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(54) **Apparatus for servicing fuel injectors.**

(57) An apparatus for servicing fuel injectors (11,12) comprises a mounting element (2) defining a chamber (6) and having a number of pairs of apertures (7,8) passing through the chamber (6), the mounting element (2) having a chamber inlet (9) leading to the chamber (6), and a number of adapter elements (16,17) adapted to fit within the apertures (7,8) and each defining a receptacle for receiving the fuel inlet (13) of a fuel injector (11,12), and each having an adapter inlet (22) for passing liquid from the chamber (6) to the receptacle from which the liquid then passes to the fuel inlet (13) of the injector (11,12). A clamping plate (42) holds a number of containers (40), beneath the mounting element (2), for collecting liquid which has passed through the injectors (11,12). The apparatus also allows the servicing of "top feed" injectors (61), which can be held in an upright position between the clamping plate (42) and the mounting element (2), with inlets (62) held within receiving elements (65) which supply liquid to the injectors (61).

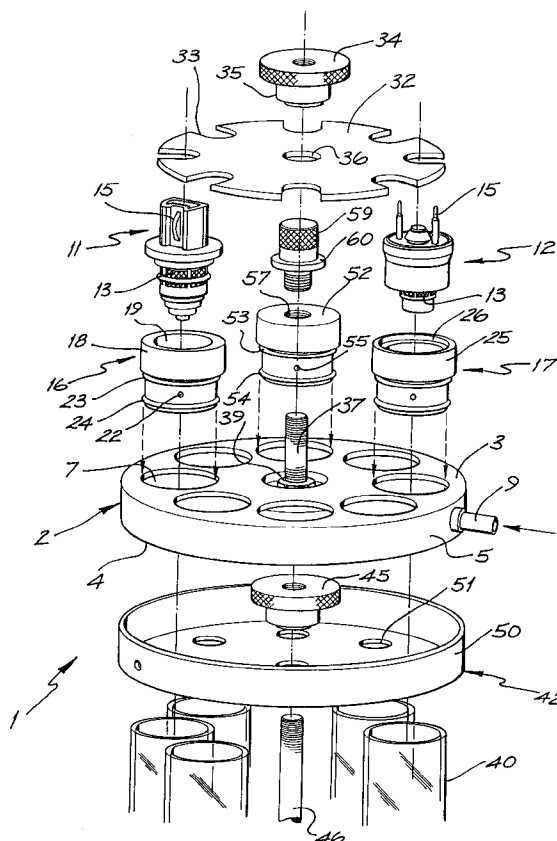


FIG. 1

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for servicing fuel injectors, and particularly, though not exclusively, for servicing electrically operated side feed fuel injectors.

It is well known in the automotive industry that electrically operated fuel injectors are being used more and more frequently to feed fuel to engines. Such fuel injectors were first manufactured as "top feed" injectors, where the fuel was fed to the injector from its top, was sprayed from the bottom, and control signal lines were connected to one side. More recently, however, "side feed" injectors have been introduced where the fuel is fed into the injector through an annular filter in its side, is sprayed from the bottom, and the control signal lines are connected to the top.

Such side feed injectors are available as single point injectors, known as Throttle Body Injectors (TBI), or, more commonly, multi point injectors. The advantage of the side feed injectors over the top feed injectors is that the fuel enters the injector over a far greater area than with the top feed injectors so that better filtering is achieved and the fuel can be sprayed out faster and under greater pressure. Furthermore, since there is a greater volume of the injector within the fuel, it is kept cooler by the fuel than the top feed injectors.

Although devices to service, that is to test and clean, top feed injectors are known, for example from US Patent No. 4,845,979, such devices are not suitable for servicing side feed injectors.

BRIEF SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide apparatus for servicing fuel injectors which allows side feed injectors to be serviced.

Accordingly, the invention provides apparatus for servicing one or more fuel injectors each having a fuel inlet, a spray outlet, and electrically operable valve means operable to permit liquid to flow from the fuel inlet to the spray outlet, the apparatus comprising:

a first mounting element comprising first and second substantially spaced apart face portions forming parts of a chamber, the first and second face portions defining at least one pair of apertures, the or each pair of apertures comprising a first aperture formed in the first face portion and a second aperture formed in the second face portion and the first and second apertures lying opposite each other, and the first mounting element defining a chamber inlet leading to the chamber; and

at least one generally cylindrical adapter element having an interior defining a receptacle of a size and shape for receiving therein at least a portion of

one of said fuel injectors including the fuel inlet thereof, such that the injector's spray outlet is directed beyond the adapter element, and an outer configuration of a size and shape for positioning within one of said pairs of apertures of said first mounting element, the or each adapter element having one or more adapter inlets therein and first and second sealing means mounted thereon, such that, when the or each adapter element is positioned in a respective one of said pairs of apertures in the first mounting element, the first and second sealing means seal the adapter element to the first and second face portions of the first mounting element and the or each adapter inlet communicates from the chamber to the receptacle of the adapter element.

In a preferred embodiment, the apparatus further comprises at least one enclosure for receiving an output spray of liquid from the spray outlet of the or each fuel injector being tested.

Preferably, control means is provided to be coupleable to the or each injector being serviced so as to operate the or each injector to spray liquid through its spray outlet.

In a preferred embodiment, the first mounting means is provided with a plurality of pairs of apertures and the apparatus further comprises a plurality of adapter elements so that a plurality of fuel injectors can be serviced simultaneously. Preferably, different ones of the adapter elements are internally configured for receiving different types of fuel injectors. Preferably, at least one adapter element is internally configured for receiving at least a portion of a side feed fuel injector so that the fuel inlet of the injector is positioned within the receptacle of the adapter element.

Preferably, at least one adapter element is internally configured for receiving at least a portion of a top feed fuel injector so that the inlet of the injector is positioned within the receptacle of the adapter element. Preferably, the or each adapter element for receiving a top feed injector comprises a first portion having an outer configuration of a size and shape for positioning within a respective one of the pairs of apertures of said first mounting element and having one or more adapter inlets extending therethrough and first and second sealing means mounted thereon, and a second portion, connectable to the first portion and defining a receptacle of a size and shape for receiving therein at least a portion of the top feed fuel injector to be tested including the fuel inlet thereof.

The apparatus preferably further comprises blanking elements, each externally configured to fit into a respective one of the pairs of apertures in the first mounting element and to close off both apertures thereof.

The apparatus preferably further comprises a second mounting element comprising a generally planar platform having a rim at a periphery thereof for

supporting the first mounting element, the platform being arranged to cover the top of the or each enclosure, and the platform being provided with one or more apertures, each aperture being positioned so as to correspond to the position of one pair of apertures in the first mounting element. Preferably, a plurality of enclosures are provided, each enclosure corresponding to a respective aperture in the platform for receiving the output spray from a respective fuel injector being tested.

The second mounting element is preferably provided with first clamping means for clamping the or each enclosure between the second mounting element and a base. Preferably, the apparatus further comprises retaining means for retaining the or each adapter element within the first mounting element. In one embodiment, the retaining means comprises second clamping means for clamping the, or each, adapter element to the first mounting means.

The second clamping means preferably also clamps the first mounting element over the second mounting element.

BRIEF DESCRIPTION OF THE DRAWINGS

One embodiment of a servicing apparatus for fuel injectors according to the invention will now be more fully described, by way of example, with reference to the drawings, of which:

Figure 1 is an exploded perspective view of a top portion of the apparatus used for servicing side feed injectors;

Figure 2 is a cross-sectional view through the apparatus of Figure 1 in assembled form;

Figure 3 is a view similar to that of Figure 1 of the apparatus used for servicing top feed injectors; and

Figure 4 is a view similar to that of Figure 2 of the apparatus of Figure 3 in assembled form.

DETAILED DESCRIPTION OF THE DRAWINGS

As shown firstly in Figures 1 and 2, the apparatus 1 for servicing fuel injectors includes a hollow mounting element 2 having a top face 3 and a bottom face 4 coupled together by an outer side wall 5 so as to define a chamber 6 therebetween. The chamber 6 is generally annular in shape with the top and bottom faces 3 and 4 being joined together at a central portion 10 thereof.

A plurality of pairs of apertures 7 and 8 are provided in the mounting element, one aperture 7 of each pair being in the top face 3 and the second aperture 8 of each pair being in the bottom face 4 and in a corresponding position to the first aperture 7. A liquid inlet 9 is provided in the side wall 5 to enable liquid to be fed into the chamber 6.

Two different types of side feed injectors 11 and

12 are shown in Figures 1 and 2. The first type 11 is used by The Ford Motor Co. and the second type 12 is used by General Motors Co. Although the injectors illustrated are Throttle Body Injectors, the multi point side feed injectors have identical operational principles. Both types are provided with a generally annular filter-covered inlet 13 extending around a side of the injectors 11 and 12 through which filter liquid enters the injector. The liquid is sprayed out from the injector from a spray outlet 14 at a lower end of the injectors. A valve (not shown) is provided in the injector between the inlet 13 and the outlet 14. The valve is electrically controlled from electrical control lines (not shown), which are connected to connectors 15 provided on an upper end of the injectors.

In order to mount each of the injectors 11 and 12 in the mounting element 2, adapter elements 16 and 17, respectively, are provided. Adapter element 16 is generally cylindrical in shape and has a cylindrical wall 18 having an open top 19 through which the injector 11 is inserted into the adapter element so that the inlet 13 is positioned within the adapter element 16. The inner side of the cylindrical wall 18 is provided with abutments 20 arranged to fit around the injector 11 and hold it so that its outlet 14 is directed downwardly and outwardly through an aperture 21 in the bottom of the adapter element 16. The cylindrical wall 18 is provided with at least one passage 22 extending from the outside of the adapter element 16 to the interior thereof. Two sealing elements 23 and 24, such as O-rings, are positioned around the outer circumference of the adapter element 16 and arranged to seal against the edges of the apertures 7 and 8, respectively, when the adapter element 16 is inserted therein. Thus, when the adapter element 16 is in position in the mounting element 2, as shown in Figure 2, the sealing elements 23 and 24 seal the chamber 6 so that liquid therein does not escape through the apertures 7 and 8, but passes through the passage(s) 22 into the interior of the adapter element 16 and thence into the inlet 17 of the injector 11 from which it can be sprayed downwardly and outwardly controlled by control signals connected to the connectors 15.

Similarly, adapter element 17 is generally cylindrical in shape and has a cylindrical wall 25 having an open top 26 through which the injector 12 is inserted into the adapter element so that the inlet 13 is positioned within the adapter element 17. The inner side of the cylindrical wall 25 is provided with abutments 27 arranged to fit around the injector 12 and hold it so that its outlet 14 is directed downwardly and outwardly through an aperture 28 in the bottom of the adapter element 17. The cylindrical wall 25 is provided with at least one passage 29 extending from the outside of the adapter element 17 to the interior thereof. Two sealing elements 30 and 31, such as O-rings, are positioned around the outer circumference of the adapter element 17 and arranged to seal against the

edges of the apertures 7 and 8, respectively, when the adapter element 17 is inserted therein. Thus, when the adapter element 17 is in position in the mounting element 2, as shown in Figure 2, the sealing elements 30 and 31 seal the chamber 6 so that liquid therein does not escape through the apertures 7 and 8, but passes through the passage(s) 29 into the interior of the adapter element 17 and thence into the inlet 17 of the injector 12 from which it can be sprayed downwardly and outwardly controlled by control signals connected to the connectors 15.

It will be appreciated that the interior configurations of the adapter elements are designed to match the outer configurations of the injectors and provide liquid communication between the passages and the inlets of the injectors. It will further be appreciated that different injectors will require different adapter elements.

In order to retain the injectors in their adapter elements within the mounting element 2, there is provided a retaining plate 32 having a plurality of recesses 33 therein at positions corresponding to the positions of the injectors. The recesses are sized and shaped so as to abut the top of the injectors but allow access to the connectors 15 on the injectors. The retaining plate is clamped to the mounting element 2 by means of a knurled hand screw 34 which includes a shoulder 35 abutting the edge of a central aperture 36 in the retaining plate 32 and screws onto an upper end of a threaded bolt 37. The lower end of the bolt 37 is threaded into a threaded recess 38 in the central portion 10 of the mounting element 2 and retained therein by a locking nut 39.

To receive the outlet sprays from each of the injectors being tested, a plurality of containers 40 are provided; one container per injector. The containers 40 are formed by vertical tubes of transparent or translucent material, such as glass or plastic, and are graduated so that the volume of liquid received can be easily measured. The containers 40 are positioned on a base plate 41 and are clamped to the base plate 41 by a clamping plate 42 having a central aperture 43 which is abutted by a shoulder 44 of a knurled hand screw 45. The knurled hand screw 45 is threaded onto an upper end of a threaded bolt 46. The lower end of the bolt 46 is threaded into a threaded recess 47 in a central portion 48 of the base plate 41 and retained therein by a locking nut 49.

The clamping plate 42 is provided around its periphery with a rim 50 on which the mounting element 2 rests. A plurality of apertures 51 are arranged in the clamping plate 42 in positions corresponding to the injectors and the containers so as to allow the spray outlet from each injector to pass into a corresponding container 40.

As shown in Figures 1 and 2, the apparatus 1 has provision for servicing eight injectors at the same time. However, if a fewer number of injectors are to

be serviced, then the apertures 7 and 8 in the mounting element 2 should be blocked to prevent liquid in the chamber 6 from escaping. There is therefore provided a further generally cylindrical adapter element 52 having a pair of sealing elements 53 and 54 arranged around its external circumference, similarly to the O-rings 23 and 24 of adapter element 16, to seal the adapter element 52 to the edges of the apertures 7 and 8, respectively.

Although for blocking the apertures in the mounting element any blanking structure will suffice, the adapter element 52, as shown in cross-section in the right hand portion of Figure 4, is preferably provided with a passageway 55 extending from the outside of the adapter element 52 to an end of a threaded recess 56 provided in the bottom of the adapter element 52. A similar threaded recess 57 is provided in the top of the adapter element 52. As will be further described below, this structure enables the adapter element 52 to be used for mounting top feed injectors. However, when being used to block the apertures in the mounting element, the threaded recess 56 is closed off by threaded blanking screw 58. A retaining screw 59 is screwed into the top recess 57 and is provided with a flange 60 against which the retaining plate 32 abuts.

As mentioned above and as shown in Figures 3 and 4, in which the same features have the same reference numerals as in Figures 1 and 2, the apparatus 1 can also be used for servicing top feed injectors 61. The top feed injector 61 includes an inlet 62 at its top, an outlet 63 at its bottom and a valve (not shown) in the injector between the inlet and the outlet. The valve is controlled by signals on control lines (not shown) connected to connectors 64 at a side of the injector 61.

In order to connect the inlet 62 of the injector 61 to the chamber 6 of the mounting element 2, adapter element 52 is used together with a top feed injector receiving element 65. The receiving element 65 is provided with a threaded portion 66 for threading into the bottom recess 56 of adapter element 52 and a receptacle portion 67 for receiving the top portion of the top feed injector 61. A passageway 68 extends between the inside of receptacle portion 67 and the outside of threaded portion 66 providing liquid communication between the passageway 55 leading to the bottom recess 56 of the adapter element 52 and the top portion of the injector 61 such that liquid from the chamber 6 of the mounting element 2 can pass to the inlet 62 of the injector 61. A retaining screw 59 is screwed into the top recess 57 of adapter element 52, in a similar fashion to that described above. The lower portion of the top feed injector 61 abuts against the aperture 51 in clamping plate 42 so that the outlet 63 sprays liquid into the container 40.

In order to clamp the mounting element 2 to the clamping plate 42, and thereby retain the injector 61 in position, a clamping frame 69 is provided. The

frame 69 comprises a pair of arms 70 and 71, each having a leg 72 at a lower end thereof for fitting into a respective aperture 73 provided in rim 50 of clamping plate 42. The upper ends of the two arms are coupled to the sides of a threaded ring 74. A knurled screw 75 is provided having a head 76 resting on hand screw 34 and a threaded shank 77 threaded into ring 74. The head 76 is preferably provided with a tip 78 resting in a corresponding dip 79 in the head of hand screw 34. Thus, by loosening screw 75 in ring 74, the tip 78 of screw 75 is forced downwards into dip 79 and forces hand screw 34 downwards towards clamping plate 42, which is being held by the legs 72 of arms 70 and 71 within the apertures 73 in the clamping plate 42.

It will be appreciated that although only one particular embodiment of an apparatus according to the invention has been described, various modifications and improvements within the scope of the invention will be apparent to a person skilled in the art. For example, although the apparatus has been described as having a separate container for each injector, if only a visual inspection of the outlet spray, e.g. of fuel, is required, rather than a quantitative analysis of its volume, only a single container for all the injectors need be provided. Furthermore, if the liquid is a cleaning fluid, the container can be provided with means for recirculating the fluid back into the inlet of the mounting element.

Further, it will be appreciated that although eight apertures 7 are illustrated it is not necessary to simultaneously service eight injectors at the one time. With side feed injectors the unused apertures 7, 51 can be closed off by means of a corresponding number of adapter elements 52. A similar comment applies in relation to the top feed injectors and elements 52 closed off by blanking screws 58.

Similarly, although the circular arrangement of the apertures 7 is convenient, it is not essential. If desired a smaller unit with, say, four apertures 7 arranged in a line can be constructed.

Claims

1. Apparatus for servicing one or more fuel injectors (11,12) each having a fuel inlet (13), a spray outlet (14), and electrically operable valve means operable to permit liquid to flow from the fuel inlet (13) to the spray outlet (14), characterised in that the apparatus comprising:
 - a first mounting element (2) comprising first and second substantially spaced apart face portions (3,4) forming parts of a chamber (6), the first and second face portions (3,4) defining at least one pair of apertures (7,8), the or each pair of apertures (7,8) comprising a first aperture (7) formed in the first face portion (3) and a second

aperture (8) formed in the second face portion (4) and the first and second apertures (7,8) lying opposite each other, and the first mounting element (2) defining a chamber inlet (9) leading to the chamber (6); and

at least one generally cylindrical adapter element (16,17) having an interior defining a receptacle of a size and shape for receiving therein at least a portion of one of said fuel injectors (11,12) including the fuel inlet (13) thereof, such that the injector's spray outlet (14) is directed beyond the adapter element (16,17), and an outer configuration of a size and shape for positioning within one of said pairs of apertures (7,8) of said first mounting element (2), the or each adapter element (16,17) having one or more adapter inlets (22) therein and first and second sealing means (23,24) mounted thereon, such that, when the or each adapter element (16,17) is positioned in a respective one of said pairs of apertures (7,8) in the first mounting element (2), the first and second sealing means (23,24) seal the adapter element (16,17) to the first and second face portions (3,4) of the first mounting element (2) and the or each adapter inlet (22) communicates from the chamber (6) to the receptacle of the adapter element (16,17).

2. Apparatus as claimed in claim 1, characterised in that it further comprises at least one enclosure (40) for receiving an output spray of liquid from the spray outlet (14) of the or each fuel injector (11,12) being tested.
3. Apparatus as claimed in claim 1 or 2, characterised in that the apparatus further comprises control means to be couplable to the or each injector (11,12) being serviced so as to operate the or each injector (11,12) to spray liquid through its spray outlet (14).
4. Apparatus as claimed in any preceding claim, characterised in that at least one adapter element (16,17) is internally configured for receiving at least a portion of a side feed fuel injector (11,12) so that the fuel inlet (13) of the side feed fuel injector (11,12) is positioned within the receptacle of the adapter element (16,17).
5. Apparatus as claimed in any preceding claim, characterised in that at least one adapter element (16,17) is internally configured for receiving at least a portion of a top feed fuel injector (61) so that the inlet (62) of the injector (61) is positioned within the receptacle of the adapter element (52,65).
6. Apparatus as claimed in claim 5, characterised in

that the or each adapter element (52,65) for receiving a top feed fuel injector (61) comprises a first portion (52) having an outer configuration of a size and shape for positioning within a respective one of the pairs of apertures (7,8) of said first mounting element (2) and having one or more adapter inlets (55) extending therethrough and first and second sealing means (53,54) mounted thereon, and a second portion (65), connectable to the first portion (52) and defining a receptacle of a size and shape for receiving therein at least a portion of the or each top feed fuel injector (61) to be tested including the fuel inlet (62) thereof.

7. Apparatus as claimed in any preceding claim, characterised in that the apparatus further comprises blanking elements (52), each externally configured to fit into a respective one of the pairs of apertures (7,8) in the first mounting element (2) and to close off both apertures (7,8) thereof.
8. Apparatus as claimed in any preceding claim, characterised in that the apparatus further comprises a second mounting element (42) comprising a generally planar platform having a rim (50) at a periphery thereof for supporting the first mounting element (2), the platform being arranged to cover the top of the or each enclosure (40), and the platform being provided with one or more platform apertures (51), each platform aperture (51) being positioned so as to correspond to the position of one pair of apertures (7,8) in the first mounting element (2).
9. Apparatus as claimed in claim 8, characterised in that the apparatus further comprises a base, and that the second mounting element (42) is provided with clamping means (45,46) for clamping the or each enclosure (40) between the second mounting element (42) and the base.
10. Apparatus as claimed in any preceding claim, characterised in that the apparatus further comprises retaining means (32) for retaining the or each adapter element (16,17) within the first mounting element (2).

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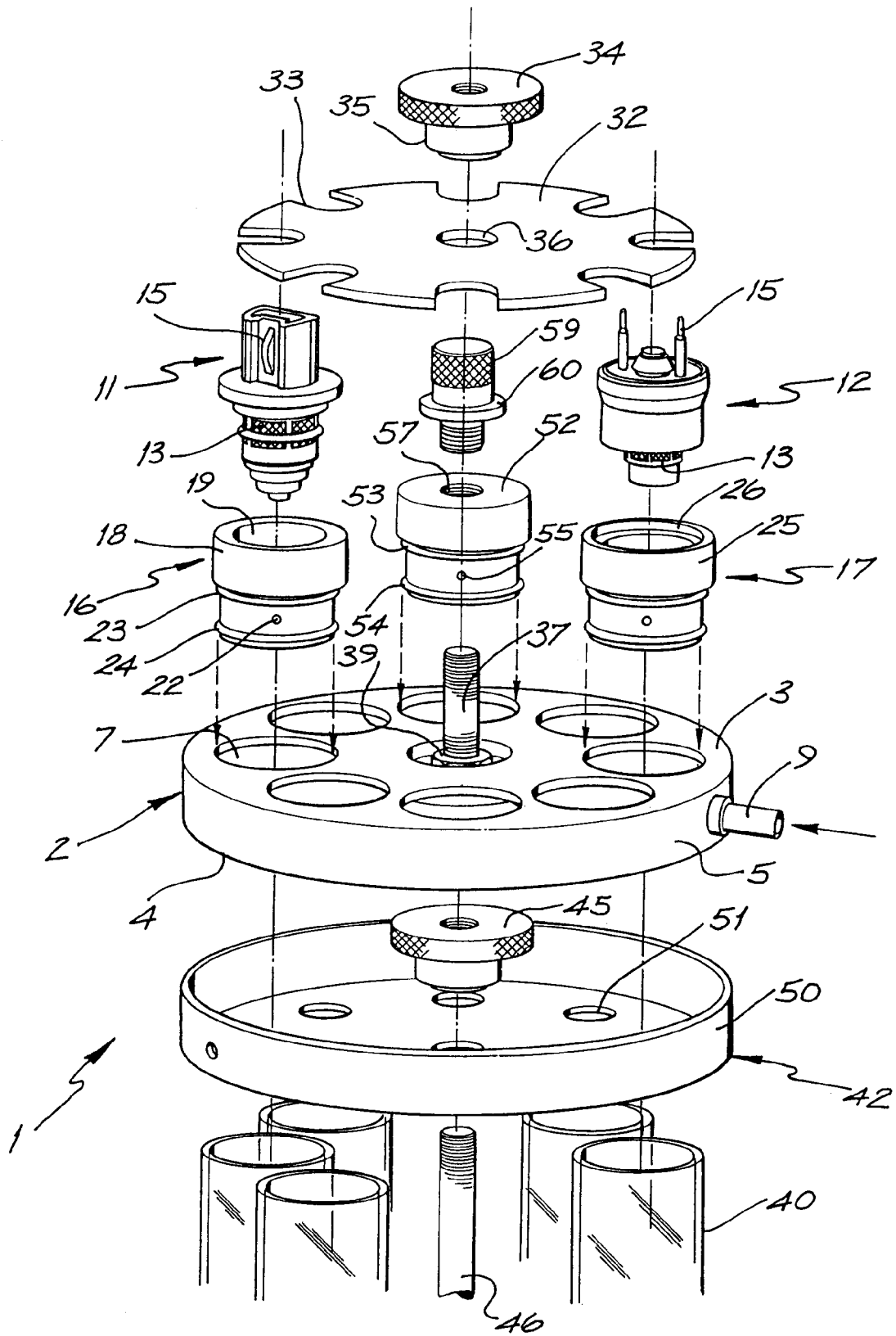
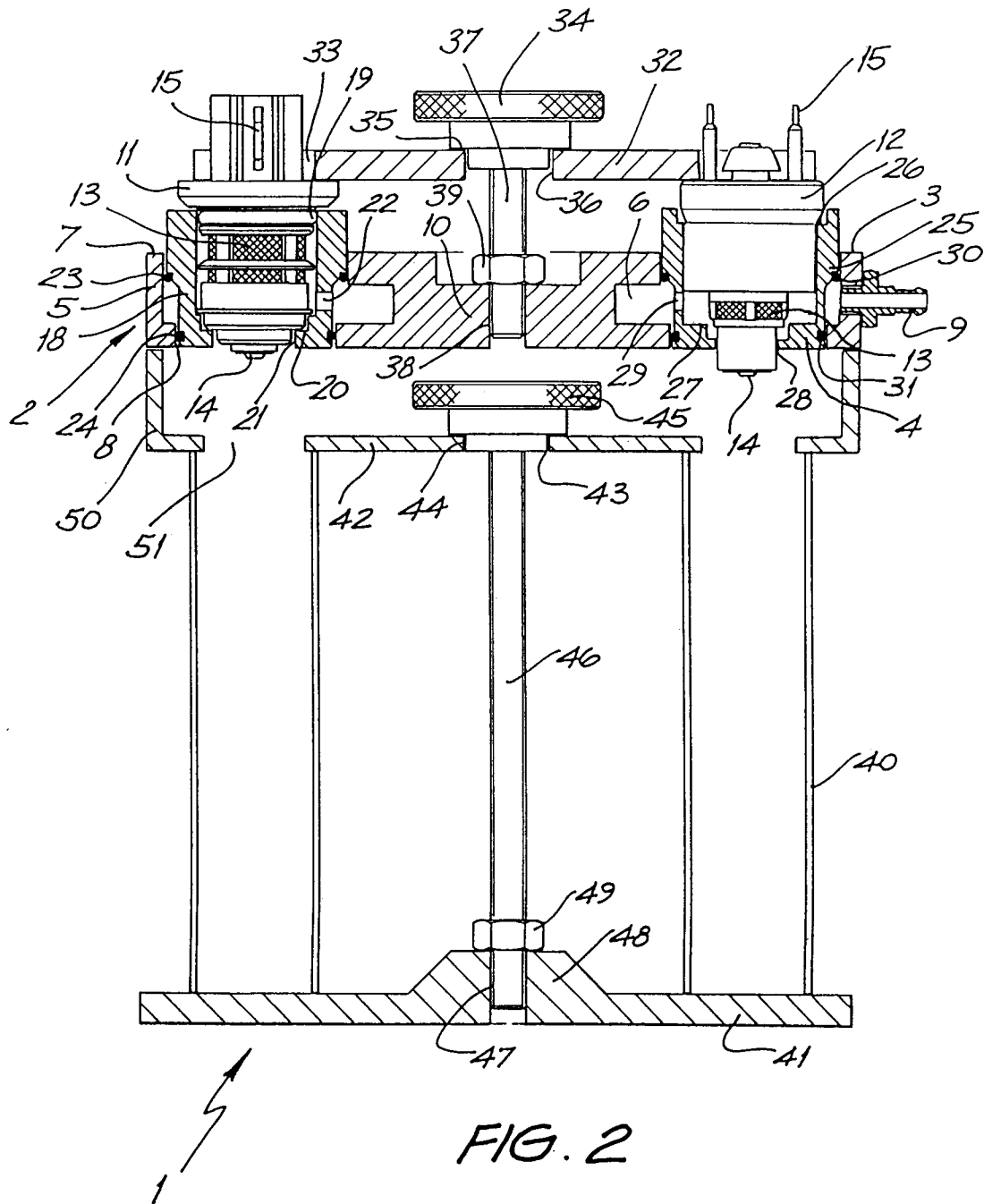


FIG. 1



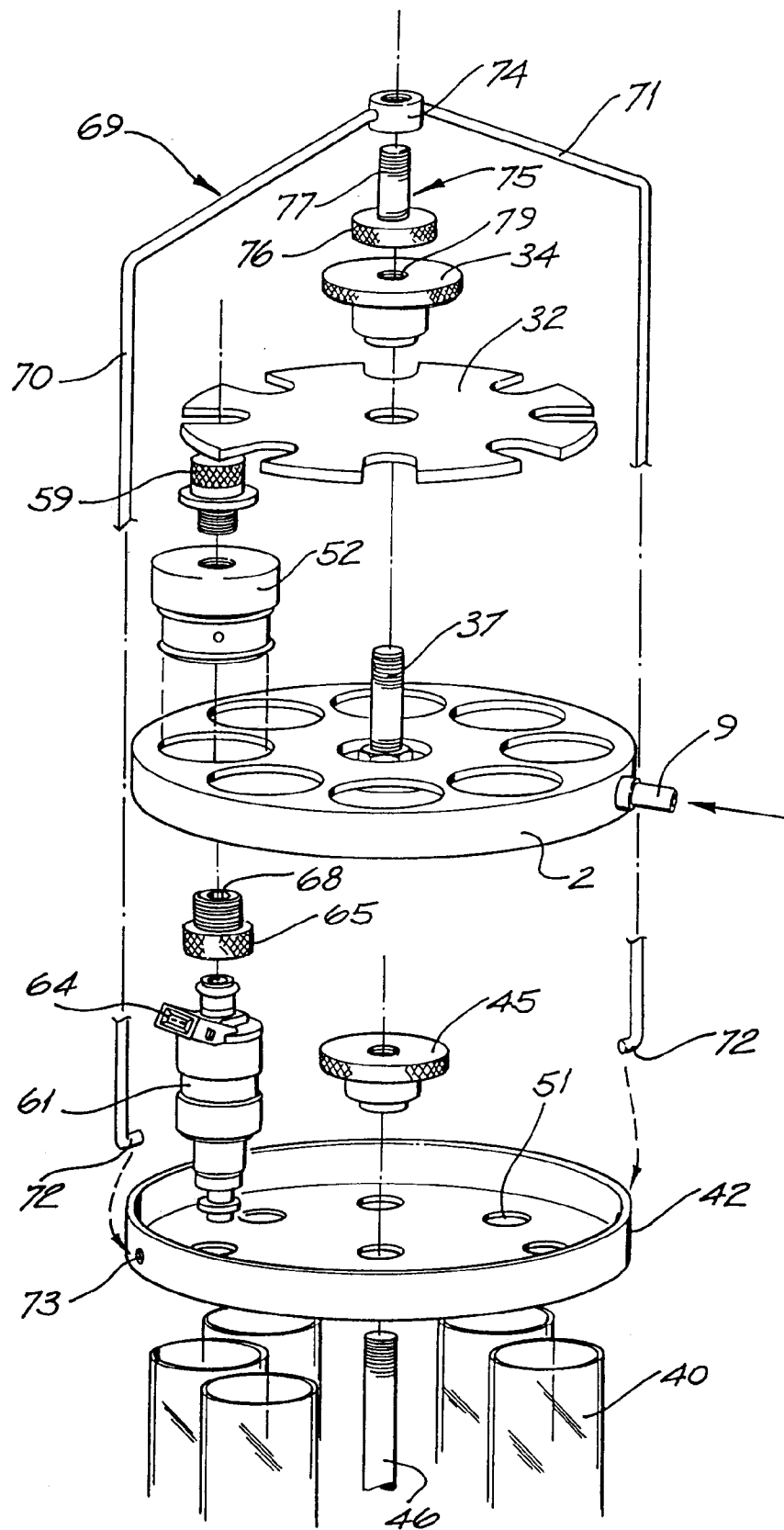


FIG. 3

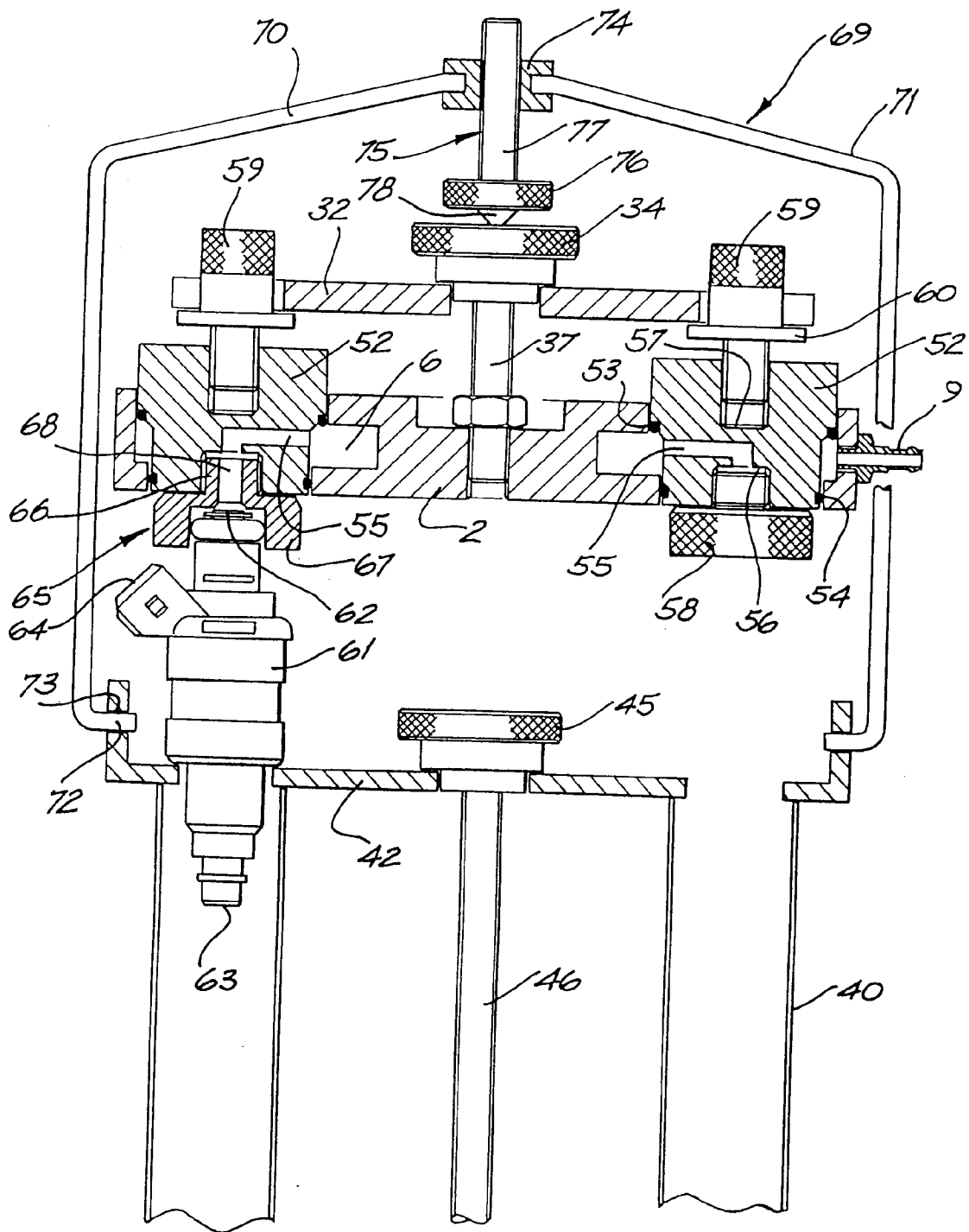


FIG. 4



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 3242

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.5)
X A	WO-A-90 13801 (CATERPILLAR) * page 5, line 30 - page 9, line 24; figures 1-9 *	1-4,7,10 8,9	F02B77/04 F02M65/00
A,D	US-A-4 845 979 (FARENDEN) * column 1, line 56 - column 2, line 43; figures 1,2 *	1-3,8,9	
A	DE-C-33 15 503 (DAIMLER-BENZ AG)		
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			F02B F02M
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 21 July 1994	Examiner Friden, C
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			

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