A fuel pumping and filter connection device for incorporation in a fuel system. The connection device may have a main body defining a fuel flow path in which there may be disposed a pump. There may also be provided a pump connector driveingly connected to the pump and connectable to an external drive means operable to effect rotation of the pump. The main body may include means for connecting the fluid flow path in fluid communication with a port of a filter. This device may be used to purge air from the fuel system in which it is incorporated.
A FUEL PUMPING AND FILTER CONNECTION DEVICE

Technical Field

[0001] The present disclosure relates to pumps and more particularly to pumps operable by means of an external drive and having filter connection means. The disclosure also relates to a method of operating such pumps.

Background

[0002] Air may enter a fuel system of an engine during routine maintenance or repair, for example by disconnecting a fuel line or replacing a filter. Air may also be drawn into the fuel system if the fuel supply fully depletes during engine operation. Air in the fuel system is very problematic as it adversely affects the delivery of fuel to the engine and may thus prevent the engine from firing.

[0003] To avoid such problems, nowadays many fuel systems are fitted with a priming pump operable to purge the fuel system of air whenever necessary. For example, this may be in a garage following routine maintenance or at a roadside having fully depleted the fuel supply. For this reason they are generally a permanent component of the fuel system and some may even be associated with the fuel filter. For instance, the priming pump may be provided in a housing interfacing the fuel filter and the fuel line.

[0004] Some of those priming pumps are manually operated while others are electrically operated. Although the manually operated priming pumps are relatively inexpensive, they may be difficult and time consuming to operate, particularly when access is limited. On the other hand, the electrically operated priming pumps may be reasonably effective in that they may bleed the fuel system with minimal effort and in little time, but they may be considerably more expensive than their manually operated counterparts. Such additional expense may be difficult to justify on a priming pump that may be used only once or twice during the entire life of the fuel system.

[0005] It is therefore a principal object of the present invention to overcome the problems associated with existing fuel system priming apparatus and their methods of use.
Summary of the Disclosure

[0006] According to a first aspect of the disclosure, there is provided a fuel pumping and filter connection device for use with a filter having a filter inlet and a filter outlet, the fuel pumping and filter connection device comprising:

a main body defining a fuel flow path;

filter connection means adapted to locate the filter such that at least one of the filter inlet and the filter outlet is arranged in fluid communication with the fuel flow path;

pumping means provided within the fuel flow path; and

pump connection means drivingly coupled to the pumping means and arranged for rotational movement relative to the main body, the pump connection means being adapted to cooperate in use with external rotary drive means for driving said pumping means.

[0007] According to a second aspect of the invention, there is provided a method of priming a fuel system comprising the steps of:

providing within the fuel system a fuel pumping and filtration device comprising: a main body defining a fuel flow path; a filter arranged in fluid communication with the fuel flow path; pumping means arranged to generate a fuel flow through the fuel flow path; and a pump connector drivingly coupled to the pumping means and arranged to connect to an external rotary drive;

providing an external rotary drive which is drivingly connectable to the pump connector;

connecting the external rotary drive to the pump connector; and

operating the external rotary drive so as to drive the pumping means.

Brief Description of the Drawings

[0008] By way of example only, four embodiments of the present disclosure will now be described in detail, with reference being made to the accompanying drawings, in which:

[0009] Figure 1 is a perspective view of a fuel pumping and filter connection device according to a first embodiment of the disclosure, which is connected to a filter;

[0010] Figure 2 is an enlarged view of part of the arrangement shown in Figure 1;

[0011] Figure 3 is a cross-section through the fuel pumping and filter connection device of Figure 2, along the line AA;

[0012] Figure 4 is a cross-section through the fuel pumping and filter connection device of Figure 2, taken along the line BB shown in Figure 3;
[0013] Figure 5 is a cross-section through the fuel pumping and filter connection device of Figure 2, taken along the line CC shown in Figure 3;

[0014] Figure 6 is perspective view corresponding to that of Figure 2, but with the pump assembly removed to reveal a receptacle;

[0015] Figure 7 shows the fuel pumping and filter connection device shown in Figure 6, but viewed in front of the receptacle;

[0016] Figure 8 is a cross-section of the fuel pumping and filter connection device of previous figures, taken along the line DD shown in Figure 3;

[0017] Figure 9 is a perspective view of the fuel pumping and filter connection device according to the first embodiment, but with the cap removed;

[0018] Figure 10 is a schematic illustration of fuel pumping and filter connection device according to the first embodiment;

[0019] Figure 11 is a schematic illustration of fuel pumping and filter connection device according to a second embodiment;

[0020] Figure 12 is a schematic illustration of fuel pumping and filter connection device according to a third embodiment; and

[0021] Figure 13 is a schematic illustration of fuel pumping and filter connection device according to a fourth embodiment.

Detailed Description

[0022] Referring initially to Figure 1, there is shown a fuel pumping and filter connection device (hereafter referred to as "the device"), generally indicated 11, for incorporation in a fuel system (not shown) associated with an engine (not shown). At the core of the device 11 there may be provided a main body 12 arranged to interconnect various components in fluid communication. For instance, the device 11 may be equipped with a filter connection portion 13 which may be disposed towards the bottom 14 of the main body 12 and may be connectable to a filter 19. The device 11 may also be furnished with a mounting portion 15 by which it may be attached to the engine (not shown) or an associated component (not shown) and which mounting portion 15 may be located at the rear 16 of the main body 12. Furthermore, the device 11 may be provided with a pump assembly 17 for pumping fuel around the fuel system, and which may be disposed on the front 18 of the main body 12. The main body 12 may be provided with a dirty fuel conduit 20 defining dirty fuel inlets 21 configured for connection to a fuel supply (not shown). The main body 12 may also be
provided with a clean fuel conduit 22 defining clean fuel outlets 23 configured for connection to a fuel delivery system, such as one or more fuel injectors. The dirty fuel inlets 21 and the clean fuel outlets 23 may be connected to each other and connectable to the filter 19 and the pump assembly 17 by various fluid flow paths and ports defined within the main body 12.

[0023] Referring now to Figures 2 to 5, the filter connection portion 13 may be disposed at the bottom 14 of the main body 12 and may form the base of the device 11. In this embodiment, the filter connection portion 13 includes a connector 25 for mechanically connecting the filter 19 to the device 11 in a manner that facilitates easy removal and replacement of said filter 19.

[0024] The connector 25 may comprise an annular wall depending from the bottom 14 of the main body 12 so as to define a socket 26. A tubular insert 27 may be located within the socket 26 and may be welded, brazed, soldered or adhered in place. Alternatively or additionally, the external diameter of the tubular insert 27 and the internal diameter of the connector 25 may be selected so as to form an interference fit. An outside end 28 of the tubular insert 27 may be provided with an external thread 29 that extends beyond connector 25 when the tubular insert 27 is fully located within the socket 26. In an alternative arrangement, the external thread 29 may be machined or otherwise formed directly on the connector 25 so as to avoid using the tubular insert 27. The external thread 29 is arranged to engage an internal thread 30 provided in a filter recess 31 located on the top of the filter 19.

[0025] There may also be provided a frusto-conical wall 35 depending from the bottom 14 of the main body 12 and surrounding the connector 25. A generally planar annular lip 36 may extend outwardly from the periphery of the frusto-conical wall 35 and may define a sealing face 37 lying substantially co-planar with the free end of the connector 25. The filter 19 may be provided with an annular seal 38 arranged to engage the sealing face 37 when the filter 19 is properly connected to the device 11. Furthermore, the connector 25, the frusto-conical wall 35 and the annular lip 36 may collectively define a dirty fuel chamber 39. The dirty fuel chamber 39 may be configured to align with one or more filter inlet 40 on the filter 19 when said filter is connected to the device 11. The one or more filter inlet 40 may be arranged around the filter recess 31 of the filter 19 in a general ring formation.

[0026] The dirty fuel conduit 20 may be provided towards the front 18 of the main body 12, possibly immediately above the frusto-conical wall 35 and arranged to extend between opposed sides 41 of the device 11. As such, the dirty fuel inlets 21 are also disposed at opposed sides 41 of the device 11 so as to accommodate differently configured fuel systems.
(not shown). The dirty fuel conduit 20 and the dirty fuel chamber 39 may be connected by a
dirty fuel passage 45 so as to enable fuel delivered through the dirty fuel inlets 21 to enter the
filter 19 via the dirty fuel passage 45 and the dirty fuel chamber 39. That dirty fuel passage
45 may be located approximately midway along the length of the dirty fuel conduit 20 and
may be substantially rectilinear so as to extend directly into the dirty fuel chamber 39.

[0027] The filter connection portion 13 may have an inlet defined at the outside end 28 of
the tubular insert 27. The interior of the tubular insert 27 defines a first portion 46 of a clean
fuel passage 47. A second portion 48 of the clean fuel passage 47 may extend from an
opening at the bottom 14 of the main body 12 and intersects the clean fuel conduit 22,
possibly at a point approximately midway along the length of the clean fuel conduit 22. The
second portion 48 of the clean fuel passage 47 is generally concentric with the connector 25
and has a diameter substantially equal to that of the interior of the tubular insert 27 such that
the first and second portions 46, 48 of the clean fuel passage 47 are generally coextensive.

[0028] The device 11 may include a non-return valve 50 which may be disposed in the
clean fuel passage 47, possibly adjacent the clean fuel conduit 22. The non-return valve 50
may be configured to restrict the flow of fuel in a particular direction, for example from the
clean fuel conduit 22 to the clean fuel passage 47. The non-return valve 50 may have an
outer casing 51 sized to form a snug fit within the clean fuel passage 47 and may be inserted
through the opening in the bottom 14 of the main body 12. The tubular insert 27 may include
retention means 52 such as a subtle narrowing within the first portion so as to restrict
inadvertent removal of the non-return valve 50. In this case, it may be necessary to locate the
non-return valve 50 in position prior to fitting the tubular insert 27.

[0029] With particular reference to Figures 3, 6 and 7, the main body 12 may extend
forward and above the dirty fuel conduit 20 to define a receptacle 58 to which the pump
assembly 17 may be mounted. The main body 12 may define at least one pre-pump channel
59 extending between the clean fuel passage 47 and the receptacle 58 for delivering clean
fuel to the pump assembly 17 and at least one post pump channel 60 extending between the
receptacle 58 and the clean fuel conduit 22 for delivering fuel to the clean fuel outlets 23. In
the present embodiment, there is provided a pair of pre-pump channels 59 having a common
first pre-pump opening 61 in the clean fuel passage 47 and which diverge to define a pair of
second pre-pump openings 62 in the receptacle 58. Similarly, there may be provided a pair of
post-pump channels 60, but these may be spaced laterally apart and may have a pair of first
post-pump openings 63 spaced axially along the clean fuel conduit 22 and a pair of second post-pump openings 64 defined in the receptacle 58.

[0030] The receptacle 58 may be defined by a generally circular wall 67 provided on the main body 12. Inside the receptacle 58 there may be provided a post-pump recess 68 and a pre-pump recess 69 arranged opposite each other and possibly kidney shaped, one recess being formed in the region of the second post-pump openings 64 and the other recess being formed in the region of the second pre-pump openings 62. The area between the post pump recess 68 and the pre-pump recess 69 defines a land 70 for supporting the pump assembly 17. The land 70 is generally stepped in that it has opposed end portions 71 adjacent the circular wall 67 that are elevated relative to a central portion 72 and which may have inwardly facing surfaces 73 that may be curved. The central portion 72 may also be provided with a shaft bore 74 which may be disposed between the second pre-pump and second post-pump openings 62,64 and which may be located eccentrically relative to the circular wall 67, for reasons explained below.

[0031] In the present embodiment the pump assembly 17 includes a sliding vane pump 80, but in other embodiments the pump assembly 17 may comprise other types of pumps. As can be seen in Figures 3 and 8, the pump assembly 17 includes a cup portion 81 which may comprise a cup base 82 that may be circular, a surrounding wall 83 upstanding from the cup base 82 and a lip 84 extending around the free edge of the surrounding wall 83. The cup base 82 of the cup portion 81 is provided with a cup hole 85 and the surrounding wall 83 may be provided with a cup inlet 86 and a cup outlet 87, possibly provided at diametrically opposed locations on the surrounding wall 83. Inside the cup portion 81 there may be provided a rotor 90 having opposed upper and lower faces 91,92 and a circumferential face 93. The rotor 90 may be carried on a shaft 94 having upper and lower ends 95,96 extending beyond the upper and lower faces 91,92. A plurality of slots 97 may be provided in the circumferential face 93 which slots 97 may be spaced equally apart and may extend radially into the rotor 90. Each slot 97 may slidably receive a vane 98 and a spring (not shown) arranged to urge the vane 98 radially outwardly relative to the rotor 90. The rotor 90 may be disposed in the cup portion 81 such that its lower face 92 may bear against the cup base 82, the lower end 96 of the shaft 94 extends through the cup hole 85 and the free ends of the vanes 98 maintain contact with the surrounding wall 83. Since the cup hole 85, and thus the shaft 94 and the rotor 90, are offset from the centre of the cup portion 81, the vanes 98 extend from the rotor 90 at different lengths so as to maintain contact with the surrounding wall 83. The cup portion 81 is located
within the receptacle 58 such that the lower end 96 of the shaft 94 locates within the shaft bore 74, the lower face of the cup portion 81 rests on the central portion 72 of the land 70, areas of the external surface of the surrounding wall 83 bear against the inwardly facing surface 73 of the end portions 71 of the land 70 and the lip 84 sits on the top of the end portions 71 of the land 70.

[0032] The pump assembly 17 may also include a cover portion 100 (see Figure 9) arranged to close the receptacle 58. The cover portion 100 may comprise a plate 101 provided with a hole 102 for receiving the upper end 95 of the shaft 94, and a lower face 103 adapted to bear against the free edge of the circular wall 67. The lower face 103 of the plate 101 may rest on the lip 84 so as to prevent axial movement of the cup portion 81 and may also contact the upper face 91 of the rotor 90 so as to prevent axial movement of the sliding vane pump 80.

[0033] A pump connection means, possibly in the form of a boss 110, may be provided on the upper end 95 of the shaft 94. In the present embodiment the boss 110 is a separate unit that may be fixed to the upper end 95 of the shaft 94, possibly by welding, brazing, soldering, adhering, splines or by way of an interference fit or other form of deformation. In an alternative embodiment the boss 110 may be integral to the shaft 94 in that it may be machined, forged or otherwise formed. The boss 110 may be sized to locate within a correspondingly shaped recess (not shown) provided on an external rotary driver (not shown) (i.e. a rotary driver which is external to the device 11, and which does not form a part thereof), such as a hand drill. In one arrangement the boss may be polygonal, possibly hexagonal. Alternatively or additionally, the upper end 95 of the shaft 94 may be provided with a profiled recess (not shown) extending axially therein for receiving a correspondingly profiled drive of an external rotary driver.

[0034] Referring now to Figure 9, the cover portion 110 may also include a removable cap 115 adapted to cover the pump connection means 110 when not being used. The removable cap 115 may take various forms, but in the present embodiment it is domed and has a peripheral edge 116 configured to form a snug fit with a rim 104 upstanding from an upper face 105 of the plate 101.

[0035] Figure 9 also shows the mounting portion 15 for attaching the device to the engine or an associated component (not shown). The mounting portion 15 may take various forms depending on the supporting surface to which it is to be attached, but in the present embodiment it comprises a generally rigid member 120 disposed at the rear of the main
body 12 and possibly defining a substantially flat, rearward facing mounting surface 121. The rigid member 120 may be provided with a pair of mounting holes 122 for receiving bolts, screws or other suitable fasteners (not shown) that may be secured in the supporting surface (not shown).

[0036] Referring now to Figures 10 to 13, there are shown four embodiments of a pump according to the present disclosure. Figure 10 is a simplified illustration of the first embodiment of the device 11 discussed above, which includes a main body 12 defining a dirty fuel flow path 20,45 having a dirty fuel inlet 21 and a dirty fuel outlet 39 and also defining a clean fuel flow path 22 60,59,47 having a clean fuel inlet 27 and a clean fuel outlet 23. A pump 80 may be disposed in one of the clean fuel flow path and the dirty fuel flow path, though in the present case it is disposed in the clean fuel flow path. There may be provided a pump connector 110 drivingly coupled to the pump 80 and connectable to an external rotary driver (not shown). The main body 12 may include a filter connection portion 13 for attaching a filter 19 to the device 11 in a manner that fluidly connects the dirty fuel outlet 39 to the filter inlet 40 of the filter 19 and for fluidly connecting the clean fuel inlet 27 with the clean fuel outlet defined by filter recess 31.

[0037] Figure 11 shows a second embodiment of the device 211 comprising a main body 212 defining a fuel flow path 220 having a fuel inlet 231 and a fuel outlet 239 and also a pump 280 disposed within that fuel flow path 220. Again, the pump 280 may be drivingly coupled to a pump connector 281 adapted for connection to an external rotary driver (not shown). This device 211 may be arranged for use with a filter 219 having a dirty fuel inlet 245 connectable to a fuel supply (not shown) and a clean fuel outlet 246 connectable to a fuel delivery system (not shown), such as an injector. The filter 219 may also have a pump outlet 250 and a pump inlet 251. The device 211 of this embodiment may also have a filter connection portion 290 which may be configured to arrange the fuel inlet 231 of the main body 212 in fluid communication with the pump outlet 250 of the filter 219 and also to arrange the fuel outlet 239 of the main body 212 in fluid communication with the pump inlet 251 of the filter 219.

[0038] The third embodiment includes a main body 312 defining a fuel flow path 320 having a clean fuel inlet 331 and a clean fuel outlet 332 and also a pump 380 disposed within the fuel flow path 320. The pump 380 may be drivingly coupled to a pump connector 381 adapted for connection to an external rotary driver (not shown). The main body 312 may also include filter connection portion 390 for arranging the clean fuel inlet 331 in fluid
communication with an outlet 360 of a filter 319. In this arrangement the filter 319 may have an inlet 361 connectable to a fuel supply (not shown) and the clean fuel outlet 332 of the main body 312 may be connectable to a fuel delivery system (not shown).

[0039] The fourth embodiment shown in Figure 13 is very similar to the third embodiment described above, except the flow direction is reversed. In this arrangement, the main body 412 defines a fuel flow path 420 having a dirty fuel inlet 421 and a dirty fuel outlet 422 and a pump 480 disposed within the fuel flow path 420. There may also be provided a pump connector 481 drivingly coupled to the pump 480 and connectable to an external rotary driver (not shown). A filter connection portion 490 may be provided for arranging the dirty fuel outlet 422 in fluid communication with an inlet 418 of a filter 419.

Industrial Applicability

[0040] The industrial application of the device 11 will now be described with reference to the first embodiment shown in Figures 1 to 10. The device 11 may be mounted to an engine or other component (not shown) by presenting the mounting surface 121 of the mounting portion 15 to the support surface (not shown) and locating bolts (not shown) through the mounting holes 122 and corresponding holes in the support surface. A fuel supply pipe (not shown) may then be coupled in fluid communication to one of the dirty fuel inlets 21 of the dirty fuel conduit 20 and a fuel delivery pipe (not shown) may then be coupled in fluid communication to one of the clean fuel outlets 23 of the clean fuel conduit 22. Many connectors suitable for coupling those components are known so no explanation of those is required here. The dirty fuel inlet 21 and the clean fuel outlet 23 not used may be closed by use of a suitable plug (not shown). The filter 19 may be connected to the main body 12 by threadingly engaging the filter recess 31 and the outside end 28 of the tubular insert 27. In this way, the dirty fuel chamber 39 will fluidly communicate with the filter inlets 40 in the filter 19 and the clean fuel passage 47 will fluidly communicate with the inlet to the filter 19 defined by the recess.

[0031] During normal use, fuel may be pumped around the fuel system by one or more pumps, such as a lift pump and or a transfer pump. Dirty fuel may enter the device 11 via the dirty fuel inlet 21 and flow along the dirty fuel conduit 20, down the dirty fuel passage 45 and into the dirty fuel chamber 39 whence it may enter the filter 19 through the filter inlets 40. The fuel may pass through the filter material and may then be directed through the first portion 46 defined by the tubular insert 27 and then into the second portion 48 of the clean
fuel passage 47. The fuel pressure generated by the lift pump or transfer pump urges the non-return valve 50 into its open position so that fuel may flow into the clean fuel conduit 22 and then out through the clean fuel outlets 23.

[0032] Sometimes air may enter the fuel system, particularly during maintenance or replacement of some components. To ensure the correct and efficient operation of the fuel system it is necessary to purge the fuel system of air, which can be effected using the device 11 and an external rotary device (not shown), such as a hand-drill. Firstly, the removable cap 115 must be removed to reveal the boss 110 provided on the upper end 95 of the shaft 94. An adaptor (not shown) having a hexagonal slot formed in its end may be secured in the chuck of the hand-drill and may be presented to the boss 110 such that the boss locates inside the slot. The hand-drill may then be operated to cause the adaptor and boss 110 to rotate in unison, which in turn causes the rotor 90 of the sliding vane pump 80 to rotate. Fuel is drawn through the cup inlet 86, directed around the interior of the cup portion 81 and then urged through the cup outlet 87 as the vanes 98 rotate. Sliding vane pumps and their uses are well known so no further explanation of this sliding vane pump 80 is required here. The system may include a valve (not shown) located downstream of the clean fuel outlet 23 and through which any air entrained in the fuel may escape.
Claims

What is claimed is:

1. A fuel pumping and filter connection device for use with a filter having a filter inlet and a filter outlet, the fuel pumping and filter connection device comprising:
   a main body defining a fuel flow path;
   filter connection means adapted to locate the filter such that at least one of the filter inlet and the filter outlet is arranged in fluid communication with the fuel flow path;
   pumping means provided within the fuel flow path; and
   pump connection means drivingly coupled to the pumping means and arranged for rotational movement relative to the main body, the pump connection means being adapted to cooperate in use with external rotary drive means for driving said pumping means.

2. A fuel pumping and filter connection device as claimed in claim 1, wherein the fuel flow path comprises a dirty fuel flow path having a dirty fuel inlet and a dirty fuel outlet, and a clean fuel flow path having a clean fuel inlet and a clean fuel outlet, the pumping means being provided in at least one of said dirty fuel flow path and said clean fuel flow path.

3. A fuel pumping and filter connection device as claimed in claim 2, wherein the dirty fuel outlet and the clean fuel inlet are configured such that they may be arranged in fluid communication with the filter inlet and the filter outlet respectively.

4. A fuel pumping and filter connection device as claimed in any preceding claim, wherein the pump connection means includes one of a profiled stud and a profiled recess adapted to cooperate with the other of the profiled stud and the profiled recess provided on the external rotary drive means.

5. A fuel pumping and filter connection device as claimed in any preceding claim, wherein there is provided a removable cap arranged to cover the pump connection means when not in use.
6. A fuel pumping and filter connection device as claimed in any preceding claim, wherein the pumping means and the pump connection means are provided on a common shaft.

7. A fuel pumping and filter connection device as claimed in any preceding claim, wherein the pumping means comprises a rotary device.

8. A fuel pumping and filter connection device as claimed in any preceding claim, wherein the pumping means comprises: a pump housing defining a chamber, a chamber inlet and a chamber outlet; a shaft extending through the housing; a rotary device disposed within the chamber and carried on the shaft; and at least one of a profiled head and a profiled recess provided on the shaft and disposed outside the chamber, said at least one of a profiled head and a profiled recess defining the pump connection means.

9. A fuel pumping and filter connection device as claimed in claim 8, wherein the pump housing comprises: a cup portion including a base and a peripheral wall; and a cover portion arranged to engage the peripheral wall, the cup portion and the cover portion having coaxial bores for rotatably supporting the shaft.

10. A fuel pumping and filter connection device as claimed in claim 8 or claim 9, wherein the main body includes a mounting portion for receiving the pump housing and an aperture for receiving an end of the shaft carrying the rotary device.

11. A fuel pumping and filter connection device as claimed in any preceding claim, wherein there is provided a secondary flow path in fluid communication with the fuel flow path, the secondary flow path having an inlet upstream of the pumping means and an outlet downstream of the pumping means.

12. A fuel pumping and filter connection device as claimed in claim 11, wherein valve means are arranged to restrict in use the flow of fuel through the secondary flow path.

13. A method of priming a fuel system comprising the steps of:
providing within the fuel system a fuel pumping and filtration device comprising: a main body defining a fuel flow path; a filter arranged in fluid communication with the fuel flow path; pumping means arranged to generate a fuel flow through the fuel flow path; and a pump connector drivingly coupled to the pumping means and arranged to connect to an external rotary drive;

providing an external rotary drive which is drivingly connectable to the pump connector;

connecting the external rotary drive to the pump connector; and

operating the external rotary drive so as to drive the pumping means.

14. A method of priming a fuel system as claimed in claim 13, and further comprising the step of: providing a removable cap arranged to cover the pump connector; and removing the removable cap to reveal the pump connector before attempting to connect the external rotary drive to the pump connector.
# INTERNATIONAL SEARCH REPORT

## A. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) and to both national classification and IPC

### INV.

- F02M37/16
- F02M37/20
- F02M37/22

## ADD.

- Marsano, Flavio

## B. FIELDS SEARCHED

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

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

- EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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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
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## Date of the actual completion of the international search

20 September 2012

## Date of mailing of the international search report

08/10/2012

## Name and mailing address of the ISA

- European Patent Office, P.B. 5818 Patentlaan 2
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## Authorized officer

Marsano, Flavio
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