



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.05.2010 Bulletin 2010/19

(51) Int Cl.:
F02D 9/10 ^(2006.01) **F16L 47/16** ^(2006.01)
F02M 35/10 ^(2006.01)

(21) Application number: **09175336.8**

(22) Date of filing: **06.11.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

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(30) Priority: **11.11.2008 JP 2008288786**
11.11.2008 JP 2008288789

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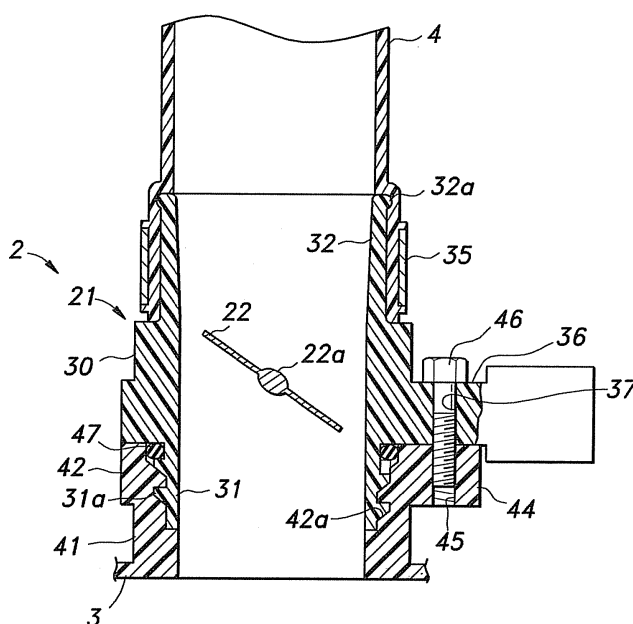
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(54) **Intake System for Internal Combustion Engines**

(57) An inlet member (41) of an intake manifold (3) is formed with a female thread (42a) around an inner circumferential surface thereof, and an outlet member (31) of a throttle body (21) is formed with a male thread (31a) around an outer circumferential surface thereof configured to be threaded into engagement with the female thread so that the intake bore of the throttle body communicates with the inner bore of the intake member

in an air tight manner. The throttle body and intake member are provided with cooperating engagement portions (36, 37, 44, 45, 46) that prevent relative rotation around an axial line of the outlet member between the throttle body and intake member. Thereby, the two parts can be joined to each other in a simple manner and without causing any undue stress to the throttle body or intake member.

Fig.5



Description

TECHNICAL FIELD

[0001] The present invention relates to an intake system for internal combustion engines, and in particular to an intake system characterized by an arrangement for connecting a throttle device with an intake manifold.

BACKGROUND OF THE INVENTION

[0002] A throttle body of a throttle device is connected to an inlet member of an intake manifold typically via flanges formed on the opposing ends of the two parts and joined to each other via a seal member and by using threaded bolts. However, when the throttle body is made of plastic material, because of the lack of precision in the planarity of the mating surface of the flange of the throttle body, and/or because the seal member applies a reaction force to the flange of the throttle body when compressed, the flange may undergo a slight deformation as the threaded bolts are fastened. This in turn could cause the deformation of the intake bore defined in the throttle body. Any change in the geometry of an intake passage may cause a change in the intake flow rate, and this prevents a precise combustion control of the engine.

[0003] Japanese patent 3620034 (patent document 1) discloses an arrangement for connecting a throttle body with an intake manifold that prevents a reaction force of a gasket from being transmitted to the flange of the throttle body. In this arrangement, a connecting tube projects from a downstream end of the throttle body, and is passed into an inlet bore formed in an inlet end of the intake manifold with a seal member interposed between the outer circumferential surface of the connecting tube and the inner circumferential surface of the inlet bore of the intake manifold.

[0004] This prior proposal still requires a flange to be formed in the throttle body, and this flange is mated with a corresponding flange of the inlet end of the intake manifold, and is connected thereto by using a fastening clip. Therefore, if the planarity of the mating surface of the flange of the throttle body is poor, it still could cause a deformation of the flange and hence a deformation of the intake bore when the two flanges are connected to each other by using the fastening clip. Also, the flanges increase the outer diameter of the connecting arrangement, and this causes an increase in the weight of the intake system and limits the freedom in the layout of the various components of the intake system.

[0005] The intake bore of a throttle body is generally circular, but may also be elliptic. By suitably selecting an elliptic shape for the intake bore, the freedom in the layout of the throttle body can be improved. Such a throttle body is disclosed in WO 2001/036799 (patent document 2), but the throttle shaft coincides with the long axis of the elliptic shape. Therefore, the length of the throttle shaft extending across the intake bore is increased as com-

pared with that when the intake bore has a circular cross section and a same opening area. This causes the bending rigidity of the throttle shaft to be reduced, and makes it more difficult to ensure the precision in the coaxiality of the bearings for the throttle shaft.

[0006] When the throttle body is made of plastic material and reinforced by fibers, the weight of the throttle body and the manufacturing cost can be both reduced. However, when injection molding a throttle body, a certain shrinkage inevitably occurs. This may reduce the precision in the dimensions and shape of the throttle body. In particular, for a satisfactory operation of the throttle valve, it is necessary that the errors in the cross sectional shape and dimensions of the intake bore are smaller than prescribed tolerable thresholds. It is known that a shrinkage tends to be greater in a direction perpendicular to the orientation of the reinforcing fibers.

BRIEF SUMMARY OF THE INVENTION

[0007] In view of such problems of the prior art, a primary object of the present invention is to provide an intake system for an internal combustion engine which is light in weight and free from deformation in the cross sectional shape of the intake bore.

[0008] A second object of the present invention is to provide an intake system for an internal combustion engine which is easy to achieve a high precision in the coaxiality of the bearings for a throttle valve.

[0009] A third object of the present invention is to provide an intake system for an internal combustion engine using a throttle body made of plastic material and yet providing a high dimensional precision.

[0010] According to the present invention, such objects can be accomplished by providing an intake system for an internal combustion engine, comprising: a throttle body (21) defining an intake bore (11) and including an outlet member (31) defining a downstream end of the intake bore; a throttle valve (22) rotatably supported in the intake bore for controlling an intake flow in the intake bore; and an intake member (3) defining an inner bore (42) communicating with an intake port of the engine (E), and including an inlet member (41) defining an upstream end of the inner bore; wherein one of the outlet member and inlet member is formed with a female thread (42a) around an inner circumferential surface thereof, and the other of the outlet member and inlet member is formed with a male thread (31 a) around an outer circumferential surface thereof configured to be threaded into engagement with the female thread so that the intake bore of the throttle body communicates with the inner bore of the intake member in an air tight manner.

[0011] Thus, the outlet member and inlet member are not required to be formed with a flange, and the two parts can be joined to each other in an air tight manner without causing any stress to the associated parts.

[0012] When the throttle body is made of readily deformable material such as plastic, it is desirable to mini-

mize radial deformation of the outlet member even when the engaged parts by the threaded engagement are subjected to axial or bending forces. It can be accomplished if the male thread is given with a saw-tooth profile having a smaller flank angle on a base end side thereof than on a free end side thereof.

[0013] To further reduce the stresses in the engaged parts and simplify the assembly work, the male thread may be formed as an interrupted screw given with axially aligned interruptions.

[0014] To enhance the air-tight and stress free connection between the outlet member and inlet member, a seal member (47) may be interposed between the inner and outer circumferential surfaces of the inlet member and outlet member opposing each other.

[0015] The threaded engagement between the outlet member and inlet member can be ensured simply by preventing the relative rotation between them. It can be readily accomplished by providing the throttle body and intake member with cooperating engagement portions (36, 37, 44, 45, 46) that prevent relative rotation around an axial line of the outlet member between the throttle body and intake member.

[0016] According to a preferred embodiment of the present invention, the cooperating engagement portions include a first flange (36) extending in a radial direction from the throttle body and formed with a first hole (37), a second flange (44) extending from the intake member in a radial direction and formed with a second hole (45) at a position aligning with the first hole when the male thread is threaded into engagement with the female thread and a bolt member (46) passed across the first and second holes.

[0017] Thereby, the two parts are prevented from rotating relative to each other by using a highly simple structure, and the assembly work is simplified.

[0018] The throttle body may comprise a motor housing (33) and the reduction gear housing (34) integrally molded with a main part of the throttle body, and the first flange (36) formed with the first hole may extend in an area surrounded by a bore member defining the intake bore, the motor housing and the reduction gear housing.

[0019] The first flange may thus be formed without increasing the outer dimensions of the throttle body. In this case, the motor housing is configured to receive an electric motor having an output shaft (23 a) extending in parallel with a throttle shaft (22a) of the throttle valve extending diametrically across the intake bore, and the throttle body further comprises a third flange (50) extending perpendicularly to the axial line of the intake bore and formed with a third hole (51) adjacent to an end of the motor housing remote from an end corresponding to the output shaft of the electric motor, the intake member being provided with a fourth hole aligning with the third hole and a fastening bolt being passed across the third and fourth holes for attaching the third flange of the throttle body to the intake member.

[0020] The cost and weight of the throttle body can be

reduced by making the throttle body with plastic material.

[0021] For efficient utilization of an available mounting space, the intake bore is given with an elliptic shape. In such a case, it is advantageous to arrange the elliptic shape such that its long axis extends at an angle, preferably greater than 45 degrees, with respect to an axial line of a throttle shaft (22a) of the throttle valve extending diametrically across the intake bore. Thereby, the overall length of the throttle shaft can be minimized. This enhances the precision in the coaxiality of the bearings for the throttle shaft, and increases the bending rigidity of the throttle shaft.

[0022] When the plastic material is reinforced by reinforcing fibers, the molded product has a greater tendency to shrink in the direction perpendicular to the orientation of the reinforcing fibers. Therefore, it is advantageous to align the orientation of the reinforcing fibers at an angle or perpendicular to the direction of maximum rigidity. Based on this consideration, if the throttle body is made of plastic material incorporated with reinforcing fibers, the fibers are preferably oriented in a direction extending at an angle with respect to a long axis of the intake bore.

[0023] The intake bore of the throttle valve may be given with an elliptic shape, but the associated inner bore of the intake member may have a circular cross section. In such a case, to ensure a favorably aerodynamic effect, the inner bore of the intake member may be given with a circular cross section, and the intake bore of the throttle body may have a cross section which progressively changes from the elliptic shape adjacent to the throttle valve to a circular shape conforming to the cross section of the inner bore of the intake member at a downstream end of the intake bore.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Now the present invention is described in the following with reference to the appended drawings, in which:

Figure 1 is a perspective view of a first embodiment of the intake system of the present invention;

Figure 2 is an exploded perspective view of the intake system;

Figure 3 is a plan view of a throttle device of the intake system;

Figure 4 is a sectional view taken along line IV-IV of Figure 3;

Figure 5 is a sectional view taken along line V-V of Figure 3;

Figure 6 is a schematic vertical sectional view of the throttle body illustrating the injection molding process therefor;

Figure 7 is a schematic cross sectional view of the throttle body illustrating the injection molding process therefor;

Figure 8 is a plan view similar to Figure 3 showing a second embodiment of the present invention;

Figure 9 is a plan view similar to Figure 3 showing a third embodiment of the present invention; and Figure 10 is a plan view similar to Figure 3 showing a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] Figures 1 to 5 show a first embodiment of the intake system for internal combustion engines according to the present invention. The intake system 1 essentially consists of an electronically controlled throttle device 2 and an intake manifold 3 connected to a downstream end of the throttle device 2. An upstream end of the throttle device 2 is connected to an air cleaner not shown in the drawings via an intake duct 4. A downstream end of the intake manifold 3 is connected to a cylinder head E1 of an automotive, in-line, four-cylinder internal combustion engine E via an injector base not shown in the drawings. In the illustrated embodiment, the intake manifold 3 is formed by injection molding plastic material.

[0026] The throttle device 2 comprises a throttle body 21 defining an intake bore 11, a throttle valve 22 formed as a butterfly valve having a throttle shaft 22a extending diametrically across the intake bore 11, an electric motor 23 for actuating the throttle valve 22 via the throttle shaft 22a and a power transmission mechanism (reduction gear mechanism) 24 for transmitting an actuating force of an output shaft 23a of the electric motor 23 to the throttle valve 22. The intake manifold 3 is provided with a valve (not shown in the drawings) which is actuated by a negative pressure actuator 7 for changing the configuration of the path of the intake flow according to the operating condition of the engine.

[0027] Referring to Figure 2, the throttle body 21 comprises a bore member 30 defining the intake bore 11 having an elliptic or circular cross section as will be described hereinafter, a connecting tube 31 extending coaxially from a downstream end of the bore member 30, a tubular extension 32 extending from an upstream end of the bore member 30 and configured to be fitted into a corresponding end of the intake duct 4, a motor housing 33 extending laterally along one side of the bore member 30 to receive the electric motor 23 therein and a reduction gear housing 34 extending also laterally in a direction angularly offset by 90 degrees from the motor housing 33 to receive the power transmission mechanism 24 therein. In the illustrated embodiment, the throttle body 21 is formed by injection molding plastic material, and is reinforced by fibers such as carbon fibers and glass fibers.

[0028] Referring to Figures 3 and 4, the bore member 30 rotatably supports the throttle shaft 22a of the throttle valve 22 via bearings 16 which may consist of metallic sleeve members (roller or ball bearings may also be used). The connecting tube 31 defines a continuous extension of the intake bore 11 of the bore member 30, and has an outer profile which is circular and smaller in outer diameter than the bore member 30. The outer surface of

the connecting tube 31 is formed with a male thread 31a having a saw-tooth shaped profile. The flank angle of this thread profile on the side facing the upstream end (base end side) is preferably smaller than that of the other side (free end side), and may be in the range of zero to 3 degrees. The number of the turns of the male thread 31a may be small, for instance in the range of one-half to three turns. Also, the thread is not required to extend over the entire circumference of the connecting tube 31, but may be formed with at least a pair of breaks (in the form of an interrupted screw) so that the bore member 30 is not required to be turned any more than half a turn to fully join the throttle body 2 with the intake manifold 3 as will be described hereinafter.

[0029] The tubular extension 32 is provided with a circular cross section, and is formed with an annular bead 32a extending radially outward at a free end thereof. As shown in Figure 1, the upstream end of the tubular extension 32 is fitted into the downstream end of the intake duct 4, and the intake duct 4 is sealably secured in position thereon by a hose clamp 35 placed around the intake duct 4. The annular bead 32a ensures an air-tight, and mechanically secure connection between the tubular extension 32 and intake duct 4.

[0030] The motor housing 33 internally defines a chamber receiving the electric motor 23 in such a manner that the output shaft 23a of the electric motor 23 extends in parallel with the throttle shaft 22a. The reduction gear housing 34 is elongated and extends along a side of the bore member 30 perpendicularly to the throttle shaft 22a, and has an end adjoining an end of the motor housing 33 from which the output shaft 23a extends. The reduction gear housing 34 internally defines a chamber receiving the power transmission mechanism 24 therein, and the throttle shaft 22a and output shaft 23a of the electric motor 23 extend into this chamber in a mutually parallel and spaced apart relationship. The power transmission mechanism 24 comprises a plurality of gear elements interposed between the motor output shaft 23a and throttle valve shaft 22a so that the rotation of the motor output shaft 23a is transmitted to the throttle shaft 22a at a prescribed gear ratio.

[0031] The bore member 30 is provided with an outer profile having a circular cross section, and the motor housing 33 and reduction gear housing 34 are each given with a rectangular block shape. A triangular gap that is defined by the outer periphery of the bore member 30 and the opposing sides of the two housings 33 and 34 are closed by a flange 36 extending perpendicularly to the axial line of the bore member 30. The flange 36 is formed with a through hole 37 extending across the thickness thereof or in parallel with the axial line of the bore member 30.

[0032] The inlet end of the intake manifold 3 is formed with a tubular inlet member 41 defining an inner bore 42, and the inner circumferential surface of the inlet member 41 is formed with a female thread 42a configured to thread with the male thread 31a of the connecting tube

31.

[0033] As shown in Figures 2 and 5, the tubular inlet member 41 is formed with a flange 44 extending in a radial direction outwardly and formed with a threaded hole 45. The thread of the threaded hole 45 may be formed in the material of the flange 44 or in a nut member (not shown in the drawings) embedded in the material of the tubular inlet member 41. The flange 44, in particular the threaded hole 45 therein is positioned in such a manner that the through hole 37 of the throttle body 21 aligns with the threaded hole 45 of the inlet member 41 when the throttle body 21 is connected to the intake manifold 3 or when the male thread 31a of the connecting tube 31 is threaded into the corresponding female thread 42a of the inlet member 42.

[0034] The connection between the throttle body 21 and intake manifold 3 is accomplished in an air tight manner by interposing a O-ring 47 between the connecting tube 31 and tubular inlet member 41, and threading the male thread 31a of the connecting tube 31 into the female thread 42a of the inlet member 42. The O-ring 47 is axially located at a base end of the connecting tube 31, and supported by an axial shoulder surface thereof facing in a downstream direction. The O-ring 47 is radially interposed between the outer circumferential surface of the connecting tube 31 and the inner circumferential surface of the tubular inlet member 41.

[0035] When the throttle body 21 is connected to the intake manifold 3, a bolt 46 is passed into the through hole 37 of the throttle body 21 and threaded into the threaded hole 45 of the inlet member 41, and this prevents the relative rotation of the throttle body 21 and intake manifold 3 around the axial line of the connecting tube 31. Therefore, the bolt 46 is not required to be firmly fastened, and may be only lightly fastened to perform its function of preventing the relative rotation of the throttle body 21 between the intake manifold 3. Likewise, the male thread 31a of the connecting tube 31 is required to be only lightly threaded into the female thread 42a of the inlet member 42 because the bolt 46 effectively prevents loosening of the threading engagement, and the O-ring 47 ensures an air-tight connection without requiring application of any large pressure. Thus, a reliable, air-tight and firm connection between the throttle device 2 and intake manifold 3 is established without causing any significant stress in the associated parts.

[0036] According to the foregoing embodiment, because the connecting tube 31 of the throttle body 21 is threaded into the tubular inlet member 41 of the intake manifold 3, flanges that were conventionally used for establishing such a connection are not required to be formed in the corresponding ends of the throttle body 21 and intake manifold 3. This reduces the weight of the intake system, and allows a compact design. Also, the elimination of the need for fastening threaded bolts across the opposing flanges prevents deformation of the surrounding parts of the throttle body 21 and intake manifold 3. In particular, in the conventional arrangement, the

planarity of the mating surfaces of the flange tended to be affected by the stresses caused by fastening the threaded bolts. Although not shown in the drawings, the threading engagement between the throttle body 21 and intake manifold 3 can be reversed without departing from the spirit of the present invention. In an alternate arrangement, a male thread is formed around the outer circumference of the inlet member 41 and a corresponding female thread is formed around the inner circumference of the connecting tube 31 of the throttle body 21. The diameters of the two parts are so dimensioned that the inlet member 41 may be threadably fitted into the connecting tube 31.

[0037] Because a saw-tooth shaped thread is used for the threading engagement between the connecting tube 31 of the throttle body 21 and tubular inlet member 41 of the intake manifold 3, the resistance against dislodgement of the throttle body 21 from the intake manifold 3 is highly strong in spite of the readily deformable nature of the materials of the throttle body 21 and the intake manifold 3, and this ensures the mechanical integrity of the intake system.

[0038] Because the thread used in the engagement between the connecting tube 31 of the throttle body 21 and tubular inlet member 41 of the intake manifold 3 consists of an interrupted thread, the assembly work is simplified, and the residual stress that may be created by the threading engagement is minimized. Such a residual stress is harmful in ensuring the precision of the circularity or other configurations of the intake bore 11 of the throttle body 21 which is required for a smooth operation of the throttle valve 22.

[0039] When the throttle body 21 and intake manifold 3 are connected to each other, because the bolt 47 is passed into the through hole 37 of the throttle body 21 and threaded into the threaded hole 45 of the inlet member 41, the throttle body 21 and intake manifold 3 are prevented from rotating relative to each other. Therefore, the connection between the throttle body 21 and intake manifold 3 can be maintained in a stable manner. Because the bolt 47 is only lightly fastened, the vibrations caused by the electric motor 23 are prevented from being transmitted to other parts of the engine. Because the flange 36 formed with the through hole 37 may extend over a space defined by the outer profiles of the bore member 30, the motor housing 33 and the reduction gear housing 34, the outer profile and weight of the throttle body 21 can be minimized.

[0040] In the illustrated embodiment, the intake bore 11 of the throttle body 21 may be given with an elliptic cross section having a long axis extending perpendicular to the axial line of the throttle shaft 22a and a short axis aligning with the axial line of the throttle shaft 22a. Therefore, the distance between the two bearings 16 is reduced, and the precision in the coaxiality of the two bearings 16 when injection molding the throttle body 21 can be improved. Also, because the span length of the throttle shaft 22a extending across the intake bore 11 is reduced,

the bending rigidity of the throttle shaft 22a can be increased and/or the throttle shaft 22a may have a smaller diameter for a given opening area of the intake bore 11. Furthermore, the reduced dimension of the throttle body 21 in the direction parallel to the throttle shaft 22a allows the throttle body 21 to be placed in a relatively limited space. The long axis may not extend exactly perpendicular to the axial line of the throttle shaft 22a when implementing the present invention, but may also extend at an angle, preferably greater than about 45 degrees, to the throttle shaft 22a for the benefits of the present invention to be obtained.

[0041] Figures 6 and 7 illustrate how the throttle body 21 is injection molded according to the present invention, and short line segments in these drawings indicate the orientations of the reinforcing fibers contained in the plastic material of the throttle body 21.

[0042] When injection molding the throttle body 21, a gate of a die assembly for introducing molten plastic material into a cavity of the die assembly to mold the throttle body 21 is located on a side thereof facing away from the reduction gear housing 34 or a side facing an axial end of the throttle shaft 22a. Therefore, the molten plastic material is filled into the cavity of the die assembly generally in parallel with the throttle shaft 22a at least in a lower part of the throttle body 21. In other words, the flow of the molten plastic material is generally perpendicular to or at an angle to the long axis of the elliptic shape of the intake bore 11 in a lower part of the throttle body 21. In this case, the bearings 16 (which may consist of metallic sleeve members or ball bearings) may be insert molded at the time of injection molding or press fitted in position following the insert molding process.

[0043] When removed from the die assembly upon completion of an injection molding process, the throttle body 21 contracts to a certain extent. The contraction ratio is greater (about 0.50%, for instance) in a direction perpendicular to the orientation of the reinforcing fibers than (about 0.15%, for instance) in the direction in parallel with the orientation of the reinforcing fibers. By thus orienting the reinforcing fibers perpendicular to or at an angle to the long axis of the elliptic shape, the direction of greater contraction is aligned with a direction of a higher rigidity in the throttle body 21 or in the direction of the long axis with the result that the throttle body 21 is allowed to contract relatively uniformly in all directions, and the amount of contraction can be minimized. This also improves the precision in the dimensions and shape of the intake bore 11, and the coaxiality between the throttle shaft 22 and bearings 16. This is particularly important when the throttle body 21 is given with a complex shape, instead of a simple cylindrical shape, (by being provided with motor and reduction gear housings, for instance), and this causes a complex residual stress distribution, and controlling the orientations of the reinforcing fibers is particularly beneficial.

[0044] When the gate is located in a part of the die cavity adjacent to a lower part of the main part of the

throttle body 21, the lower end surface of the throttle body 21 or the lower end surface of the bore member 30 can be formed with a particularly high precision. Burrs and other irregular features may be formed in the part adjacent to the gate or a lower part of the bore member 30, but presence of such burrs or the likes in this area do not create any problem.

[0045] Figure 8 shows a modified embodiment of the present invention. In Figure 8, the parts corresponding to those of the previous embodiment are denoted with like numerals without repeating the description of such parts. The throttle body 21 is formed with a flange extension 50 extending from the flange 36 into a space defined between an end of the motor housing 33 remote from the side of the output shaft 23a and an adjacent part of the bore member 30. The flange extension 50 is formed with a through hole 51. An outer peripheral part of the tubular inlet member 42 is formed with a flange (not shown in the drawings) formed with a threaded hole so as to align with the through hole 51. When the throttle body 21 and intake manifold 3 are connected to each other, a threaded bolt (not shown in the drawings) is passed through the through hole 51 and threaded into the corresponding threaded hole on the side of the tubular inlet member 42.

[0046] According to this structure, because the throttle body 21 is attached to the intake manifold 3 at two points located adjacent to either axial end of the motor housing 33, and this is effective in controlling the vibrations of the electric motor 23.

[0047] Figure 9 shows a second embodiment of the present invention. In Figure 9, the parts corresponding to those of the previous embodiment are denoted with like numerals without repeating the description of such parts. In this case, the throttle valve 22 is actuated by an accelerator wire in a per se known manner. For this purpose, a throttle drum 61 is attached to an outer end of the throttle shaft 22a, and the housings for an electric motor and a gear reduction mechanism are omitted. A flange 62 formed with a through hole 63 extends in a radial direction from a part of the bore member 30 which is angularly offset (90 degrees, for instance) from the accelerator drum 61 or the throttle shaft 22a. In this case also, the tubular inlet member 42 is formed with a threaded hole for threadably receiving a threaded bolt passed through the through hole 63.

[0048] Figure 10 shows a third embodiment of the present invention. In Figure 10, the parts corresponding to those of the previous embodiments are denoted with like numerals without repeating the description of such parts. In this embodiment, the intake bore 11 is given with an elliptic shape, and the long axis A of the elliptic shape extends at an angle with respect to the axial line of the throttle shaft 22a. This embodiment provides similar advantages as those of the previous embodiments.

[0049] In the foregoing embodiments, the throttle shaft was oriented perpendicular to or at an angle relative to the long axis of the elliptic shape. However, there may be a need to orient the throttle shaft in parallel with the

long axis of the elliptic shape owing to space requirements or any other reason. In such a case, according to a certain aspect of the present invention, it is advantageous to orient the reinforcing fibers perpendicular to or at an angle to the long axis of the elliptic shape, and thereby avoid the direction of the least rigidity of the throttle body from being aligned with the direction of the maximum contraction of the plastic member reinforced by fibers.

[0050] Although the present invention has been described in terms of preferred embodiments thereof, it is obvious to a person skilled in the art that various alterations and modifications are possible without departing from the scope of the present invention which is set forth in the appended claims.

[0051] The contents of the original Japanese patent applications on which the Paris Convention priority claim is made for the present application are incorporated in this application by reference.

[0052] An inlet member 41 of an intake manifold 3 is formed with a female thread 42a around an inner circumferential surface thereof, and an outlet member 31, of a throttle body 21 is formed with a male thread 31a around an outer circumferential surface thereof configured to be threaded into engagement with the female thread so that the intake bore of the throttle body communicates with the inner bore of the intake member in an air tight manner. The throttle body and intake member are provided with cooperating engagement portions 36, 37, 44, 45, 46 that prevent relative rotation around an axial line of the outlet member between the throttle body and intake member. Thereby, the two parts can be joined to each other in a simple manner and without causing any undue stress to the throttle body or intake member.

Claims

1. An intake system for an internal combustion engine, comprising:

a throttle body (21) defining an intake bore (11) and including an outlet member (31) defining a downstream end of the intake bore;
a throttle valve (22) rotatably supported in the intake bore for controlling an intake flow in the intake bore; and
an intake member (3) defining an inner bore (42) communicating with an intake port of the engine (E), and including an inlet member (41) defining an upstream end of the inner bore;

wherein one of the outlet member and inlet member is formed with a female thread (42a) around an inner circumferential surface thereof, and the other of the outlet member and inlet member is formed with a male thread (31a) around an outer circumferential surface thereof configured to be threaded into en-

gagement with the female thread so that the intake bore of the throttle body communicates with the inner bore of the intake member in an air tight manner.

2. The intake system for an internal combustion engine according to claim 1, wherein the male thread is given with a saw-tooth profile having a smaller flank angle on a base end side thereof than on a free end side thereof.
3. The intake system for an internal combustion engine according to claim 1 or 2, wherein the male thread is formed as an interrupted screw given with axially aligned interruptions.
4. The intake system for an internal combustion engine according to any one of the preceding claims, wherein a seal member (47) is interposed between the inner and outer circumferential surfaces of the inlet member and outlet member opposing each other.
5. The intake system for an internal combustion engine according to any one of the preceding claims, wherein the throttle body and intake member are provided with cooperating engagement portions (36, 37, 44, 45, 46) that prevent relative rotation around an axial line of the outlet member between the throttle body and intake member.
6. The intake system for an internal combustion engine according to claim 5, wherein the cooperating engagement portions include a first flange (36) extending in a radial direction from the throttle body and formed with a first hole (37), a second flange (44) extending from the intake member in a radial direction and formed with a second hole (45) at a position aligning with the first hole when the male thread is threaded into engagement with the female thread and a bolt member (46) passed across the first and second holes.
7. The intake system for an internal combustion engine according to claim 6, wherein the throttle body comprises a motor housing (33) and the reduction gear housing (34) integrally molded with a main part of the throttle body, and the first flange (36) formed with the first hole extends in an area surrounded by a bore member defining the intake bore, the motor housing and the reduction gear housing.
8. The intake system for an internal combustion engine according to claim 7, wherein the motor housing is configured to receive an electric motor having an output shaft (23a) extending in parallel with a throttle shaft (22a) of the throttle valve extending diametrically across the intake bore, and the throttle body further comprises a third flange (50) extending perpendicularly to the axial line of the intake bore and

formed with a third hole (51) adjacent to an end of the motor housing remote from an end corresponding to the output shaft of the electric motor, the intake member being provided with a fourth hole aligning with the third hole and a fastening bolt being passed across the third and fourth holes for attaching the third flange of the throttle body to the intake member.

9. The intake system for an internal combustion engine according to any one of the preceding claims, wherein the throttle body is made of plastic material. 5 10
10. The intake system for an internal combustion engine according to any one of the preceding claims, wherein the intake bore is given with an elliptic shape having a long axis extending at an angle with respect to an axial line of a throttle shaft (22a) of the throttle valve extending diametrically across the intake bore. 15
11. The intake system for an internal combustion engine according to claim 9 or 10, wherein the throttle body is made of plastic material incorporated with reinforcing fibers which are oriented in a direction extending at an angle with respect to a long axis of the intake bore. 20 25
12. The intake system for an internal combustion engine according to claim 10 or 11, wherein the inner bore of the intake member is given with a circular cross section, and the intake bore of the throttle body has a cross section which progressively changes from the elliptic shape adjacent to the throttle valve to a circular shape conforming to the cross section of the inner bore of the intake member at a downstream end of the intake bore. 30 35

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Fig. 1

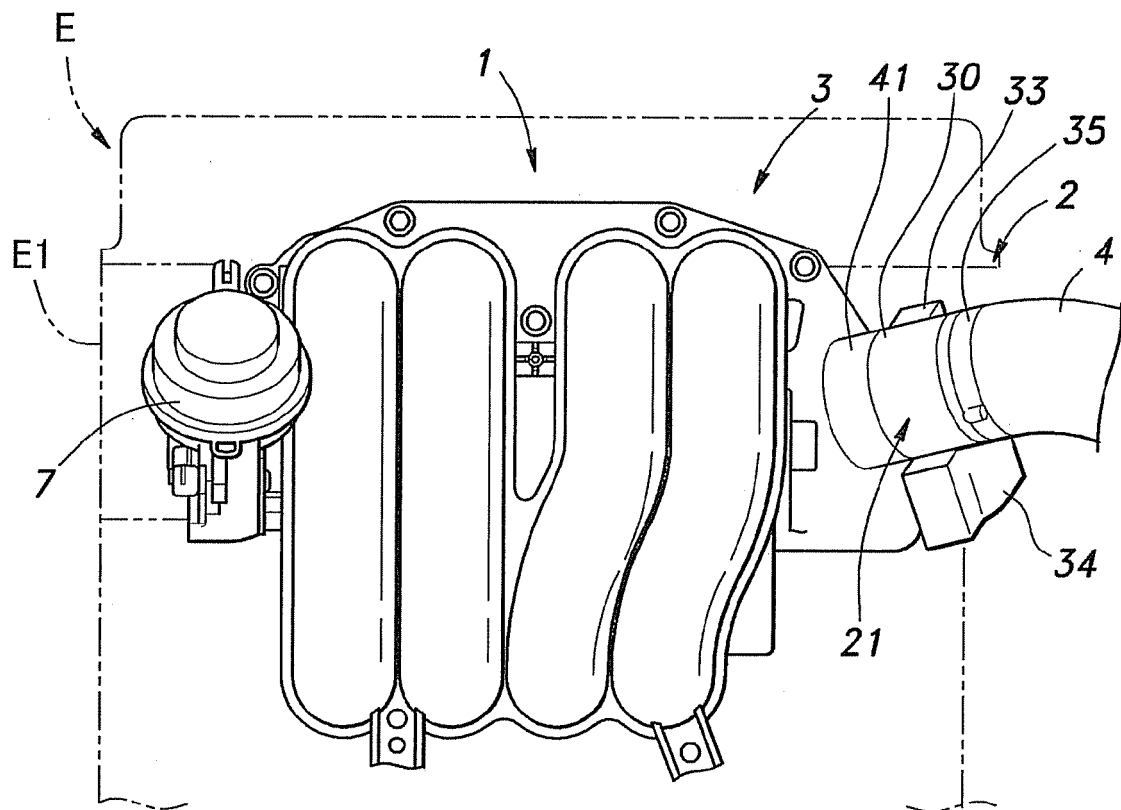


Fig.2

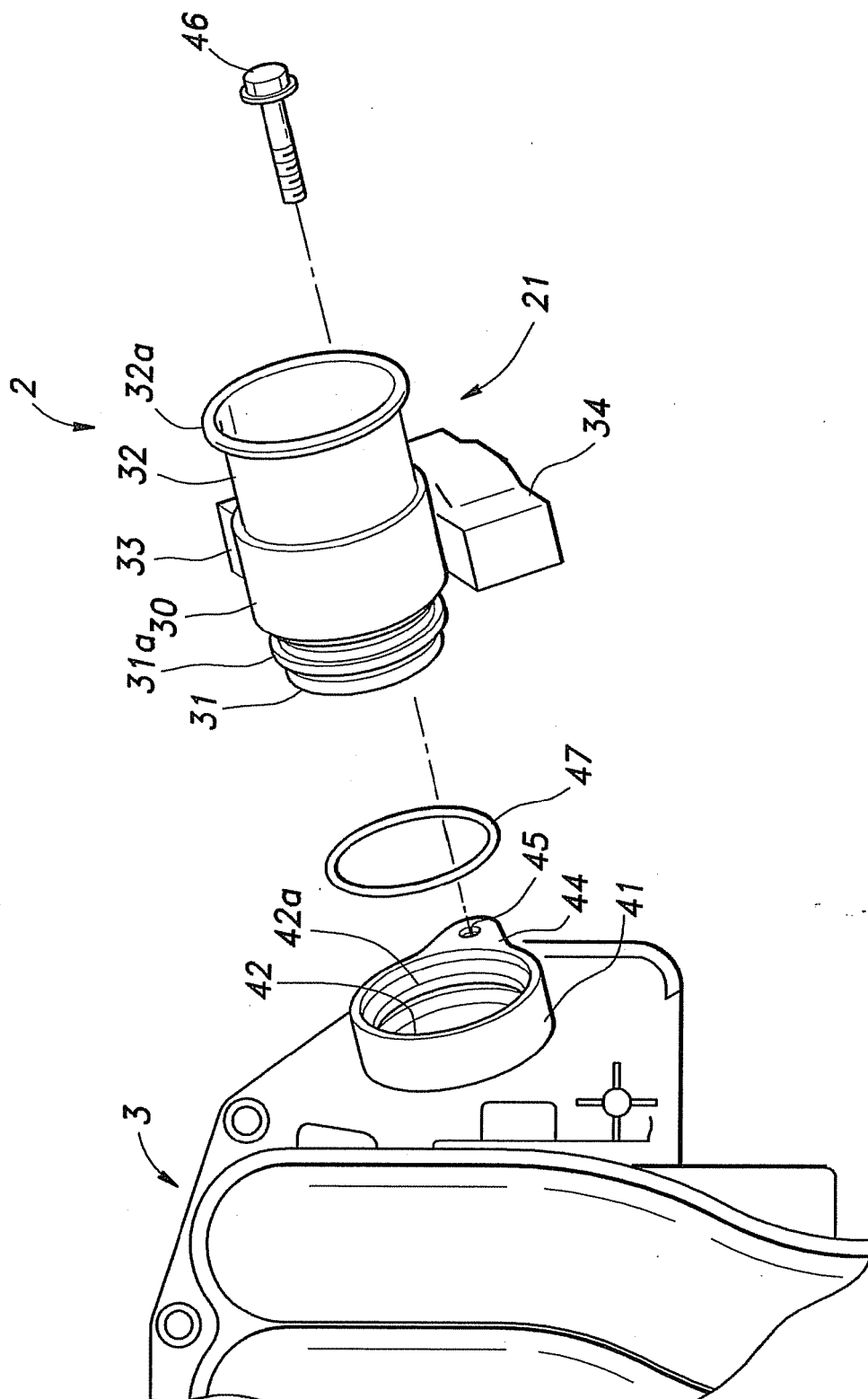


Fig.3

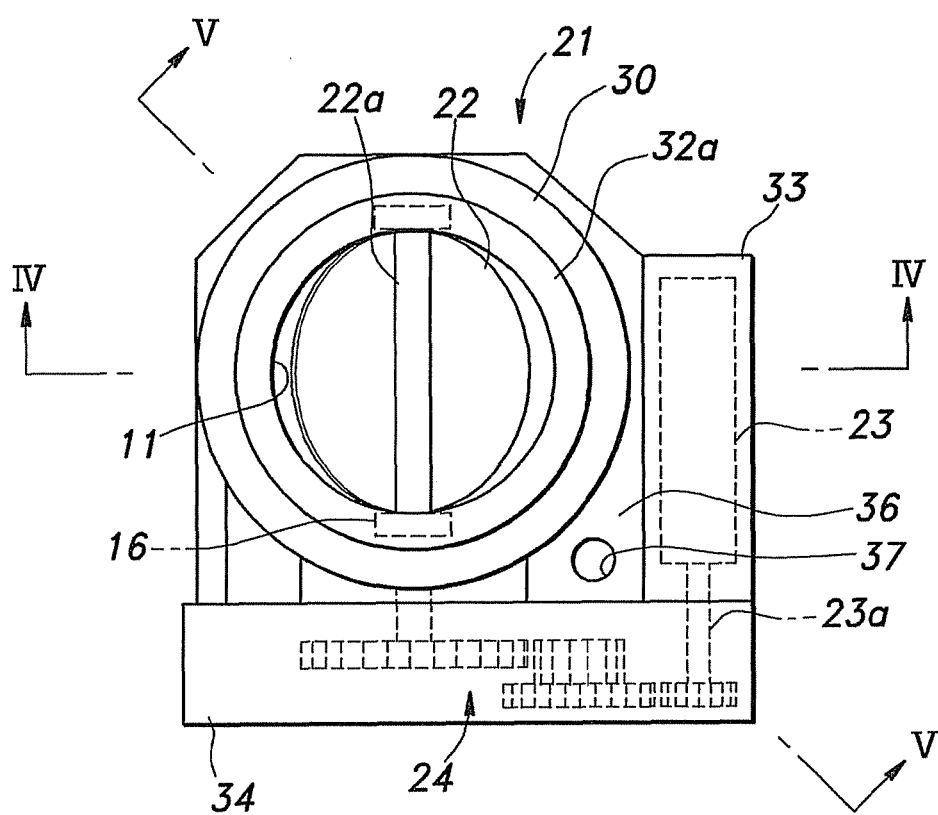


Fig.4

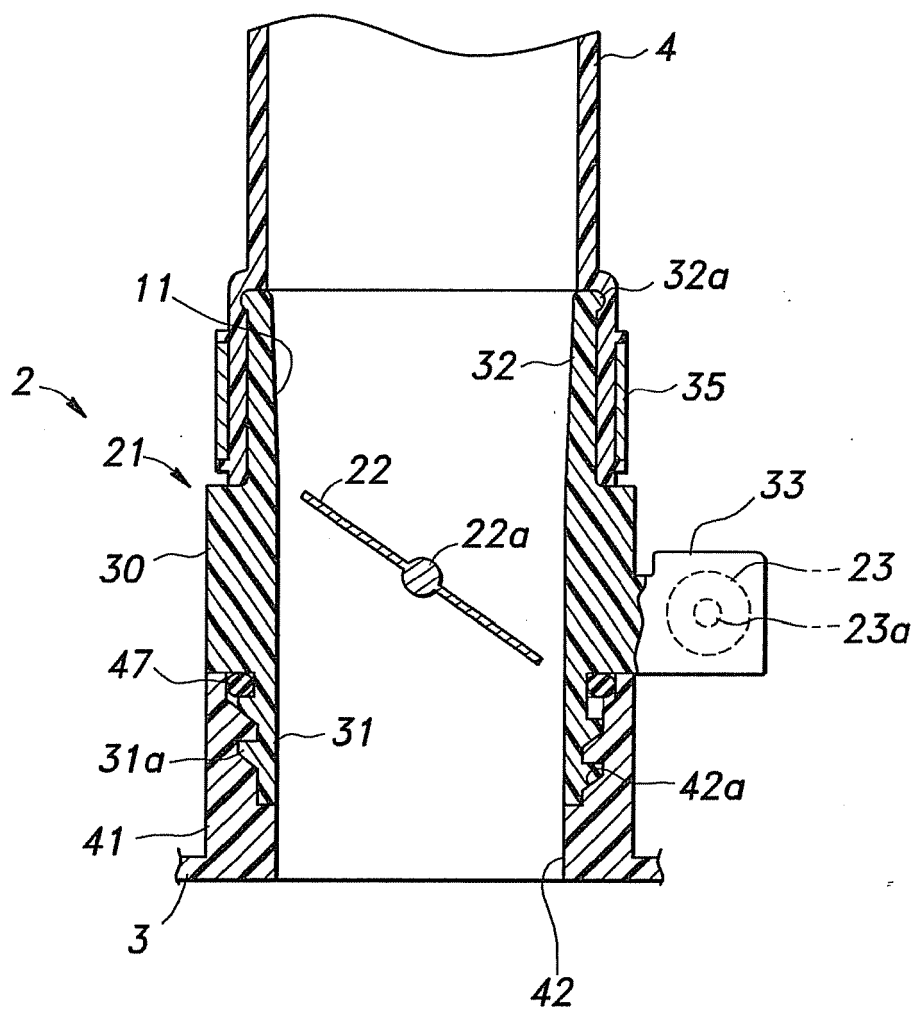


Fig.5

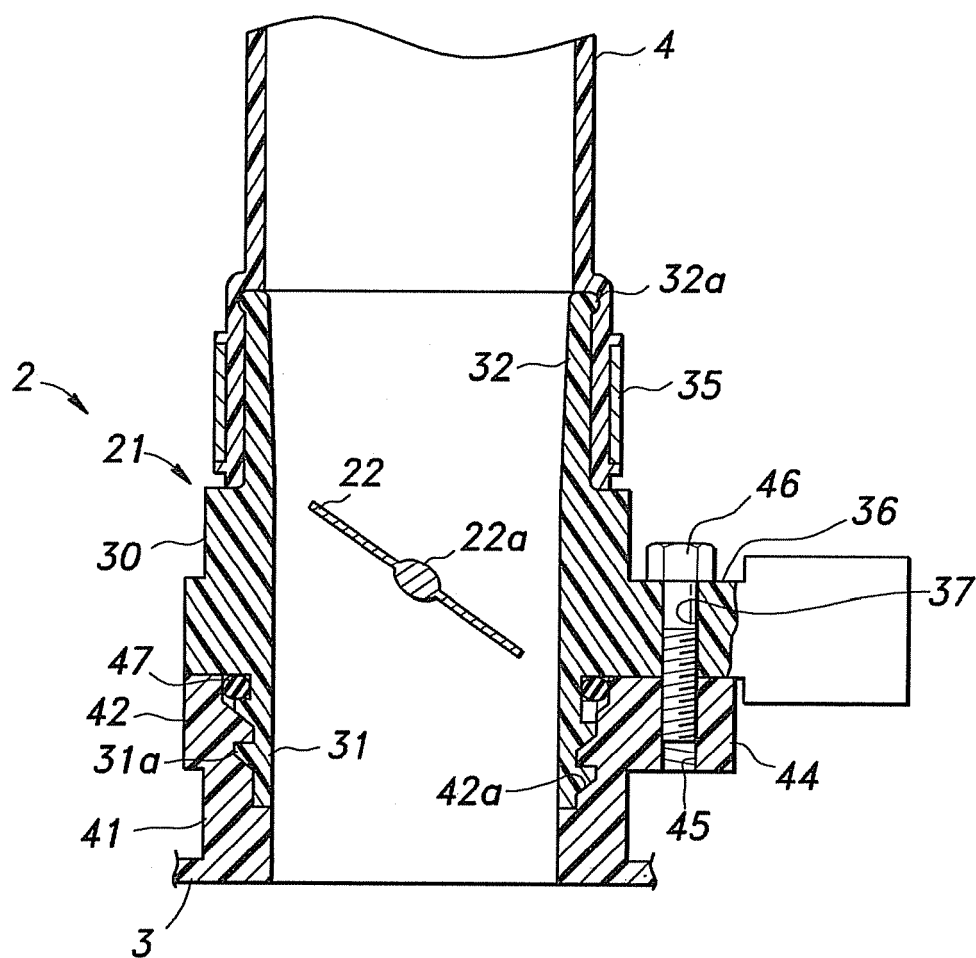


Fig.6

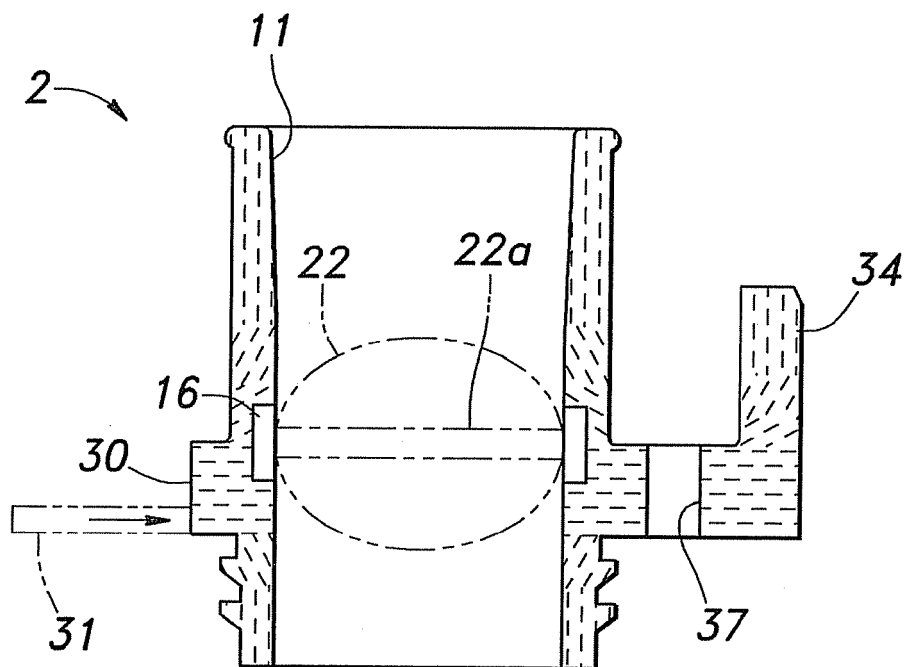


Fig.7

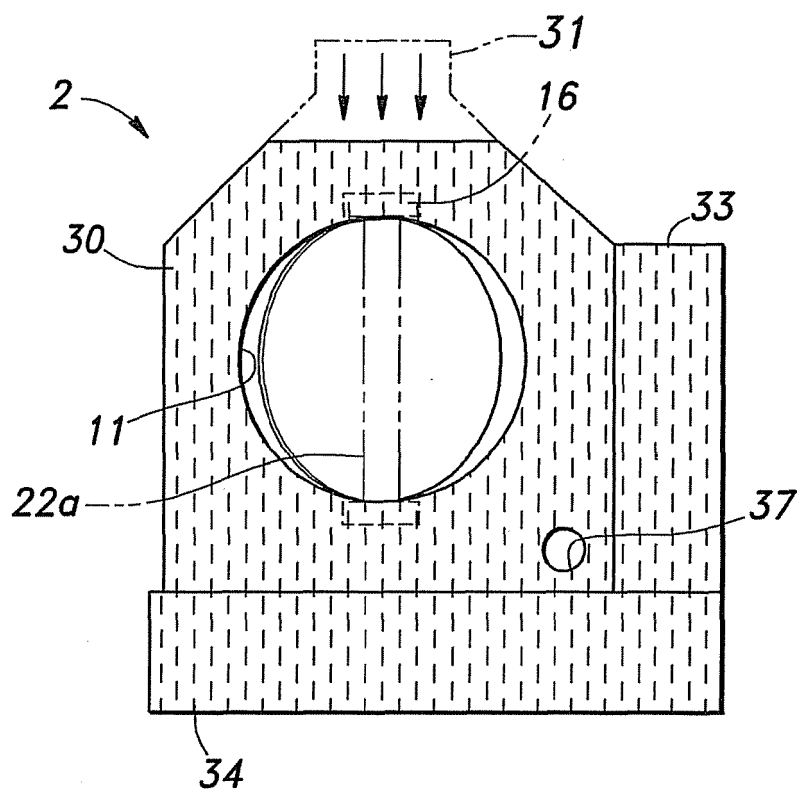


Fig.8

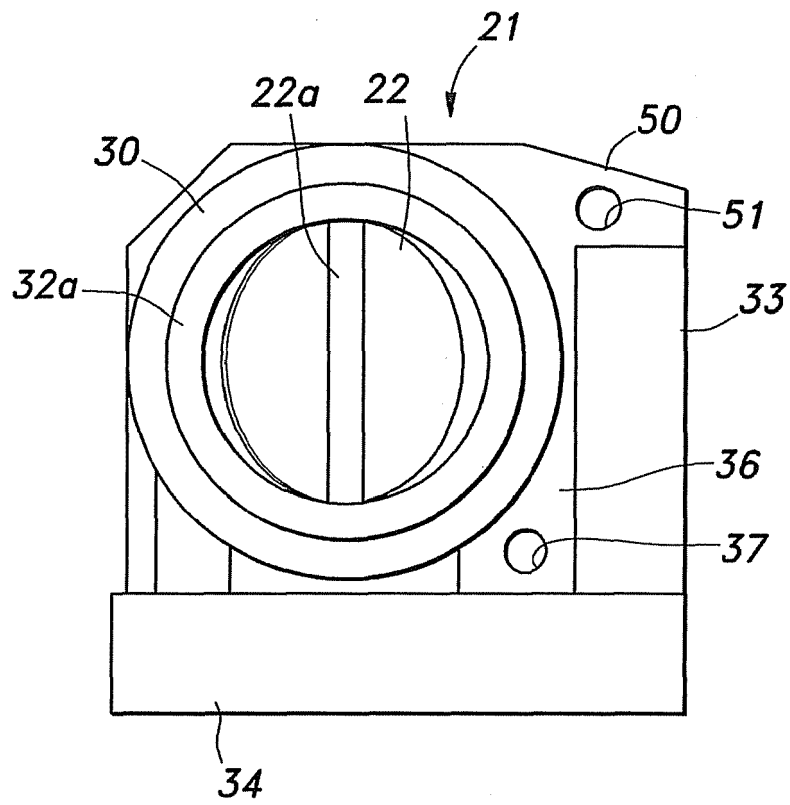


Fig.9

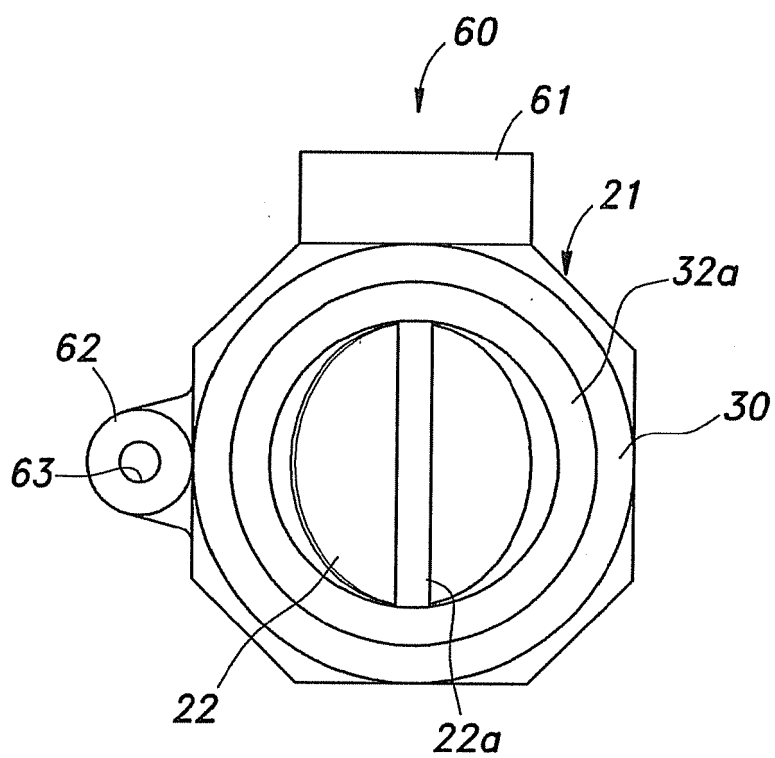
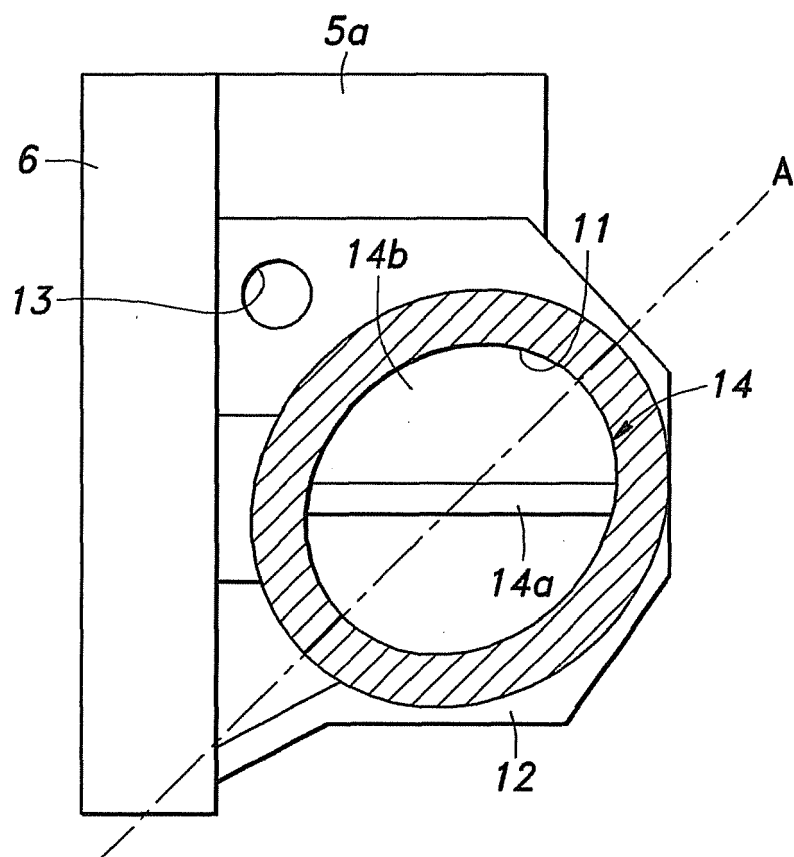


Fig. 10





EUROPEAN SEARCH REPORT

Application Number
EP 09 17 5336

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 1 408 228 A1 (AISAN IND [JP]) 14 April 2004 (2004-04-14)	1-8	INV. F02D9/10
A	* paragraph [0027] - paragraph [0071]; figures 1-18 *	9-12	F16L47/16
Y	EP 1 336 736 A2 (DELPHI TECH INC [US]) 20 August 2003 (2003-08-20)	1,4-8	ADD. F02M35/10
A	* paragraph [0025] - paragraph [0034]; figures 1-2 *	2-3,9-12	
Y	FR 2 908 833 A1 (VALEO SOC PAR ACTIONS SIMPLIFI [FR]) 23 May 2008 (2008-05-23)	9-12	
A	* page 7, line 4 - page 21, line 13; figures 1-6 *	1-8	
Y	US 4 050 721 A (STREIT KENNETH F) 27 September 1977 (1977-09-27)	2-3	
A	* column 3, line 56 - column 5, line 64; figures 1-4 *	1,4-12	
Y	EP 0 433 518 A1 (MECAPLAST SAM [MC]) 26 June 1991 (1991-06-26)	9-12	TECHNICAL FIELDS SEARCHED (IPC)
A	* column 3, lines 1-43; figures 1-3 *	1-8	F02D
A	EP 0 987 429 A1 (MARK IV SYSTEMES MOTEURS SA [FR]) 22 March 2000 (2000-03-22)	1-12	F16B
	* paragraph [0008] - paragraph [0031]; figures 9-10 *		F16L
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 29 January 2010	Examiner Martinez Cebollada
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	

 2
EPO FORM 1503 03.02 (P04C01)

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ON EUROPEAN PATENT APPLICATION NO.**

EP 09 17 5336

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The members are as contained in the European Patent Office EDP file on
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29-01-2010

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1408228	A1	14-04-2004	DE 60310330 T2	12-07-2007
			JP 3968290 B2	29-08-2007
			JP 2004132233 A	30-04-2004
			KR 20040032772 A	17-04-2004
			US 2004123835 A1	01-07-2004

EP 1336736	A2	20-08-2003	AT 331127 T	15-07-2006
			DE 60306219 T2	14-06-2007

FR 2908833	A1	23-05-2008	CN 101605972 A	16-12-2009
			CN 101605973 A	16-12-2009
			EP 2092171 A1	26-08-2009
			EP 2092172 A1	26-08-2009
			EP 2092173 A1	26-08-2009
			WO 2008061692 A1	29-05-2008
			WO 2008061693 A1	29-05-2008
			WO 2008061694 A1	29-05-2008

US 4050721	A	27-09-1977	NONE	

EP 0433518	A1	26-06-1991	NONE	

EP 0987429	A1	22-03-2000	AT 264453 T	15-04-2004
			DE 69916387 D1	19-05-2004
			DE 69916387 T2	04-05-2005
			FR 2783283 A1	17-03-2000
			JP 4266451 B2	20-05-2009
			JP 2000087764 A	28-03-2000
			US 6182628 B1	06-02-2001

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3620034 B [0003]
- WO 2001036799 A [0005]