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(54) Servo controlled valve with cylindrical shutter for adjusting the intake air flow rate in an internal combustion engine

(57) A servo controlled valve (1) for adjusting the intake air flow rate in an internal combustion engine; the servo controlled valve (1) presents: a valve body (2), in which an air passage channel (3) is defined; an electrical motor (7) carried by the valve body (2); a valve seat (4) obtained within the valve body (2) and along the air passage channel (3); and a shutter (5) which engages the valve seat (4) and is rotationally mounted about an axis of rotation (6) perpendicular to the air passage channel (3) to turn between an opening position and a closing position of the air passage channel (3) under the bias of the electrical motor (7); the shutter (5) has a cylindrical shape, a longitudinal axis of symmetry coaxial to the axis of rotation (6), and presents an internal pipe (8) which is through and perpendicular to the axis of rotation (6) so as to be aligned with the air passage channel (3) in the opening position and to be perpendicular to the air passage channel (3) in the closing position.

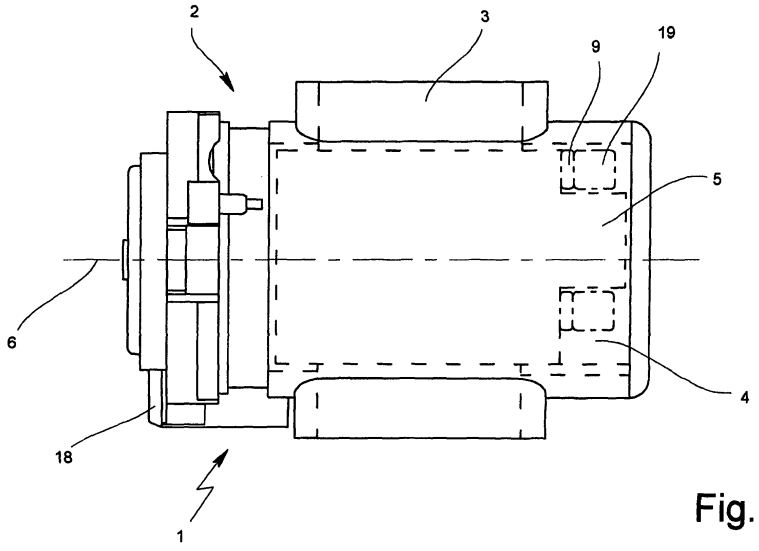

Fig. 2

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Description

TECHNICAL FIELD

[0001] The present invention relates to a servo controlled valve for adjusting the intake air flow rate in an internal combustion engine.

BACKGROUND ART

[0002] In modern internal combustion engines, a servo controlled butterfly valve, which adjusts the intake air flow rate which is fed to the cylinders, is normally contemplated. A servo controlled butterfly valve presents a valve body accommodating a valve seat engaged by a butterfly valve plate, which is keyed on a rotational shaft to turn from an opening position to a closing position by effect of the action of an electrical motor coupled to the shaft itself by means of a geared drive. A position sensor, which is adapted to detect the angular position of the shaft (i.e. of the butterfly valve plate), is coupled to one end of the shaft to allow a control unit to feedback control the electrical motor.

[0003] The currently marketed servo controlled butterfly valves are costly when they need to be mounted on small displacement engines (typically one-cylinder or two-cylinder motorcycles engines), i.e. when they need to adjust the flow rate of a small section intake channel.

DISCLOSURE OF INVENTION

[0004] It is the object of the present invention to provide a servo controlled valve for adjusting the intake air flow rate in an internal combustion engine, which valve is free from the above-described drawbacks and, specifically, is easy and cost-effective to implement.

[0005] According to the present invention, a servo controlled valve for adjusting the intake air flow rate in an internal combustion engine as claimed by the accompanying claims is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The present invention will now be described with reference to the accompanying drawings which illustrate some non-limitative examples of embodiment thereof, in which:

- figure 1 is a perspective and diagrammatic view of a servo controlled valve made according to the present invention;
- figure 2 is a plan view of the servo controlled valve in figure 1 with parts removed for clarity;
- figure 3 is a perspective view of the servo controlled valve in figure 1 with parts removed for clarity;
- figure 4 is a perspective and diagrammatic view of a lid for closing a chamber of the servo controlled valve in figure 1;
- figure 5 is an elevation side view of a variant of the servo controlled valve in figure 1 with parts removed for clarity;
- figure 6 is a perspective view of the servo controlled valve in figure 5 with parts removed for clarity;
- figure 7 is a perspective view of a further part of the servo controlled valve in figure 5 with parts removed for clarity;
- figure 8 is a diagrammatic and section view of a detail of the servo controlled valve in figure 5; and
- figure 9 schematically shows a shutter of the servo controlled valve in figure 5 in five different positions.

PREFERRED EMBODIMENTS OF THE INVENTION

[0007] In figure 1, numeral 1 indicates as a whole an electronically controlled servo controlled valve for adjusting the intake air flow rate in an internal combustion engine (not shown).

[0008] Servo controlled valve 1 comprises a valve body 2, in which an air passage channel 3 is defined; within valve body 2 and along air passage channel 3 it is obtained a valve seat 4 (shown in figure 2), which has a tubular cylindrical shape and is engaged by a cylindrical shutter 5 (shown in figure 2) mobile between an opening position and a closing position of air passage channel 3. Shutter 5 is rotationally mounted within valve seat 4 to turn about an axis of rotation 6 perpendicular to air passage channel 3 between the opening position and the closing position of air passage channel 3 under the bias of an electrical motor 7 carried by valve body 2.

[0009] As shown in figure 3, shutter 5 has a cylindrical shape, a longitudinal axis of symmetry coaxial to axis of rotation 6, and presents an internal pipe 8 which is through and perpendicular to axis of rotation 6 so as to be aligned with air passage channel 3 in the opening position and to be perpendicular to air passage channel 3 in the closing position.

[0010] According to the embodiment shown in figures 1-4, internal pipe 8 of shutter 5 has a rectangular section having preferably rounded vertexes; consequently, also air passage channel 3 presents a rectangular section having preferably rounded vertexes. This embodiment in which internal pipe 8 of shutter 5 has a rectangular section allows internal pipe 8 to be optimised, i.e. allows to obtain a high air introduction area of internal pipe 8 while maintaining a reduced size of valve seat 4.

[0011] According to the embodiment shown in figures 5-7, internal pipe 8 of shutter 5 has a circular section; consequently, also air passage channel 3 presents a circular section.

[0012] According to the embodiment shown in the attached figures, shutter 5 presents an internally full cylindrical tubular shape. According to a different embodiment (not shown), shutter 5 presents an internally hollow cylindrical shape; consequently, internal pipe 8 is defined by a pair of through openings which are obtained through the side surface of shutter 5 and are reciprocally aligned

along a direction perpendicular to axis of rotation 6.

[0013] As shown in figure 3, shutter 5 consists of a single monolithic body formed by moulded plastic material and is hinged to valve body 2 by means of a pair of bushings 9 (only one of which is shown in figures 2 and 3), each of which accommodates therein a corresponding end of shutter 5 itself and is formed by steel. The low friction coefficient existing between each steel bushing 9 and the corresponding end of shutter 5 formed by plastic material allows a smooth, easy rotation of shutter 5 itself about axis of rotation 6.

[0014] According to the embodiment shown in the attached figures, electrical motor 7 is arranged by the side of shutter 5 and is coupled to shutter 5 itself by means of a geared drive 10 having a demultiplying effect (i.e. reducing the angular speed and increasing the motive torque). According to the embodiment shown in figures 1-4, geared drive 10 comprises a gear 11, which is integral with the shaft of electrical motor 7 and meshes with an external ring gear of an idle intermediate gear 12; an internal ring gear of idle gear 12 meshes with a gear 13 integral with shutter 5.

[0015] According to the embodiment shown in figures 5-7, gear drive 10 does not include intermediate idle gear 12, and consequently gear 11 integral with the shaft of electrical motor 7 directly meshes with gear 13 integral with shutter 5.

[0016] According to a different embodiment (not shown), electrical motor 7 is coaxial to shutter 5 and presents a shaft axis directly keyed onto shutter 5 itself. Such embodiment allows to simplify servo controlled valve 1 and to reduce the dimensions of servo controlled valve 1 itself by effect of the lack of geared drive 10; on the other hand, such embodiment requires the use of an electrical motor 7 capable of developing a much higher torque due to the lack of the demultiplying effect generated by geared drive 10.

[0017] Preferably, shutter 5 is coupled to an inductive position sensor 14 of the "contactless" type to detect the angular position of shutter 5 itself so as to allow a feedback control of the position of shutter 5 itself. Position sensor 14 is of the type described in patent application US6236199B1 and comprises a rotor 15 (shown in figures 6 and 7), which is integral with shutter 5, and a stator 16 (shown in figure 4), which is arranged in use facing rotor 15. Rotor 15 is defined by a flat metallic loop, which is closed in short circuit, presents a series of lobes, and is incorporated by co-moulding in shutter 5.

[0018] According to a preferred embodiment, an accommodation chamber 17 (shown in figures 3 and 6), which is closed by a removable lid 18, is obtained in valve body 2. Rotor 15 of position sensor 14 is integral with shutter 5 and is located in accommodation chamber 17, while stator 16 of position sensor 14 is supported by lid 18; in this manner, position sensor 14 is actually formed when lid 18 is fastened to valve body 2 to close accommodation chamber 17. According to the embodiment shown in figures 1-4, accommodation chamber 17 also accommodates electrical motor 7 and geared drive 10; specifically, electrical motor 7 presents a cylindrical shape and is arranged in a tubular accommodation which extends within accommodation chamber 17 and is arranged by the side of valve seat 4. According to the embodiment shown in figures 5-7, electrical motor 7 and geared drive 10 are arranged outside accommodation chamber 17.

[0019] According to a preferred embodiment shown in figure 3, a pair of lip seals 19 (only one of which is shown in figure 3), which are arranged about opposite ends of shutter 5 to seal valve seat 4, are contemplated.

[0020] Finally, the servo controlled valve comprises a male electrical connector 20 (shown in figures 1, 3 and 4), which is carried by lid 18, is electrically connected to electrical motor 7 by means of a pair of pins 21 (shown in figure 4), and is electrically connected to stator 16 of position sensor 14. In the embodiment shown in figures 1-4, electrical connector 10 is arranged laterally and externally to accommodation chamber 17; in the embodiment shown in figures 5-7, electrical connector 20 is arranged through accommodation chamber 17, which presents a through hole 22 (shown in figures 5 and 6) through which electrical connector 20 is arranged.

[0021] As shown in figure 8, servo controlled valve 1 preferably comprises a return spring 23 (generally a torsional spring), which presents an end 24 integral with shutter 5 and an opposite end 25 integral with valve body 2; valve body 2 preferably presents a removable lid 26 at end 25 of return spring 23.

[0022] Return spring 23 tends to turn shutter 5 in a direction opposite to the opening direction (i.e. in the direction which takes shutter 5 from the closing position to the maximum opening position) so that shutter 5 is taken to a negative limp-home position (i.e. a partial opening in direction contrary to the normal opening positions). In this manner, in absence of the action of electrical motor 7, shutter 5 is arranged in the limp-home position and electrical motor 7 must be activated to generate a motive torque which overcomes the bias of return spring 23 so as to move shutter 5 to the closing position or to the maximum opening position.

[0023] Obviously, both the limp-home position and the all opening positions are defined by corresponding stop bodies (not shown), which may be provided with corresponding fastenable/releasable dowels for fine adjustment of the positions.

[0024] Figure 9 schematically shows shutter 5 in the negative limp-home position (figure 9-A), shutter 5 in the closing position (figure 9-B), shutter 5 in two partially opening positions (figures 9-C and 9-D), and shutter 5 in the maximum opening position (figure 9-E).

[0025] The above-described servo controlled valve 1 is simple and cost-effective to manufacture when it is dimensioned to adjust the flow rate of a small section intake channel; i.e. servo controlled valve 1 above-described is particularly adapted to be mounted on small displacement internal combustion engines (typically mo-

torcycles one-cylinder or two-cylinder engines).

[0026] The cost-effectiveness of the above-described servo controlled valve 1 essentially derives from the fact that the above-described servo controlled valve 1 presents a smaller number of components with respect to a similar traditional servo controlled valve and that the components of the above-described servo controlled valve 1 are simpler to manufacture with respect to the same components of a similar traditional servo controlled butterfly valve. Specifically, shutter 5 consists of a single monolithic body formed by moulded plastic material.

[0027] In virtue of the lower number of components, the above-described servo controlled valve 1 is specifically robust and reliable.

[0028] Finally, the above-described servo controlled valve 1 determines along the air passage channel 3 lower load losses with respect to a similar traditional servo controlled butterfly valve because, while in the opening position, internal pipe 8 is not crossed by any shaft as instead occurs in a similar traditional butterfly valve.

Claims

1. A servo controlled valve (1) for adjusting the intake air flow rate in an internal combustion engine; the servo controlled valve (1) comprises:

a valve body (2), in which an air passage channel (3) is defined;
an electrical motor (7) carried by the valve body (2);
a valve seat (4) obtained within the valve body (2) and along the air passage channel (3); and
a shutter (5), which engages the valve seat (4) and is rotationally mounted about an axis of rotation (6) perpendicular to the air passage channel (3) to turn from an opening position to a closing position of the air passage channel (3) under the bias of the electrical motor (7);
the servo controlled valve (1) is **characterised in that** the shutter (5) has a cylindrical shape, a longitudinal axis of symmetry coaxial to the axis of rotation (6), and presents an internal pipe (8) which is through and perpendicular to the axis of rotation (6) so as to be aligned with the air passage channel (3) in the opening position and to be perpendicular to the air passage channel (3) in the closing position.

2. A servo controlled valve (1) according to claim 1, wherein the internal pipe (8) of the shutter (5) has a circular section.

3. A servo controlled valve (1) according to claim 1, wherein the internal pipe (8) of the shutter (5) has a rectangular section.

4. A servo controlled valve (1) according to claim 3, wherein each through opening has a rectangular section having rounded vertexes.

5. A servo controlled valve (1) according to one of the claims from 1 to 4, wherein the shutter (5) presents an internally full cylindrical tubular shape.

6. A servo controlled valve (1) according to one of the claims from 1 to 4, wherein the shutter (5) presents an internally hollow cylindrical shape; the internal pipe (8) is defined by a pair of through openings which are obtained through the side surface of the shutter (5) and are reciprocally aligned along a direction perpendicular to the axis of rotation (6).

7. A servo controlled valve (1) according to one of the claims from 1 to 6, wherein the shutter (5) consists of a single monolithic body formed by moulded plastic material.

8. A servo controlled valve (1) according to claim 7, wherein the shutter (5) is hinged to the valve body (2) by means of a pair of bushings (9), each of which accommodates therein a corresponding end of the shutter (5) itself.

9. A servo controlled valve (1) according to claim 8, wherein the bushings (9) are formed by steel.

10. A servo controlled valve (1) according to one of the claims from 1 to 9, wherein the electrical motor (7) is coaxial to the shutter (5) and presents a shaft directly keyed onto the shutter (5).

11. A servo controlled valve (1) according to one of the claims from 1 to 9, wherein the electrical motor (7) is arranged by the side of the shutter (5) and is coupled to the shutter (5) itself by means of a geared drive (10).

12. A servo controlled valve (1) according to claim 11, wherein an accommodation chamber (17), which accommodates the electrical motor (7) and the geared drive (10) and is sealed by a removable lid (18), is obtained in the valve body (2).

13. A servo controlled valve (1) according to claim 12, wherein the geared drive (10) comprises a first gear (11), which is integral with the shaft of the electrical motor (7) and meshes with an external ring gear of a second idle gear (12); an internal ring gear of the second idle gear (12) meshes with a third gear (13) integral with the shutter (5).

14. A servo controlled valve (1) according to one of the claims from 1 to 13, wherein a position sensor (14) for detecting the angular position of the shutter (5)

is coupled to the shutter (5) itself; the position sensor (14) is provided with a rotor (15) which is integral with the shutter (5), and with a stator (16) which is arranged in use facing the rotor (15).

15. A servo controlled valve (1) according to claim 14, wherein an accommodation chamber (17), which is sealed by a removable lid (18), is obtained in the valve body (2); the rotor (15) of the position sensor (14) is integral with the shutter (5) and is located in the accommodation chamber (17) of the valve body (2) and the stator (16) of the position sensor (14) is supported by the removable lid (18) of the accommodation chamber (17).

16. A servo controlled valve (1) according to one of the claims from 1 to 15, wherein a pair of lip seals (19) arranged about opposite ends of the shutter (5) to seal the valve seat (4) are contemplated.

17. A servo controlled valve (1) according to one of the claims from 1 to 16, and comprising a return spring (23), which tends to turn the shutter (5) in a direction opposite to the direction of opening.

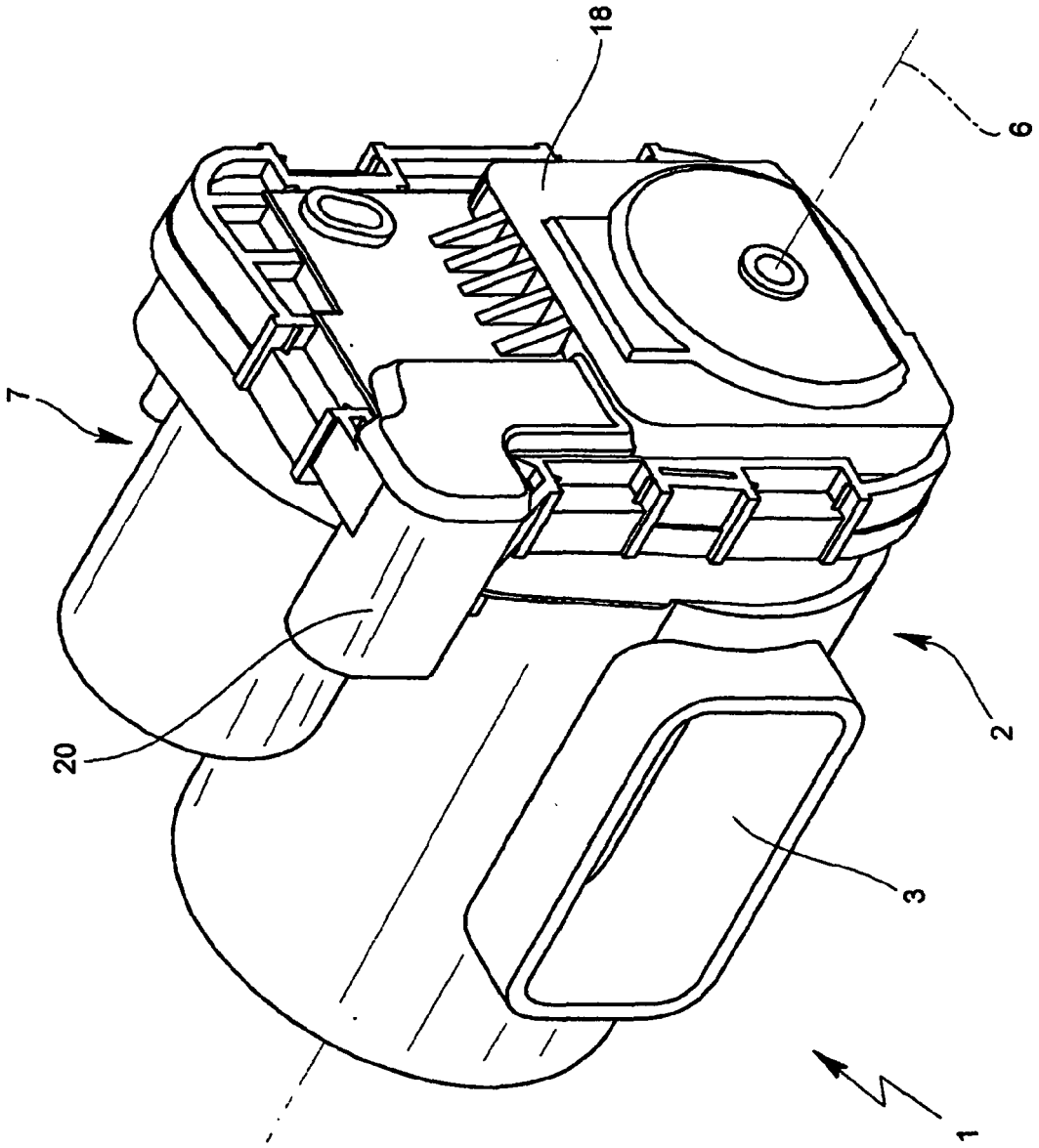
18. A servo controlled valve (1) according to claim 17, wherein the return spring (23) presents a first end (24) integral with the shutter (5) and a second opposite end (25) integral with the valve body (2).

19. A servo controlled valve (1) according to claim 18, wherein the valve body (2) presents a removable lid (26) at the second end (25) of the return spring (26).

20. A servo controlled valve (1) according to claim 17, 18 and 19, wherein the return spring (23) tends to turn the shutter (5) in a direction opposite to the opening direction to take the shutter (5) itself to a negative limp-home position.

21. A servo controlled valve (1) according to claim 20, wherein the limp-home position and the maximum opening position are defined by corresponding stop bodies.

Fig. 1



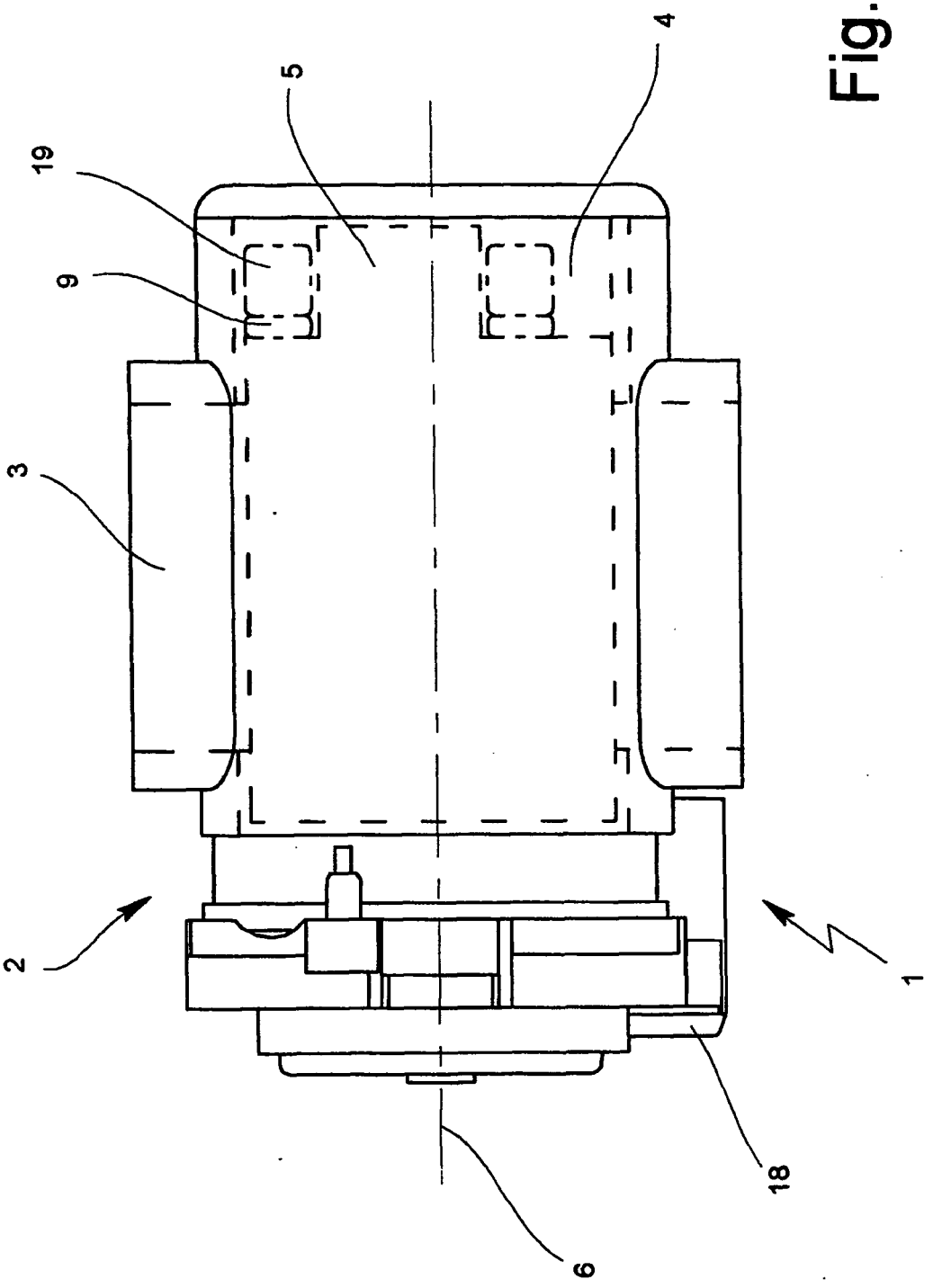


Fig. 2

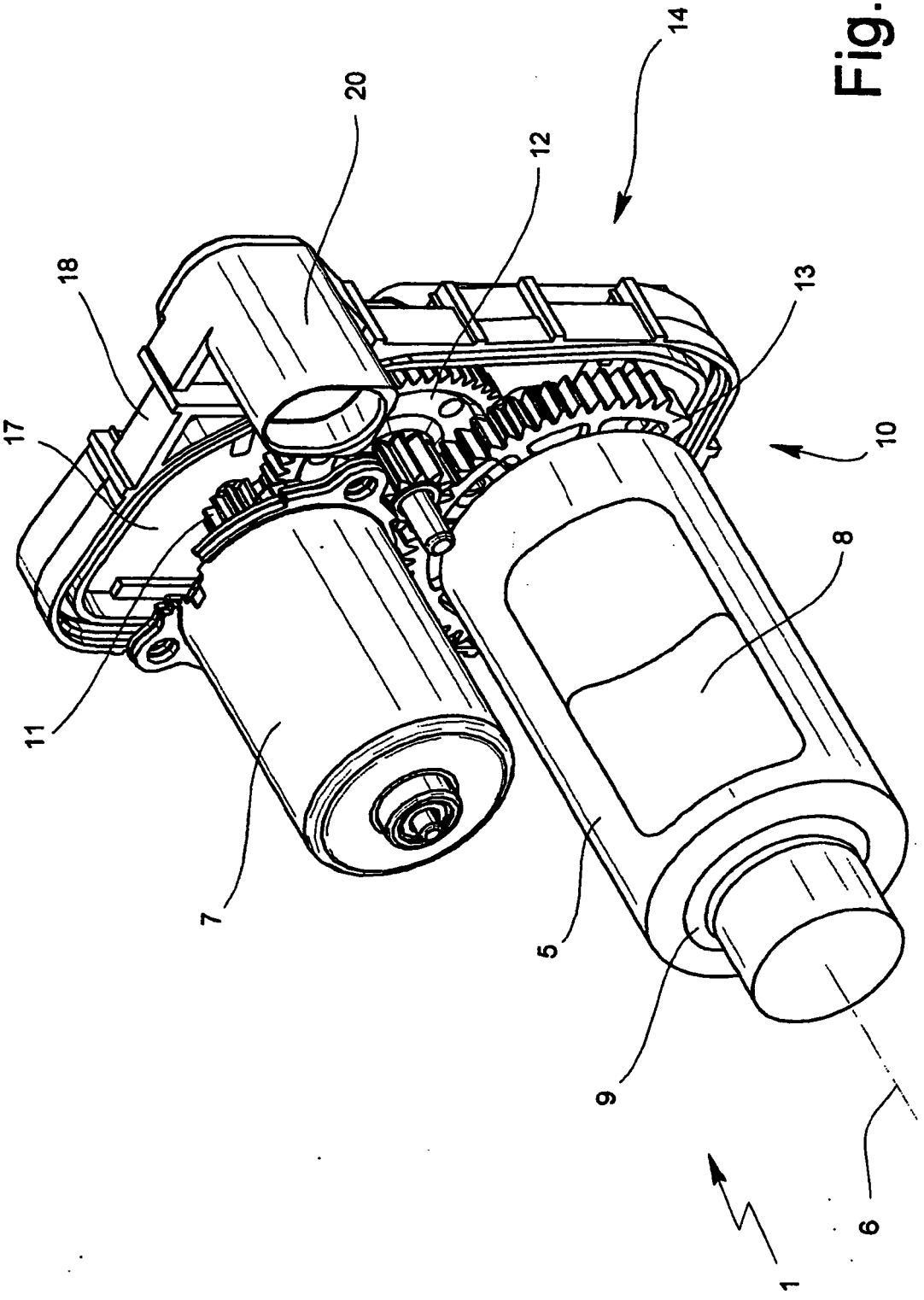


Fig. 3

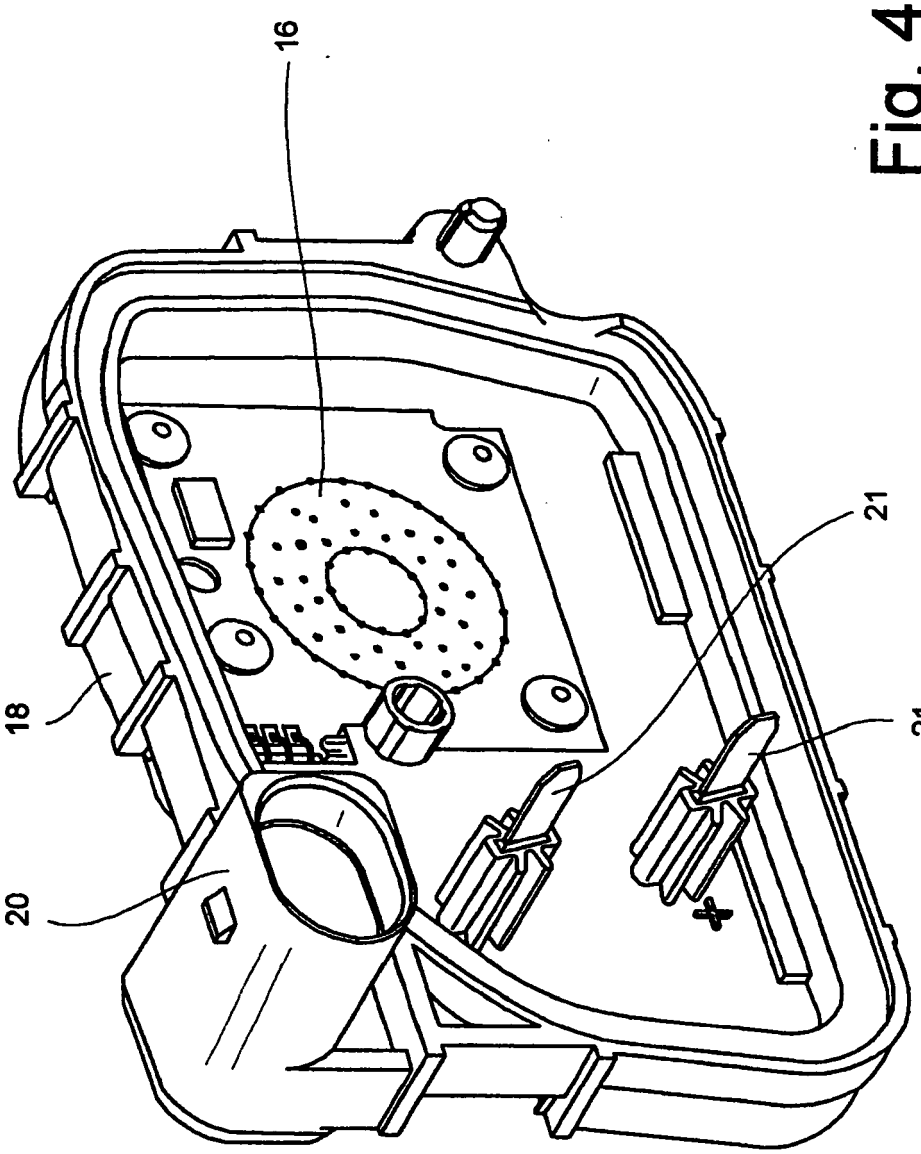


Fig. 4

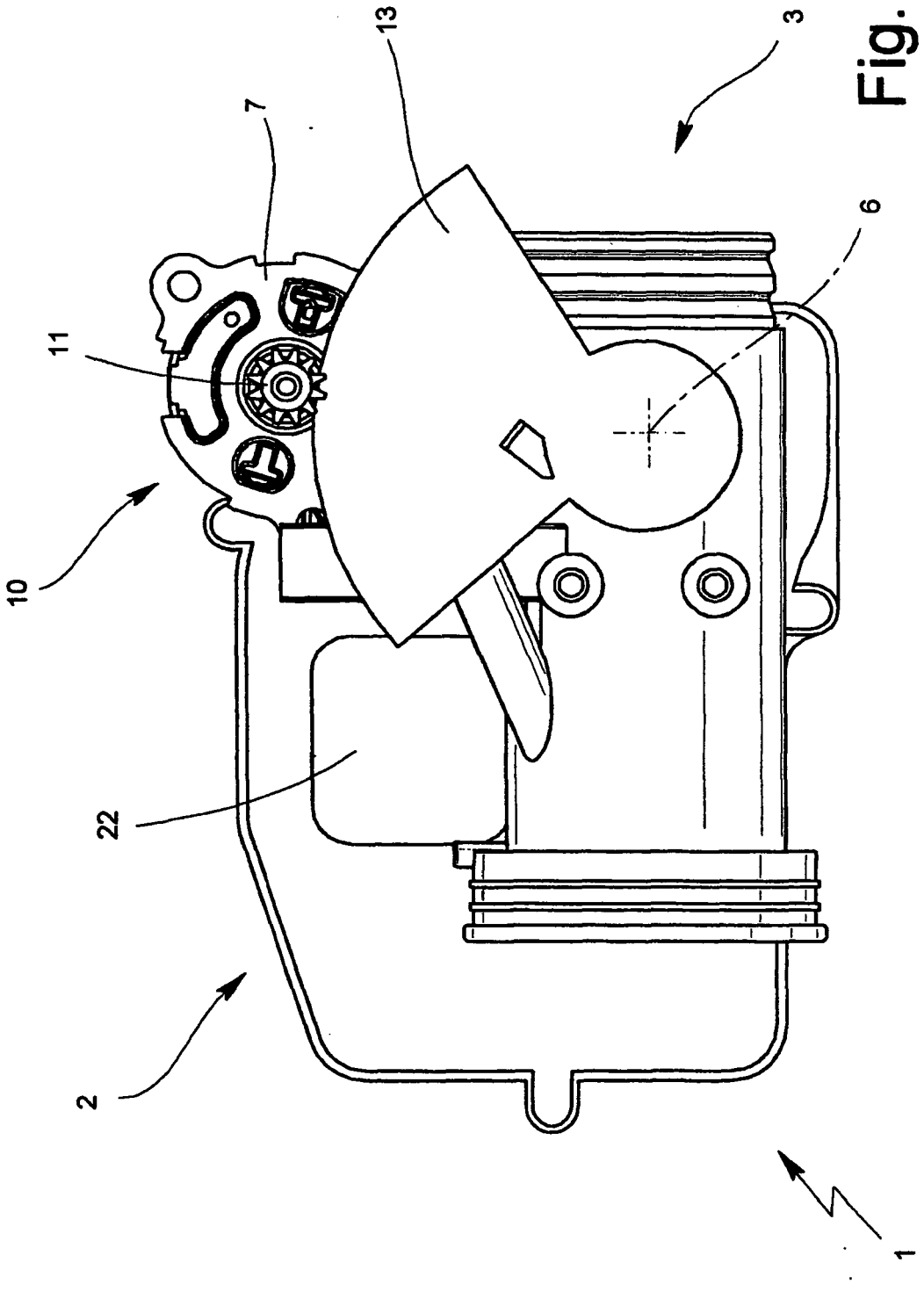


Fig. 5

Fig. 6

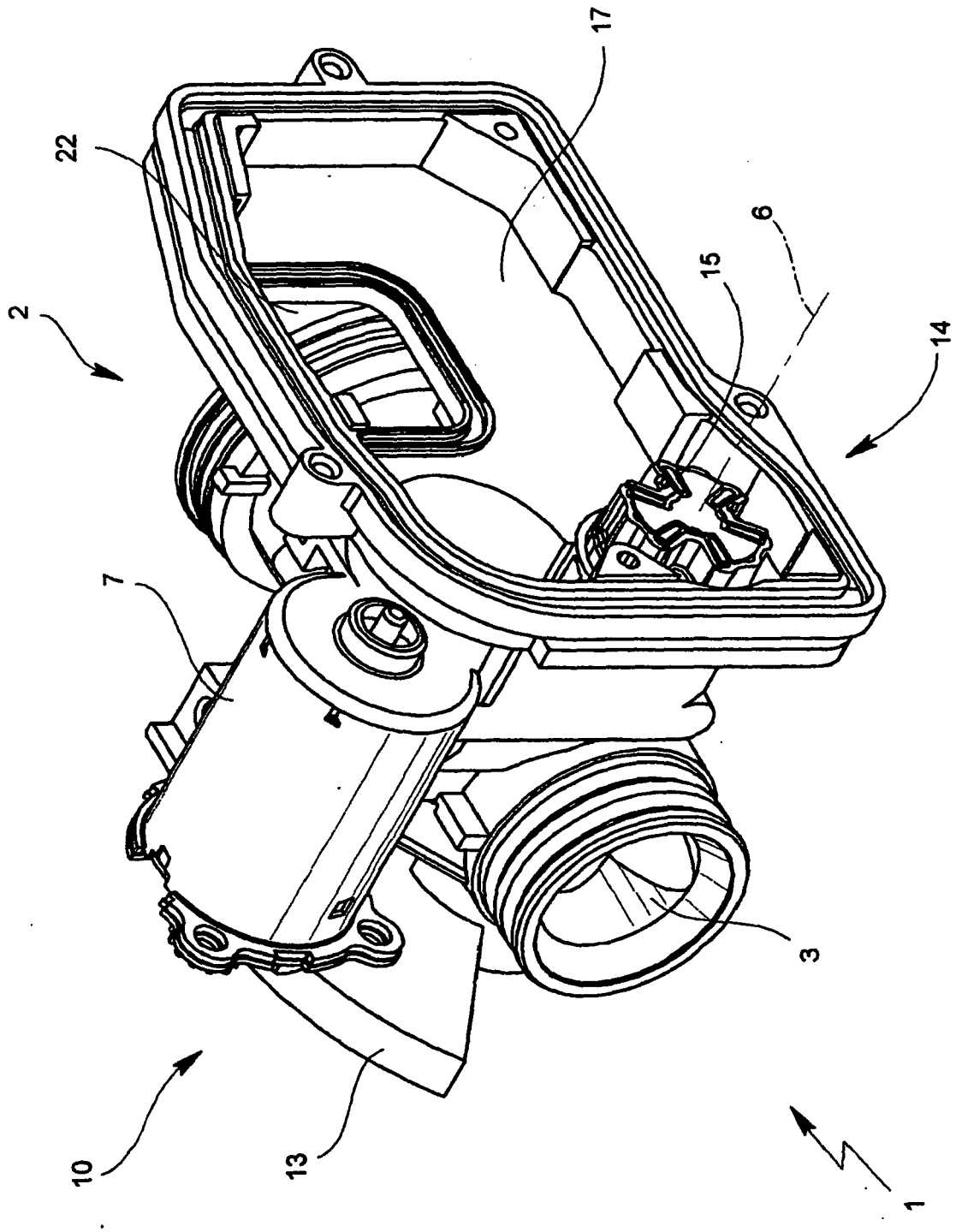
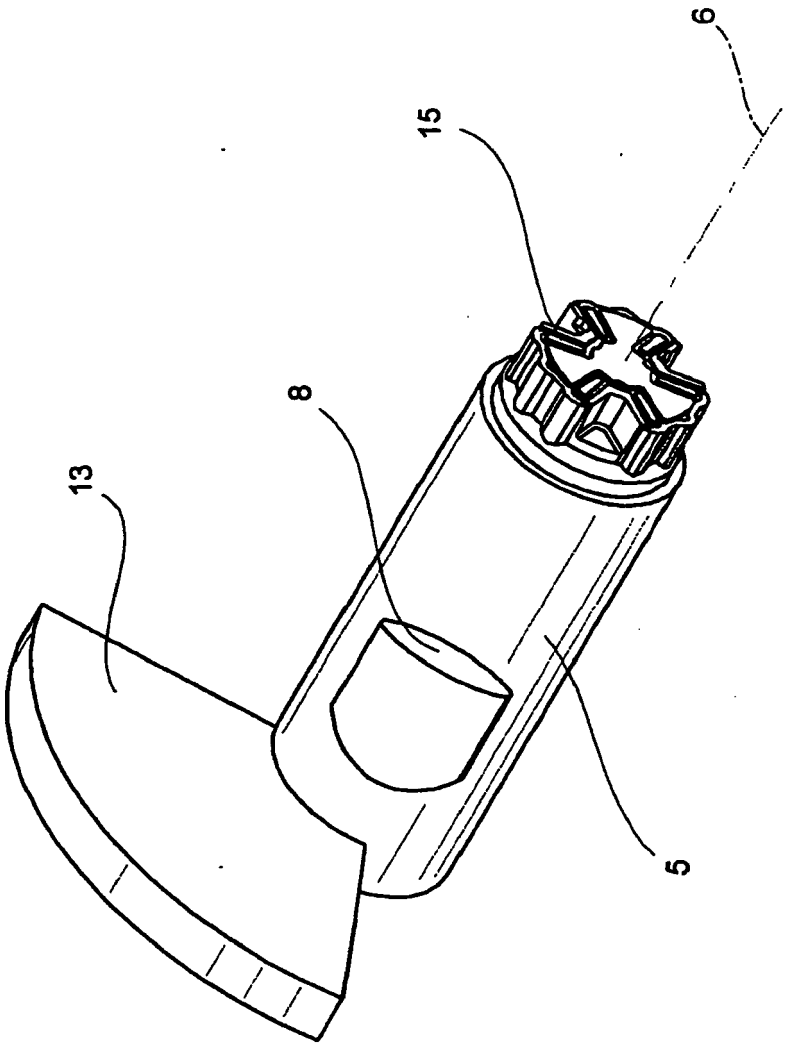


Fig. 7



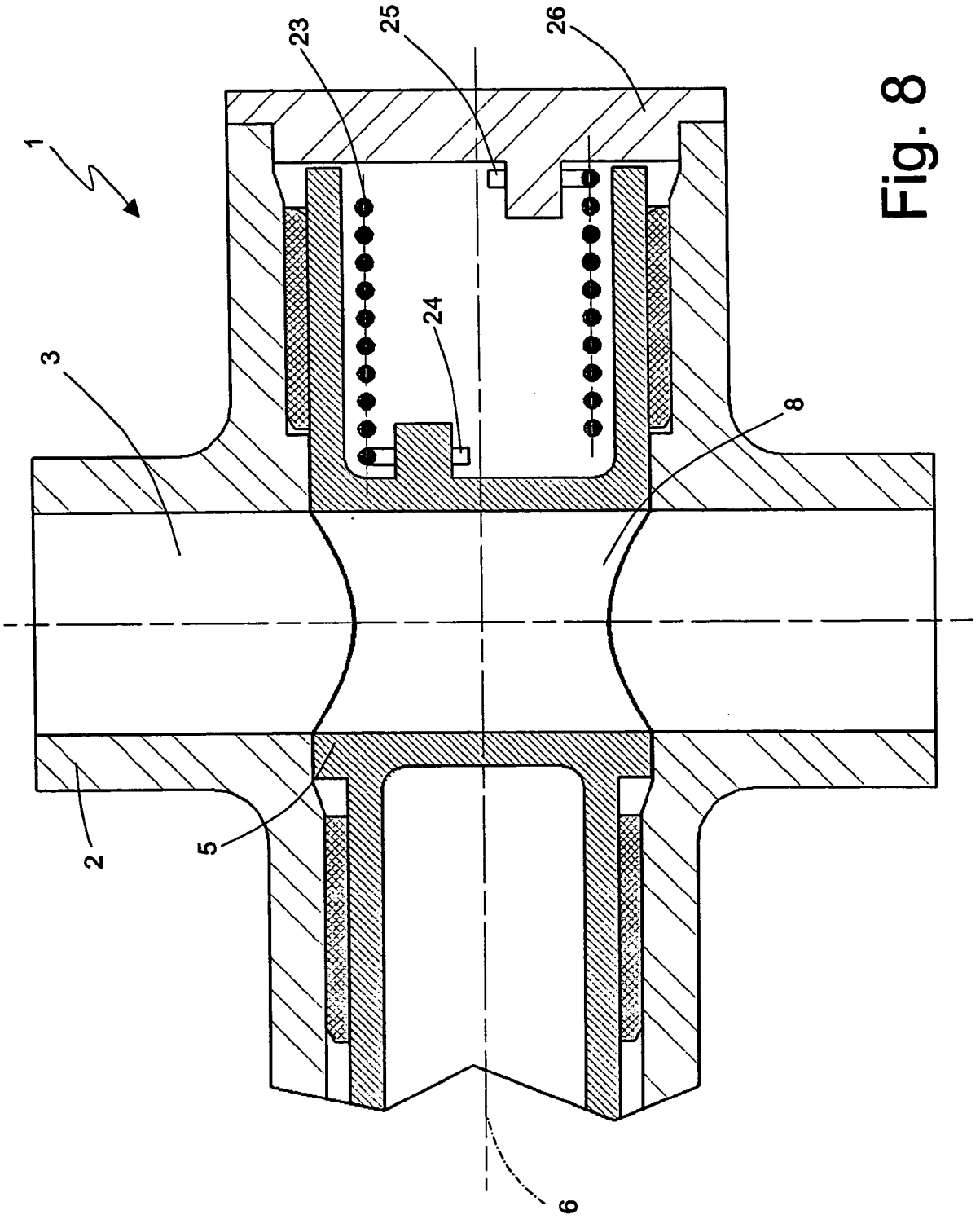


Fig. 8

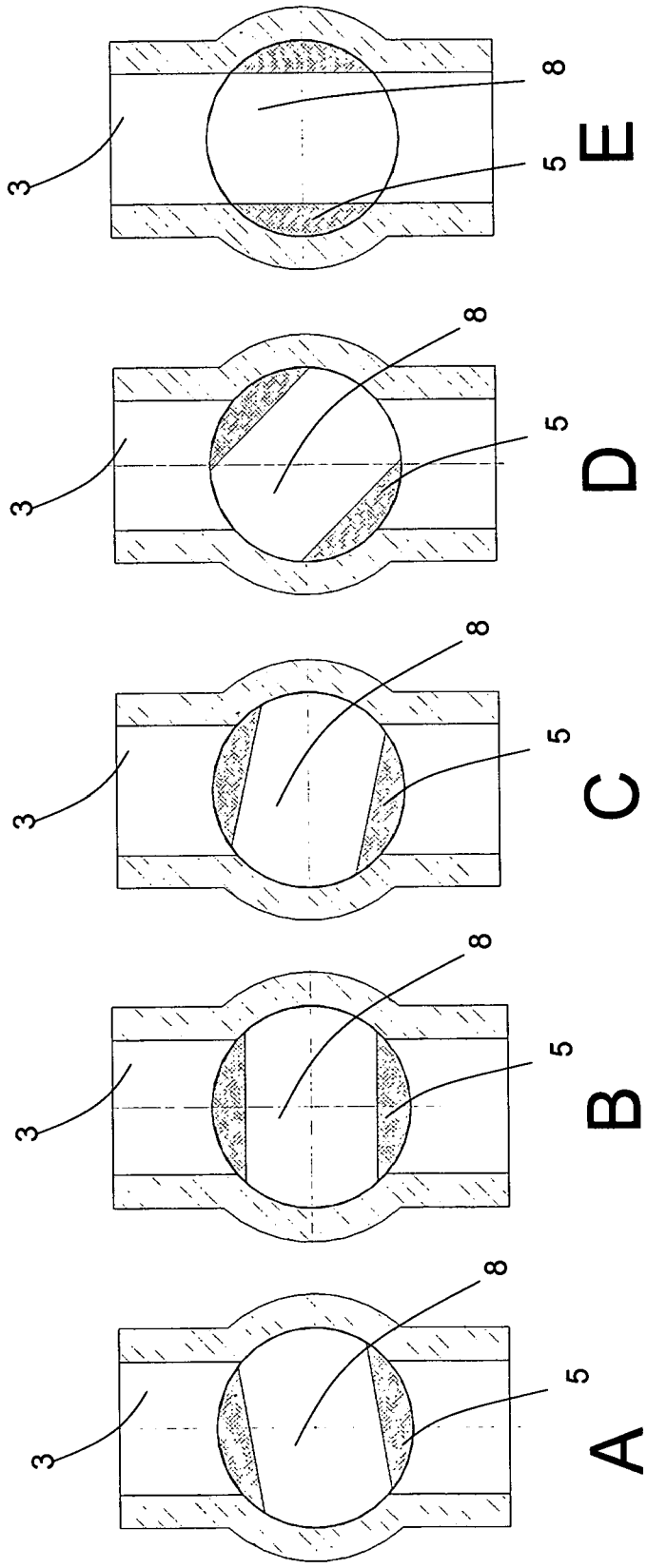


Fig. 9

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Application Number
EP 06 42 5879

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 June 2007	Mallo López, Manuel

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