(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 096 123 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
02.05.2001 Bulletin 2001/18

(51) Int. Cl.[7]: **F02D 9/10**, F02M 37/14

(21) Application number: **00119635.1**

(22) Date of filing: **08.09.2000**

(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

(30) Priority: **26.10.1999 JP 30367899**

(71) Applicant:
AISAN KOGYO KABUSHIKI KAISHA
Obu-shi, Aichi 474-8588 (JP)

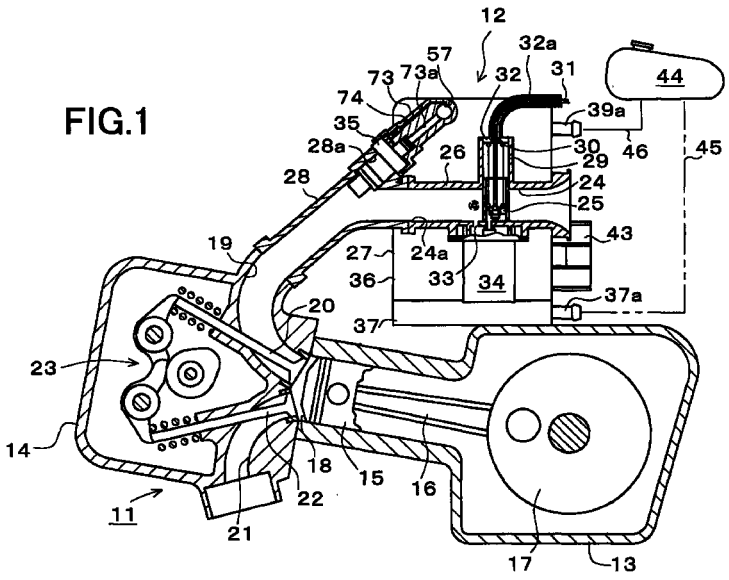
(72) Inventors:
- **Nawa, Hideaki**
  Obu-shi, Aichi 474-8588 (JP)
- **Nishimura, Kazuhiko**
  Obu-shi, Aichi 474-8588 (JP)
- **Wada, Satomi**
  Obu-shi, Aichi 474-8588 (JP)
- **Sakaue, Yasunori**
  Obu-shi, Aichi 474-8588 (JP)

(74) Representative:
Prüfer, Lutz H., Dipl.-Phys. et al
PRÜFER & PARTNER GbR,
Patentanwälte,
Harthauser Strasse 25d
81545 München (DE)

(54) Fuel supply apparatus for engines

(57) A fuel supply apparatus 12 includes a throttle body 26 including an air-intake passage 24a and a throttle valve 25 and fuel supplying devices; a fuel pump 61, a fuel filter 62, a pressure regulator 63, and an electric control unit 64. Those fuel supplying devices 61-64 are provided in unitary relation with respect to the throttle body 26. The apparatus 12 also includes a body case 27 which is integrally formed with the throttle body 26 and accommodates the fuel supplying devices 61-64. The body case 27 is formed with openings 38, 40, 58 for allowing insertion/removal of the devices 61-64 in/from the case 27, recesses 65-67 for allowing the devices 61-64 to be fitted therein, and covers 39, 41, 37 for closing the openings 38, 40, 58.

FIG.1



EP 1 096 123 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a fuel supply apparatus for supplying fuel together with air to a combustion chamber of an engine to be used in vehicles such as motorcycles.

2. Description of Related Art

[0002] Conventionally, a fuel injection apparatus is adopted as one of fuel supply apparatus for engines of, for example, motorcycles. This kind of fuel injection apparatus has a basic configuration including a throttle body having an air-intake passage, a fuel injection valve for injecting fuel into the air-intake passage, a fuel pump for supplying under pressure the fuel to the fuel injection valve, a pressure regulator for regulating the pressure of fuel to be supplied to the fuel injection valve, and a fuel filter for removing foreign substances included in the fuel to be supplied. There has also been proposed a fuel tank installing therein a fuel pump and a pressure regulator.

[0003] This kind of fuel tank accommodating the fuel pump and pressure regulator, however, needs works of inserting and fixing the pump and the regulator (namely, constituent devices) into the tank. Additionally, the fuel tank has to be provided with members or parts for securing the constituent devices. This would raise a problem that a restriction is imposed on the design flexibility of the fuel tank to be mounted on a motorcycle of which appearance is regarded as important, and also deteriorate the workability of inserting the devices in the fuel tank. Such the fuel tank tends to increase in size in order to have therein a receiving space enough to accommodate the pump and regulator.

[0004] The fuel tank including the fuel pump is usually mounted on a motorcycle near a driver's side. Therefore, the noise produced by the fuel pump, particularly at idling, might be offensive to the driver's ears. On the other hand, at maintenance, the pump and the regulator have to be removed from the tank. This removal workability is also low.

[0005] To resolve the above problems, a fuel injection apparatus has been proposed in Japanese patent application laid-open No. 10-122101. This apparatus can be disposed in a receiving space for a conventional multiple carburetor of a motorcycle in order to improve mounting or maintenance workability.

[0006] The above fuel injection apparatus is so configured, as shown in Fig. 13, that a multiple throttle body 82 includes a plurality of air-intake passages 81 each internally provided with a throttle valve 80, a fuel distributing section 83 is fixedly disposed in one side of the throttle body 82, and a fuel supplying section 84 is fixedly disposed in the other side. The fuel distributing section 83 includes a fuel distributing pipe 85 and a plurality of fuel injection valves 86 connected to the pipe 85. The fuel supplying section 84 includes a fuel reservoir chamber 87, a fuel pump 88, a fuel filter 89, and a pressure regulator and others. The multiple throttle body 82, the fuel distributing section 83, and the fuel supplying section 84 are united together as above in order to achieve the above purpose.

[0007] However, the above conventional fuel injection apparatus in which the fuel supplying section 84 is fixed to the multiple throttle body 82 has the following disadvantages.

[0008] In the above-mentioned fuel injection apparatus, the devices constituting the fuel supplying section 84, namely, the fuel reservoir chamber 87, the fuel pump 88, the fuel filter 89, and the pressure regulator and others, are simply individually secured to the side of the throttle body 82 through a base member or directly by bands and screws (not shown), with the major parts of those devices 87-89 exposed to the outside. In the above fuel injection apparatus the uniting means to only arrange the devices 87-89 constituting the fuel supplying section 84 in a line along the direction of the length of the multiple throttle body 82 and fix them by the bands and screws. This is merely the uniting in relation to placement of the constituent devices.

[0009] Therefore, most of the devices 87-89 are exposed to the outside, so that measures against water and dust are insufficient and also protection against external impact is poor. There is also a possibility that the devices 87-89, which are merely individually fixed to the throttle body 82 by bands and screws, come down or detach from the body 82 by vibration or impact. In particular, the united devices 87-89 are often mounted on the body or frame of a motorcycle with the devices exposed to the outside. Even if the devices 87-89 are covered in a secondary manner, accordingly, muddy water and dust may enter the gaps between the cover and the devices 87-89, then adhering to the devices. Thus, such the secondary cover could not provide desired effects. The devices 87-89 individually need works for attaching the bands and screws and tightening the screws, which results in troublesome attaching/detaching works of the devices 87-89.

SUMMARY OF THE INVENTION

[0010] The present invention has been made in view of the above circumstances and has an object to overcome the above problems and to provide a fuel supply apparatus for engines, wherein fuel supplying devices can be securely fixed in the throttle body in unitary relation and appropriately protected from muddy water, dust, external impact, thereby to improve workability of attaching/detaching the devices to/from the throttle body.

[0011] Additional objects and advantages of the

invention will be set forth in part in the description which follows and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

[0012] To achieve the purpose of the invention, there is provided a fuel supply apparatus for an engine, including fuel supplying devices provided in unitary relation with a throttle body including an air-intake passage and a throttle valve disposed in the passage, characterized by including: a body case integrally provided with the throttle body and configured for fixedly assembling the fuel supplying devices therein, the body case being provided with openings for allowing insertion and removal of the fuel supplying devices in and from the body case, recesses for holding the fuel supplying devices therein, and a cover member for closing the openings.

[0013] The above apparatus is so configured that the fuel supplying devices are inserted through the openings in the body case integral with the throttle body and fitted in the corresponding recesses, so that the fuel supplying devices can be easily fixed in place with respect to the body. When the cover members are attached to the body case to close the openings respectively, the fuel supplying devices can be fixedly assembled in the body case which covers them. On the other hand, the fuel supplying devices can be easily removed from the body case by detachment of the cover members.

[0014] Accordingly, the fuel supplying devices configured as a unit with respect to the throttle body can be securely fixed with proper protection from muddy water, dust, and external impact. Furthermore, the workability of attaching/detaching the devices to/from the throttle body can be improved.

[0015] In the fuel supply apparatus according to the present invention, preferably, the throttle body and the body case are integrally made of resin.

[0016] Accordingly, the above apparatus, including the throttle body and the body case which are integrally made of resin, can be relatively easily manufactured at low cost and achieve light weight. The fuel supply apparatus can also provide an improved workability of mounting/demounting of the apparatus on/from a vehicle, and therefore contribute to light weight of the vehicle.

[0017] In the above apparatus according to the present invention, preferably, the fuel supplying devices include at least a fuel pump and a pressure regulator.

[0018] In this case, since at least the fuel pump and the pressure regulator are united with the throttle body so as to be handled as a one-piece unit with the throttle body, the fuel supply apparatus needs no structure of fixing them to another members such as a fuel tank. Accordingly, the fuel tank can be downsized, enhancing the degree of flexibility in vehicle design including the fuel supplying devices. The noise which is generated by the fuel pump at idling can also be reduced.

[0019] More preferably, in the fuel supply apparatus according to the present invention, the body case is provided with a recess for holding the fuel pump therein and a terminal for current supply, the terminal being disposed adjacent to the recess and connected with an electrode terminal of the fuel pump when the fuel pump is fitted in the recess.

[0020] In the above apparatus, insertion of the fuel pump in the recess of the body case allows the electrode terminal of the pump to be connected with the current supplying terminal, which can save time and labor for wiring connection. Thus, the number of parts and the assembling steps relating to the electrical wiring can be reduced, achieving a shortened electrical wiring for the fuel pump. The workability of attachment or detachment of the fuel pump to or from the throttle body can be enhanced.

[0021] Preferably, in the fuel supply apparatus according to the present invention, the body case is provided with an inlet for admitting fuel from a fuel tank connected with the fuel supply apparatus, a fuel passage for allowing flow of the fuel admitted through the inlet to the fuel pump, and an outlet for discharging excess fuel produced in the pressure regulator to return the fuel to the fuel tank.

[0022] In the above apparatus, since the fuel inlet, fuel outlet, and fuel passage related to the fuel pump and the pressure regulator are all disposed in the body case, a simplified arrangement of the fuel piping can be achieved. Consequently, the number of parts and the number of assembling steps in relation to the fuel piping can be decreased. The workability of attaching/detaching at least the fuel pump and the pressure regulator to/from the throttle body can be further improved. The high pressure fuel piping section including the fuel pump and others can be properly protected from the external impact.

[0023] Preferably, in the fuel supply apparatus according to the present invention, a fuel injection valve is disposed adjacent to the throttle body, and a fuel supply port through which the fuel is supplied to the fuel injection valve is provided in the body case.

[0024] In the above apparatus, the fuel is supplied to the fuel injection valve disposed adjacent to the throttle body through the fuel supply port of the body case. Accordingly, the fuel injection valve can be directly provided in the body case integral with the throttle body. Since the fuel injection valve is also provided in association with the air-intake passage of the throttle body, those throttle body, fuel supplying devices, and fuel injection valve can be assembled. Accordingly, the throttle valve, the fuel supplying devices, and the fuel injection valve can be adjusted according to variations in respective qualities and performances, enabling control of the performance and quality of the assembled or

united fuel supply apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The accompanying drawings, which are incorporated in and constitute a part of this specification illustrate an embodiment of the invention and, together with the description, serve to explain the objects, advantages and principles of the invention.

[0026] In the drawings,

Fig. 1 is a schematic partially sectional view of an engine and a fuel supply apparatus in an embodiment according to the present invention;
Fig. 2 is a front view of the fuel supply apparatus in the embodiment;
Fig. 3 is a top view of the fuel supply apparatus shown in Fig. 2;
Fig. 4 is a sectional view of a throttle body of the fuel supply apparatus taken along line IV-IV in Fig. 3;
Fig. 5 is back view of the apparatus shown in Fig. 2, corresponding to a front view of a body case of the fuel supply apparatus;
Fig. 6 is a left side view of the fuel supply apparatus of Fig. 5;
Fig. 7 is a sectional view of the apparatus taken along line VII-VII in Fig. 6;
Fig. 8 is a sectional view of a part of the apparatus taken along line VIII-VIII in Fig. 6;
Fig. 9 is an enlarged sectional view of a part of the apparatus taken along line IX-IX in Fig. 7;
Fig. 10 is a sectional view of the body case in the embodiment;
Fig. 11 is a sectional view of the throttle body with the body case exploded into a main body and a lower cover;
Fig. 12 is a schematic partially sectional view of a fuel supply apparatus and an engine in another embodiment according to the present invention; and
Fig. 13 is a schematic structural view of a conventional fuel injection apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] A detailed description of a preferred embodiment of a fuel supply apparatus for an engine according to the present invention will now be given referring to the accompanying drawings. It is to be noted that the engine in the present embodiment is used for a small-sized motorcycle.

[0028] Fig. 1 is a schematic partially sectional view of an engine 11 and a united fuel supply apparatus 12. The engine 11 is provided with a cylinder block 13 and a cylinder head 14. The cylinder block 13 includes a piston 15, a connecting rod 16, and a crankshaft 17 connected to the piston 15 through the rod 16. The cylinder head 14 is formed with an air-intake port 19 through which a combustible mixture of air and fuel is fed into a combustion chamber 18, an air-intake valve 20 for opening/closing the port 19, a discharge port 21 for discharging burnt gas from the combustion chamber 18, a discharge valve 22 for opening/closing the port 21, and a valve driving mechanism 23 for driving the valves 20 and 22 respectively to open and close.

[0029] In the present embodiment, the fuel supply apparatus 12 is operated to supply the combustible fuel-air mixture into the air-intake port 19. The fuel supply apparatus 12 is provided with a throttle body 26 including an air-intake passage 24 and a throttle valve 25 disposed in the passage 24, and a body case 27 for providing a plurality of fuel supplying devices in unitary relation with respect to the body 26. The throttle body 26 and the body case 27 are integrally molded of resin. An outlet 24a of the air-intake passage 24 is connected with an end (an inlet) of an air-intake manifold 28 made of resin, and another end (an outlet) of the manifold 28 is connected with the air-intake port 19, thus providing communication between the air-intake passage 24 and the air-intake port 19.

[0030] Fig. 2 is a front view of the fuel supply apparatus 12, showing the side of the throttle body 26 in the present embodiment. Fig. 3 is a top view of the same of Fig. 2. Fig. 4 is a sectional view of the throttle body 26 of the fuel supply apparatus 12 taken along line IV-IV in Fig. 3.

[0031] The throttle valve 25 is a piston valve which is movable in a perpendicular direction to the air-intake passage 24. The throttle body 26 includes an integral cylinder 29 which is perpendicularly communicated with the passage 24. The throttle valve 25 is slidably assembled in the cylinder 29 (see Fig. 1). A cover 32 is fitted in the opening of the cylinder 29 opposite to the air-intake passage 24. A spring 30 provided between the throttle valve 25 and the cover 32 normally urges the valve 25 downward (in Fig. 1) to close the air-intake passage 24. A wire 31 connected with the valve 25 is joined to a handlebar (not shown) which is controlled by a driver. A wire guide 32a integral with the cover 32 serves to guide the wire 31 to the handlebar. When this wire 31 is pulled by operation of the handlebar, the throttle valve 25 is moved upward against the urging force of the spring 30, thereby opening the air-intake passage 24. Thus, outside air is taken in the air-intake passage 24.

[0032] The throttle body 26 is also provided with a bypass 33 accompanying the air-intake passage 24 to bypass around the throttle valve 25. An idle speed control valve (ISC valve) 34 is fixed to the throttle body 26 by hot caulking. This ISC valve 34 is electrically controlled to open and close the bypass 33. At a full close of the throttle valve 25, namely, at idling of the engine 11, the ISC valve 34 is controlled to make fine regulation of the amount of intake air to be supplied to the engine 11.

[0033] A fuel injection valve (injector) 35 is disposed

adjacent to the outlet 24a of the air-intake passage 24. The injector 35 is fitted in a hole 28a which is an inlet of the air-intake manifold 28. This injector 35 is electrically controlled to inject fuel into the air-intake manifold 28. Accordingly, the fuel is injected from the injector 35 into the air allowed to flow from the passage 24 to the manifold 28, forming a combustible fuel-air mixture, which is taken in the combustion chamber 18 upon open of the air-intake valve 20.

[0034] Fig. 5 is a back view of the apparatus 12, corresponding to a front view of the body case 27. Fig. 6 a left side view of the apparatus 12 of Fig. 5. Fig. 7 is a sectional view of the apparatus 12 taken along line VII-VII in Fig. 6. Fig. 8 is a sectional view of a part the apparatus 12 taken along line VIII-VIII in Fig. 6. Fig. 9 is an enlarged sectional view of a part of the apparatus 12 taken along line IX-IX in Fig. 7.

[0035] As shown in Figs. 5 and 6, the body case 27 is constructed of a main case 36, a lower cover 37 fixed to the underside of the main case 36, a first opening 38 formed in the left side face (in Fig. 7) of the main case 36, a plug 39 for closing the opening 38, a second opening 40 formed in the front face of the main case 36, a front cover 41 for closing the second opening 40, and an electrical wiring connector 43 disposed in the right side face (in Fig. 5) of the main case 36. The plug 39 is made of resin with an integral outlet pipe 39a serving as an outlet for fuel. The lower cover 37 is made of resin with an integral inlet pipe 37a serving as an inlet for fuel. As shown in Fig. 1, those inlet pipe 37a and outlet pipe 39a are connected to a fuel tank 44 mounted on the motorcycle by way of pipes 45 and 46 respectively. The inlet pipe 37a serves to admit the fuel transmitted from the fuel tank 44 into the body case 27. The outlet pipe 39a serves to discharge the fuel out of the body case 27. In the motorcycle, the inlet pipe 37a is disposed below the outlet pipe 39a.

[0036] The main case 36, as shown in Figs. 7 and 8, fixedly holds therein fuel supplying devices, namely, a fuel pump 61, a fuel filter 62, a pressure regulator 63, and an electronic control unit (ECU) 64. Each of the devices 61-63 has a substantially cylindrical shape, and the ECU 64 has a box shape. As shown in Fig. 7, the fuel filter 62 and the pressure regulator 63 are united together by caulking. This united fuel filter 62 and pressure regulator 63 is arranged above and perpendicularly to the fuel pump 61. In this configuration, a discharge port 61a of the fuel pump 61 is inserted in an admission port 62a of the fuel filter 62 in a mutual engagement relation. Thus, the fuel pump 61 is directly connected with the fuel filter 62. The connecting part between the pump 61 and the filter 62 is sealed with an O-ring not shown.

[0037] The fuel pump 61 is electrically driven to discharge, at high pressure, the fuel transmitted from the fuel tank 44. The fuel filter 62 serves to remove foreign substances included in the fuel discharged from the fuel pump 61. The pressure regulator 63 serves to regulate the pressure of the fuel discharged from the fuel pump 61 at a predetermined level. Excess fuel resulting from the pressure regulation is discharged out of the fuel supply apparatus 12 through the outlet pipe 39a. The ECU 64 controls the injector 35 to control fuel injection. The ECU 64 contains a pressure sensor not shown. The main case 36 is provided with a fuel supply port 57 through which the fuel discharged by the pump 61 is supplied to the injector 35. On the other hand, the lower cover 37 includes a fuel passage 37b which allows the fuel having entered the body case 27 through the inlet pipe 37a to flow toward the fuel pump 61 and a projection 37c which is engaged with the underside of the pump 61 to press it upward in Fig. 7.

[0038] When the fuel pump 61 having the above structure is driven, the fuel is admitted into the body case 27 through the inlet pipe 37a, flowing through the fuel passage 37b, and sucked into the fuel pump 61 through a suction port 61b of the pump 61. The fuel that is increased in pressure by the fuel pump 61 is discharged from the discharge port 61a, cleaned by the fuel filter 62, and succeedingly regulated in pressure by the pressure regulator 63. Then, the fuel is supplied to the injector 35 through the fuel supply port 57. The excess fuel produced in the pressure regulator 63 is discharged through the outlet pipe 39a.

[0039] Fig. 10 is a sectional view of only the body case 27. Fig. 11 is a sectional view of the throttle body 26 with the body case 27. It is to be noted that the body case 27 is illustrated in Figs. 10 and 11 in an exploded state into the main case 36 and the lower cover 37. As shown in Fig. 10, the main case 36 is internally provided with a first recess 65, a second recess 66, and a third recess 67, each having a shape matching to each of the outside shapes of the devices 61-64. The first opening 38 is used for insertion/removal of a combination of the fuel filter 62 and the pressure regulator 63 in/from the first recess 65. The main case 36 also has a third opening 58 used for insertion/removal of the fuel pump 61 in/from the third recess 67 from below.

[0040] As shown in Figs. 7 and 9, the main case 36 is provided with current supply terminals 70 disposed adjacently to a part of the third recess 67 so as to come into alignment with electrode terminals 71 of the pump 61 when inserted in the third recess 67. Thus, the terminals 70 of the main case 36 are connected with the terminals 71 of the pump 61. In addition, the second recess 66 is provided with an electrode terminal 72 which is connected to an electrode terminal not shown of the ECU 64 when inserted in the second recess 66.

[0041] As shown in Fig. 11, the main case 36 is provided with a piping cap 73 integrally formed therewith. This piping cap 73 has a fuel passage 73a communicating with the fuel supply port 57. As shown in Fig. 4, the piping cap 73 is disposed covering the head portion of the injector 35 placed in the air-intake manifold 28, thereby allowing the flow of the fuel from the fuel supply port 57 to the injector 35. The piping cap 73 is provided

in advance with a wiring 74 which is connected to an electrode terminal of the injector 35.

[0042] Accordingly, the above fuel supplying devices 61-64 are inserted and fixed in place in the body case 27 in the following manner. The fuel filter 62 and the pressure regulator 63 are first inserted into the first recess 65 of the main case 36 through the first opening 38. The plug 39 is then fitted in the first opening 38 to close it. In the present embodiment, the plug 39 can be fixed there by hot plate welding.

[0043] Subsequently, the fuel pump 61 is inserted into the third recess 67 of the main case 36 through the third opening 58. The discharge port 61a of the pump 61 is thus engaged in the admission port 62a of the fuel filter 62 and therefore the electrode terminals 71 of the pump 61 are connected with the current supply terminals 70 respectively. Then, the lower cover 37 is fixed to the underside of the main case 36, closing the third opening 58. Hot plate welding can also be adopted to fix the lower cover 37 to the main case 36 in the present embodiment. With the lower cover 37 fixed as above, the projection 37c of the cover 37 presses the bottom of the fuel pump 61, thus securing the pump 61 in the third recess 67.

[0044] Next, the ECU 64 is inserted in the second recess 66 through the second opening 40 and the electrode terminal of the ECU 64 is connected with the electrode terminal 72. The front cover 41 is fixed to the front face of the main case 36, thereby closing the second opening 64. Similarly, hot plate welding can be adopted to fix the front cover 41.

[0045] In the present embodiment, the plug 39, the front cover 41, and the lower cover 37 are provided for correspondingly closing the first, second, and third openings 38, 40, and 58. They correspond to cover members of the invention.

[0046] As described above, the fuel supply apparatus 12 is configured such that the fuel supplying devices, namely, the fuel pump 61, the fuel filter 62, the pressure regulator 63, and the ECU 64 are inserted into the body case 27 formed integrally with the throttle body 26 through the first, second, and third openings 38, 40, and 58 respectively and are fitted in the corresponding first, second, and third recesses 65, 66, and 67. Accordingly, the devices 61-64 can be easily positioned in place. After that, the openings 38, 40, and 58 are closed by the plug 39, the front cover 41, and the lower cover 37, respectively, which are welded to the body case 27. The devices 61-64 can thus be fixedly assembled in the body case 27 which entirely covers them.

[0047] The fuel supply apparatus 12 in the present embodiment can be reduced in the number of parts and the number of assembling steps related to the fixing operation, as compared with the conventional apparatus wherein the devices 87-89 are individually fixed by belts and screws. This makes it possible to improve an attaching workability of the devices 61-64 to the throttle body 26. The devices 61-64 can also be protected properly from muddy water, dust, and external impact. In this respect, the fuel supply apparatus 12 can be of high weather resistance, durability, and impact resistance, and thus of enhanced performance and quality. The devices 61-64 can be united with the throttle body 26, which can provide a compact and simple appearance.

[0048] As inserted in the corresponding recesses 65-67, the devices 61-64 can be surely fixed in place. The fuel supply apparatus 12 with a compact integral configuration as mentioned above can achieve space savings on a motorcycle and also facilitate the mounting works to the motorcycle body.

[0049] On the other hand, the devices 61-64 can be easily removed from the body case 27 by taking off the covers 39, 41, and 37 to open the openings 38, 40, and 58 respectively. This can also improve the detaching workability of the devices 61-64 from the throttle body 26.

[0050] It is to be noted that the conventional fuel injection apparatus is configured such that the fuel reservoir chamber 87, the fuel pump 88, the fuel filter 89 and others are individually secured to one side of the throttle body 82 by the bands and screws. This would deteriorate the workability of mounting or demounting the devices and cause most of the devices 87-89 to be exposed to the outside, resulting in poor water-resistance, impact-resistance, and dust-resistance.

[0051] To the contrary, since the fuel supply apparatus 12 in the present embodiment can provide a good workability of attaching/detaching the devices 61-64, it can achieve the uniting which is superior in water-resistance, dust-resistance, and impact-resistance to the conventional apparatus. In this regard, the uniting to configure the fuel supply apparatus 12 in the present embodiment includes not only uniting of the devices 61-64 for the placement with respect to the throttle body 26 but also uniting of those devices for the purpose of improvements in the weather-resistance, durability, impact-resistance, appearance, and handling workability.

[0052] In the fuel supply apparatus 12 in the present embodiment, since the throttle body 26 and the main case 36 of the body case 27 are made of resin in one-piece, design and manufacture of the throttle body 26 and the main case 36 can be relatively facilitated and also both the bodies 26 and 36 can be reduced in weight. In addition, in the present embodiment, the use of the air-intake manifold 28 made of resin can save weight of the unit including the manifold 28. This can also reduce the cost of the fuel supply apparatus 12, improve the workability of mounting or demounting the apparatus 12 with respect to the motorcycle, and contribute to reduction in weight of the motorcycle.

[0053] In the fuel supply apparatus 12 in the present embodiment, the fuel pump 61 and the pressure regulator 63 are configured in unitary relation with the throttle body 26, which allows the devices 61 and 63 to be handled as a one-piece unit with the throttle body

26. This can eliminate the need of any additional structure for fixing the devices 61 and 63 to other devices such as the fuel tank 44. Accordingly, the external appearance of the fuel tank 44 is not spoiled, enhancing the degree of flexibility in design of a vehicle including the fuel supply apparatus 12.

[0054] The fuel pump 61 and the pressure regulator 63 are not accommodated in the fuel tank 44, so that the fuel tank 44 can be reduced in size. Since the fuel pump 61 is assembled inside the body case 27, furthermore, the reduction of the noise by the pump 61 at idling can be achieved.

[0055] In the fuel supply apparatus 12 in the present embodiment, when the fuel pump 61 is fitted in the third recess 67 of the body case 27, the electrode terminal 71 of the pump 61 are correspondingly connected with the current feeding terminal 70. This makes it possible to save time and labor for the wiring connection relating to the fuel pump 61. Similarly, the ECU 64 is fitted in the second recess 66 of the body case 27, while the electrode terminal of the ECU 64 is connected with the electrode terminal 72, resulting in a saving in time and labor for the wiring connection relating to the ECU 64. As a result, the number of parts and the number of assembling steps needed for electrical wiring and others can be reduced and therefore the workability of attaching/detaching the fuel pump 61 and the ECU 64 to/from the throttle body 26 can be enhanced. The ECU 64 is assembled in the body case 27 with the above wiring connection, and the fuel pump 61 and the injector 35 having an electrical relation to the ECU 64 are disposed adjacent to the body case 27, which can shorten the length of the electrical wiring.

[0056] In the fuel supply apparatus 12 in the present embodiment, the body case 27 is provided with the inlet pipe 37a and the fuel passage 37b related to the fuel pump 61 and the outlet pipe 39a related to the pressure regulator 63. In addition, the fuel pump 61, the fuel filter 62, and the pressure regulator 63 are directly connected with one another without the use of piping, so that the arrangement of fuel piping for the fuel supplying devices can be simplified. Therefore, the number of parts and the number of assembling steps for the fuel piping can be reduced, which allows further improvements in the workability of attaching/detaching the devices 61-63 to/from the throttle body 26. In addition, since the high pressure fuel piping section constituted of the fuel pump 61 and others are placed inside the body case 27 without exposure to the outside, the fuel piping section can be properly protected from the external impact.

[0057] In the present embodiment, the injector 35 disposed adjacent to the throttle body 26 is supplied with fuel through the fuel supply port 57 of the body case 27 and the piping cap 73. The injector 35 is fitted in the piping cap 73 and thus united with the body case 27. The injector 35 is also disposed in relation to the air-intake passage 24 of the throttle body 26 through the air-intake manifold 28. Accordingly, the injector 35 and the fuel supplying devices 61-64 are assembled in the body case 27 in connection with the throttle body 26. This allows adjustment of the throttle valve 25 and the above devices 35 and 61-64 according to variations in respective quality and performance, thereby enabling control of the performance and quality of the assembled fuel supply apparatus 12.

[0058] In the fuel supply apparatus 12 in the present embodiment, the injector 35 is fitted in the hole 28a of the air-intake manifold 28 and also covered by the piping cap 73 of the body case 27. Since the injector 35 is not exposed to the outside, accordingly, the water-resistance, dust-resistance, and impact-resistance of the injector 35 can be enhanced as well as those of the other fuel supplying devices 61-64.

[0059] The present invention may be embodied in other specific forms without departing from the essential characteristics thereof. For instance, in the above embodiment, as shown in Fig. 1, the injector 35 is fitted in the hole 28a of the air-intake manifold 28 communicated to the air-intake passage 24 such that the end of the injector 35 is positioned adjacently to the outlet 24a of the passage 24, while the head of the injector 35 is inserted in the piping cap 73 of the body case 27, thus allowing the injector 35 to be included in the united fuel supply apparatus 12.

[0060] Instead of the above arrangement, another structure may be used. One example thereof is shown in Fig. 12. A fuel supply apparatus 76 is so configured that the injector 35 is disposed with its end fitted in a hole 19a formed near the air-intake port 19 of the cylinder head 14, instead of being fitted in the air-intake manifold 28, while the head of the injector 35 is fitted in the end portion of the fuel piping 75 extending from the fuel supply port 57 of the body case 27. Thus, the injector 35 may be included in the united apparatus 76.

[0061] In the above embodiment, although the ECU 64 is assembled in the body case 27 as one of the fuel supplying devices to be used for fuel injection control, the ECU 64 may be separately arranged from the united fuel supply apparatus.

[0062] In the above embodiment, furthermore, the injector 35 is provided in the piping cap 73 of the body case 27 as a fuel supplying device. Alternatively, the injector 35 may be arranged separately from the united fuel supply apparatus.

[0063] Although the throttle valve 25 used in the above embodiment is a piston valve, it may be a butterfly valve.

[0064] The foregoing description of the preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention. The embodiment chosen and described in order to explain the prin-

ciples of the invention and its practical application to enable one skilled in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto, and their equivalents.

Claims

1. A fuel supply apparatus (12) for an engine, including fuel supplying devices (61-64) provided in unitary relation with a throttle body (26) including an air-intake passage (24) and a throttle valve (25) disposed in the passage, characterized by including:

a body case (27) integrally provided with the throttle body (26) and configured for fixedly assembling the fuel supplying devices (61-64) therein,
the body case (27) being provided with openings (38, 40, 58) for allowing insertion and removal of the fuel supplying devices in and from the body case, recesses (65, 66, 67) for holding the fuel supplying devices therein, and a cover member (37) for closing the openings (38, 40, 58).

2. The fuel supply apparatus according to claim 1, wherein the throttle body (26) and the body case (27) are integrally made of resin.

3. The fuel supply apparatus according to claim 1 or 2, wherein the fuel supplying devices include at least a fuel pump (61) and a pressure regulator (63).

4. The fuel supply apparatus according to claim 3, wherein the body case (27) is provided with a recess (67) for holding the fuel pump (61) therein and a terminal (70) for current supply, the terminal (70) being disposed adjacent to the recess (67) and connected with an electrode terminal (71) of the fuel pump (61) when the fuel pump is fitted in the recess (67).

5. The fuel supply apparatus according to claim 3 or 4, wherein the body case (27) is provided with an inlet (37a) for admitting fuel from a fuel tank (44) connected with the fuel supply apparatus (12), a fuel passage (37b) for allowing flow of the fuel admitted through the inlet (37a) to the fuel pump (61), and an outlet (39a) for discharging excess fuel produced in the pressure regulator (63) to return the fuel to the fuel tank (44).

6. The fuel supply apparatus according to any one of claims 1 to 5, wherein a fuel injection valve (35) is disposed adjacent to the throttle body (26), and a fuel supply port (57) through which the fuel is supplied to the fuel injection valve (35) is provided in the body case (27).

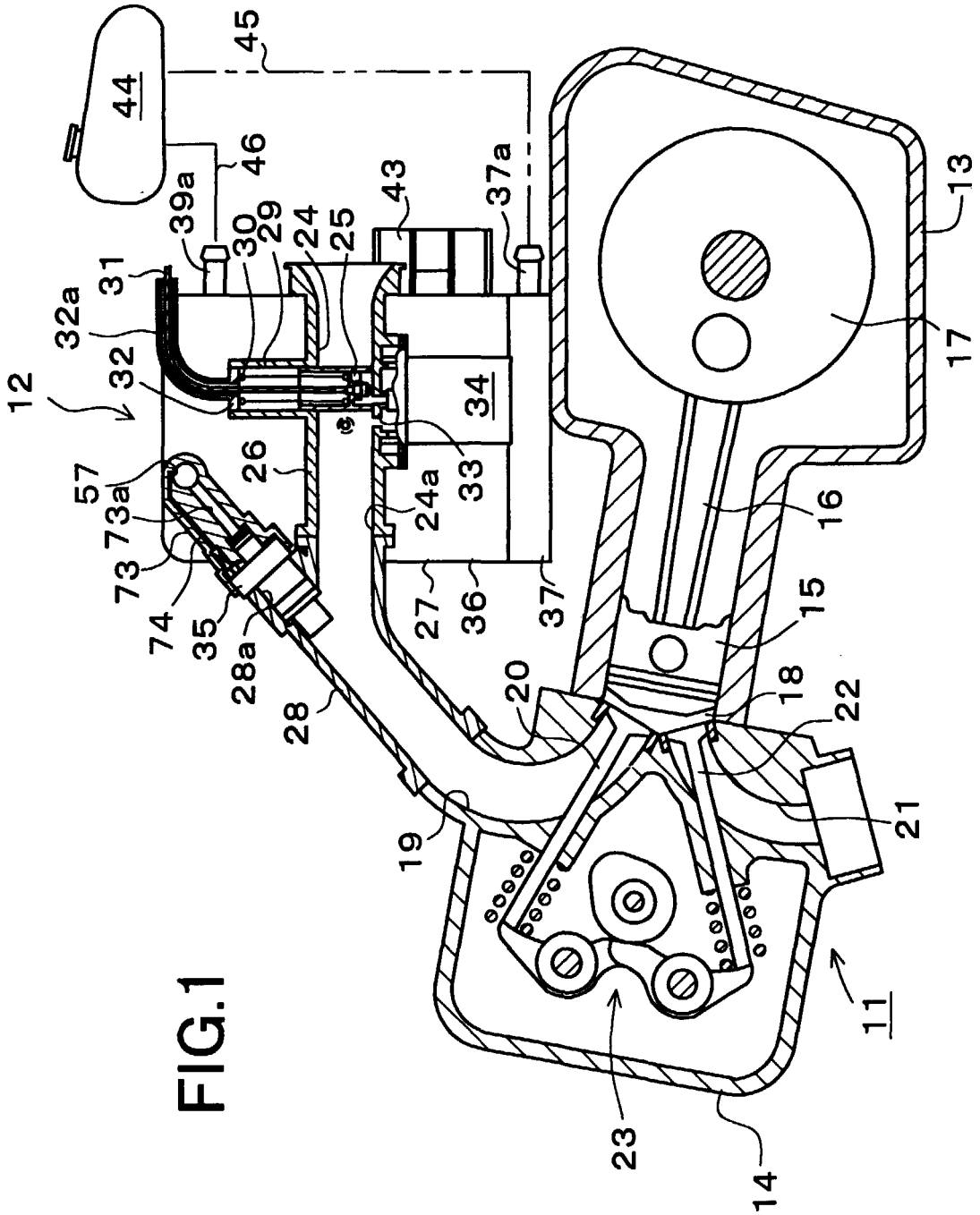

44
45
46
39a
30
29
24
25
43
37a
31
32a
32
12
34
33
57
73a
73
74
35
28a
28
26
24a
27
36
37
13
17
16
15
18
22
20
21
19
23
14
11

FIG.1

FIG.2

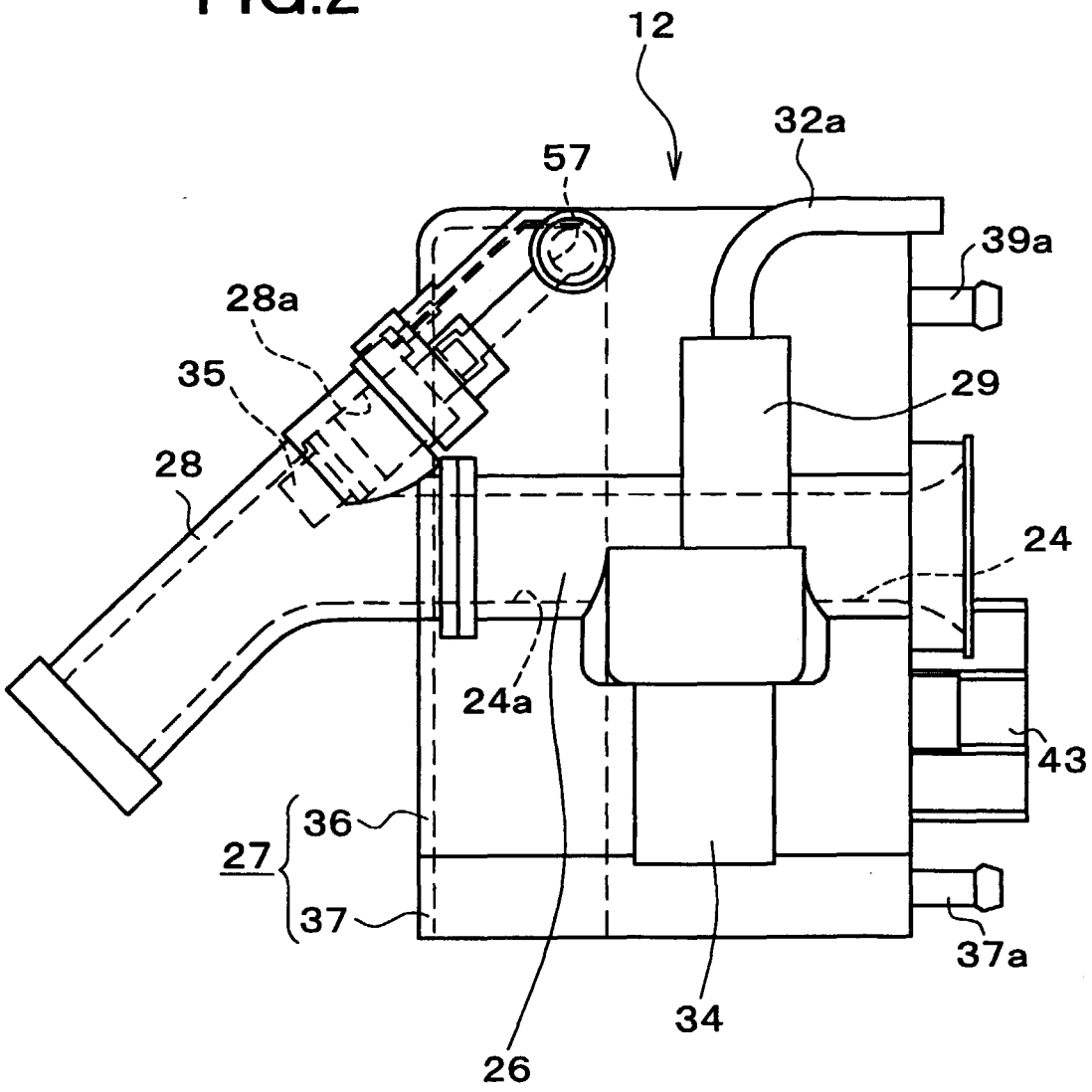


FIG.3

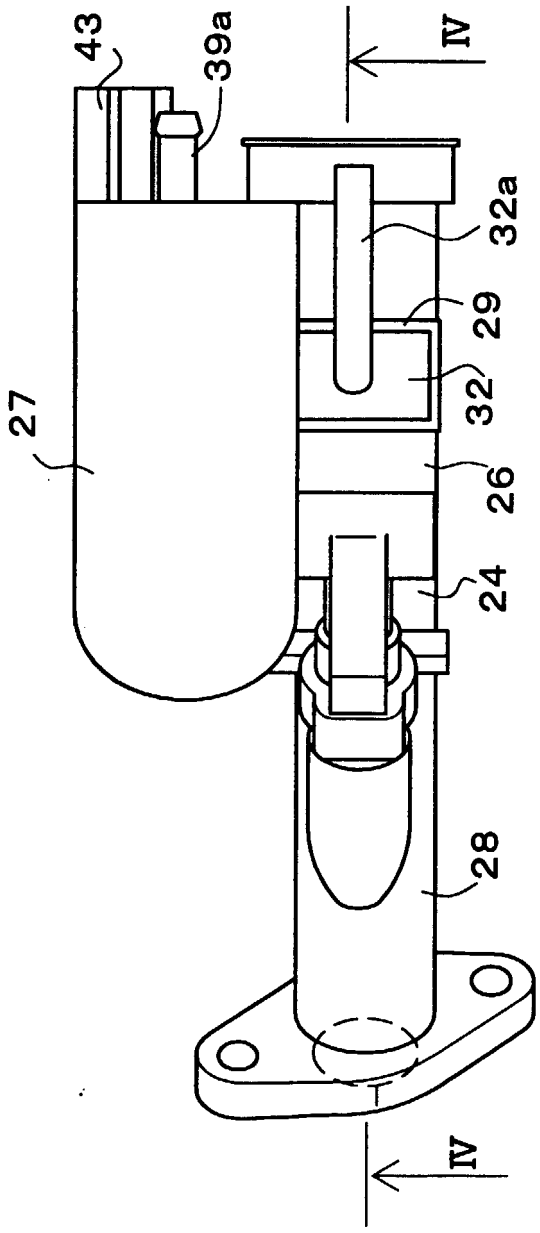


FIG.4

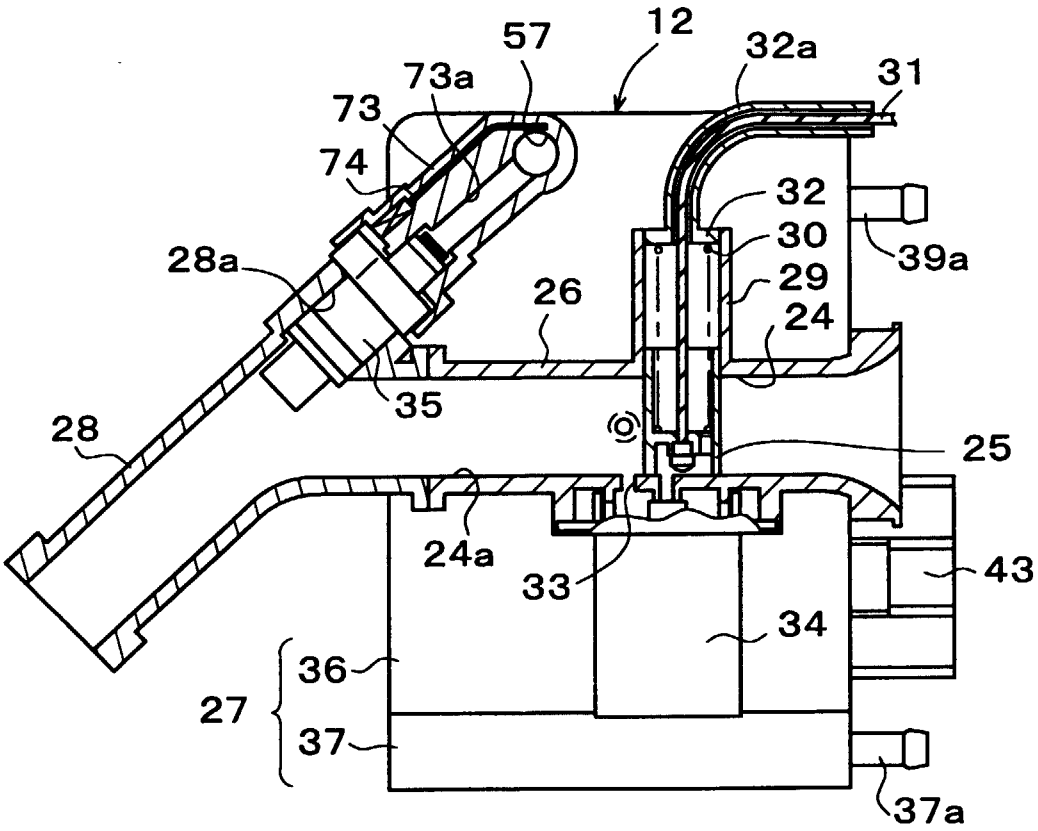

12
57
73a
73
74
32a
31
32
30
29
24
39a
28a
26
35
28
25
24a
33
43
34
36
27
37
37a

FIG.5

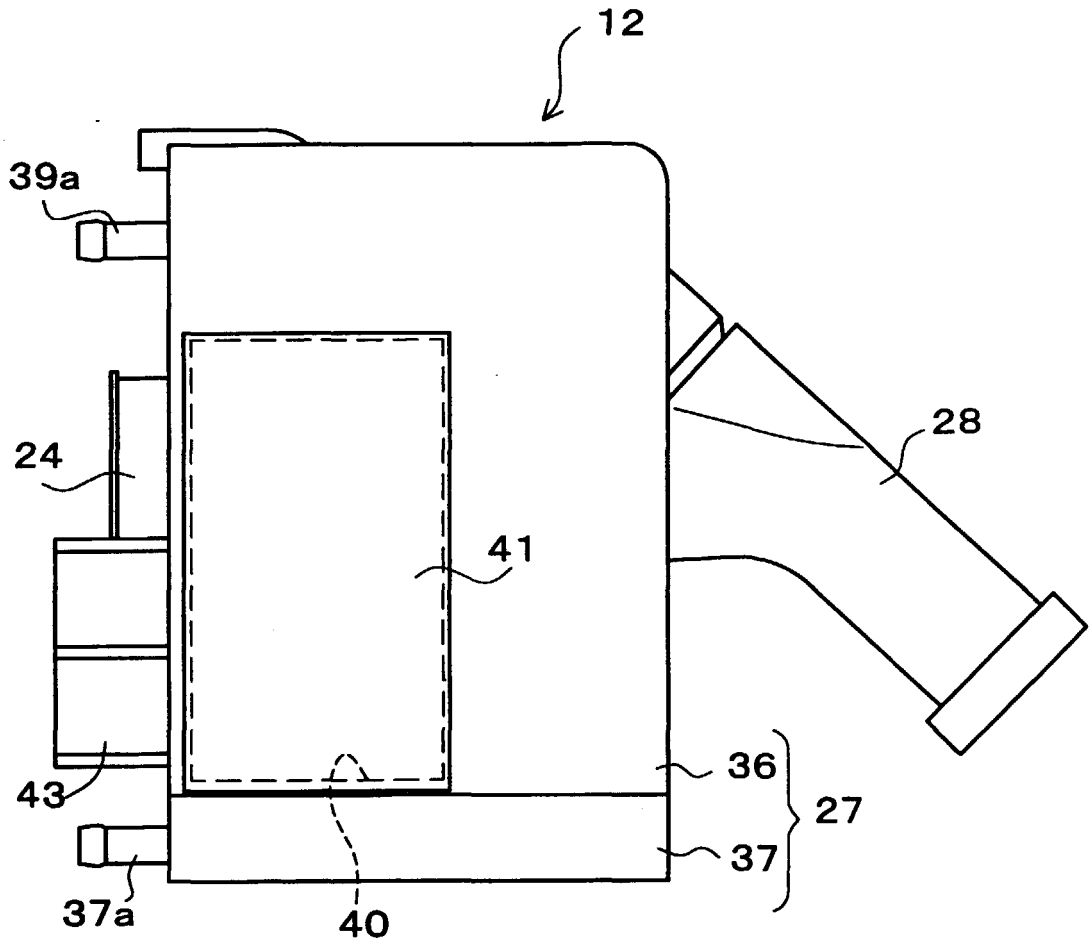


FIG.6

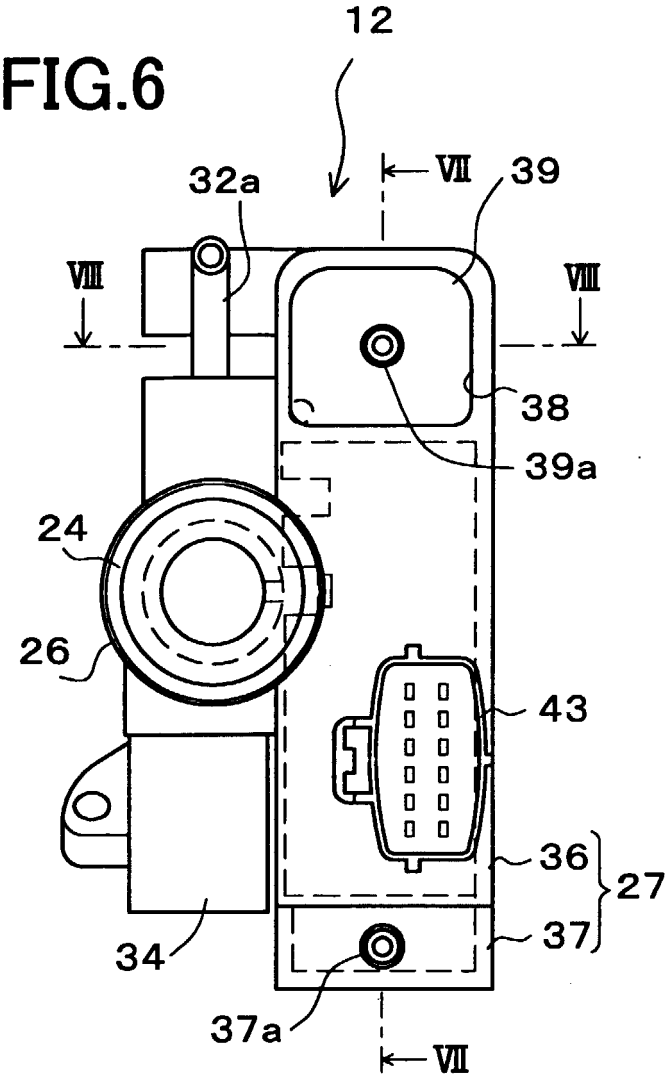


FIG.7

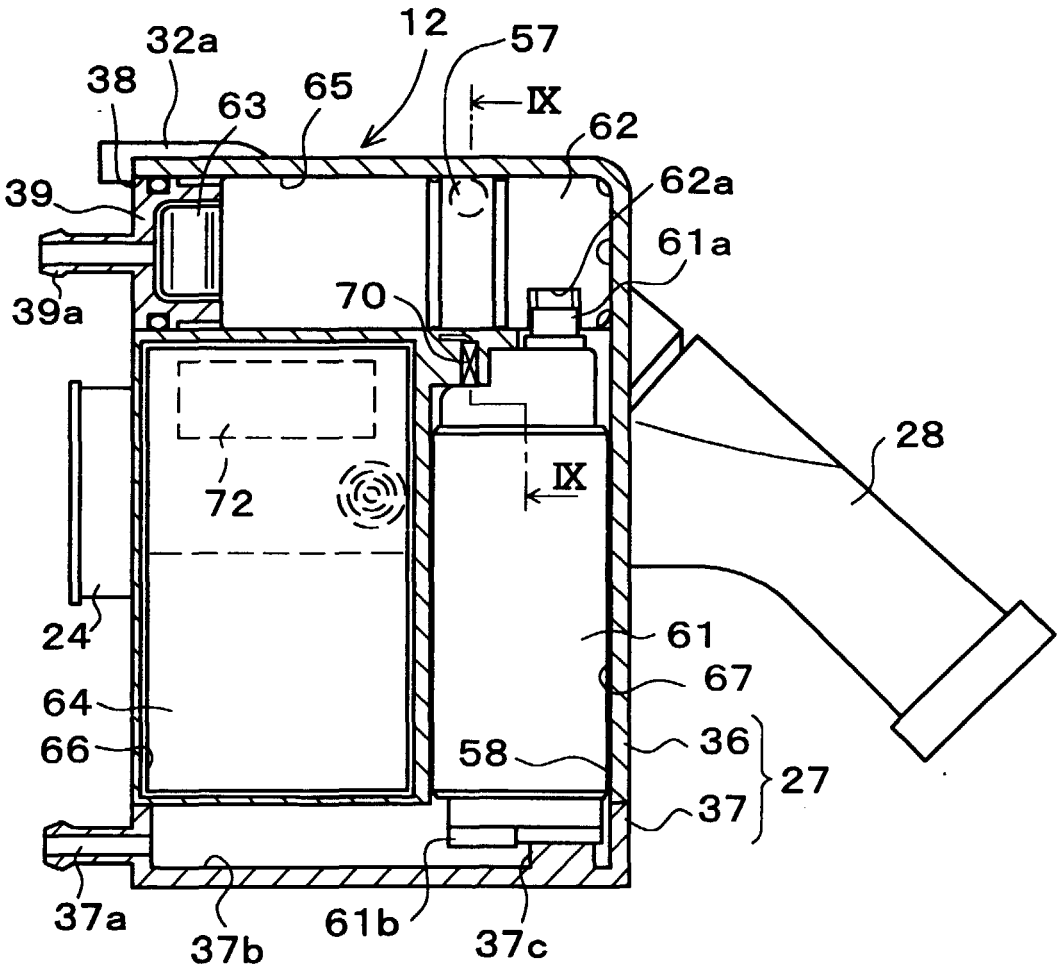

12
32a
38
63
65
57
IX
62
62a
39
61a
39a
70
28
72
IX
24
61
67
64
66
58
36
27
37
37a
37b
61b
37c

FIG.8

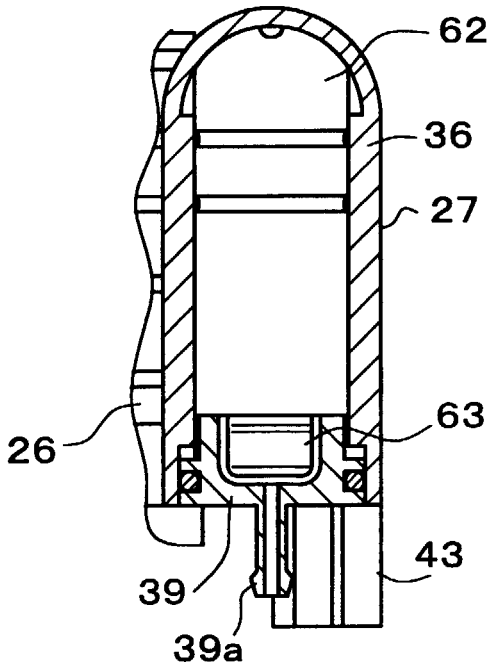


FIG.9

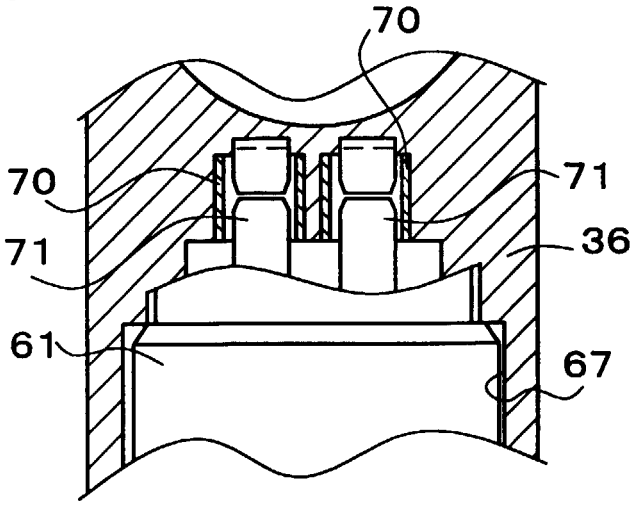


FIG.10

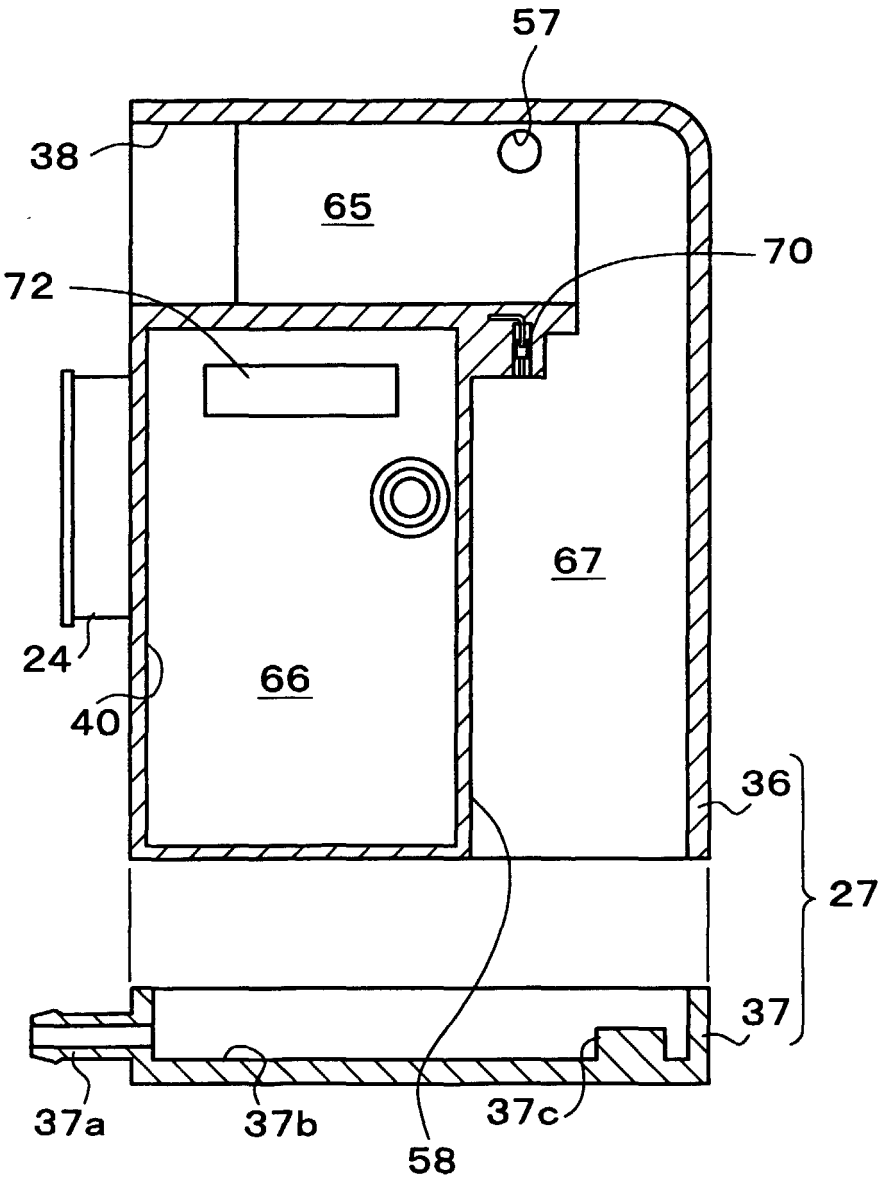
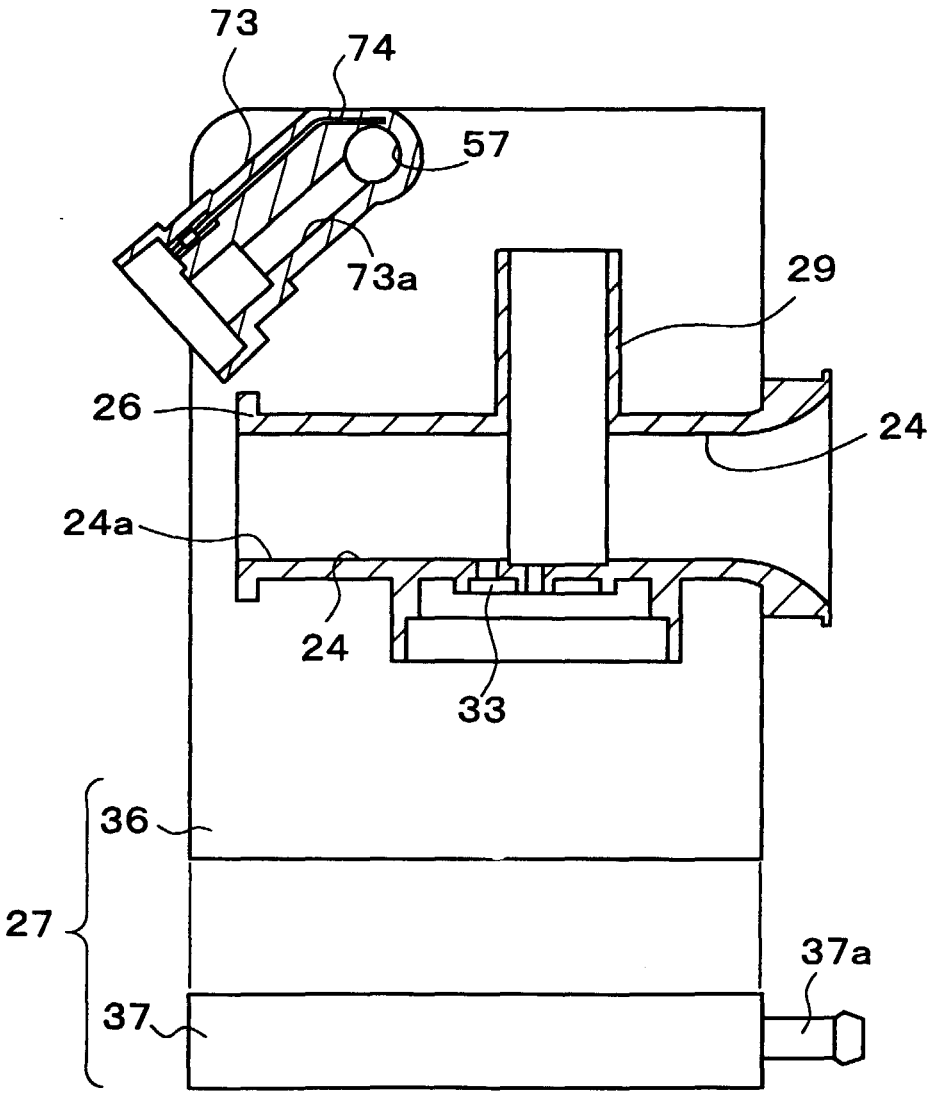


FIG.11



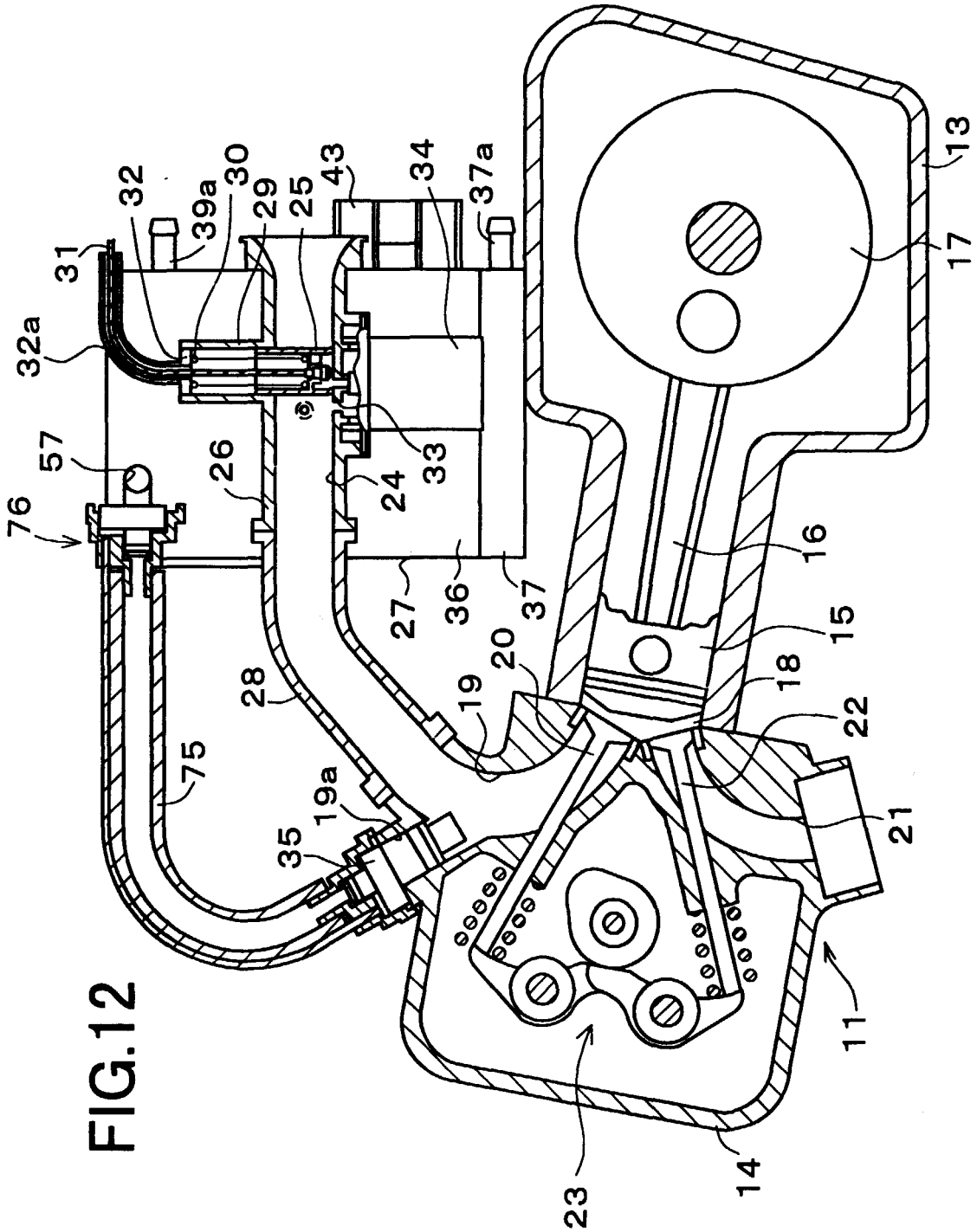

13
17
16
15
18
22
21
11
14
23
20
19
28
27
36
37
24
33
26
57
76
75
35
19a
43
34
37a
30
29
25
39a
32
31
32a

FIG.12

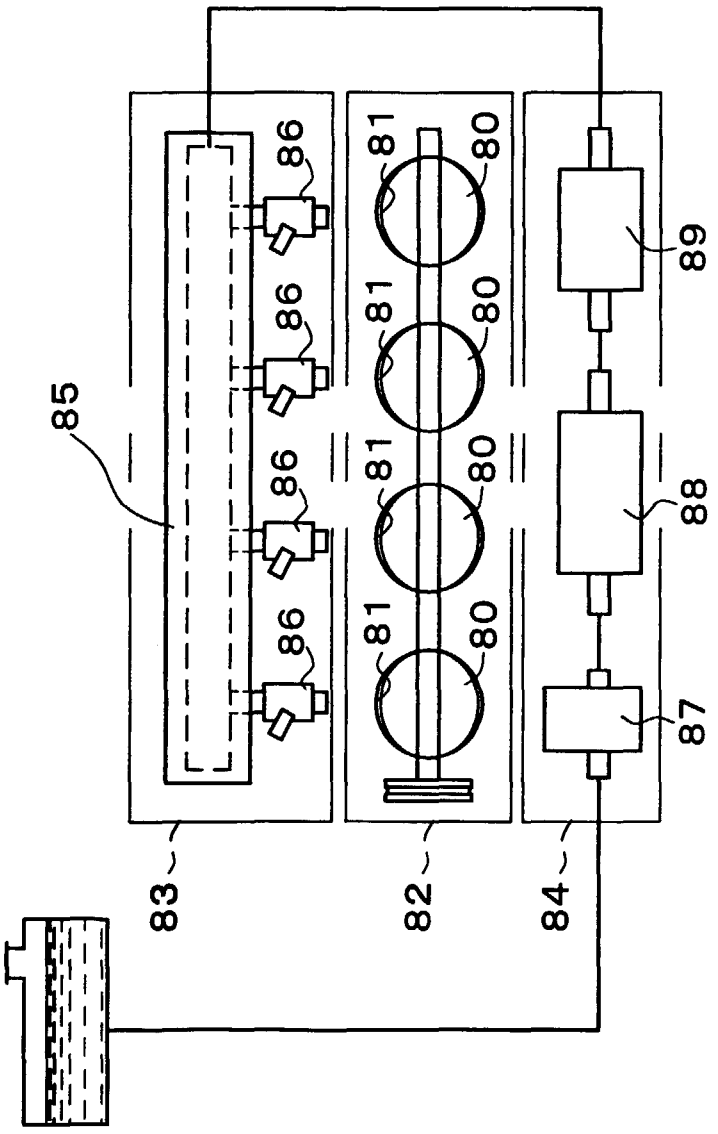


FIG.13

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 11 9635

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)
P,X A	JP 11 303702 A (KEIHIN) 2 November 1999 (1999-11-02) * abstract; figure 1 *	1 3-5	F02D9/10 F02M37/14
D,A	JP 10 122101 A (KEIHIN) 12 May 1998 (1998-05-12) * figure 1 *	1	
A	DE 42 01 401 A (BOSCH) 22 July 1993 (1993-07-22) * column 3, line 3 - line 16; figures 1,2 *	4	
A	DE 198 20 421 A (HITACHI) 12 November 1998 (1998-11-12)		
A	US 5 482 021 A (ROCHE) 9 January 1996 (1996-01-09)		
A	JP 02 256838 A (HONDA) 17 October 1990 (1990-10-17) * abstract; figures 1,2 *	1,3	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)
F02D
F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 February 2001	Joris, J

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)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 11 9635

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.

05-02-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 11303702 A	02-11-1999	NONE	
JP 10122101 A	12-05-1998	NONE	
DE 4201401 A	22-07-1993	JP 5280438 A	26-10-1993
		US 5399075 A	21-03-1995
DE 19820421 A	12-11-1998	JP 10306735 A	17-11-1998
		US 6067958 A	30-05-2000
US 5482021 A	09-01-1996	DE 4440205 A	18-05-1995
		IT RM940680 A,B	11-05-1995
		JP 2673105 B	05-11-1997
		JP 7180641 A	18-07-1995
		SE 509027 C	30-11-1998
		SE 9403858 A	12-05-1995
JP 02256838 A	17-10-1990	JP 2709133 B	04-02-1998
		US 5094212 A	10-03-1992

EPO FORM P0459

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