(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
24 May 2007 (24.05.2007)

PCT

(10) International Publication Number
WO 2007/057034 A1

(51) International Patent Classification:
F16K 1/16 (2006.01) *F02D 9/18* (2006.01)
F16K 7/06 (2006.01) *F02M 35/10* (2006.01)
F02D 9/16 (2006.01)

(21) International Application Number: PCT/EP2005/012262

(22) International Filing Date: 15 November 2005 (15.11.2005)

(25) Filing Language: English

(26) Publication Language: English

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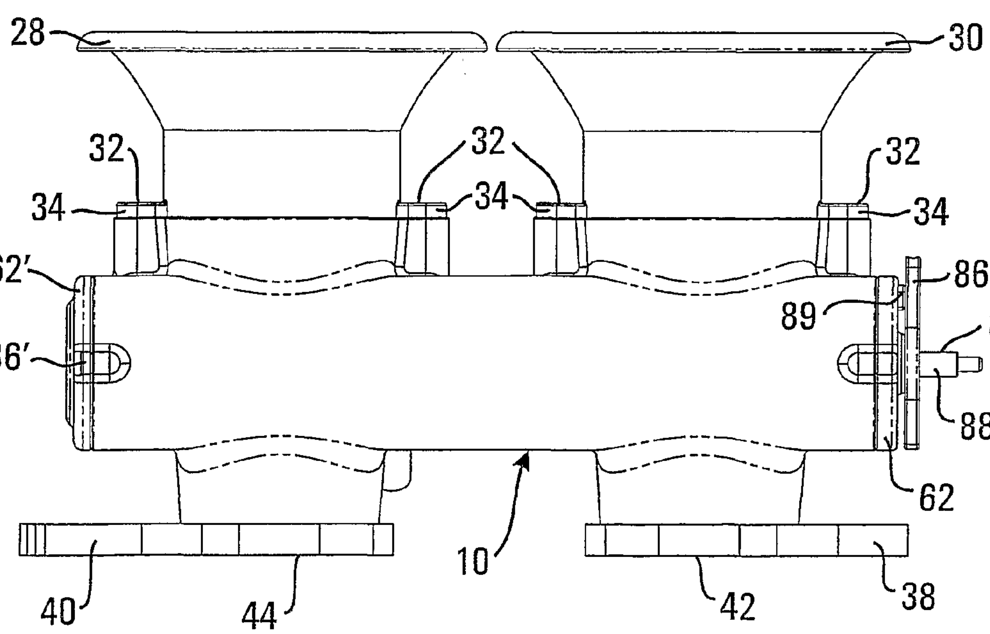
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: FLOW CONTROL DEVICE



(57) Abstract: A flow control device, in particular but not exclusively for a throttle body, comprises a duct having a central axis, at least one flow control member pivotally mounted about an axis extending transversely to said duct, said axis being spaced from said central axis and said, flow control member cooperating with an opposite side of said duct or with a second flow control member to define a throat of variable area.

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FLOW CONTROL DEVICE

The present invention relates to a fuel control device comprising a duct having a central axis and a flow control member pivotably mounted about an axis extending transversely to the duct.

Flow control devices of this kind are well known, for example as so called throttle bodies used to regulate the flow of air into an internal combustion engine. In such throttle bodies the flow control member frequently takes the form of a so-called butterfly valve. The butterfly is a disc-shaped piece of metal mounted on a relatively narrow spindle which passes transversely across the duct and intersects the central axis of the duct. Such butterfly valves are also frequently used in carburettors.

A problem with such butterfly valves is that, even in the fully open position, in which the disc of the butterfly valve generally lies edge on to the flow through the throttle body with the plane of the disc parallel to the central longitudinal axis of the duct, the disc and the spindle, as well as the screws which normally secure the disc to the spindle, disturb the flow through the duct. This increases the flow resistance and reduces the maximum flow possible through the duct.

In practise it is very difficult to achieve any significant reduction in the resistance caused by the butterfly valve in the open position. The spindle has to have a minimum diameter for strength reasons. The disc normally passes through a narrow slot in the spindle and the screws securing the disc to the spindle are splayed at their free ends projecting beyond the outer side of the spindle to prevent the screws or the disc undesirably separating from the spindle in the event of vibration and entering into the engine. When assembling the butterfly valve the screws have to be engaged through the spindle and through the disc and splayed at their split ends after the spindle has been inserted into the throttle body and after the disc has been inserted through the slot in the spindle. This makes it difficult to install the butterfly valve in the throttle body or carburettor body.

The other alternative of passing the spindle through a passage extending through a thickened central portion of the disc along a diameter thereof is also problematic. Quite apart from the increased complexity of the shape of the disc, such a design leads to a thicker overall construction and thus represents a greater blockage in the duct of the throttle body or carburettor. In addition, it is necessary to pin the butterfly disc to the spindle to ensure it rotates with the spindle and this also involves the danger that the pin may become loose and be ingested into the engine.

Irrespective of how the butterfly valve is actually designed there is also a significant problem involved in connecting two or more butterfly valves together in a synchronized manner when using pairs of throttle bodies or multiple carburettor installations.

One alternative which has been used for many years is to replace the butterfly valve with a slide valve arrangement, i.e. an arrangement in which a plate is moved transversely to the central longitudinal axis of the duct of the throttle body or carburettor to progressively occlude or free the duct. Such throttle slides are however problematic from a number of points of view. First of all, if the guide is made too tight, then there is always a significant danger of the throttle slide sticking. Should the throttle slide stick in the fully open state this can have dangerous consequences. If the guide for the throttle slide is made looser in an attempt to avoid sticking then there is always a significant danger of air leakage into the throttle body or carburettor which undesirably affects the fuel/air mixture and the running of the engine, particularly at low speeds. The synchronization of a plurality of throttle slides also poses considerable difficulties in practice.

The principle object of the present invention is to provide a flow control device which presents substantially no flow resistance in the fully open position, which is relatively easy to realize and manufacture in practice, which avoids sticking problems and which enables a plurality of flow control devices to be ganged together so that the flow through each throttle body or carburettor is synchronized over the full range of operation from idling to full throttle.

In addition, it is an aim of the present invention to realise a fuel flow device which is very compact and in particular of short overall length.

Furthermore, it is an object of the present invention to provide a design of flow control device which can readily be made economically by mass production methods, which is of light weight and which utilizes relatively little material.

In order to satisfy these objects there is provided, in accordance with the present invention, a flow control device comprising a duct having a central axis, at least one flow control member pivotally mounted about an axis extending transversely to said duct, said axis being spaced from said central axis and said flow control member cooperating with an opposite side of said duct or with a second flow control member to define a throat of variable area.

Although the flow control member can be arranged to cooperate with an opposite side of the duct it is preferred when a second flow control member is provided which is pivotable about a second axis extending transversely to the duct, generally parallel to the first said axis, at the side of the central axis opposite from the first central axis.

When such first and second flow control members are provided they are preferably connected together by a transmission. The transmission can for example comprise a first gear drivingly connected to the first flow control member and rotatable about the first axis and a second gear drivingly connected to said second flow control member and rotatable about the second axis, with the first gear meshing with the second gear.

In a particularly preferred embodiment, the first and second flow control members comprise rod-shaped bodies having respective first and second cut-outs which cooperate to define said variable throat, said first and second cut-outs being positionable at any intermediate angle between a first pivotal position in which the said rods cooperate to substantially close off said duct and a second pivotal position in which said cut-outs lie generally opposite to one another and define a flow passage having an inlet and an outlet, said inlet and said outlet corresponding in shape to entrance and exit sections of the flow duct respectively adjacent to said inlet and said outlet.

Each of the rods preferably has a cross-sectional shape at the cut-out corresponding to a segment of a circle defined by a cord.

It will be appreciated from the foregoing that, because the flow control member or the flow control members is/are pivotably mounted in a body defining the duct, it is readily possible to arrange for them to rotate freely without unwanted air leakage and without the danger of the flow control members sticking.

Furthermore, because each flow control member can be realized as a single part there is no danger of securing pins, screws or the like coming loose and being ingested by the engine or other apparatus to which the flow control device is connected.

Of importance is the advantage that the flow control member or flow control members can readily be contrived so that the duct is not obscured at all by the flow control member or members in the fully open position, so that the flow control member or members do not cause any restriction of the cross-sectional flow area of the duct and the duct is therefore able to flow the maximum possible quantity of fluid, be it air, another gas or a liquid medium. Moreover this advantage can be obtained irrespective of whether the duct has a circular cross-section, or a rectangular cross-section, or some other desired cross-sectional shape and also irrespective of whether the duct is arranged to converge or diverge in the area of the throat.

Because the flow control member or members can be made from round bar they can be relatively easily manufactured in metal or realized as injection moulded components.

The duct of the flow control device will be defined in a body and this body can have first and second transverse passages of circular cross-section corresponding in diameter to the first and second rods. Not only can such transverse passages of circular cross-section be manufactured in metal by a straightforward boring operation, they can also be manufactured costeffectively in a plastic material, in particular in a fibre reinforced plastic material, by injection moulding.

Because the first and second transverse passages are of circular cross-section, as are the rods, it is easy to provide seals, in particular ring seals between the rods and the walls of the transverse passages, for example in suitable ring grooves, so that any potential air leakage can be effectively prevented.

The flow control device of the present invention is preferably incorporated into a throttle body. The throttle body preferably has first and second ducts extending generally parallel to one another, for example for feeding a pair of intake ports of an internal combustion engine.

In this case the first and second rods each have two cut-outs positioned along the rods at positions corresponding to the first and second ducts. Because the cut-outs are machined on the rods, or formed integrally with the rods in an injection moulding process, the two flow devices in each throttle body are perfectly synchronized with one another from the outset so that there is no need to provide adjustments to allow for flow balancing through the two ducts. This significantly simplifies the design.

In the above designs it can be advantageous to provide an idling adjustment for each duct. This can be done by providing a bypass passage for the or each duct, said bypass passage comprising a first bore in said body upstream of said first and second flow control members and intersecting said duct, a second bore downstream of said first and second flow control members and intersecting said duct and a passage communicating between said first and second bores outside of said duct.

A variable restrictor, such as a needle valve realised as a grub screw with a conical point, can then be provided in one of the first and second bores, or in the passage, by which the size of the bypass flow can be regulated. This facilitates the setting of the idling speed of an engine equipped with a throttle body or carburettor incorporating the flow control device of the present invention.

When used as a throttle body a fuel injector bore is conveniently provided in the throttle body for each duct and preferably intersects the respective duct. Normally the fuel injector bore will be placed to intersect the respective duct downstream of the flow control members, in which case it is conveniently inclined relative to a longitudinal direction of the duct so that it points into the duct away from the flow control members. However, this is not essential, the fuel injection could take place upstream of the flow control members.

For many engines it is often desirable to provide two or more throttle bodies alongside one another, with each throttle body frequently having two flow ducts.

In accordance with the present invention the or each flow control member can have, at at least one end face, a feature of shape which cooperates with a complementary feature of shape of a further flow control member of a second throttle body to gang the respective flow control members together for common rotational movement. This not only means that the flow control members of a plurality of throttle bodies can be driven from a single throttle actuator, it also means that the movements of the flow control members of each of the throttle bodies can be fully synchronized without the need to provide special flow balancing arrangements for each duct or throttle body.

In one preferred design the features of shape comprise at least one bore and at least one pin at an end face of one said flow control member and at least one pin and at least one bore of complementary shape at a confronting end face of a further flow control member. This means that the pins and bores can simply be plugged together by movement of the two throttle bodies towards one another without the need for any further connecting mechanism. The relative axial positions of the flow control members are maintained by the bolting of the throttle bodies to the mating flange of the induction manifold or cylinder head and indeed the pin and bore construction permits differential thermal expansion to take place without affecting the connection. One of the pins and bores at least should be provided eccentrically to the axis of rotation of the respective flow control member.

A throttle actuator is preferably non-rotatably connected to at least one of the flow control members and conveniently comprises a throttle quadrant. The connection between the throttle actuator and the flow control member can be realized in a variety of ways. In one embodiment the throttle quadrant could be machined into or injection moulded with the relevant flow control member. In another embodiment it can be made as a separate component and bolted to an end face of the flow control member via a central bolt, with a driving dog positioned eccentrically of the central bolt to prevent relative rotation between the throttle quadrant and the flow control member.

The connection between the throttle quadrant and the respective flow control member can be effected using a complementary pin and bore arrangement precisely in the same manner as is used to connect two control rods together in alignment with one another. This means that only one design of flow control member is necessary which simplifies the manufacturing process and enables further cost-savings to be made.

Further preferred embodiments of the flow device of the invention are set forth in the subordinate claims. It will be noted that the flow device of the present invention can be used not only as a flow control valve in a fuel system but rather in any fluid control system, such as a hydraulic flow control system or a pneumatic flow control system.

The invention will now be described in further detail by way of example only and with reference to the accompanying drawings in which are shown:

Fig. 1 shows a flow device in the form of a throttle body seen from the side,

Fig. 2 is a view of the throttle body of Fig. 1 seen from below,

Fig. 3 is a view of the throttle body of Fig. 1 seen from the front,

Fig. 4 is a view similar to Fig. 3 but with the inlet trumpets removed,

Fig. 5 is a section taking on the plane AA of Fig. 4, with Fig. 5A showing the flow control members in the fully closed position and Fig. 5B showing them in the fully open position,

Fig. 6 is a perspective view of the throttle body of Figs. 1 to 5 with the gear case removed,

Fig. 7 is a perspective view of the first and second flow control members used in the throttle body of Figs. 1 to 6 shown in the fully open position (Fig. 7A) and in the fully closed position (Fig. 7B),

Fig. 8 is a schematic illustration of an alternative embodiment of the invention,

Fig. 9 is an illustration resembling Fig. 8 but showing the use of a membrane to improve the flow through the duct at different throat openings and

Fig. 10 is a view of another alternative embodiment of the invention.

Turning now to the drawings of Figs. 1 to 7 there can be seen a flow control device 10 in the form of a throttle body having first and second ducts 12, 14 each with a respective central axis 16, 18. At the front of the throttle body 10 there is provided a flange 20, 22 at the inlet 24, 26 to each duct 12, 14 to which a respective inlet trumpet 28, 30 is attached via respective bolts which pass through bores 32 in lugs 34 of the trumpets into tapped bores 36 of the throttle body 10. At the rear of the throttle body is a flange 38, 40 for each duct 12, 14 which enables the throttle body to be bolted to an inlet manifold or to a face of a cylinder head.

In this embodiment the flow ducts 12, 14 are of circular cross-section and taper on their paths through the throttle body from the respective inlet 24, 26 to the respective outlet 42, 44. As can be seen the throttle body10 has first and second flow control members 46, 48 which are pivotally mounted about respective axes 50, 52 (Figs. 5A and 5B) extending transversely to said ducts 12, 14. The axes 50, 52 are each spaced from the central axes 16, 18 of the flow ducts 12, 14 and are disposed on opposite sides of the central axes 16, 18. The flow control members 46, 48 cooperate with each other to define respective throats 54, 56 of variable area in the ducts 12, 14. In Fig. 3 and Fig. 7B the throats 54, 56 are shown with a minimal flow area, in Figs. 4 and 5A they are shown fully closed and in Figs. 5B and 7A they are shown fully open. It is apparent from the drawings that the flow control members 46, 48 are provided with respective cut-outs in order to achieve the variable throat area. This is not however essential as will be explained later with respect to Figs. 8 to 10.

As can be seen from Figs. 6, 7A and 7B the first flow control member 46 is connected to the second flow control member 48 by a transmission comprising a first gear 58 drivingly connected to the first flow control member 46 and rotatable about the first axis 50 and a second gear 60 drivingly connected to the second flow control member 48 and rotatable about the second axis 52. The gears 58 and 60 can be injection molded at the same time as the flow control members in one piece with the flow control members. The first gear 58 meshes with the second gear 60 and the timing of the gears, i.e. their positions with respect to the flow control members is such that the flow control members move in a fully synchronised manner from the closed position (Fig. 7B) to the fully open position (Fig. 7A) so that the valve throat areas are always symmetrically positioned with respect to the respective central axes 16, 18 of the two flow ducts. The gears 58, 60 cannot be seen in Figs. 1, 2 and 3 because they are covered by a gear cover 62 to preclude the ingress of contamination.

In the present embodiment the first and second flow control members 46, 48 comprise rod-shaped bodies having, for each flow duct 12, 14, respective first and second cut-outs 64, 66 which cooperate to define the variable throat in each flow duct. Because the throttle body has two flow ducts extending generally parallel to one another in this example the said first and second rods 46, 48 respectively have two first cut-outs 64 64' and two second cut-outs 66, 66' positioned along the rods at locations corresponding to said first and second ducts 12, 14.

In this example the first and second cut-outs 64, 64' and 66, 66' can be positioned by rotation of the rods 46, 48 at any desired position (throttle opening) between a first pivotal position (Figs.4, 5A and 7B) in which the said rods cooperate to substantially close off the flow ducts and a second pivotal position (Figs. 5B and 7A) in which the cooperating pairs of cut-outs 64, 66 and 64', 66' lie generally opposite to one another and define a flow passage having an inlet 68 and an outlet 70, said inlet 68 and said outlet 70 corresponding in shape to entrance and exit sections of the associated flow duct 12, 14 respectively adjacent to said inlet and said outlet.

That is to say, in the fully open state, the walls 65, 67 of the cut-outs 64, 64', 66, 66' lie in positions which conform fully to the shape of the respective flow duct 12, 14, as shown in Fig. 5B. One way of considering the shape of the cooperating cut-outs is to imagine the rod-shaped bodies as initially having no cut-outs and being positioned in the throttle body 10 so that they extend across the flow ducts. If a boring tool is now used to bore a passage through the two rods at the position of each flow duct, with the passage having a tapering cylindrical shape corresponding to the tapering cylindrical shape of each flow duct, then the resultant shape of the cut-out in each rod for each flow duct is precisely the desired shape of the actual cut-out 64, 64', 66 66'. There are no steps at the transition from the walls of the flow ducts to the cut-outs in the rods or at the transitions from the cut outs in the rods to the walls of the ducts.

As a result of this design the rods 46, 48 each having a cross-sectional shape at the cut-outs 64,64', 66, 66' corresponding to a segment of a circle defined by a chord 72, 74 irrespective of the axial position at which the cross-section is taken. The radial depth of the chord does however vary over the width of the duct.

The throttle body has first and second transverse passages 73, 75 of circular cross-section corresponding in diameter to said first and second rods in order to accommodate the rods in the throttle body. If desired respective seals, e.g. O-ring seals can be provided between the rods and the walls of the transverse passages, e.g. in ring grooves of the rods, to ensure sealing. This is however not essential. Adequate sealing can be achieved if the diameter of the transverse passages closely equates to that of the rods.

A bypass passage is provided for each flow duct. The bypass passage comprises, in respect of each flow duct 12, 14, a first bore 76 in said body 10 upstream of said first and second flow control members 46, 48 and intersecting the respective duct 12, 14, a second bore 78 downstream of said first and second flow control members and intersecting the respective duct 12, 14 and a passage 80 communicating between said first and second bores 76, 78 outside of the respective duct. A variable restrictor (not shown) is provided in one of said first and second bores 76, 78 or in the passage 80.

It can, for example, comprise a needle valve realised as a grub screw screwed into the upper part of the first bore 76, the grub screw having a conical point (not shown) which cooperates with a suitable valve seat defined in the lower part of the first bore beneath the passage 80. The upper parts of the bores 76 and 78 and the ends of the cross-drilling for the passage 80 outside of the bores 76 and 78 must be closed off to prevent unwanted infiltration of air.

A fuel injector bore 82 for a fuel injector 84 is provided in the throttle body 10 for each flow duct 12, 14. The fuel injector bore 82 extends through the throttle body and intersects the respective duct 12, 14 downstream of the flow control members 46, 48. The fuel injector bore 82 is preferably inclined relative to a longitudinal direction of the duct (equivalent to the central axis 16, 18 thereof) and points into the duct away from the flow control members 46, 48.

A throttle actuator 86 is non-rotatably connected to at least one of said flow control members 46 in Fig. 1. The throttle actuator comprises a throttle quadrant which is secured by a bolt 87 which passes through an aperture in the gear casing 62 into a threaded bore 86' provided in the end of the flow control rod 46 and also has a cylindrical pin 89 which engages through an arcuate slot in the gear casing 62 with a bore 90 provided in the flow control rod 46.

Two or more throttle bodies can be arranged alongside one another. For this purpose the or each flow control member has, at at least one end face, a feature of shape (such as the protruding pin 88' at the free end of bolt 88) which mates with a complementary feature of shape (such as the bore 86') of a further flow control member to gang the respective flow control members together for common rotational movement. That is to say a second throttle body identical to throttle body 10 could be positioned to the right of the throttle body 10 shown in Fig. 2 so that the pin 88' engages through the end cap 62' into the bore 86' of a flow control member of the second throttle body. To ensure the rotation produced by the throttle actuator is transmitted to the flow control members of both throttle bodies a further pin and bore are necessary. For example the pin 89 of Fig. 2 could be extended through the actuator quadrant to engage through an arcuate slot in the gear casing 62 or end cover 62' into a bore such as 90 provided in the end of the corresponding flow control member of the second throttle body.

It is not necessary for the bolt 88 to engage in a threaded bore if two throttle bodies are placed side by side with the actuator quadrant 86 between them. Instead bolt 88 could be a simple pin since it cannot be lost due to the proximity of the two throttle bodies. It should be noted that the bolt or pin 88 is not required in the above design for torque transmission between the actuator quadrant 86 and the flow control member or members 46 since the two mutually offset pins 88 and 89 fulfil this function.

It is however entirely possible to dispense with the second pin 89 and to use the bolt or pin 88 for torque transmission from the actuator quadrant to the flow control member. One way of achieving this is to form the pin 88 with a tapering round, square or polygonal or cross section or splined or keyed portion adapted to engage in a corresponding aperture in the end of the associated flow control member. Such an arrangement (not shown in the drawings) could e.g. be secured by a central threaded bolt passing coaxially through the pin into the flow control member 46 and has the advantage that backlash free transmission of torque is possible. It also has the advantage that an arcuate slot in the gear cover is not necessary so that the ingress of contamination into the gear casing 62 through such an arcuate slot is not possible.

Indeed, with a tapering round, square or polygonal cross section of the pin, or with a pin with a splined or keyed portion, the relevant portion of the pin can blend into a cylindrical portion of the pin adjacent to the throttle actuator so that the cylindrical portion passes through the gear casing where it can easily be sealed, so that contamination is kept away from the gears. A pin with a tapering or non tapering square cross section, or with a polygonal cross section or with a splined portion can also be made with two oppositely directed ends each with the same cross-sectional shape so that two throttle bodies can be placed side by side and the respective flow control members 46 driven from one throttle quadrant.

The throttle quadrant 86 does not have to be positioned between two adjacent throttle bodies, it could also be placed at one end of a row of throttle bodies. E.g. if a second throttle body is placed to the left of the throttle body 10 in Fig. 2 then complementary features of shape such as two mating pins and bores could be provided there to ensure all the flow control members 46, 48 of the two throttle bodies move together in a synchronised manner. The features of complementary shape do not have to be mating pins and bores. it would for example be possible to have a bar shaped projection extending across a diameter of one end face of one flow control member mating with a complementary bar shaped recess at the end face of a mating flow control member. In such a case the confronting end covers 62, 62' could be omitted and replaced by a flexible boot extending between the two throttle bodies

The first and second flow control members can be machined from metal, for example from an aluminium alloy but preferably comprise injection-moulded members. The injection-moulded members are injection-moulded in a fibre reinforced plastic of high thermal stability, e.g. a plastic which is stable at temperatures above those likely to be encountered in practise. A plastic which is stable at temperatures above 300 °C is preferred.

The body defining the ducts, i.e. the housing of the throttle body, preferably also comprises an injection-moulded part and is preferably also injection-moulded in a fibre reinforced plastic of high thermal stability. It could also be a metal die casting, as could the flow control members.

In the embodiment discussed so far each duct is of circular cross-section, at least in the vicinity of said flow control member or members and tapers from the respective inlet trumpet 28, 30 to the associated mounting flange 38, 40. The use of a tapering duct is not essential it could be of regular cylindrical shape. Also other cross-sectional shapes are possible, for example an elliptical cross-section. In addition a duct of rectangular cross-section could be used, at least in the vicinity of said flow control member or members.

A flow control device with a duct of rectangular cross-section is illustrated in Fig. 8 and in Figs 9 and 10. In the description of Fig. 8 and in the description of the subsequent figures the same reference numerals as used in connection with the first embodiment of Figs. 1 to 7 will be used to describe parts having the same function as in the first embodiment. It will be understood that the same description applies unless something is stated to the contrary. The drawings of Figs 8 to 10 are highly schematic and not all details are shown.

In the embodiment of Fig. 8, as in the subsequent embodiments of Figs. 9 and 10 the flow control members 46, 48 are again of generally rod-like shape but are pivotable about an axis 50, 52 eccentric with respect to the cross-section of said flow control member. The flow control members have a cylindrical portion 46", 48" which engages in a corresponding cylindrical bearing in the body of the flow control device 10. The axes 50, 52 are positioned transverse to the duct 12 outside of the duct.

The flow control members each have a cross-sectional shape selected such that a portion of the flow control member intersecting said duct has a substantially constant width at an intersection with said duct, irrespective of a selected pivotal position of said control member, whereby to minimize the gaps which exists between a wall of the duct and the flow control member. It will be noted that for this purpose the flow control member has two arcuate surfaces which are each formed by an arc centred on the respective axis 50, 52 which is coaxial to the cylindrical portions 46", 48". It can readily be seen from Fig. 8, as indeed from the other figures that it would be possible to provide just one flow control member which cooperates with the opposing wall of the duct rather than with a second flow control member. In this case, in the embodiment of Fig. 8, the opposing wall would be located at the position of the centreline 16. It will be noted that the drawing shows the flow control members in the fully closed position in solid lines and in the fully open position in dotted lines.

Fig. 9 shows an embodiment closely similar to that of Fig. 8 but with a flexible and extensible membrane 94, 96 extending over the portion of each flow control member extending into the duct 12. The membranes are fixed to wall means 98, 98' of the duct 12 upstream and downstream of said flow control member, for example by trapping them between mating bolted together flanges. The flow duct 12 is broader in the throttle body than in the continuations of the duct upstream and downstream of the throttle body by the double thickness of the membranes. This avoids step changes in the internal dimension of the flow passage.

Fig. 10 shows an embodiment similar to Fig. 9 but in which the flow control members have a different shape. Here they are of circular cross-section again with eccentric cylindrical portions 46", 48". Here first and second resilient elements 100, 102 and 104, 106 contact respective portions of the flow control members extending into said duct at respective upstream and downstream positions. The resilient members, which could be thin spring steel sheet members, are fixed to wall means 98 of said duct 12 upstream and downstream of the flow control members 46, 48 and are resiliently biased into contact therewith.

Although the ducts 12 in Figs. 8 to 10 are said to be of rectangular cross-section they could be of other shapes, e.g. of square, circular or elliptical cross-section with or without taper.

Patent Claims

1. A flow control device comprising a duct having a central axis, at least one flow control member pivotally mounted about an axis extending transversely to said duct, said axis being spaced from said central axis and said flow control member cooperating with an opposite side of said duct or with a second flow control member to define a throat of variable area.

2. A flow control device according to claim 1 wherein a second flow control member is provided which is pivotable about a second axis extending transversely to said duct generally parallel to the first said axis at a side of said central axis opposite from the first said axis.

3. A flow control device in accordance with claim 2, wherein said flow control member is connected to said second flow control member by a transmission.

4. A flow control device in accordance with claim 3, wherein said transmission comprises a first gear drivingly connected to said first flow control member and rotatable about said first axis and a second gear drivingly connected to said second flow control member and rotatable about said second axis, said first gear meshing with said second gear.

5. A flow control device in accordance with any one of the preceding claims 2 to 4, wherein said first and second flow control members comprise rod-shaped bodies having respective first and second cut-outs which cooperate to define said variable throat, said first and second cut-outs being positionable between a first pivotal position in

which the said rods cooperate to substantially close off said duct and a second pivotal position in which said cut-outs lie generally opposite to one another and define a flow passage having an inlet and an outlet, said inlet and said outlet corresponding in shape to entrance and exit sections of said duct respectively adjacent to said inlet and said outlet.

6. A flow control device in accordance with claim 5, said rods each having a cross-sectional shape at said cut-out corresponding to a segment of a circle defined by a chord.

7. A flow control device in accordance with any one of the preceding claims, wherein said duct is defined in a body having first and second transverse passages of circular cross-section corresponding in diameter to said first and second rods.

8. A flow control device in accordance with claim 7, there being respective seals provided between said rods and walls of said transverse passages.

9. A flow control device in accordance with claim 8, wherein said seals comprise ring seals.

10. A flow control device in accordance with any one of the preceding claims, when incorporated into a throttle body.

11. A flow control device in accordance with claim 10, wherein said throttle body has first and second ducts extending generally parallel to one another.

12. A flow control device in accordance with claim 11, wherein said first and second rods each have first and second cut-outs positioned along said rods at positions corresponding to said first and second ducts.

13. A flow control device in accordance with any one of the preceding claims, wherein a bypass passage is provided for the or each said duct, said bypass passage comprising a first bore in said body up-stream of said first and second flow control members and intersecting said duct, a second bore downstream of said first and second flow control members and intersecting said duct and a passage communi-cating between said first and second bores outside of said duct.

14. A flow control device in accordance with claim 13, wherein a variable restrictor is provided in one of said first and second bores or in said passage.

15. A flow control device in accordance with any one of said preceding claims, there being a fuel injector bore extending in a body of said de-vice defining said duct and intersecting said duct.

16. A flow control device in accordance with claim 15, wherein said fuel injector bore intersects said duct downstream of said flow control members.

17. A flow control device in accordance with claim 16, wherein said fuel injector bore is inclined relative to a longitudinal direction of said duct and points into said duct away from said flow control members.

18. A flow control device in accordance with any one of the preceding claims, wherein the or each said flow control member has at at least one end face a feature of shape which mates with a complementary

feature of shape of a further flow control member of a second flow control device to gang the respective flow control members together for common rotational movement.

19. A flow control device in accordance with claim 18, wherein said features of shape comprise at least one bore and at least one pin at an end face of one said flow control member and at least one pin and at least one bore of complementary shape at a confronting end face of said further flow control member.

20. A flow control device in accordance with any one of the preceding claims, wherein a throttle actuator is non-rotatably connected to at least one of said flow control members.

21. A flow control device in accordance with claim 20, wherein said throttle actuator comprises a throttle quadrant.

22. A flow control device in accordance with any one of the preceding claims, wherein a throttle actuator is positioned between a pair of adjacent flow control devices.

23. A flow control device in accordance with claim 22 wherein said throttle quadrant is drivingly connected to a respective flow control member of each flow control device.

24. A flow control device in accordance with any one of the preceding claims, wherein an inlet trumpet and/or an air filter is connectable to an upstream end of each said duct.

25. A flow control device in accordance with claim 10 and claim 24, wherein said throttle body has a flange at an upstream end of said duct for connection to said inlet trumpet and/or to said air filter.

26. A flow control device in accordance with claim 10 and any other one of the preceding claims, wherein said throttle body has a flange at an outlet end for mounting to a cylinder head or other structure.

27. A flow control device in accordance with any one of the preceding claims, wherein said first and second flow control members comprise injection-moulded members.

28. A flow control device in accordance with claim 27, wherein said injection-moulded members are injection-moulded in a fibre reinforced plastic of high thermal stability.

29. A flow control device in accordance with any one of the preceding claims, wherein a body defining said duct comprises an injection-moulded part.

30. A flow control device in accordance with claim 29, wherein said injection-moulded part is injection-moulded in a fibre reinforced plastic of high thermal stability.

31. A flow control device in accordance with any one of the preceding claims wherein said duct is of circular cross-section, at least in the vicinity of said flow control member or members.

32. A flow control device in accordance with any one of the preceding claims wherein said duct is of rectangular cross-section, at least in the vicinity of said flow control member or members.

33. A flow control device in accordance with claim 1, claim 31 or claim 32, wherein said flow control member is of generally rod-like shape and is pivotable about an axis eccentric with respect to a cross-section of said flow control member.

34. A flow control device in accordance with claim 33, wherein said axis is positioned transverse to said duct outside of said duct.

35. A flow control device in accordance with claim 34, wherein said flow control member has a cross-sectional shape selected such that a portion of said flow control member intersecting said duct has a substantially constant width at an intersection with said duct irrespective of a selected pivotal position of said flow control member whereby to minimize a gap existing between a wall of said duct and said flow control member.

36. A flow control device in accordance with any one of the preceding claims, wherein a flexible and extensible membrane extends over a portion of said flow control member extending into said duct, said membrane being fixed to wall means of said duct upstream and downstream of said flow control member.

37. A flow control device in accordance with any one of the claims 1 to 35, wherein first and second resilient elements slidingly contact respective portions of said flow control member extending into said duct at respective upstream and downstream positions, said resilient

members being fixed to wall means of said duct upstream and downstream of said flow control member and resiliently biased into contact therewith.

38. A flow control device in accordance with any one of the preceding claims, when adapted for use as a flow control valve in a hydraulic flow control system.

39. A flow control device in accordance with any one of the preceding claims 1 to 37, when adapted for use as a flow control valve in a pneumatic flow control system.

40. A flow control device in accordance with any one of the preceding claims 1 to 37, when adapted for use as a flow control valve in a fuel system.

41. A flow control device substantially as described herein with reference to and as illustrated in any of the accompanying drawings.

FIG. 1

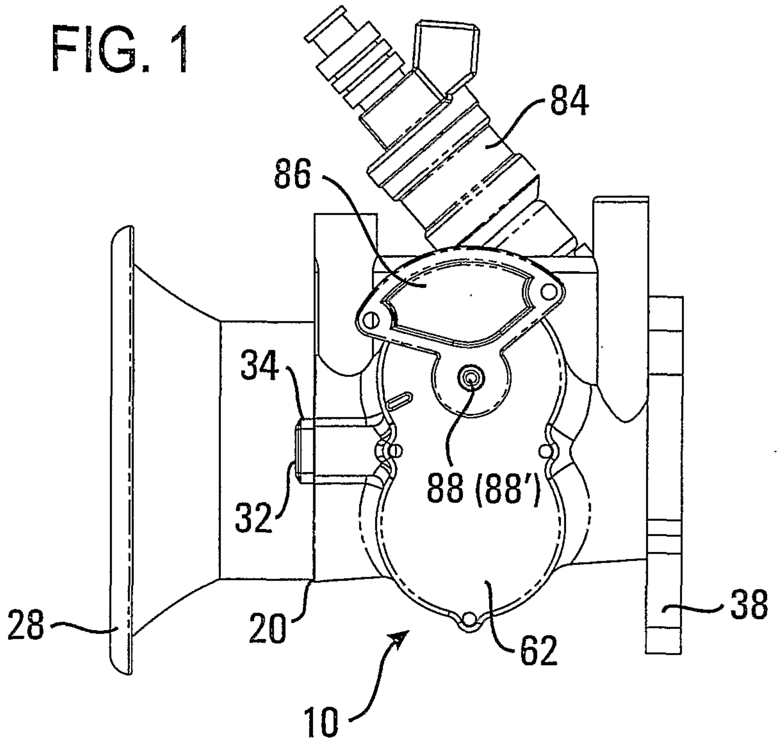
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FIG. 2

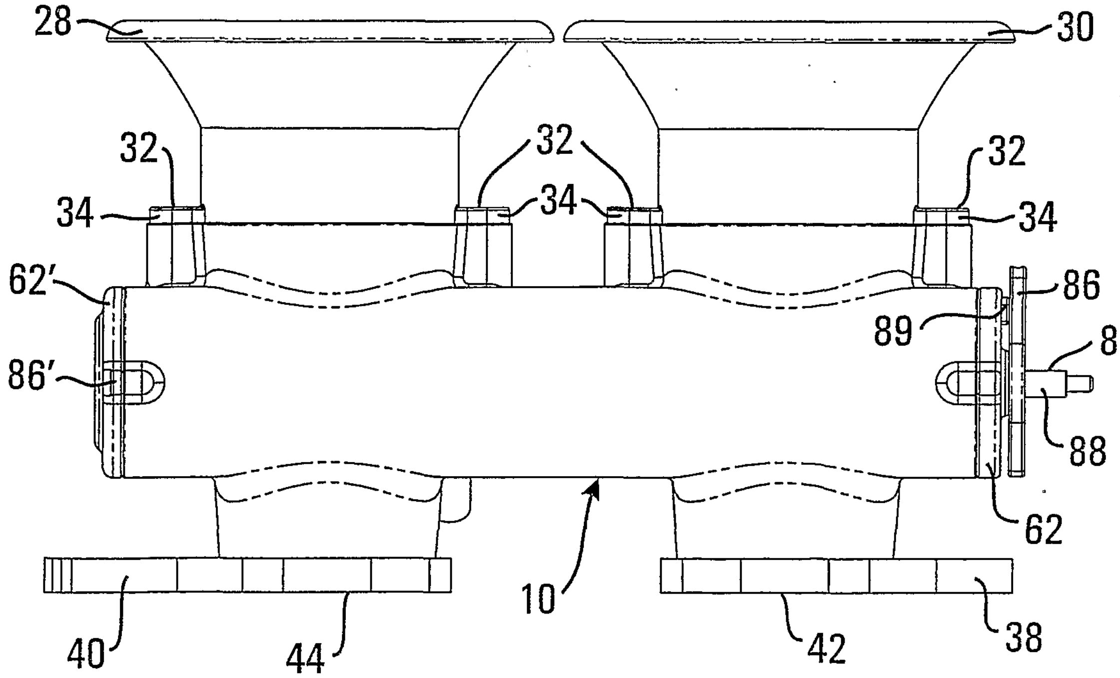
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FIG. 3

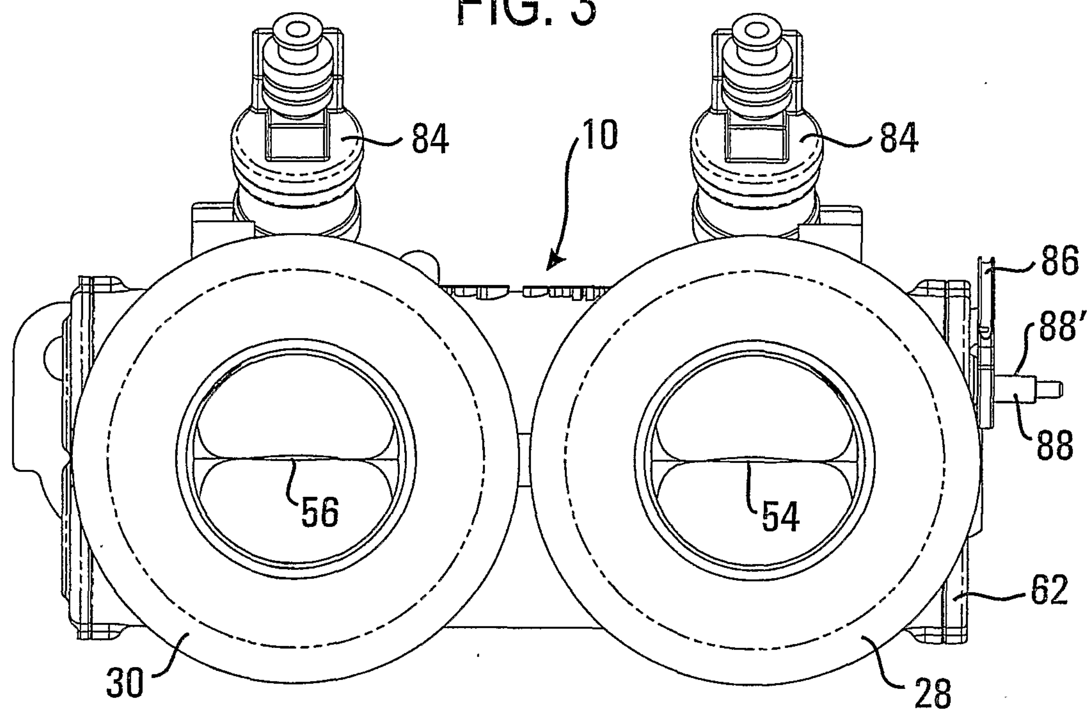
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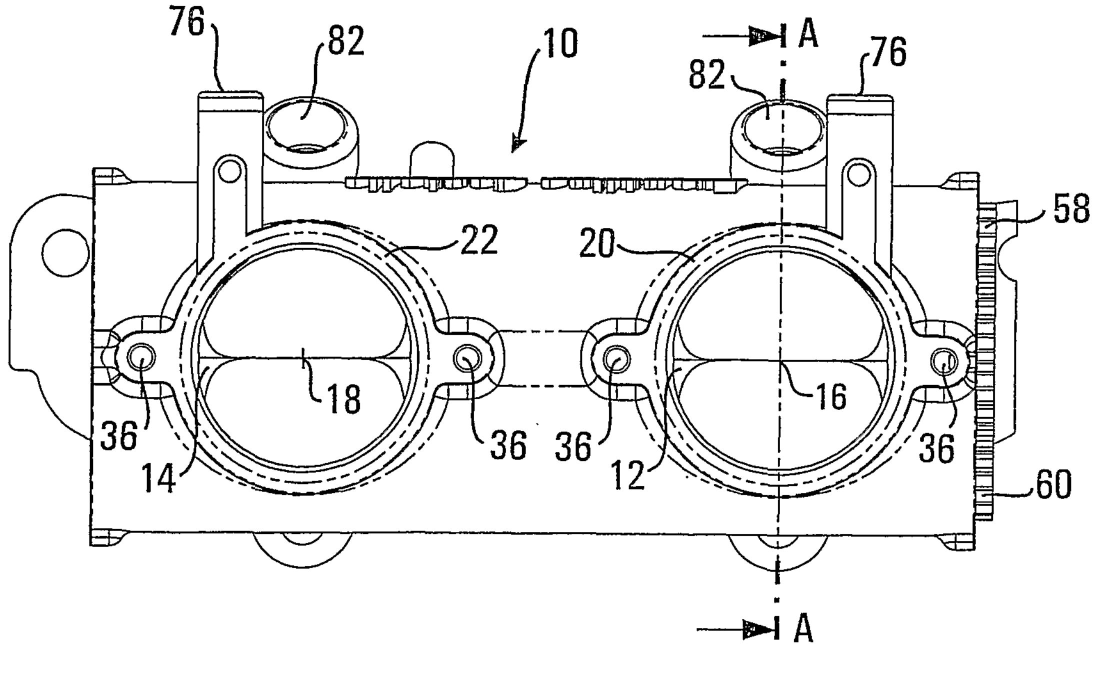
FIG. 4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12
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A

FIG. 5A

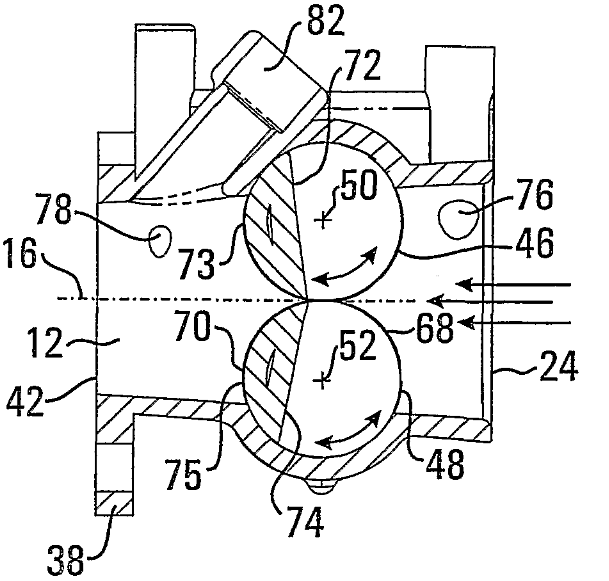


FIG. 5B

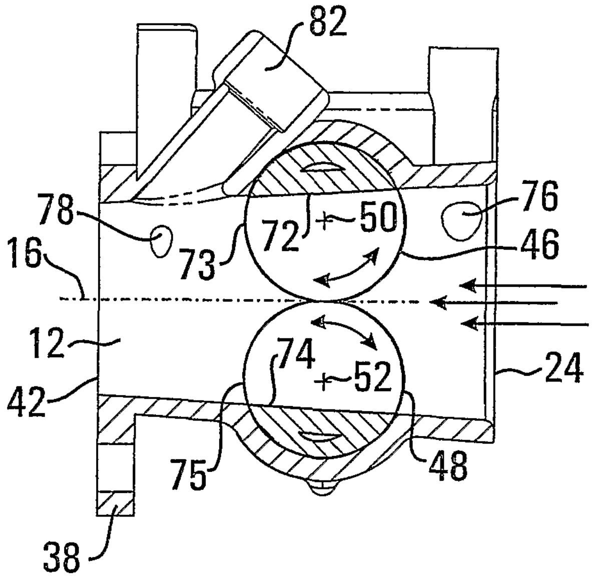


FIG. 6

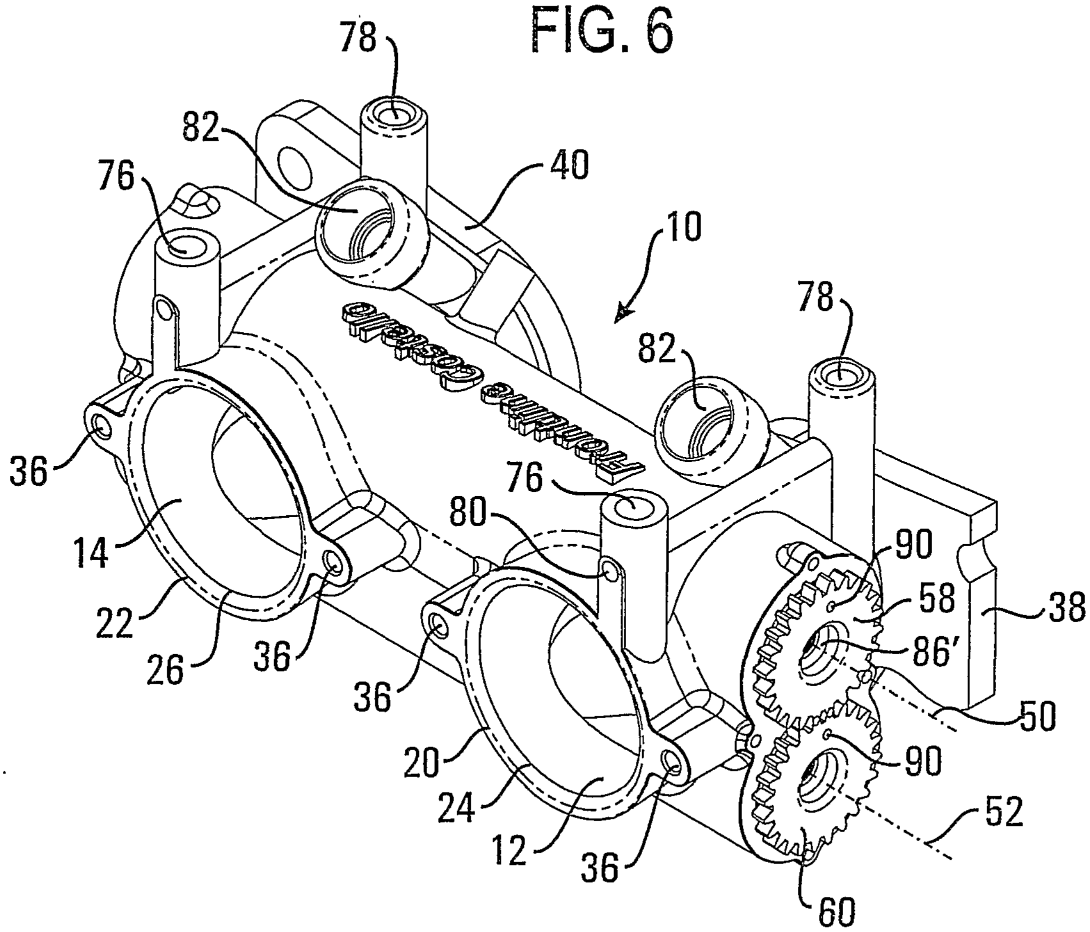


FIG. 7A

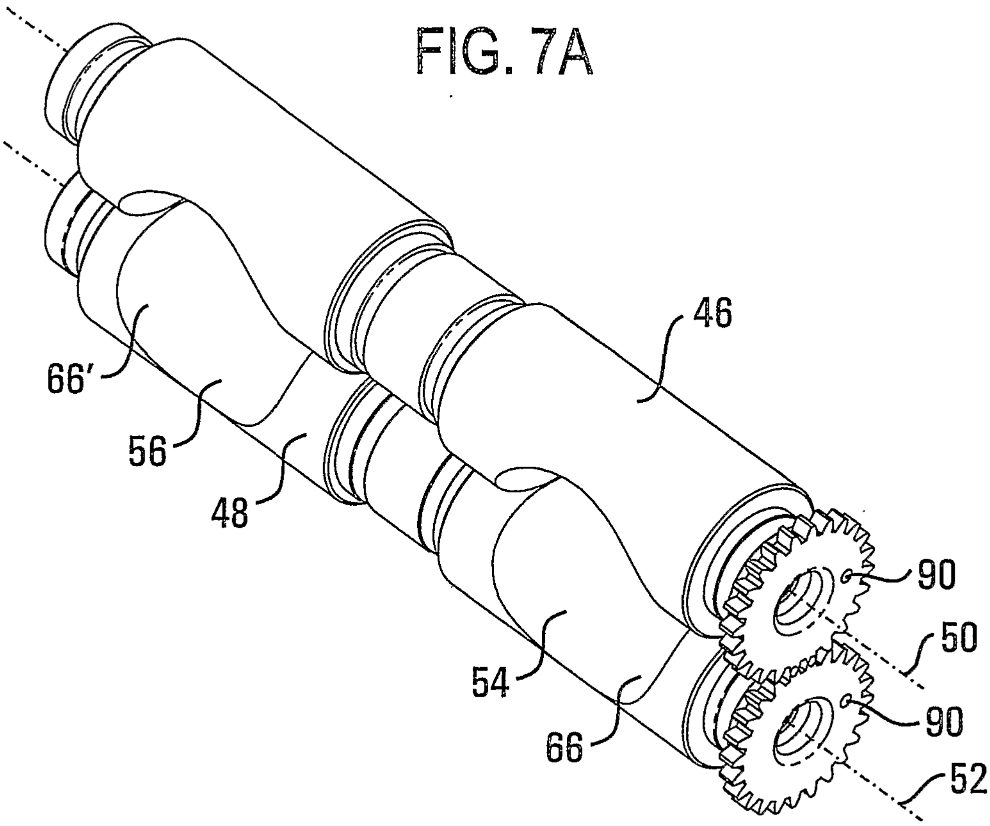


FIG. 7B

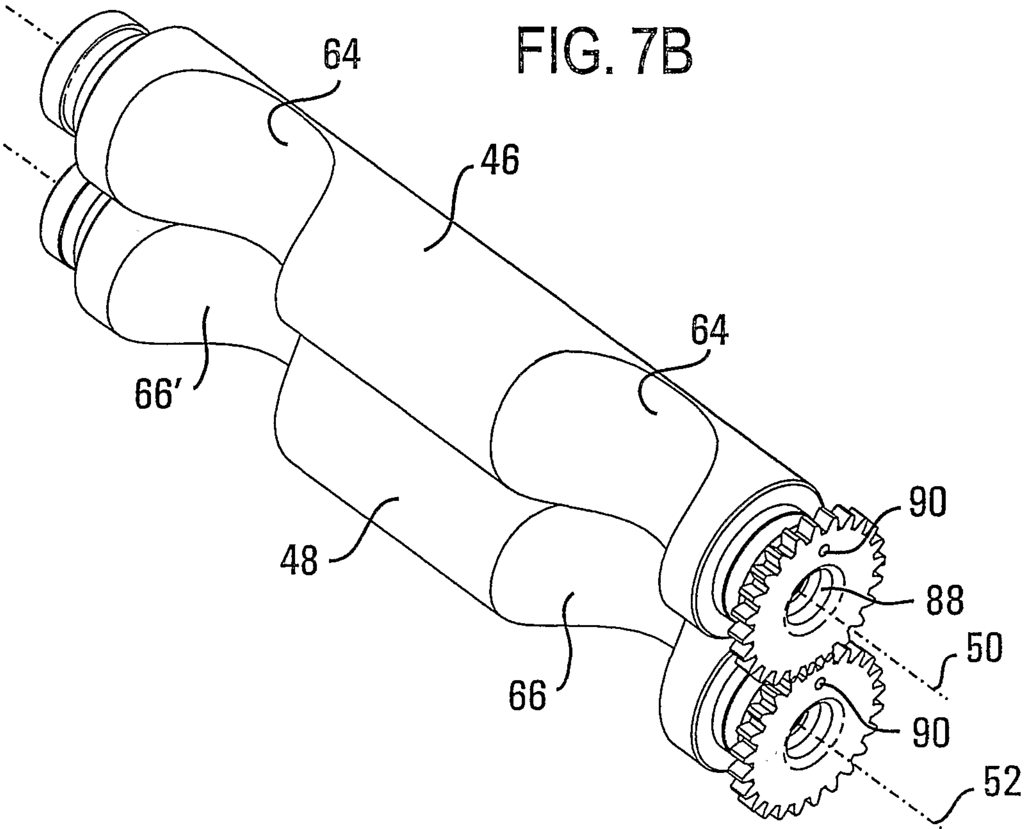


FIG. 8

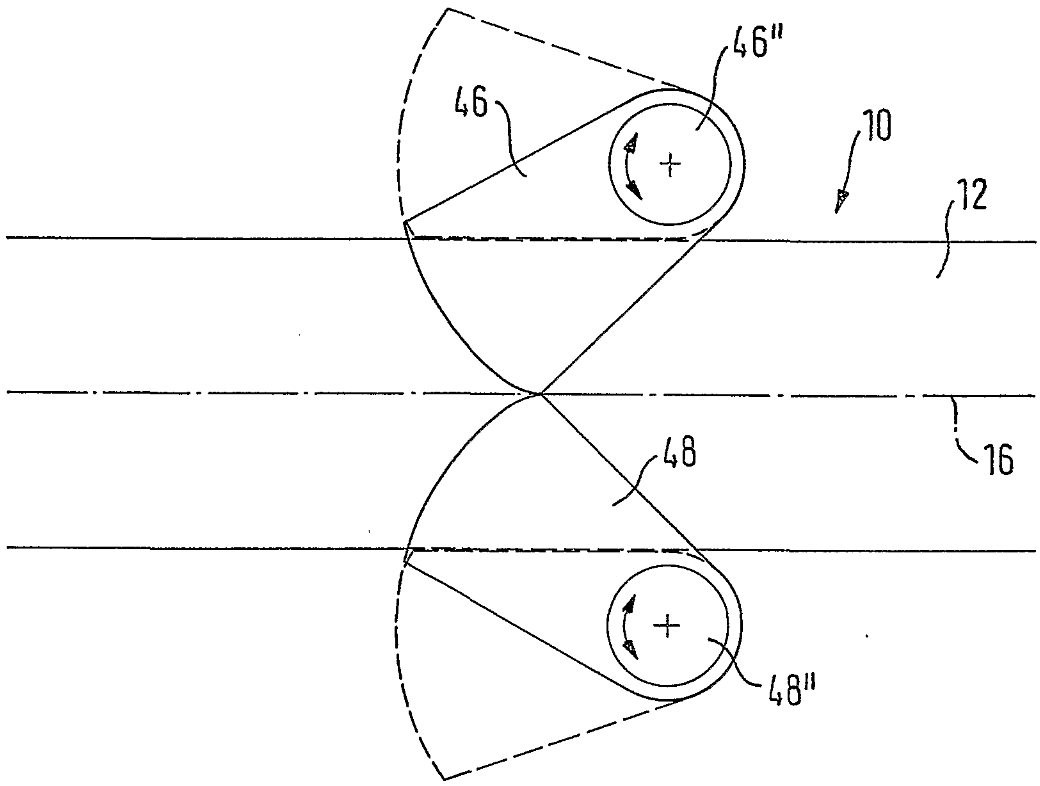


FIG. 9

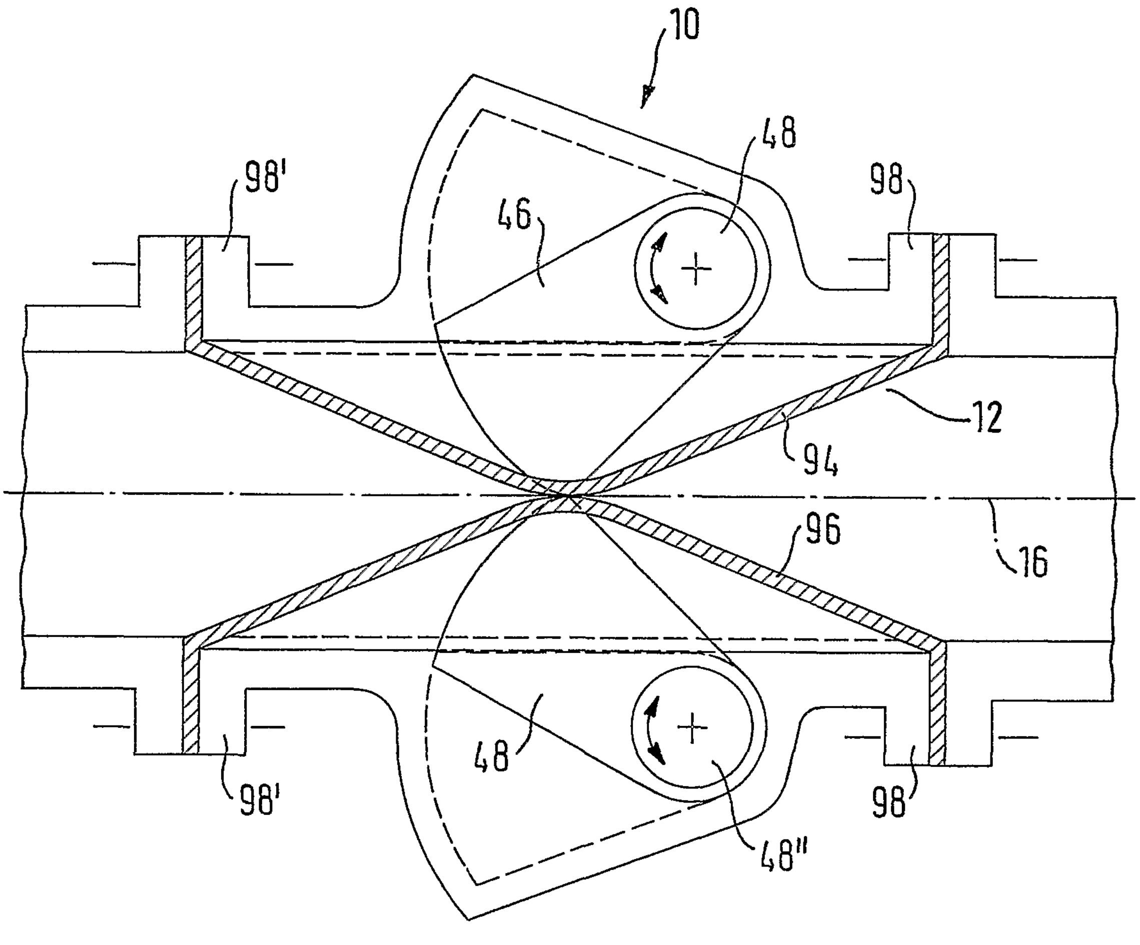
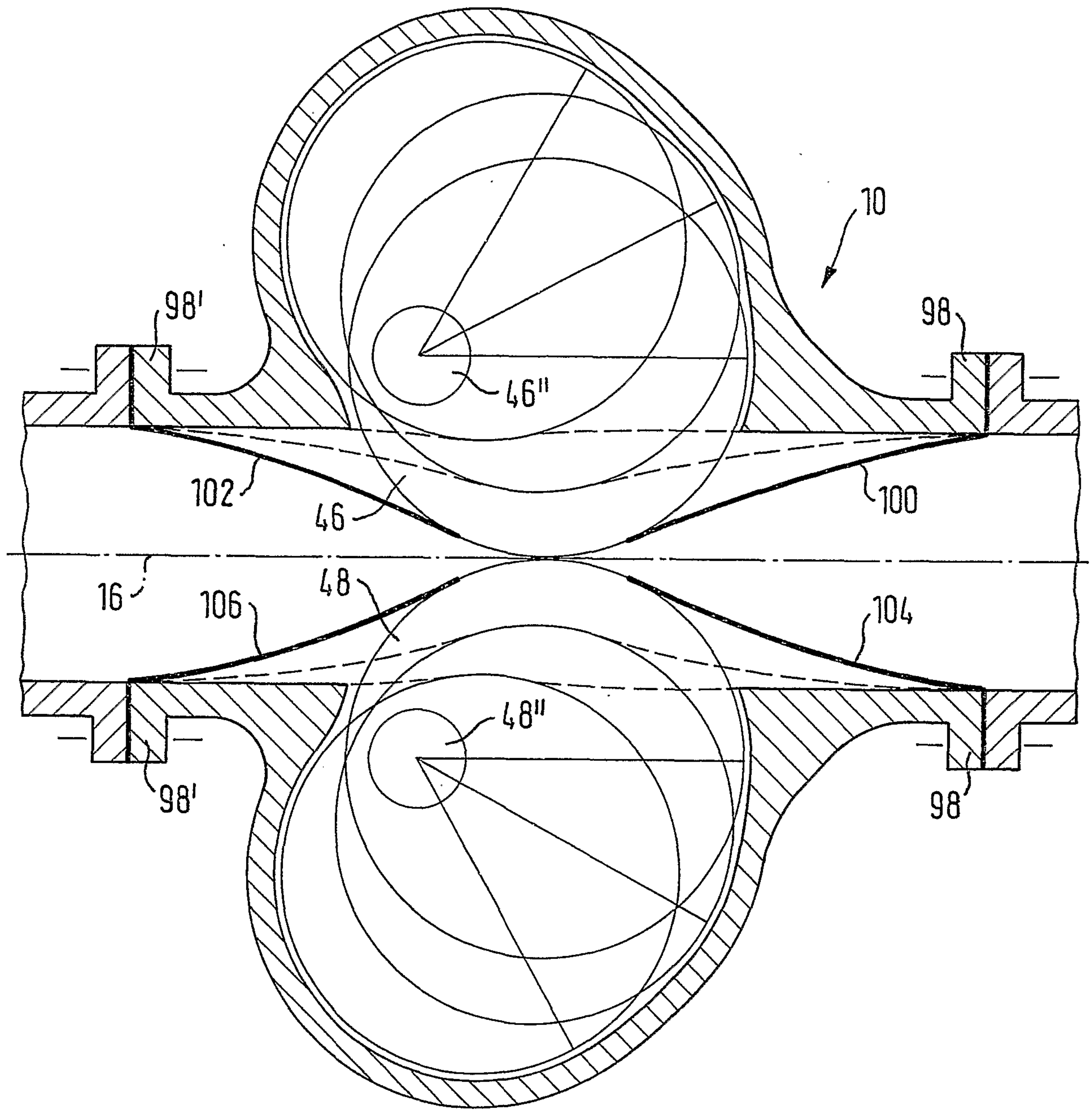


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2005/012262

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16K1/16 F16K7/06 F02D9/16 F02D9/18
ADD. F02M35/10

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16K F02D

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97/06375 A (HORTON, PAUL, RICHARD) 20 February 1997 (1997-02-20) page 8, line 5 - page 15, line 18; figures -----	1-6,10, 11,15, 18, 20-34, 38-41
X	US 5 573 223 A (KAWABE ET AL) 12 November 1996 (1996-11-12) column 5, line 6 - column 13, line 27; figures 1-15 -----	1-10,18, 20,22, 24-26, 31,36-41

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 July 2006	24/07/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Ceuca, A-N

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 37 33 441 C1 (BAYERISCHE MOTOREN WERKE AG, 8000 MUENCHEN, DE) 29 December 1988 (1988-12-29) column 2, line 50 - column 3, line 56; figure 1	1,2,7, 10, 13-17, 24-26, 33-35, 37-41
X	EP 1 388 652 A (PIERBURG GMBH) 11 February 2004 (2004-02-11) paragraph [0012] - paragraph [0021]; figures 3-6	1,10,11, 13-17, 26-35, 38-41
E	GB 2 414 060 A (* PRO TUNE LTD; PRO TUNE LTD) 16 November 2005 (2005-11-16) the whole document	1-41

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2005/012262

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US 5573223	A	12-11-1996	NONE		
DE 3733441	C1	29-12-1988	NONE		
EP 1388652	A	11-02-2004	DE	10236393 A1	04-03-2004
GB 2414060	A	16-11-2005	NONE		