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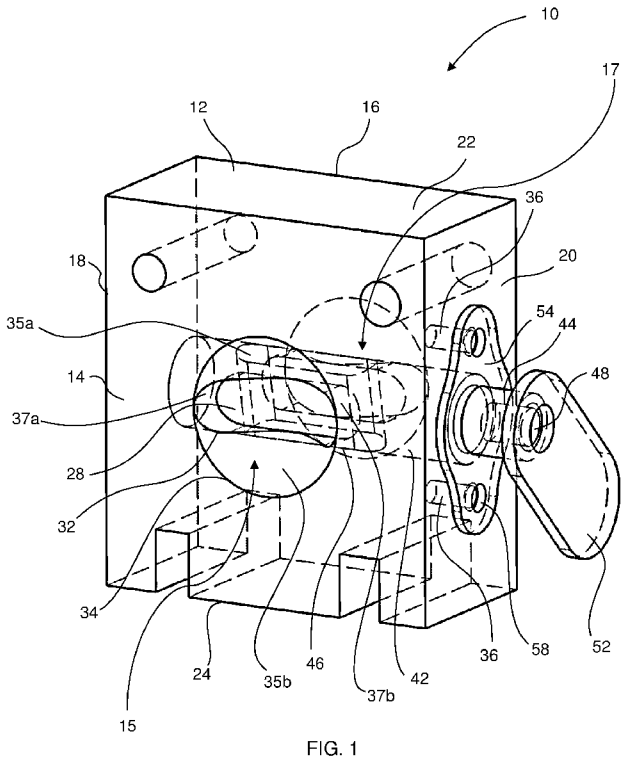


FIG. 1

(57) Abstract: A valve is provided for use in an exhaust gas stream. The valve comprises a housing, the housing comprising an inlet with an inlet aperture, an outlet with an outlet aperture, the outlet opposing the inlet; and a bore intersecting the inlet aperture and the outlet aperture to allow communication between the inlet and the outlet via the bore. The valve also comprises a valve member located within the bore of the housing, wherein the valve member comprises a spindle or shaft body with a slot extending through the body to define a fluid flow pathway therethrough, the valve member being rotatable within the bore, for alignment of the fluid flow pathway relative to the inlet aperture and the outlet aperture, between an open position and a closed position. An exhaust gas system and vehicle having an engine exhaust are also provided.

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VALVE WITH SLOT

TECHNICAL FIELD

This disclosure relates to a valve for controlling the passage of hot gases through a duct, e.g. an Exhaust Gas Recirculation (EGR) valve for use in an exhaust gas system. This valve would be of particular use in a vehicle, between an engine block and an engine after-treatment system for reducing Nitrous Oxide, and other harmful emissions. It could be upstream from the turbine of a turbocharger (either in the exhaust manifold or separate from the exhaust manifold), or downstream from the turbine of a turbocharger.

BACKGROUND TO THE INVENTION

Valves are used to control the passage of exhaust gases from internal combustion engines. Such valves may be used, for example, in exhaust brakes, thermal management systems, waste heat recovery systems, exhaust gas recirculation (EGR) valves and EGR bypass valves.

Typically, butterfly valves are used. The present invention provides an alternative solution which has one or more advantages over butterfly valves.

SUMMARY OF THE INVENTION

A first aspect of the invention relates to a valve for use in an exhaust gas stream. The valve comprises:

a housing comprising:

an inlet with an inlet aperture,

an outlet with an outlet aperture, the outlet opposing the inlet; and

a bore intersecting the inlet aperture and the outlet aperture to allow communication between the inlet and the outlet via the bore; and

a valve member located within the bore of the housing,

wherein the valve member comprises a spindle or shaft body with a slot extending through the body to define a fluid flow pathway therethrough, the valve member being rotatable within the bore, for alignment of the fluid flow pathway relative to the inlet aperture and the outlet aperture, between an open position and a closed position,

wherein the inlet further comprises an inlet guide to guide fluid towards the inlet aperture, the inlet guide tapering towards the inlet aperture; and/or the outlet

further comprises an outlet guide to guide fluid away from the outlet aperture, the outlet guide tapering away from the outlet aperture.

As the valve member is moved in use, fluid passing through the valve can be throttled, e.g. by the orientation of the valve member.

The term 'open position' used herein is intended to define a 'fully open' condition of the valve, that is to say, where a maximum flow of fluid is permitted to pass through the valve, in use.

By guiding the fluid through the valve the flow is enhanced.

In embodiments, the slot has an elongate profile with a longitudinal axis parallel to the longitudinal axis of the spindle or shaft body.

In embodiments, the inlet aperture has an elongate profile with a longitudinal axis parallel to the longitudinal axis of the slot and the inlet aperture having a linear central region, a first curved end region and second curved end region.

In embodiments, the inlet guide comprises a surface inclined towards the linear central region of the inlet aperture and thereby guide fluid towards the central region of the inlet aperture

In embodiments, the inlet guide comprises a first curved surface extending around the first curved end region and a second curved surface extending around the second curved end region, wherein the first curved surface and second curved surface are complimentary to the respective curved end regions and guide fluid towards the inlet aperture.

In embodiments, the outlet aperture has an elongate profile with a longitudinal axis parallel to the longitudinal axis of the slot and the outlet aperture having a linear central region, a first curved end region and second curved end region.

In embodiments, the outlet guide comprises a surface inclined towards the linear central region of the outlet aperture and thereby guide fluid away from the central region of the outlet aperture

In embodiments, the outlet guide comprises a first curved surface extending around the first curved end region and a second curved surface extending around the second curved end region, wherein the first curved surface and second curved surface are complimentary to the respective curved end regions and guide fluid away from the outlet aperture.

In use, the inclined and curved surfaces help to ensure laminar flow and minimise frictional fluid losses through the valve.

In embodiments, the inlet guide circumscribes the inlet aperture and/or the outlet guide circumscribes the outlet aperture.

In embodiments, the inlet has a circular outer perimeter and/or the outlet has a circular outer perimeter.

In embodiments, the inlet and outlet are arranged to define a common flow axis for fluid passing through the valve, and wherein the fluid flow pathway of the valve member defines a through axis, wherein the through axis of the fluid flow pathway and the common flow axis are aligned when the valve member is in the open position.

In embodiments, the slot, inlet aperture and outlet aperture are flush when the valve member is in the open position. In other words, in the open condition, the valve is 'full-bore'.

In embodiments, the fluid flow pathway of the valve member faces internal surfaces of the bore when the valve member is in the closed position, i.e. the through axis is offset from the common flow axis.

In embodiments, the longitudinal axis of the spindle or shaft is orthogonal to the longitudinal axis of the fluid flow pathway of the slot.

According to a second aspect of the invention, there is provided a valve for use in an exhaust gas stream, the valve comprising:

a housing having an inlet, an outlet and a bore, the inlet being in communication with the outlet via the bore; and

a valve member located within the bore of the housing;

wherein the valve member has a fluid flow pathway therethrough, and the valve member is movable within the bore for alignment of the pathway between an open position and a closed position.

In embodiments of any aspect of the valve, a fluid flow pathway extends through the valve member itself. Therefore, as the valve member is moved in use, fluid passing through the valve can be throttled, e.g. by the orientation of the valve member.

In embodiments of any aspect of the valve, the inlet and outlet are arranged to define a common flow axis for fluid passing through the valve, and the fluid flow pathway of the valve member defines a through axis which is aligned with the common flow axis of the valve, when the valve member is in the open position.

The term 'open position' used herein is intended to define a 'fully open' condition of the valve, that is to say, where a maximum flow of fluid is permitted to pass through the valve, in use.

In embodiments of any aspect of the valve, each of the inlet and outlet defines an aperture having a perimeter. The fluid flow pathway in the valve member defines inlet and outlet openings, each having a perimeter. The perimeter of the inlet and outlet openings is flush with or within the perimeter of the inlet and outlet apertures when the valve member is in the open position.

In other words, in the open condition, the valve is 'full-bore'.

Advantageously, no butterfly valve is required, as the orientation of the fluid flow pathway in the valve member itself determines whether fluid is permitted to pass through. This is a simple solution that requires less components than using a butterfly valve, is easy to assemble, and the internal friction is lower than when using a butterfly valve so less torque is required to move the valve member between its open and closed positions.

In embodiments of any aspect of the valve, in the closed position, the through axis of the fluid flow pathway is arranged in the direction of an internal surface of the bore, i.e. offset from the common flow axis.

Advantageously, in the closed position, the through axis of the fluid flow pathway is out of alignment with the inlet and the outlet of the valve, so substantially no fluid flow is permitted through the valve. The possible flow path defined in the clearance between the external surface of the valve member and the bore of the housing can be minimised by precision manufacturing of the components. Moreover, this arrangement creates a tortuous path which will have the effect of minimising potential leakage.

In embodiments of any aspect of the valve, the valve further comprises a controller for moving the valve member between the open position and the closed position.

In embodiments of any aspect of the valve, the volume of fluid flow permitted through the valve is varied by controlling the position of the valve member. This enables fine control of the fluid flow through the valve. In exemplary embodiments, the controller is configured to move the valve member to one or more intermediate positions between the open position and the closed position.

In embodiments of any aspect of the valve, the controller is a linkage coupled with an end of the valve member.

In embodiments of any aspect of the valve, the valve member is connected to, for example, an actuator, for automatic operation, via the linkage. In exemplary embodiments, the valve member has a free end extending from bore, and the linkage is connected to said free end.

In embodiments of any aspect of the valve, the valve member is rotatable in the bore. The valve member is arranged within the bore so that the open position is a first rotational orientation of the valve member.

In embodiments of any aspects of the valve, the closed position is a second rotational orientation of the valve member.

In embodiments of any aspects of the valve, the valve member is configured for continuous rotation within the bore.

In embodiments of any aspects of the valve, in use, rotating the valve member in a first direction causes the valve member to move from the first rotational

orientation to the second rotational orientation, and continuing to rotate the valve member in the first direction causes the valve member to move from the second rotational orientation back to the first rotational orientation.

In embodiments of any aspects of the valve, the fluid flow pathway is a slot that extends through the valve member.

In embodiments of any aspects of the valve, the area of the profile of the slot is smaller than the area of the profile of the inlet of the housing.

Advantageously, this can help to reduce the internal leakage of fluid within the valve, by helping to direct fluid to pass through the slot, and help to prevent fluid from passing around the outside of the valve member and out through the bore, i.e. leaking.

In embodiments of any aspect of the valve, the slot has a substantially stadium-shaped profile i.e. the slot has two substantially parallel sides connected by two curved ends.

In embodiments of any aspect of the valve, the inlet and the outlet have a substantially stadium-shaped profile, i.e. the inlet and outlet have two substantially parallel sides connected by two curved ends.

Advantageously, the stadium-shape of the slot, inlet and outlet simplifies the manufacturing process, enabling cost savings to be made compared to alternative shapes, for example, rectangular. It should be understood, however, that it not essential that the slot, the inlet and/or the outlet are stadium shaped; they can be any shape that generates the desired flow rate and pressure drop characteristics across the valve. For example, the slot, the inlet and/or the outlet could be rectangular, square, or made up of a series of discreet apertures, e.g. circular apertures, and still perform their required function.

In embodiments of any aspects of the valve, the inlet and outlet are formed in substantially circular recesses in the housing of the valve.

In embodiments of any aspects of the valve, the valve member is a spindle or a shaft of circular cross-section.

In embodiments of any aspects of the valve, the longitudinal axis of the spindle or shaft is orthogonal to the through axis of the fluid flow pathway.

In embodiments of any aspects of the valve, the spindle or shaft have an end portion of reduced cross-sectional area. Preferably, the valve further comprises a cap configured to fit over the end portion of the spindle, the cap being secured to the housing to retain the spindle within the bore of the housing.

In embodiments of any aspects of the valve, the housing comprises front, back and side surfaces, the inlet and the outlet being in the front and back surfaces respectively, and the bore extending through the housing from one of the side surfaces.

In embodiments of any aspects of the valve, the bore is a blind bore that only extends part-way through the housing from one of the side surfaces.

Advantageously, this reduces the number of possible leakage paths for fluid, reducing the amount of leakage from the valve in use.

Another aspect of the invention provides an exhaust gas system for a vehicle, comprising a conduit for conveying an exhaust gas stream and a valve in communication with the conduit, wherein the valve is according to the valve of any previous aspect of the invention.

A final aspect of the invention provides a vehicle having an engine exhaust, a conduit for the passage of an exhaust gas stream from the exhaust, and a valve in communication with the conduit, wherein the valve is according to the valve of any previous aspect of the invention.

Other features and aspects of the invention will be apparent from the claims and the following description of exemplary embodiments, made with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a perspective view of a valve according to an embodiment of the invention;

Figure 2 is an exploded perspective view of the valve of figure 1;

Figure 3 is a front view of the valve of figure 1, with a shaft of the valve shown in a first rotational orientation;

Figure 4 is a cross-sectional view through the plane A-A of figure 3;

Figure 5 is a close-up view of the section A of figure 4;

Figure 6 is a front view of the valve of figure 1, with a shaft of the valve shown in a second rotational orientation;

Figure 7 is a cross-sectional view through the plane B-B of figure 6;

Figure 8 is a close-up view of the section B of figure 4;

Figure 9 is a perspective view of an alternative valve, with discrete circular slots in a shaft of the valve;

Figure 10 is a perspective view of an alternative valve, with a rectangular slot in a shaft of the valve;

Figure 11 is a perspective view of an alternative valve, with an offset rectangular slot in a shaft of the valve; and

Figure 12 is a perspective view of an alternative valve, with a circular slot in a shaft of the valve.

DESCRIPTION OF EMBODIMENTS

Referring firstly to Figures 1 and 2, a valve is indicated generally at 10. The valve 10 has a housing 12 with an inlet 15 and an outlet 17. The inlet 15 is in communication with the outlet 17, via a bore 26 in the housing 12. As will be described in more detail below, a valve member is located within the bore of the housing 12. The valve member has a fluid flow pathway extending therethrough. In use, the valve member is movable within the bore 26 for alignment of the fluid flow pathway relative to the inlet aperture and outlet aperture between an open position and a closed position. Hence, when the valve 10 is part of an exhaust gas system, for example, fluid will enter the inlet 15, and may pass through or be blocked from passing through to the outlet 17, dependent on the orientation of the pathway through the valve member. As such, the valve member can be used to throttle flow through the valve 10.

In this embodiment, the valve housing 12 is generally rectangular-shaped, having front and back surfaces 14, 16, side surfaces 18, 20, and top and bottom surfaces 22, 24. The inlet 15 is located on the front surface 14 of the valve 10, and the outlet 17 is located on the back surface 16 of the valve 10.

In this embodiment, the bore 26 extends from one of the side surfaces 20 towards the other side surface 18, i.e. it has a longitudinal axis orthogonal to the fluid path defined between the inlet 15 and outlet 17. The bore 26 is a blind bore, so terminates before reaching the side surface 18.

The interrelationship between the bore 26 and the inlet 15 and outlet 17 defines opposing longitudinal openings 28, 30 in the bore 26 (best shown in Figure 2), which connect the bore 26 to the inlet and outlet 15, 17, i.e. an inlet aperture and an outlet aperture. In this embodiment, the openings 28,30 have an elongate profile with a longitudinal axis. The inlet and outlet openings 28, 30 each have an end region at each longitudinal end, and a central region intermediate the end regions. In this embodiment, the openings 28, 30 are both generally stadium-shaped in profile, with two flat sides connected by semi-circular parts.

The inlet 15 defines a mouth 32 for the opening 28 on the front surface 14 of the housing 12, whereas the outlet 17 defines a mouth 33 for the opening 30 in the back surface 16 of the housing 12.

In this embodiment, the mouth 32 is in a circular recessed portion 34 of the front surface 14 of the housing. The recessed portion 34 of the front surface is concave, generally tapering towards its centre, in profile (as can be seen in figure 3, for example). The recessed portion of the front surface 14 acts a guide to guide fluid towards the opening 28.

The mouth 33 is in a circular recessed portion of the back surface 16 of the housing. The recessed portion of the back surface 16 is concave, generally tapering towards its centre, in profile (as can be seen in figure 4, for example). The recessed portion of the back surface 16 acts as a guide to guide fluid away from the opening 30.

In this embodiment, to guide fluid towards the opening 28, the recessed portion of the front surface 14 has an upper inclined surface 35a inclining towards an upper edge of the central region of the opening 28 and a lower inclined surface 35b

inclining towards a lower edge of the central region of the opening 28. To guide fluid towards the end regions of the opening 28, the recessed portion of the front surface 14 has curved surfaces 37a, 37b extending around the respective end regions. This can be seen most clearly in Figures 1 and 4.

Likewise, to guide fluid away from the opening 30, the recessed portion of the back surface 16 has an upper inclined surface 35a inclining outwardly from an upper edge of the central region of the opening 30 and a lower inclined surface 35b inclining outwardly from a lower edge of the central region of the opening 30. To guide fluid away from the end regions of the opening 30, the recessed portion of the back surface 16 has curved surfaces 37a, 37b extending around the respective end regions. This can be seen most clearly in Figure 4. In use, for fluids travelling through the valve, the recessed portions in the front surface 14 and back surface 16 , and particularly the inclined and curved surfaces, help to ensure laminar flow and minimise frictional fluid losses through the valve.

In Figures 1, 2 and 3, it can be seen that the curved surfaces 37a, 37b extend towards the respective end regions in a direction parallel with a central axis Y that passes through the openings 28, 30 (see figure 3). The curved surfaces 37a, 37b in effect 'extend' the internal side surfaces of the slot, which help to keep flow through the slot laminar, as there are no major profile changes to overcome, which can turn the flow turbulent. This helps to reduce energy losses within the valve in use.

The circular concave shape of the recessed portions defines areas for aiding connection of further components to the inlet 15 and outlet 17 of the valve 10, e.g. pipes/hoses carrying fluid.

In this embodiment, the shape and configuration of mouth 33 on the back surface 16 is identical to the shape and configuration of the mouth 32 on the front surface 14, so will not be described in any further detail.

It can be seen that there is therefore an open path defined between the front surface 14 and the back surface 16 of the housing 12, e.g. for fluid to pass through the valve 10 (described in more detail below).

In this embodiment, a plurality of further bores 36 are included in the side surface 20, with at least one on either side of the bore 26. The further bores 36 are blind bores, configured for securing a retaining cap to the housing 12 (described in more detail below).

A number of other bores and cut outs can also be included in the housing 12, but will not be described in detail. For example, one or more bores can extend from the front surface 14 to the back surface 16, adjacent the top of the housing 12, for inserting fastening members, e.g. bolts, for securing the valve 10 within an exhaust system. Similarly, one or more cut-outs may be included in the bottom surface 24 of the housing 12, e.g. to help seat the valve 10 within an exhaust system.

Typically, the housing 12 will be machined from a solid block of material, e.g. steel. In exemplary embodiments, the bore 26 and the openings 28, 30 will be formed in the housing 12, before the mouth and recessed portions are added to the front and back surfaces 14, 16. This will result in very little wasted material during manufacturing of the housing 12.

As mentioned above, a valve member is located in the bore 26, for use in throttling fluid (typically gases) passing through the valve 10. In this embodiment, the valve member takes the form of a spindle 40, and is rotatable within the bore 26, e.g. via bearings (not shown) within the bore. It should be noted, however, that bearings are not essential. The spindle 40 is defined by a main shaft 42 and a projecting portion 44. In this embodiment, the shaft 42 and the projecting portion 44 are both cylindrical, with the projecting portion 44 extending along, and being concentric with, the same longitudinal axis as the shaft 42; the projecting portion 44 being integral with the shaft 42. Alternatively, the two parts could be provided separately before being fixed together. The projecting portion 44 has a smaller diameter than the shaft 42, such that an end surface of the shaft creates an annular surface 45 surrounding the projecting portion 44, for engaging a retaining cap (described below).

When the valve is assembled, the shaft 46 extends longitudinally in the bore further than the openings 28, 30. In other words, as can be seen most clearly in Figure 1, the free end of the shaft 42 opposite the projecting portion 44 is closer to the side surface 18 than the closest longitudinal ends of the openings 28, 30. This helps to

ensure that there is no alternative flow path through the valve for fluid to leak through, i.e. it improves the seal of the valve member in the valve.

The shaft 42 includes a longitudinal slot 46. The slot 46 extends transversely through the shaft 42. In this embodiment, the slot 46 has an elongate profile, the profile having a longitudinal axis that is parallel to the longitudinal axis of the shaft 42. In this embodiment, the slot 46 has a constant cross-section, with a generally stadium-shaped profile, i.e. a profile that matches the shape of the openings 28, 30 on the housing 12. Therefore, it can be seen that if the slot 46 of the shaft 42 lines up with the openings 28, 30, a smooth path is defined through the housing 12, from the front surface 14 of the housing 12, through the spindle 40, to the back surface 16 of the housing 12. Advantageously, if the slot 46 and the openings 28, 30 line up, a smooth flow path will be defined through the valve 10 from the inlet 15 to the outlet 17. The smooth transition from the housing to the slot will minimise turbulence and reduce the risk of energy loss as fluid passes through the valve 10 in use.

In other words, the inlet 15 and outlet 17 each define an aperture having a perimeter, and the fluid flow pathway in the valve member defines the inlet and outlet openings 28, 30, each also having a perimeter. When the valve member is in an open position (described in more detail below), the perimeter of the inlet and outlet openings 28, 30 is flush with or within the perimeter of the inlet and outlet apertures.

In this embodiment, the longitudinal length of the slot 46 is the same as the longitudinal length of the openings 28, 30 of the housing 12, but it will be appreciated that the longitudinal length could be varied.

The projecting portion 44 has a longitudinal bore 48 at a longitudinal end opposite the shaft 40, for attaching a lever 52 to the spindle 40. The lever 52 enables a user to easily operate the spindle 40 in use, to rotate the spindle 40 within the bore 26 of the housing 12. The lever 52 can be attached to the projecting portion 44 of the spindle with any suitable fastening member, e.g. a bolt. Further, the lever 52 can also be connected to an actuator, for example. This would enable the valve 10 to be electronically controlled, or otherwise automated, e.g. in communication with a control system.

A cap 54 retains the spindle 40 within the bore 26 of the housing 12. In this embodiment, the cap 54 is generally lemon-shaped and includes a central hole 56 arranged intermediate two further holes 58. The central hole 56 has a larger diameter than the further holes 58, and is dimensioned to fit on the projecting portion 44 of the spindle 40. The further holes 58 are arranged such that, when the cap 54 is placed on the projecting portion of the spindle 40, the further holes 58 line up with the bores 36 on the side surface 20 of the housing 20, such that fastening members can be used to secure the cap 54 to the housing 12, retaining the spindle 40 within the bore 26 of the housing 12.

To assemble the valve 10, the spindle 40 is inserted inside the bore 26 of the housing 12, until the slot 46 is generally aligned (in the axial direction) with the openings 28, 30. When the spindle 40 is correctly located, the shaft 42 will be substantially within the bore 26, and the projecting portion 44 will protrude from the opening of the bore. The shaft 42 and bore are dimensioned such that the annular surface 45 of the spindle 40 lines up with the side surface 20 of the housing 12 when the spindle 40 is correctly located, to define a substantially planar surface. The cap 54 is placed on to the projecting portion 44 until it abuts the annular surface 45 and the side surface 20 of the housing 12. Fastening members, e.g. screws, are placed through the further holes 58 of the cap 54 and into the bores 36 in the side surface 20 of the housing 12, to secure the cap 54 to the housing 12. Therefore, the cap 54 retains the spindle 40 within the bore 26 of the housing 12. Finally, the lever 52 is attached to the projecting portion 44 of the spindle 40 as previously described, e.g. by passing a bolt through an opening in the lever 52 and into the bore 48 of the projecting portion 44 of the spindle 40.

A user can operate the lever 52 to rotate the spindle 40 within the bore 26 of the housing 12. The shaft 42 of the spindle 40 has a first rotational orientation where the slot 46 is aligned with the openings 28, 30 to define a fluid flow path through the valve 10, i.e. a central through axis X passing through the slot 42 aligns with the central axis Y passing through the openings 28, 30 (see figure 3). Figures 3 and 4 show the shaft 42 in the first rotational orientation. It can be seen that in this embodiment, the depth of the slot 46 is lower than the width of the openings 28, 30.

The shaft 42 of the spindle 40 also has a second rotational orientation where the slot 46 is arranged relative to the openings 28, 30 such that the slot 46 is no longer

aligned with the openings 28, 30, and the fluid flow path through the valve 10 is closed off. Figures 5 and 6 show the shaft 42 in the second rotational orientation. In this embodiment, in the second rotational orientation, the shaft has been rotated by 90 degrees relative to the orientation of the shaft in the first rotational orientation. Therefore, the central axis X of the slot 46 is perpendicular to the central axis Y of the openings 28, 30 and, in use, the fluid flow through the valve is blocked by the external surface of the shaft 42.

Between the first and second rotational orientations of the shaft 42 are an unlimited number of intermediate rotational orientations of the shaft 42. In any of the intermediate rotational orientations of the shaft, the fluid flow through the valve 10 in use is partially throttled as the slot 46 is not completely aligned with the openings 28, 30, e.g. the central axis X of the slot 46 is at 30 degrees to the central axis Y of the openings 28, 30. The result of the shaft being in an intermediate rotational orientation and the slot 46 not being fully aligned with the openings 28, 30 is that the cross-sectional area of the fluid flow path defined between the first and second openings 28, 30 is reduced relative to the cross-sectional area of the fluid flow path defined between the first and second openings 28, 30 when the shaft 42 is in the first rotational orientation. The flow-rate of fluid passing through the valve 10 reduces proportionally to the reduction in cross-sectional area, assuming the flow velocity stays the same. Therefore, in use, the flow-rate of the fluid permitted through the valve 10 in this intermediate rotational orientation is reduced relative to the flow-rate permitted when the shaft is in the first orientation, i.e. the flow is throttled. As can be seen, the extent of throttling, i.e. the reduction in flow-rate through the valve is determined by the rotational orientation of the shaft 42.

Advantageously, during manufacture of the valve 10, the shaft 42 and bore 26 are carefully machined with tight tolerances so that the clearance between the external surface of the shaft 42 and the internal surface of the bore 26 is very small. This can help reduce the potential leakage within the valve 10. Further, the potential leakage path defined between the shaft 42 and the bore 26 out of the valve 10, e.g. out through the bore 26, is long and tortuous, which should discourage fluid from flowing down this path.

In this embodiment, the shaft 42 is configured so that it can be continuously rotated, to vary the fluid flow path defined through the valve 10 as required. Rotating the shaft 42 in a first direction rotates the shaft 42 from the first rotational

orientation to the second rotational orientation and continuing to rotate the shaft 42 in the first direction changes the shaft from the second rotational orientation back to the first rotational orientation. Therefore, in one revolution of the shaft, i.e. 360 degrees, the shaft rotates from the first rotational orientation to the second rotational orientation, and back to the first rotational orientation, twice. This can be varied as desired however, by varying the configuration of the valve 10. For example, the width of the slot 46 and/or the openings 28, 30 can be extended to require a greater degree of rotation, to rotate the shaft 46 between the first and second rotational orientations.

Alternatively, the maximum degree of rotation of the shaft 42 can be limited by, for example, including a stop on the inside of the bore 26, for engaging a corresponding projection on the shaft 42. The shaft 42 would be free to rotate in the first direction from the first rotational orientation to the second rotational orientation, but the second rotational orientation would define the maximum degree of rotation of the shaft 42. To return the shaft 42 to the first rotational orientation from the second rotational orientation, the shaft 42 would need to be rotated in a second direction that is opposite to the first direction.

Figures 9 to 12 show a number of further embodiments of the valve 10. In each of these further embodiments, the valves 110, 210, 310, 410 correspond to the valve 10, with like features indicated with like numbers, but with the prefix '1', '2', '3' or '4' as appropriate.

In each of the further embodiments, the only variant is the shape of the slot. Varying the shape of the slot can result in different fluid flow characteristics when fluid is passed through the valve in use. The variations shown in figures 9 to 12 are examples of how the shape of the slot can be varied, and are not intended to be limiting; other slot shapes can be used, as desired.

In figure 9, a number of discrete slots 146 are included in the shaft 142. Each slot 146 is circular in profile.

In figure 10, a slot 246 is included in the shaft 142, which is rectangular in profile.

In figure 11, a slot 346 is included in the shaft 342, which is rectangular in profile, but offset from the longitudinal axis of the shaft 342, so is a cut-out of an external section of the shaft 346.

In figure 12, a slot 446 is included in the shaft 442, which is circular in profile.

The materials making up the valves of figures 1 to 12 are resistant to hot exhaust gases, and typically of metal but can be any suitable material.

The valve is easy to assemble. It can also be cheaper to manufacture than the butterfly as it requires less components, e.g. no rivets are required.

The valve has appropriate dimensions for use in an exhaust gas system, or similar, i.e. appropriate to connect an exhaust hose, for example. Therefore, the diameter of the bore typically ranges from approximately 25mm to 80mm, with the housing, spindle, inlet and outlet dimensioned to suit. As a person skilled the art will recognise, valves of this type are very specialised. They are typically designed to work with inlet and outlet pipes of between 30 and 90mm. Within an exhaust systems, there is a compact space limitation due to the arrangement of the system.

Examples of relative dimensions are as follows:

For a 30mm inlet and outlet pipe diameter, a single valve housing will typically be around 30mm in length from front to back, the spindle diameter will typically be around 15mm, the slot will be about 30mm in longitudinal length with curves at either end of radii 5mm each, so 10mm in height.

For a 40mm inlet and outlet pipe diameter, a single valve housing will typically be around 33mm in length from front to back, the spindle diameter will typically be around 16.5mm, the slot will be about 40mm in longitudinal length with curves at either end of radii 5mm each, so 20mm in height.

For a 90mm inlet and outlet pipe diameter, a single valve housing will typically be around 100mm in length from front to back, the spindle diameter will typically be around 85mm, the slot will be about 90mm in longitudinal length with curves at either end of radii 30mm each, so 60mm in height.

It has been found to be advantageous that one or more of the inclined surfaces of the recessed portions of the front surface 14 and/or the back surface 16 may be inclined at around 60°.

For an exhaust gas system for a vehicle, having a conduit for conveying an exhaust gas stream and a valve in communication with the conduit, the valve can be any of the valves as described above.

For a vehicle having an engine exhaust, a conduit for the passage of an exhaust gas stream from the exhaust, and a valve in communication with the conduit, the valve can be any of the valves described above.

Although the invention has been described above with reference to one or more preferred embodiments, it will be appreciated that various changes or modifications may be made without departing from the scope of the invention as defined in the appended claims.

The embodiments described above are typically intended for use in hot exhaust gas systems, but will also have applications in other valve systems, e.g. cool gas valve systems or liquid valve systems.

Claims

1. A valve for use in an exhaust gas stream, the valve comprising:
a housing comprising:
an inlet with an inlet aperture,
an outlet with an outlet aperture, the outlet opposing the inlet; and
a bore intersecting the inlet aperture and the outlet aperture to allow communication between the inlet and the outlet via the bore; and
a valve member located within the bore of the housing,
wherein the valve member comprises a spindle or shaft body with a slot extending through the body to define a fluid flow pathway therethrough, the valve member being rotatable within the bore, for alignment of the fluid flow pathway relative to the inlet aperture and the outlet aperture, between an open position and a closed position,
wherein the inlet further comprises an inlet guide to guide fluid towards the inlet aperture, the inlet guide tapering towards the inlet aperture; and/or the outlet further comprises an outlet guide to guide fluid away from the outlet aperture, the outlet guide tapering away from the outlet aperture.

2. The valve of claim 1, wherein the slot has an elongate profile with a longitudinal axis parallel to the longitudinal axis of the spindle or shaft body.

3. The valve of claim 2, wherein the inlet aperture has an elongate profile with a longitudinal axis parallel to the longitudinal axis of the slot, and the inlet aperture has a linear central region, a first curved end region and second curved end region.

4. The valve of claim 3, wherein the inlet guide comprises a surface inclined towards the linear central region of the inlet aperture, to thereby guide fluid towards the central region of the inlet aperture.

5. The valve of any of claims 3 or 4, wherein the inlet guide comprises a first curved surface extending around the first curved end region and a second curved surface extending around the second curved end region, wherein the first curved surface and second curved surface are complimentary to the respective curved end regions, to thereby guide fluid towards the inlet aperture.

6. The valve of any of claims 2 to 5, wherein the outlet aperture has an elongate profile with a longitudinal axis parallel to the longitudinal axis of the slot, and the outlet aperture has a linear central region, a first curved end region and second curved end region.

7. The valve of claim 6, wherein the outlet guide comprises a surface inclined towards the linear central region of the outlet aperture, to thereby guide fluid away from the central region of the outlet aperture.

8. The valve of claim 6 or claim 7, wherein the outlet guide comprises a first curved surface extending around the first curved end region and a second curved surface extending around the second curved end region, wherein the first curved surface and second curved surface are complimentary to the respective curved end regions, to thereby guide fluid away from the outlet aperture.

9. The valve of any previous claim, wherein the inlet guide circumscribes the inlet aperture and/or the outlet guide circumscribes the outlet aperture.

10. The valve of any previous claim, wherein the inlet has a circular outer perimeter and/or the outlet has a circular outer perimeter.

11. The valve of any previous claim, wherein the inlet and outlet are arranged to define a common flow axis for fluid passing through the valve, and wherein the fluid flow pathway of the valve member defines a through axis, wherein the through axis of the fluid flow pathway and the common flow axis are aligned when the valve member is in the open position.

12. The valve of any previous claim, wherein the slot, inlet aperture and outlet aperture are flush when the valve member is in the open position.

13. The valve of any previous claim, wherein the longitudinal axis of the spindle or shaft is orthogonal to the longitudinal axis of the fluid flow pathway of the slot.

14. An exhaust gas system for a vehicle, comprising a conduit for conveying an exhaust gas stream and a valve in communication with the conduit, wherein the valve is according to the valve of any of claims 1 to 13.

15. A vehicle having an engine exhaust, a conduit for the passage of an exhaust gas stream from the exhaust, and a valve in communication with the conduit, wherein the valve is according to the valve of any of claims 1 to 13.

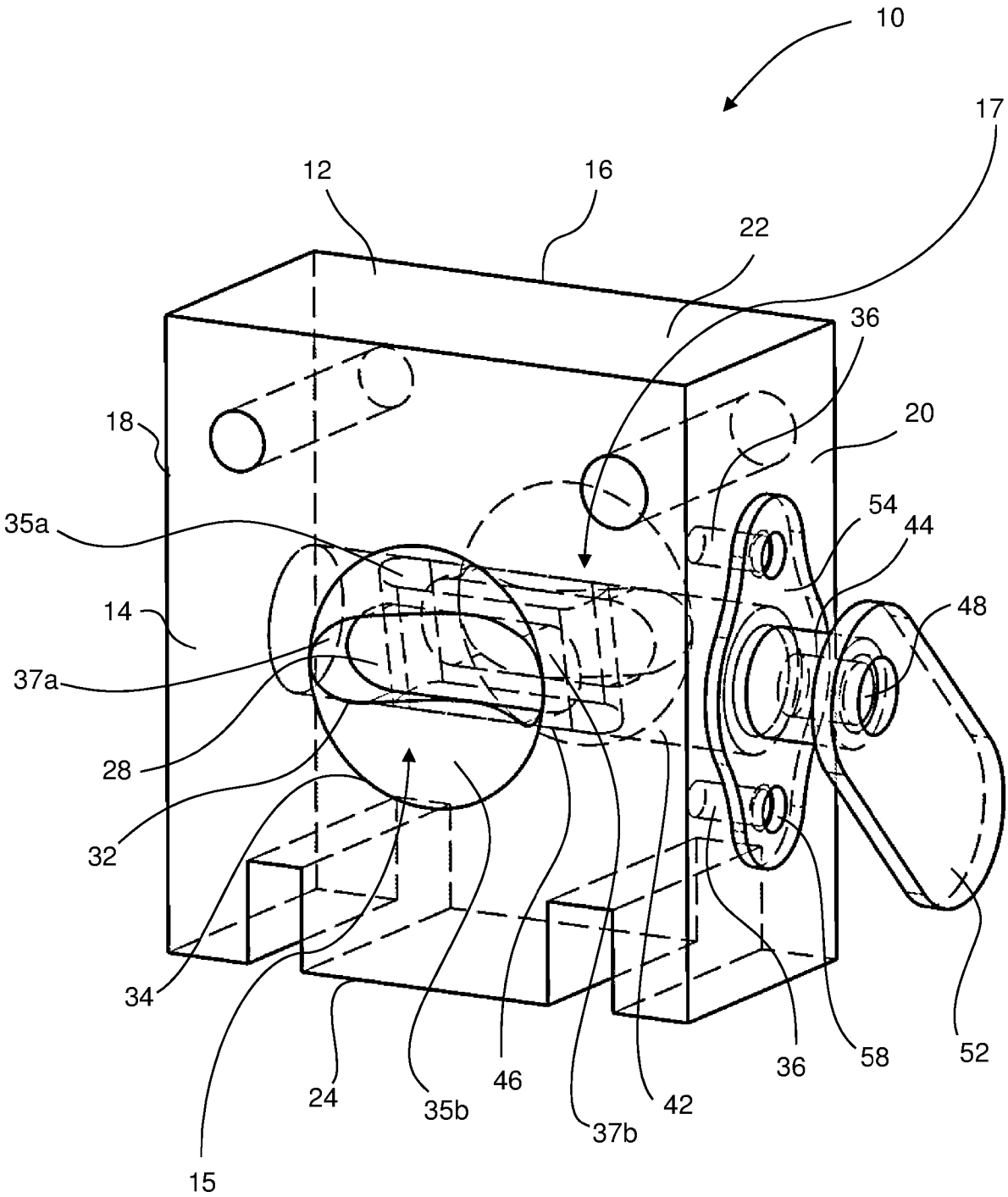

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35a
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35b
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37b
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FIG. 1

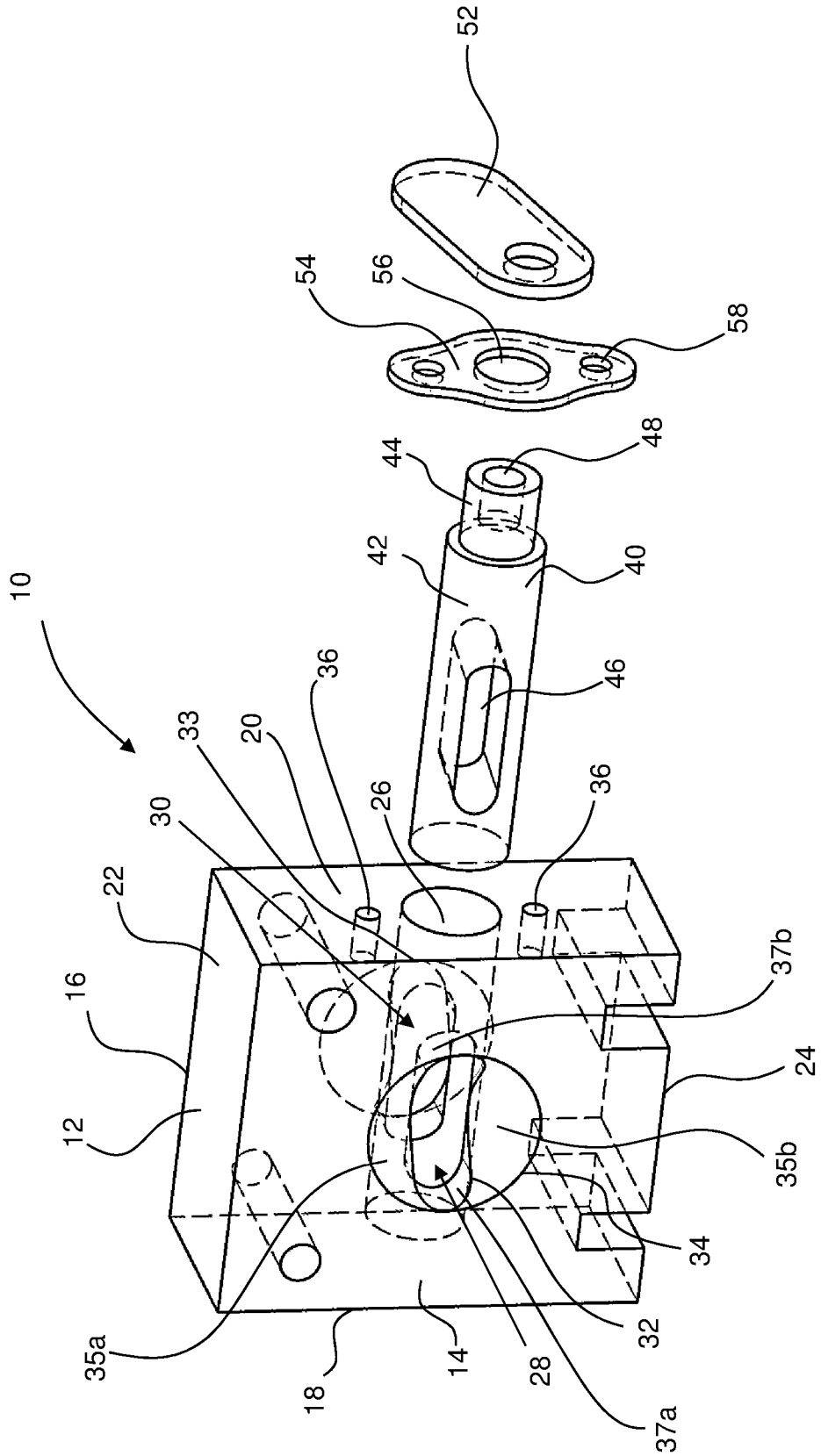

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14
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37a

FIG. 2

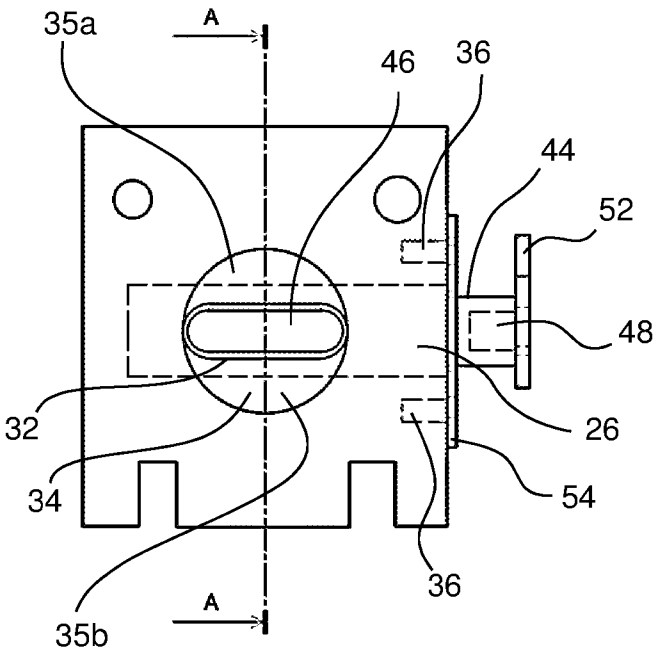

35a
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36
35b
A

FIG. 3

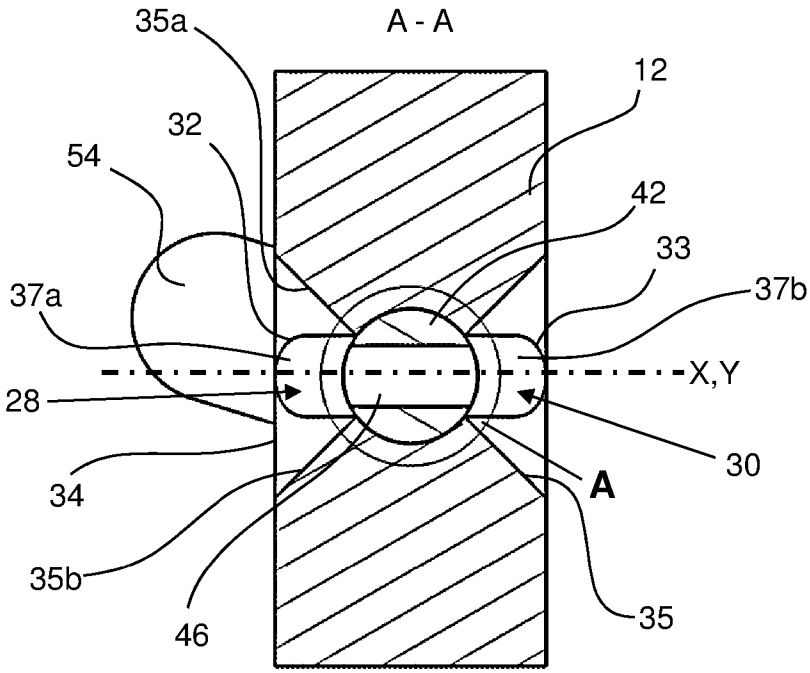

35a
A - A
12
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37a
37b
X,Y
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A
35b
46
35

FIG. 4

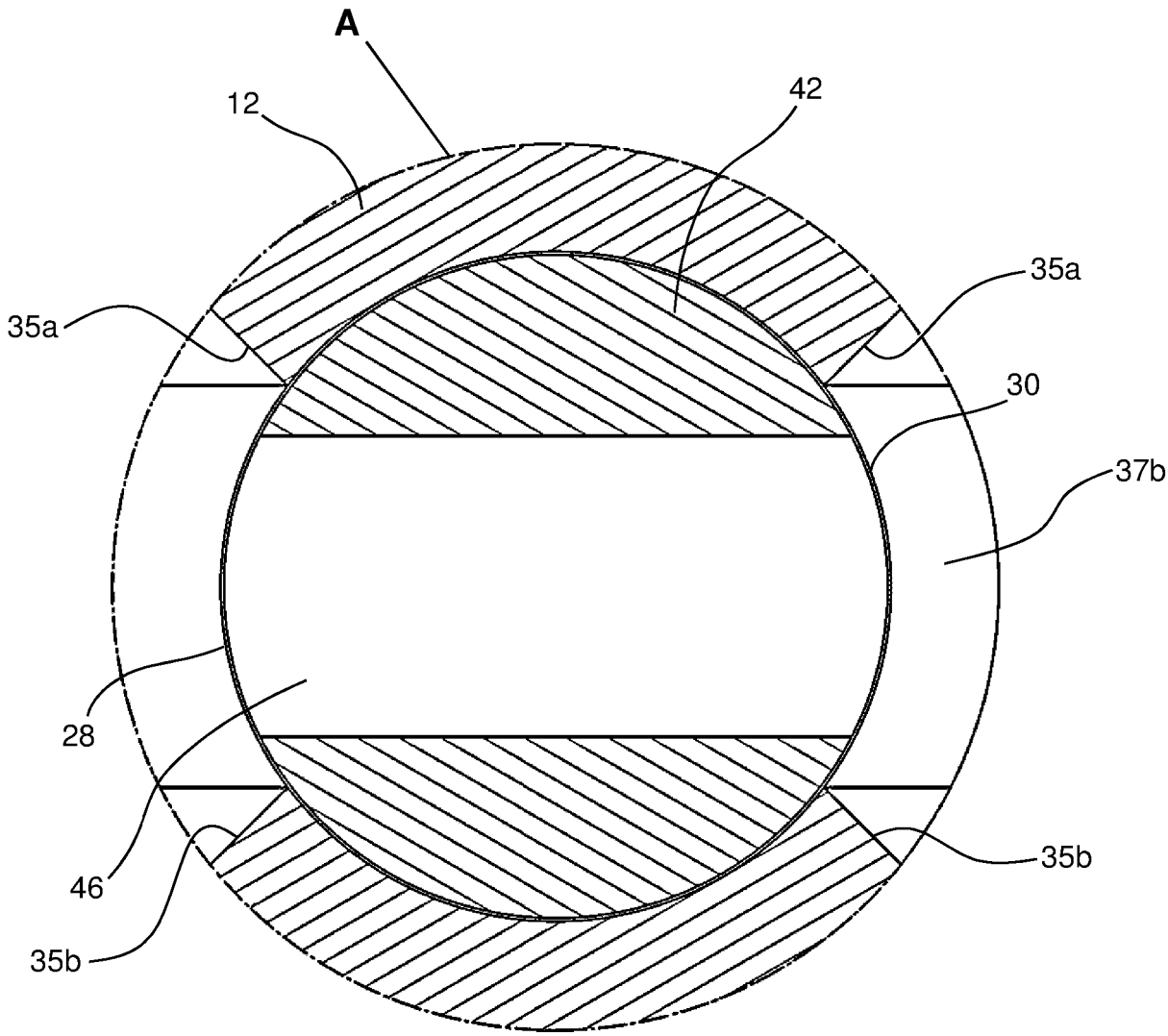


FIG. 5

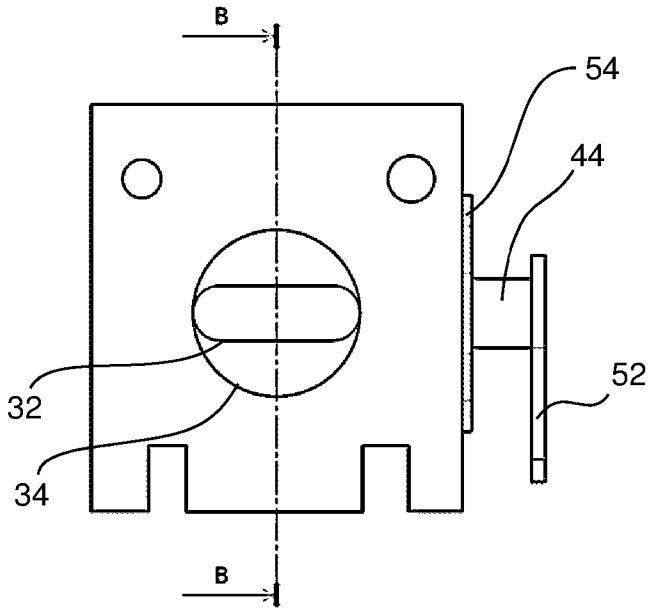


FIG. 6

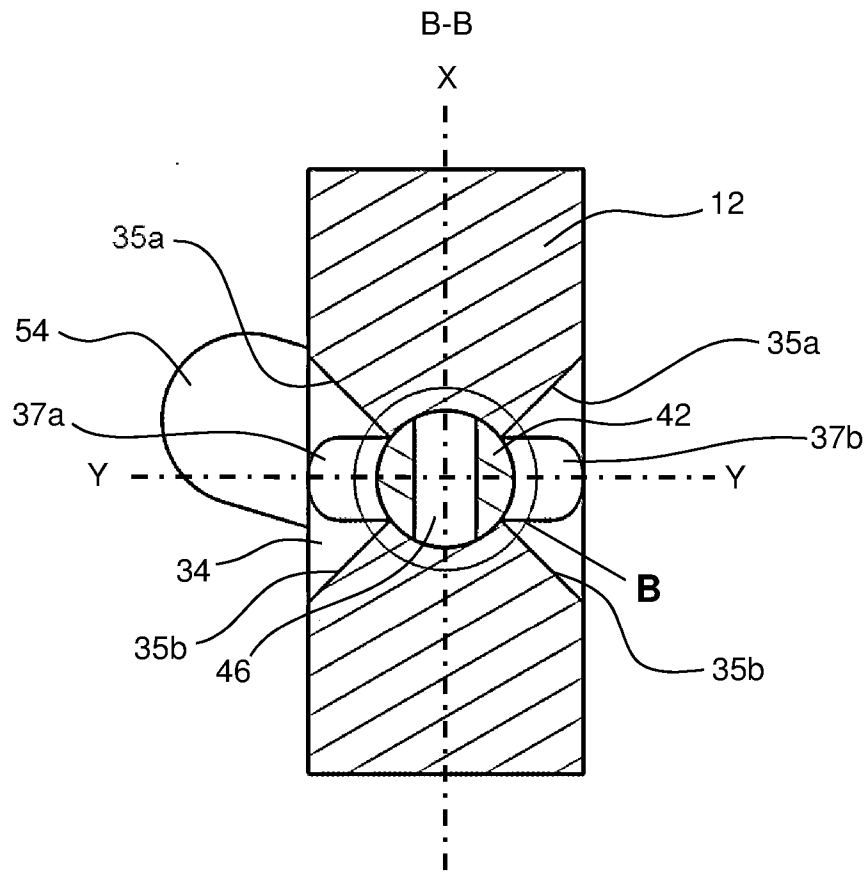


FIG. 7

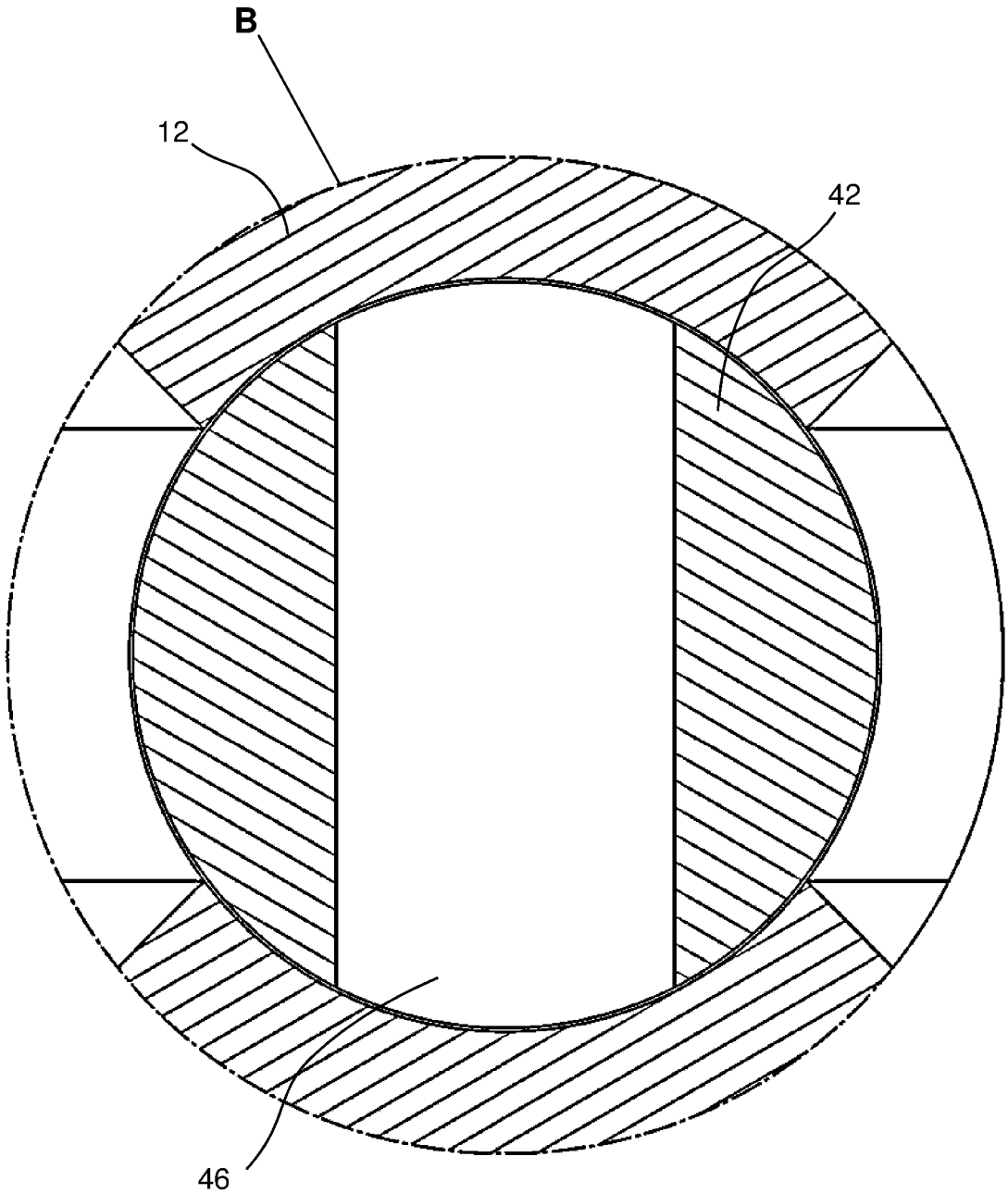


FIG. 8

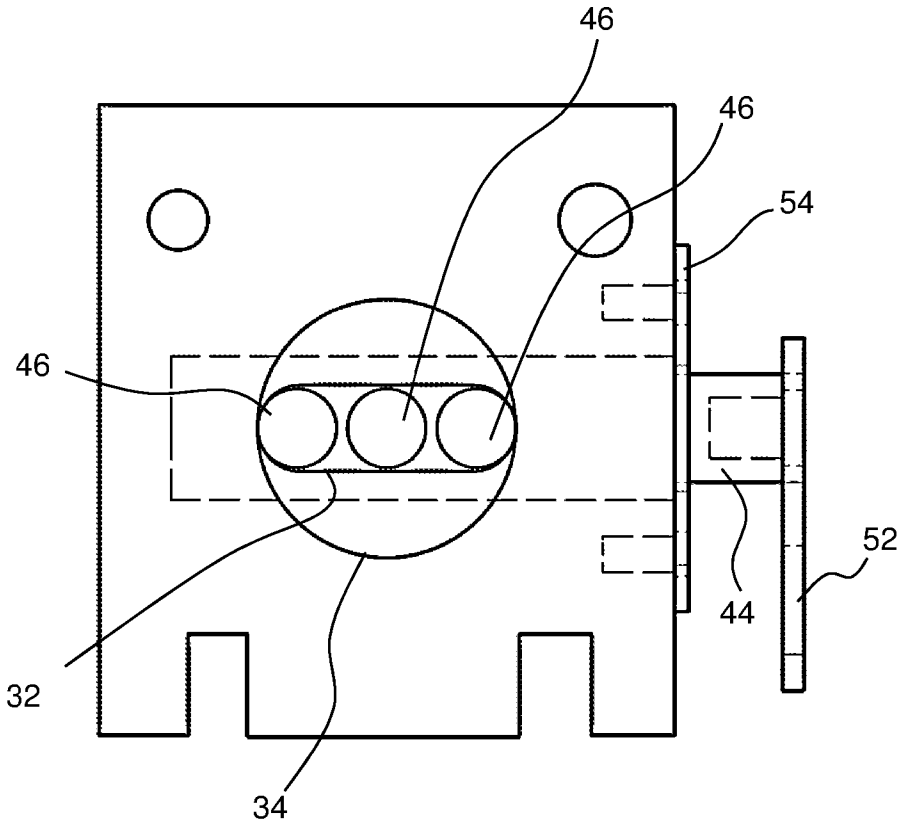


FIG. 9

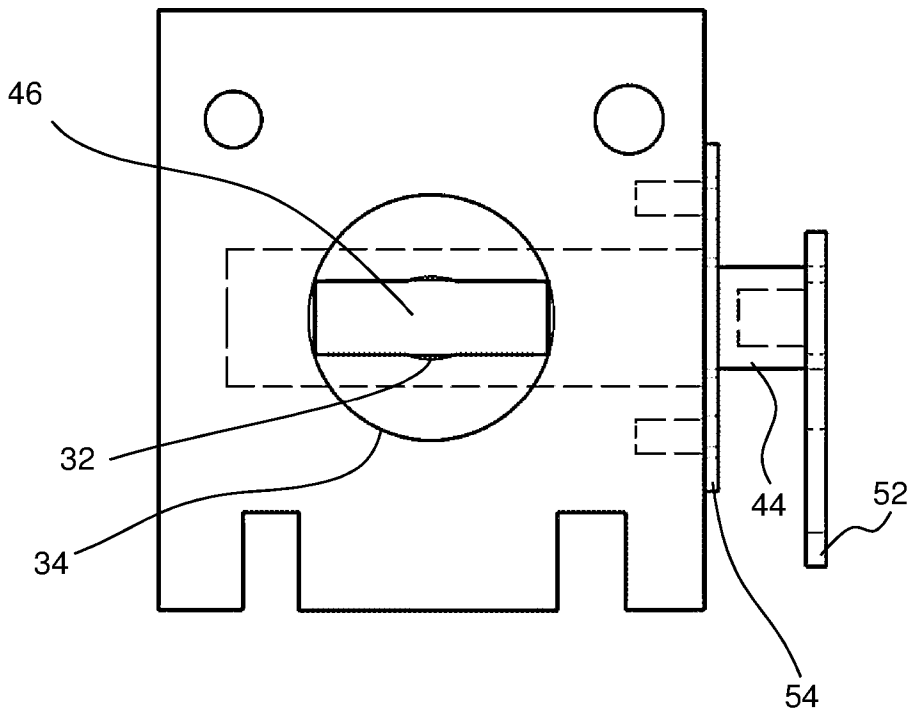


FIG. 10

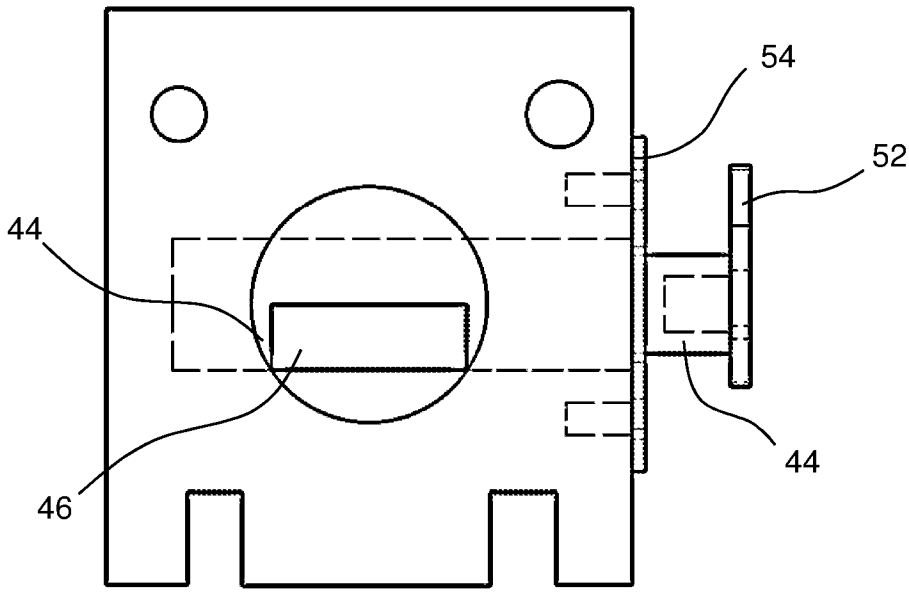


FIG. 11

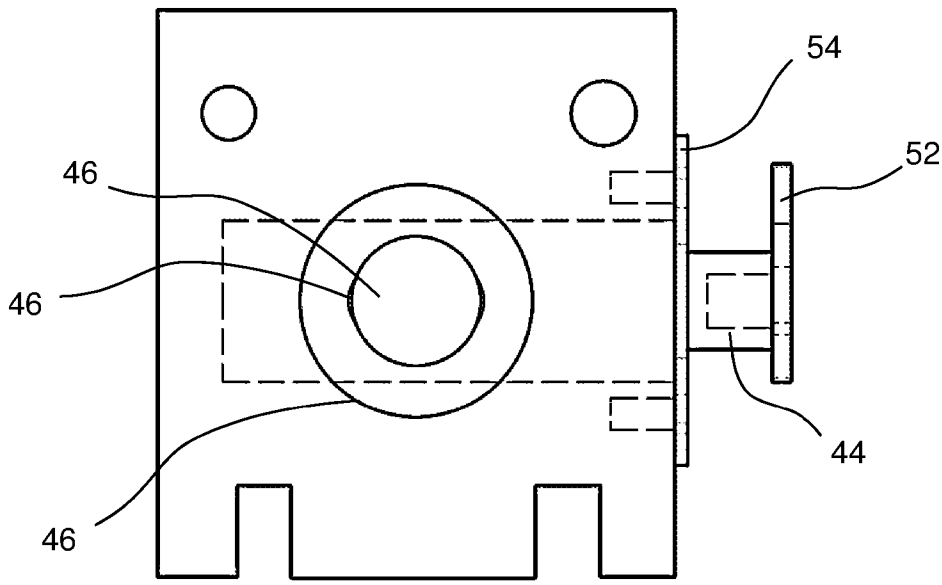


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2017/050373

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16K5/04 F16K27/06 F02M26/70 F16K47/08
ADD.

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 F02M

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 1 721 877 A (HARVEY FELDMEIER ET AL) 23 July 1929 (1929-07-23) page 1, line 47 - page 2, line 48; figures	1-15
X	US 4 711 264 A (MEDVID RICHARD J [US]) 8 December 1987 (1987-12-08) column 2, line 26 - column 3, line 3; figures	1,2,9-15
X	US 3 305 211 A (PHILLIPS EDWIN D) 21 February 1967 (1967-02-21) column 9, line 24 - column 10, line 25; figures 23-26	1,9-15
A	DE 10 2012 224093 A1 (CONTINENTAL AUTOMOTIVE GMBH [DE]) 26 June 2014 (2014-06-26) the whole document	1-15

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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
7 April 2017	20/04/2017

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, Fax: (+31-70) 340-3016	Ceuca, Antonio

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2017/050373

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009/194726 A1 (AIHARA TAMIO [JP] ET AL) 6 August 2009 (2009-08-06) the whole document	1-15

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2017/050373

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