[0018] The plate 13 of any of the embodiments described hereinbefore may take the form of a relatively thick plate, the openings 15 being formed by etching the plate, the upstream regions 15a of the openings 15 being etched from one surface of the plate, the downstream regions 15b being etched from the other surface of the plate. Alternatively, the plate 13 may be manufactured by building up layers of material using an electro-forming technique. For example, thin layers of nickel or chromium may be built up to form the plate 13 and the openings 15 which extend through the plate. It will be appreciated, however, that other micro-machining techniques may be used to form the plate 13 and the openings 15 which extend through the plate.

Claims

1. A filter characterised by a plate (13) arranged to be received within a bore (11) or drilling of a fuel injector, the plate (13) being provided with a plurality of openings (15) whereby fuel can flow from an upstream side of the plate (13) to a downstream side thereof, the openings (15) having been formed using a micro-machining technique.
2. The filter as claimed in Claim 1, wherein each of the openings includes an upstream region (15a) of relatively large dimensions and a downstream region (15b) of relatively small dimensions.
3. The filter as claimed in Claim 2, wherein a plurality of downstream regions (15b) are associated with each upstream region (15a).
4. The filter as claimed in Claim 2 or Claim 3, wherein the upstream regions (15a) take the form of grooves formed in the plate (13).
5. The filter as claimed in any of Claims 2 to 4, wherein the downstream regions (15b) take the form of slats (16) formed in the plate (13).

6. The filter as claimed in Claim 5 when dependent on Claim 4, wherein the grooves are arranged substantially perpendicular to the slats (16).
7. The filter as claimed in Claim 2 or Claim 3, wherein the upstream regions (15a) are any one of hexagonal, circular, triangular or square form. 5
8. The filter as claimed in Claim 2 or Claim 3, wherein the downstream regions (15b) are any one of hexagonal, circular, triangular or square form. 10
9. The filter as claimed in any of the preceding claims wherein, in use, the plate (13) is secured to one or both of a location member (12) or a fixing member (14) for locating the plate (13) within the bore (11) or drilling. 15
10. A method of manufacturing a filter as claimed in any of the preceding claims, comprising the step of micro-machining a plate (13) to form a plurality of openings (15). 20
11. The method as claimed in Claim 10, wherein the step of micro-machining the plate (13) comprises the step of etching the plate (13) to form the openings (15). 25
12. The method as claimed in Claim 10, wherein the step of micro-machining the plate (13) comprises the step of building up layers of material to form the plate (13) and the openings (15) using an electro-forming technique. 30

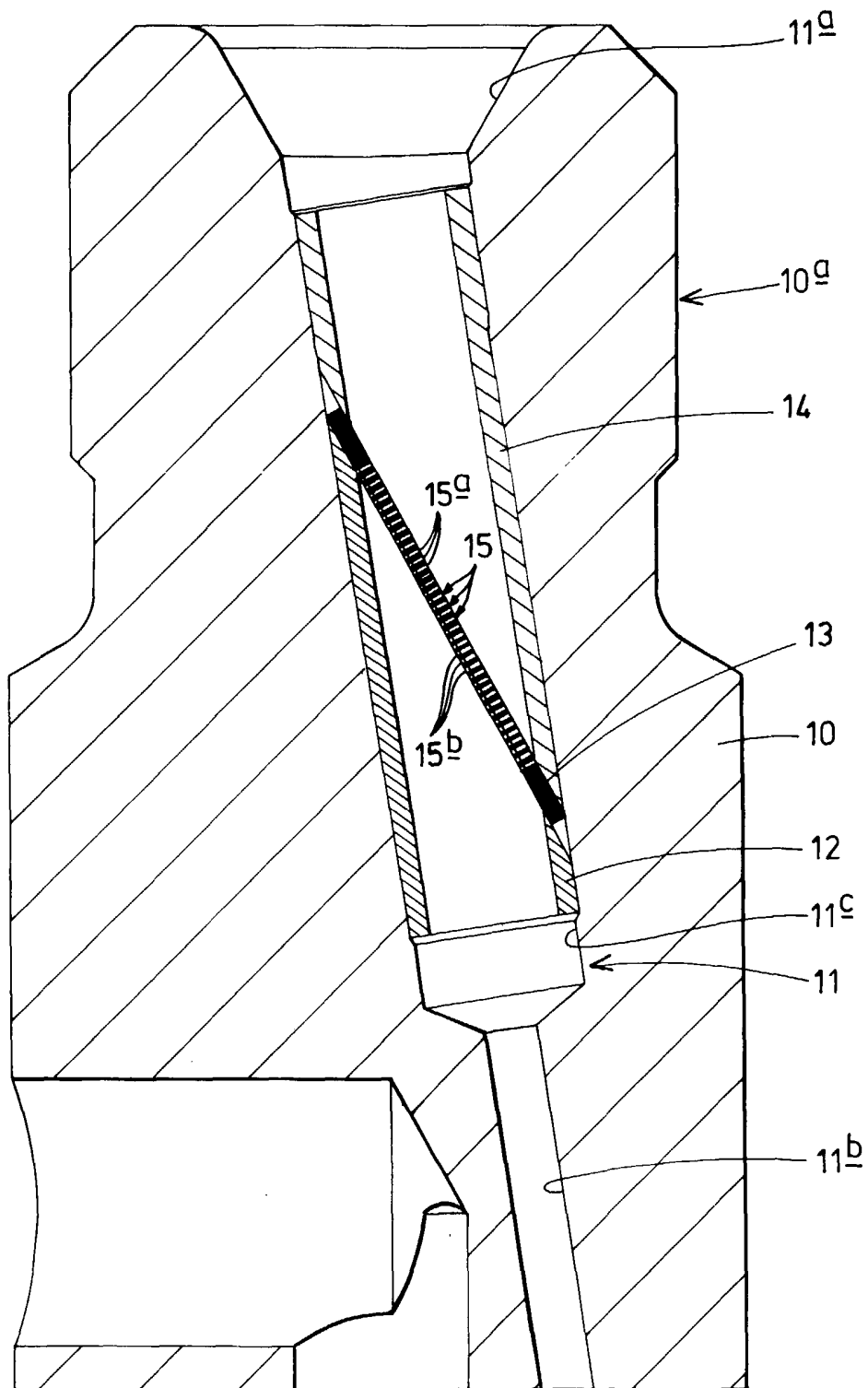
35

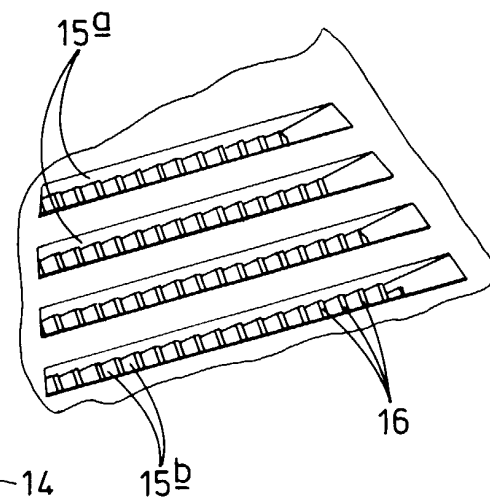
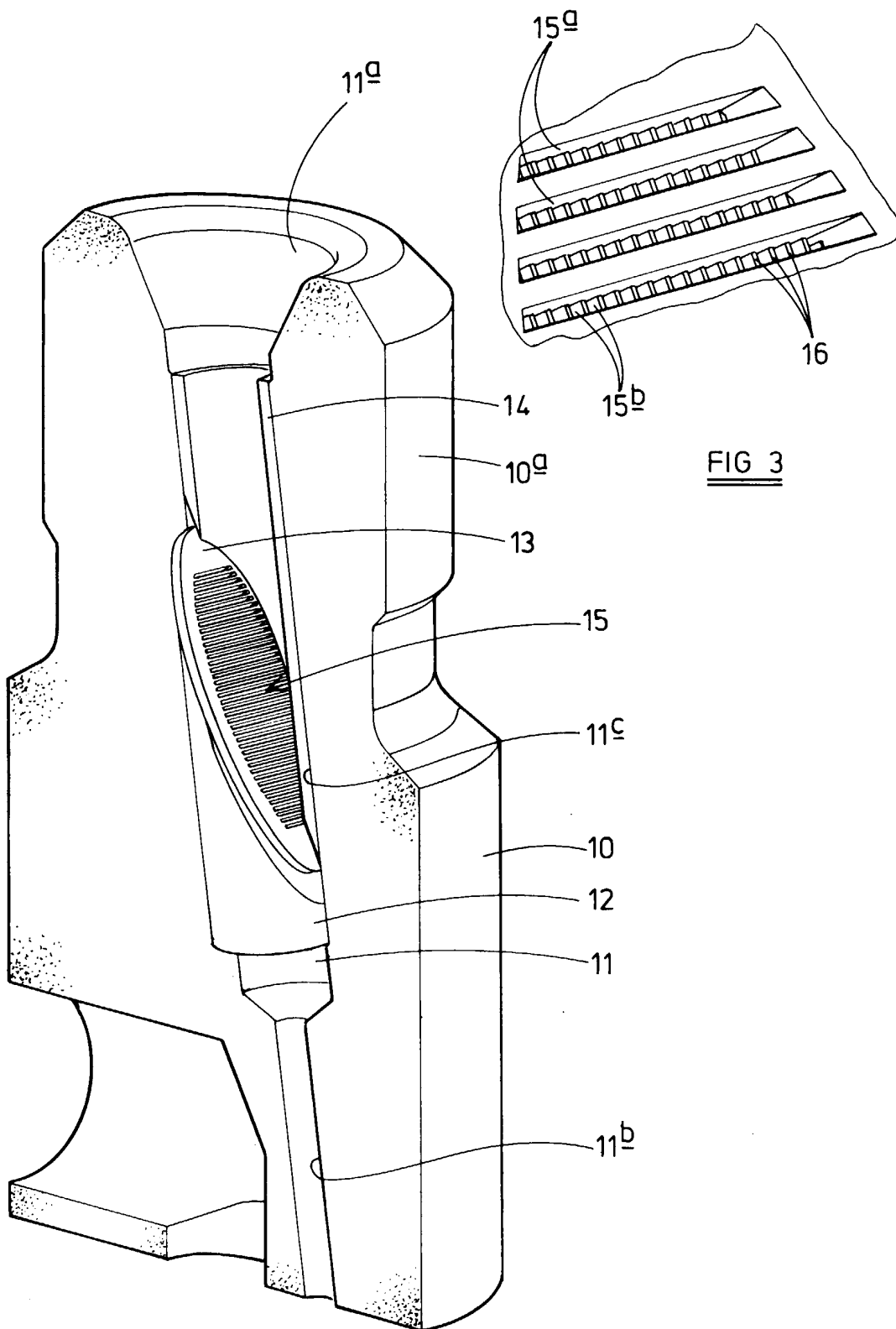
40

45

50

55





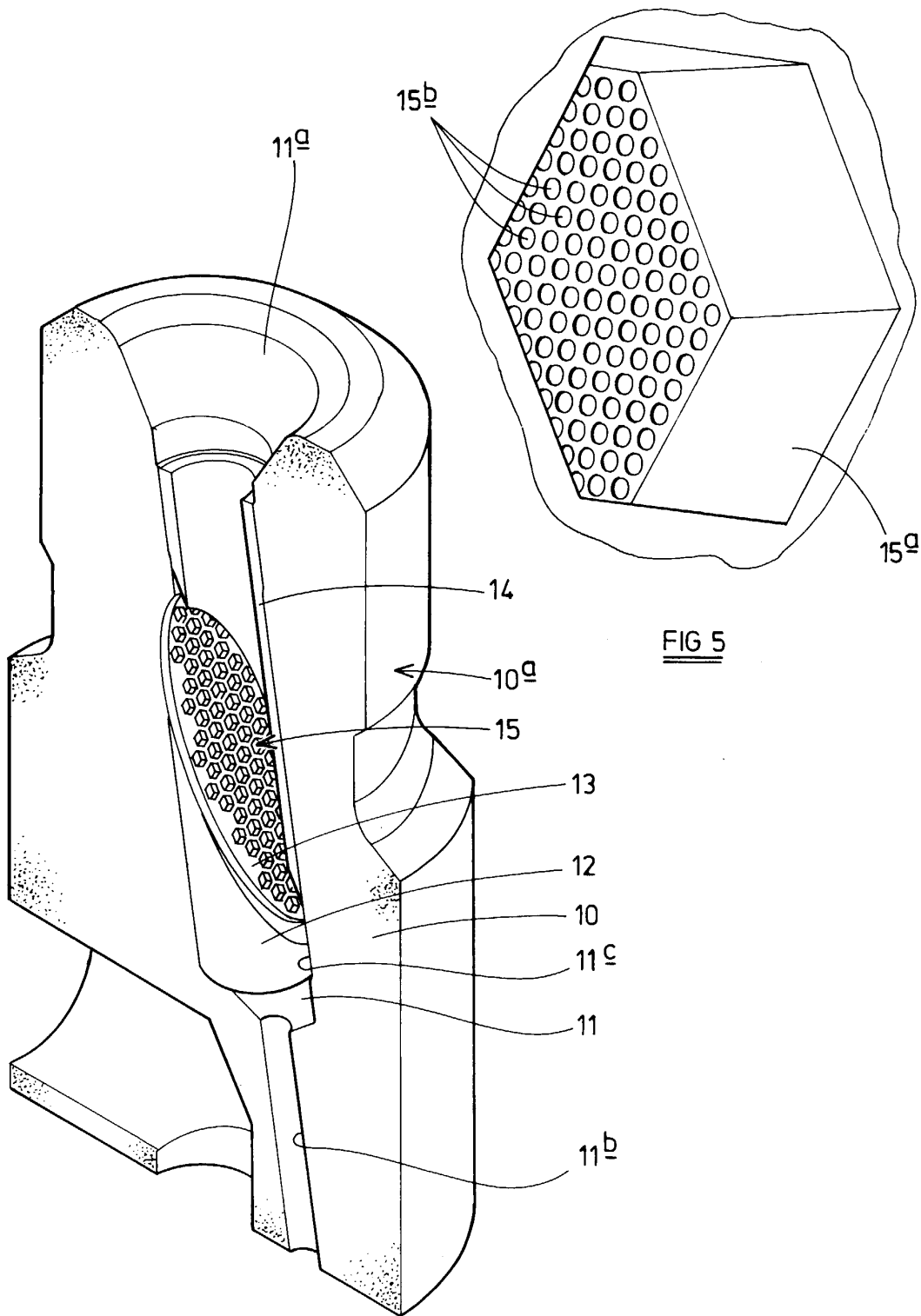


FIG 5

FIG 4



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 30 8526

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	WO 93 18299 A (SIEMENS AUTOMOTIVE LP) 16 September 1993 (1993-09-16) * page 4, line 15 - page 6, line 15; figures 1-5 *	1,2, 7-10,12	F02M61/16
X	DE 196 38 201 A (BOSCH GMBH ROBERT) 2 April 1998 (1998-04-02) * column 3, line 68 - column 5, line 20; figures 1-4 *	1,9-12	
X	GB 2 112 065 A (DAIMLER BENZ AG) 13 July 1983 (1983-07-13) * page 1, line 78 - line 88; figures 1,2 *	1,10,12	
X	DE 196 22 350 A (BOSCH GMBH ROBERT) 11 December 1997 (1997-12-11) * column 2, line 18 - column 4, line 42; figures 1-9,14,15 *	1,10-12	
X	US 5 730 368 A (HEYSE JOERG ET AL) 24 March 1998 (1998-03-24) * column 6, line 28 - column 17, line 15; figures 3-32 *	1,9,10, 12	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	EP 0 611 886 A (NIPPON DENSO CO) 24 August 1994 (1994-08-24) * column 8, line 17 - column 11, line 49; figures 3-10 *	1-11	F02M B01D
A	DE 32 10 209 A (BOSCH GMBH ROBERT) 29 September 1983 (1983-09-29) * page 8, last paragraph - page 10, last paragraph; figures 3-6 *	1-4	
A	US 4 876 008 A (TIKKANEN TIM) 24 October 1989 (1989-10-24) * column 2, line 17 - column 4, line 3; figures 1-5 *	1-6	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 14 February 2000	Examiner Hakhverdi, M
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 (P04001)

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

EP 99 30 8526

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-02-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9318299 A	16-09-1993	DE 69306766 D	30-01-1997
		DE 69306766 T	28-05-1997
		EP 0629266 A	21-12-1994
		US 5423489 A	13-06-1995
DE 19638201 A	02-04-1998	JP 10089191 A	07-04-1998
		US 6003791 A	21-12-1999
GB 2112065 A	13-07-1983	DE 3150607 C	28-07-1983
		FR 2518653 A	24-06-1983
DE 19622350 A	11-12-1997	JP 10057842 A	03-03-1998
		US 5925205 A	20-07-1999
US 5730368 A	24-03-1998	DE 4435163 A	04-04-1996
		BR 9506393 A	16-09-1997
		CN 1136343 A	20-11-1996
		WO 9610694 A	11-04-1996
		EP 0740743 A	06-11-1996
		JP 9506409 T	24-06-1997
EP 0611886 A	24-08-1994	JP 6312147 A	08-11-1994
		CA 2115819 A	18-08-1994
		DE 69415362 D	04-02-1999
		DE 69415362 T	10-06-1999
		JP 6299932 A	25-10-1994
		US 5492277 A	20-02-1996
DE 3210209 A	29-09-1983	JP 58162762 A	27-09-1983
US 4876008 A	24-10-1989	US 4932112 A	12-06-1990

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82