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(54) **Enrichment fuel circuit for a carburettor**

(57) The present invention is concerned with a diaphragm carburettor having a throttle bore. a fuel chamber, an idle fuel circuit extending between the fuel chamber and the throttle bore and controllable by an idle adjustment member, a high speed fuel circuit extending between the fuel chamber and the throttle bore and controllable by a high speed adjustment member. and an enrichment fuel circuit extending between the fuel chamber and the throttle bore for supplying fuel to the throttle bore independently of the idle and high speed fuel circuits. <Figure 1>

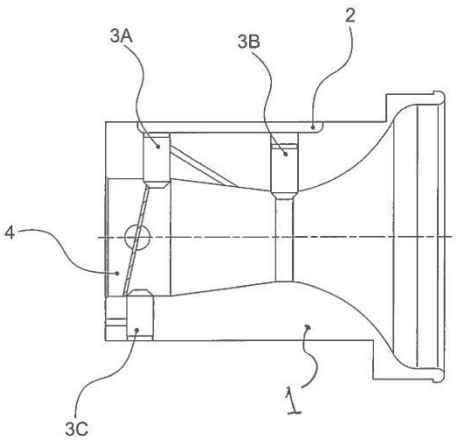


Figure 1

Enrichment Fuel Circuit for a Carburettor

Field of the Invention

The present invention relates to a diaphragm carburettor, and in particular to novel arrangements for facilitating fuel flow during acceleration of an engine to which the carburettor is fitted. The present invention is especially but not exclusively applicable to a carburettor for supplying fuel to low capacity two-stroke or four-stroke engines designed for use on, for example, chain saws, concrete saws, trimmers, lawn mowers and karts and the like.

Background of the Invention

Carburettors are well known devices that function to supply a fuel/air mixture to the one or more cylinders of two-stroke and four-stroke engines. However, there can be acceleration problems due to a carburettor supplying insufficient fuel on acceleration. This conventionally arises from the inertia of moving components within the carburettor, imperfect machining within the carburettor, limitations on the location of components arising from various design and/or cost constraints, as well as elevated temperatures and vibration transmitted from the engine.

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If sufficient fuel is supplied for acceleration, this over or under supply can cause the engine performance problems in start-up, warm-up, lower and part throttle positions. Ultra-lean acceleration will deprive the engine of proper cooling leading to various issues. Current designs include a series of progression holes allowing fuel to flow into the throttle bore to mix with the air. This type of arrangement has limitations in terms of the location at which the progress holes can be machined, resulting in acceleration issues. Part throttle jets have also been used but again have limitations in relation to the possible location of the jets. Angled fuel nozzles have been used to improve acceleration but the delivery of fuel from these nozzles can be quite coarse resulting in the engine hesitating during acceleration due to an over-supply of fuel.

The present invention has therefore been developed to solve the above problems and is primarily intended to provide a carburettor with the ability to supply an improved mixture of fuel as required from a partially open throttle to a wide open throttle allowing the engine to have stable operation across that throttle range.

Summary of the Invention

To solve the above problem the present invention includes a carburettor which has three fuel circuits, fuel circuit one is an idle fuel circuit which is controlled by an idle adjustment needle for low engine

speed, fuel circuit two is an enrichment fuel circuit which takes fuel from a fuel metering chamber and fuel circuit three is a high fuel circuit which is controlled by a high speed needle for maximum engine speed. Fuel circuit one supplies fuel to a first nozzle. There is one air circuit that flows air from the throttle bore to the first nozzle. The design of the nozzle allows the air and fuel to mix prior to exiting the nozzle at high velocity resulting in a more complete mixture of air and fuel to form a mist. This premix of air and fuel is released into the throttle bore where further mixing of air occurs. This results in a more accurate supply of air and fuel to the engine during the acceleration modes and wide open throttle.

According to a preferred embodiment of the invention there is provided a carburettor comprising a throttle bore; a fuel chamber; an idle fuel circuit extending between the fuel chamber and the throttle bore and controllable by an idle adjustment member; a high speed fuel circuit extending between the fuel chamber and the throttle bore and controllable by a high speed adjustment member; and an enrichment fuel circuit extending between the fuel chamber and the throttle bore for supplying fuel to the throttle bore independently of the idle and high speed fuel circuits.

Preferably, the idle fuel circuit comprises a first nozzle operable to delivery fuel to the throttle bore.

Preferably, the carburettor comprises a first air delivery passage arranged to supply air to the first nozzle.

Preferably, the high speed fuel circuit comprises a second nozzle operable to deliver fuel to the throttle bore.

Preferably, the carburettor comprises a second air delivery passage arranged to supply air to the second nozzle.

Preferably, the enrichment fuel circuit comprises a third nozzle operable to deliver fuel to the throttle bore.

Preferably, the carburettor comprises a third air delivery passage arranged to supply air to the third nozzle.

Preferably, one or more of the nozzles defines an airflow path arranged to combine air with fuel flowing through the nozzle.

Preferably, one or more of the nozzles comprises a fixed jet arranged to control the flow of fuel or air into the nozzle.

Preferably, the carburettor comprises a choke bore in communication with the throttle bore, at least one portion of a sidewall of the choke bore being adapted to modify air flow through the choke bore.

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Preferably, wherein at least one portion of the choke bore sidewall is adapted to rotate about a longitudinal axis of the choke bore in order to modify the airflow.

Preferably, the carburettor comprises drive means operable to effect rotation of the at least one portion of choke bore sidewall.

Preferably, the choke bore sidewall comprises multiple sidewall portions of different profiles.

Preferably, the carburettor comprises a throttle valve operable to regulate air flow through the throttle bore, wherein the throttle valve is in operative association with an enrichment valve operable to regulate delivery of fuel to the fuel enrichment circuit.

Preferably, the carburettor comprises a cam displaceable by a throttle valve shaft such as to effect regulation of the delivery of fuel to the fuel enrichment circuit, the cam being operable to displace a shuttle valve between a closed position disabling the fuel enrichment circuit and an open position enabling the fuel enrichment circuit.

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Brief Description of the Drawings

The present invention will now be described with reference to the accompanying drawings, in which;

FIG 1 shows a carburettor according to an embodiment of the invention and illustrating the arrangement of an idle fuel circuit and a high fuel circuit;

FIG 2 shows a fuel flow path from a fuel metering chamber to a fuel enrichment air and fuel nozzle;

FIG 3 illustrates a throttle shutter in a closed position;

FIG 4 shows the throttle shutter in an open position;

FIG 5 shows a detail section of the machining of journals for the fuel enrichment air and fuel nozzle;

FIG 6 shows the direction of fuel flow for the enrichment air and fuel nozzle;

FIG 7 illustrates a side elevation of an air nozzle for the air and fuel nozzle;

FIG 8 shows an end view of the air nozzle;

FIG 9 shows in detail a fuel nozzle for the air and fuel nozzle;

FIG 10 shows a cross-section of the air nozzle and fuel nozzle combined to form the air and fuel nozzle;

FIG 11 shows the enrichment fuel circuit, idle fuel circuit and high fuel circuit without a respective air and fuel nozzle;

FIG 12 shows the enrichment fuel circuit, idle fuel circuit and high fuel circuit incorporating a respective air and fuel nozzle;

FIG 13 illustrates the enrichment fuel circuit and high fuel circuit without a respective air feedhole while the idle fuel circuit is shown with an air feedhole;

FIG 14 illustrates the use of a fixed jet to control the air or fuel flow;

FIG 15 illustrates a choke bore having multiple different wall portions adapted to modify air flow through the choke bore;

FIG 16 illustrates in detail the shape of a choke bore wall portion profile;

FIG 17 illustrates in detail the shape of another choke bore wall portion profile;

FIG 18 shows the support bearing that forms an air gap between the body and choke bore wall;

FIG 19 shows how additional supports can be added to the choke bore wall;

FIG 20 illustrates drive means operable to effect rotation of the choke bore wall;

FIG 21 illustrates a piston and cam assembly in a carburettor according to the invention;

FIG 22 shows the throttle shutter and piston in the closed position;

FIG 23 shows the throttle shutter and piston in the opened position;

FIG 24 illustrates a piston that is driven by a cam; and

FIG 25 illustrates a cam profile for the cam illustrates in Figure 24.

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Description of the Preferred Embodiments

Referring now to the accompanying drawings, there is illustrated a diaphragm carburettor according to the invention. It should be noted that for the purposes of clarity not all of the possible or optional features of the carburettor are illustrated in each Figure, but the features shown in one or more of the Figures may of course be combined with one or more other features illustrated in one or more of the other Figures.

Figure 1 illustrates a body 1 of the diaphragm carburettor of the invention, including a fuel metering chamber 2 formed in an upper portion of the body 1. It will be appreciated that a suitable fuel reservoir in the form of a container may be provided about said upper portion of the body 1 to enclose and further define the fuel metering chamber 2. The body 1 has a first air and fuel nozzle 3a that forms part of an idle fuel circuit extending between the fuel-metering chamber 2 and a throttle bore 4 which extends through the interior of the body 1 in conventional fashion. As will be described in detail hereinafter, the air fuel nozzle 3a is arranged to combine liquid fuel and air to issue as a mist or atomised dispersion of fuel in air, into the throttle bore for onward delivery to one or more cylinders of the associated engine for combustion. Again it should be noted that not all features of the carburettor are illustrated in Figure 1.

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The body 1 also has a second air and fuel nozzle 3b that forms part of a high-speed fuel circuit likewise extending between the fuel-metering chamber 2 and the throttle bore 4. In a preferred arrangement the high speed fuel circuit is arranged to supply fuel from the fuel metering chamber 2 to a throat of the throttle bore 4, which will often have a venturi type cross section as illustrated, and again as an atomised dispersion of the liquid fuel in air.

A third air fuel nozzle 3c is also provided and forms part of an enrichment fuel circuit extending between the fuel-metering chamber 2 and the throttle bore 4 as hereinafter described in greater detail. In a preferred arrangement the fuel enrichment circuit is arranged to supply fuel from the fuel metering chamber 2 to the throttle bore 4 at a location upstream of the outlet of the high speed fuel circuit.

Figure 2 shows a flow path in the form of a transfer journal 5 that is connected to a machined hole 6 that is drilled in to the metering chamber 2. Another connection hole 7 is machined from the transfer journal 5 in to the air and fuel nozzle 3c. The air and fuel nozzle 3c is assembled into the body 1 such as to project into the throttle bore 4 and intersects the connection hole 7. A fuel flow path is therefore defined between the fuel metering chamber 2 and the throttle bore 4 via the hole 6, journal 5, connection hole 7 and the air and fuel nozzle 3c, collectively forming the enrichment fuel circuit.

The air and fuel nozzle 3c is assembled in to the body 1 by a press fit. The press fit ensures that fuel does not leak external to the body 1. The air and fuel nozzle 3c could also be threaded in to the body 1 if required, or secured in any other suitable fashion. The transfer journal 5 and/or connection hole 7

could also be replaced by external machining or pipework (not shown) outside the body 1, or any other functional alternative, which facilitates fluid communication between the fuel-metering chamber 2 and the air and fuel nozzle 3c.

Figure 3 shows the air and fuel nozzle 3c in a non-working status. Fuel cannot flow from the metering chamber 2 into the transfer journal 5, the air and fuel nozzle 3c and on to the throttle bore 4. This is due to the absence of a vacuum on the air and fuel nozzle 3c because a throttle valve in the form of a throttle shutter 8 is in the closed position.

Figure 4 shows the air and fuel nozzle 3c in the open working status. With the throttle shutter 8 now in an opened position the air and fuel nozzle 3c receives a vacuum signal in throttle bore 4. This allows fuel to flow from the metering chamber 2 in to the transfer journal 5, in to the air and fuel nozzle 3c and in to the throttle bore 4.

The air and fuel nozzle 3c can also pull air from an airflow path in the form of a feedhole 10 extending from the throttle bore 4 to the air and fuel nozzle 3c. In this case the quantity of fuel and air entering the air and fuel nozzle 3c is controlled by the feed hole 9 and 10 respectively. In other cases a jet (not shown) or both a feedhole and jet can control the quantity of fuel and air supplied to the air and fuel nozzle 3c. With the air and fuel nozzle 3c opened the engine can now overcome the acceleration problems due to the fuel and air flowing from the nozzle 3c being allowed to mix prior to entering the throttle bore 4 resulting in better atomisation of the fuel. This will allow stable running of the engine.

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Figure 5 shows a section of the body 1 with the air and fuel nozzle 3c flowing both fuel and air together in to the throttle bore 4 when the throttle shutter 8 is in the opened position.

Figure 6 shows the direction of fuel flow through the body 1 in to the throttle bore 4.

Figure 7 illustrates an air nozzle 11 forming part of the air and fuel nozzles 3a, 3b, 3c that has an air entry hole 12 and a air exit hole 13 for the air to flow through. The fuel transfer ports 14 show the fuel direction flow.

Figure 8 is a front elevation of the air nozzle 11 where the fuel transfer ports 14 and the exit hole 13 can be seen in more detail. This air nozzle 11 can also be reversed to flow fuel instead of air depending on the application and engine requirements.

Figure 9 shows a fuel nozzle 15 forming part of the air and fuel nozzles 3a, 3b, 3c with the fuel entry hole 16 and an exit hole 17. The fuel nozzle 15 surrounds the air nozzle 11 to form the air and fuel nozzles 3a, 3b, 3c.

Figure 10 shows the assembly of nozzle 11 and 15 to form the air and fuel nozzles 3a, 3b, 3c.

Figure 11 shows a cross-section through the diaphragm carburettor body 1 in which the air and fuel nozzles 3a, 3b, 3c have been omitted from the idle fuel circuit, high speed fuel circuit and the enrichment fuel circuit. This shows the transfer journal 5 that forms part of the enrichment fuel circuit. A hole 18 is machined from the transfer journal 5 in to the metering chamber 2. Another hole 9 is machined from the transfer journal 5 in to an air and fuel journal 37 which replaces the air and fuel nozzle 3c. The air feedhole 10 is machined or otherwise formed in the body 1 and extending from the throttle bore 4 in to the air and fuel journal 37. The air and fuel journal 37 remains independent of both the idle fuel circuit 19 and high speed fuel circuit 20.

Figure 12 shows a cross-section through the diaphragm carburettor body 1. Figure 12 shows the air and fuel nozzle 3c forming part of the fuel enrichment circuit, the air and fuel nozzle 3a forming part of the idle fuel circuit 19, and the air and fuel nozzle 3b forming part of the high speed fuel circuit 20. An air feedhole 21 is provided from the throttle bore 4 to supply air to the air and fuel nozzle 3a. An air feedhole 22 is provided from a choke bore 40 to supply air to the air and fuel nozzle 3b. The choke bore 40 is located upstream of and in communication with the throttle bore 4, and together they define a through passage in the body 1. In this way air can be supplied to the respective nozzle 3a, 3b, 3c to mix with the fuel flow through the nozzle in order to generate an atomised dispersion of fuel in the air, which is then supplied to the throttle bore 4 for onward supply and combustion within the cylinder(s) of the engine (not shown).

Figure 13 shows a further cross-section through the diaphragm carburettor body 1. This arrangement illustrates that the air feedholes can be included or removed depending on the engine requirements. In some cases the air and fuel nozzle 3a, 3b, 3c will only require a partial quantity of air so all air feedholes are not required. The air and fuel nozzle 3b and 3c have no air feedholes and the air and fuel nozzle 3a has the air feedhole 21. This arrangement serves to illustrate that the air and fuel nozzle 3a, 3b, 3c can include and exclude the air feedholes as required.

Figure 14 shows the enrichment fuel circuit with an assembled jet 23 to control the quantity of fuel flow in to the air and fuel nozzle 3c. The assembled jet 23 can be applied to all or some of the air and fuel nozzles 3a, 3b, 3c either through the air or fuel pathway depending on the engine requirements, and the jet 23 can be of conventional form and dimensioned to provide the requisite fuel metering function.

Figure 15 shows an end elevation of the carburettor according to the invention, as viewed from the choke bore 40 end. A sidewall of the choke bore 40 comprises a sidewall profile made up of two different wall profiles 24 and 25 in order to speed up or slow down the velocity of air flowing through the choke bore 40 extending through the body 1. This helps the atomisation of fuel at various part throttles leading to improved acceleration. Various surface features, shapes, and/or profiles of the choke bore 40 sidewall may thus be utilised to modify the airflow through the choke bore, such as to for example to generate increased turbulence and therefore mixing of the fuel and air.

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Figure 16 shows a cross-section through the sidewall profile 24. Profile 24 is not confined to this shape but can be either regular or irregular in the profile shape and surface finish. This profile can be machined or otherwise formed into the body 1 or provided as a separate component to be fitted into the body 1 by any suitable means.

Figure 17 shows a cross-section through the profile 25. Profile 25 is not confined to this shape but can be either regular or irregular in the profile shape and surface finish. This profile can be machined into the body 1 or provided as a separate component to be fitted into the body 1 by any suitable means.

Figure 18 shows the profile 24 assembled onto some form of a bearing 37. The bearing 37 is assembled into the body 1. This assemble forms an air gap 38 that allows the profile 24 to rotate with the body 1 about a longitudinal axis of the choke bore 40. The bearing 37 can also be applied to the profile 25. The rotation of profile 24 and 25 will speed up the velocity of air entering the carburettor that will allow for better atomisation of the fuel leading to improvement acceleration and power delivery.

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Figure 19 shows the profile 24 with more than one bearing 37a and 37b for additional support. This also applies to profile 25.

Figure 20 shows the profile 24 connected up to drive means in the form of an electric motor 47 so that the rotation speed of profile 24 can be increased or decrease. This also applies to profile 25. The electric motor can be fitted into the body 1 or external to the body 1.

Figure 21 shows an end view cross-section through the body 1 illustrating the throttle shutter 8 connected between opposed portions of a throttle shaft 26 and 27 in order to allow the shutter 8 to be pivoted between the open and closed positions. The throttle shaft 26, 27 is rotated by the throttle lever assembly 28 which determines the positions from closed to open of the throttle shutter 8. The throttle lever assembly 28 may be actuated by any suitable means, for example cable actuated or the like. Mounted at one end of the throttle shaft 26, 27 is a cam 29 that is in contact with an enrichment valve in the form of a piston 48. A spring 31 applies a force on the piston 48 to bias the piston 48 into contact with the cam 29.

Figure 22 shows a longitudinal cross-section through the body 1 of the carburettor and showing the same arrangement of features as illustrated in Figure 21. The throttle shutter 8 is in the closed position. A journal 30 is machined from the fuel-metering chamber 2 to a piston journal 35. A conduit 32 is provided from the piston journal 35 to the air fuel nozzle 3c. When the throttle shutter 8 is closed fuel can flow from the metering chamber 2 into the piston journal 35 through the journal 30. The piston 48 has two seals 33 and 34. Seal 34 prevents fuel from flowing into the conduit 32 while

the throttle shutter 8 is in the closed position as the cam 29 is arranged to position the piston 38 such that the seal 34 is upstream of and thus blocking access to the conduit 32..

Figure 23 shows a cross-section through the body 1. The throttle shutter 8 is in the opened position. As the throttle shutter 8 starts the cam 29 rotates and this action displaces the piston 48 against the bias of the spring 31. The seal 34 is therefore displaced beyond the conduit 32 and now allows fuel to flow from the piston journal 35 to the air fuel nozzle 3c through the conduit 32. The cam 29 can be calibrated to deliver fuel to the engine with more precision through the range of throttle shutter 8 positions and engine rpm.

Note the air and fuel nozzle 3c can also be a standard nozzle or a machined exit hole or any other suitable functional form operable to deliver fuel. In this way position dependent fuel enrichment can be implemented and linked to throttle position, or more particularly to the position of the throttle shutter 8.

Figure 24 shows in detail the piston 48 and its seal 33 and 34 which each comprises a captured O-ring but can be of any other suitable form.

Figure 25 shows in detail the cam 29. Cam 29 has a cam profile 36 that is used to move the piston 48. Cam profile 36 can be adjusted to different shapes in order to deliver the correct quantity of fuel to the engine for calibration. Note the cam is an example but some other form of mechanism can be used to move the piston.

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Claims

1. A carburettor comprising a throttle bore; a fuel chamber; an idle fuel circuit extending between the fuel chamber and the throttle bore and controllable by an idle adjustment member; a high speed fuel circuit extending between the fuel chamber and the throttle bore and controllable by a high speed adjustment member; and an enrichment fuel circuit extending between the fuel chamber and the throttle bore for supplying fuel to the throttle bore independently of the idle and high speed fuel circuits.

2. A carburettor as claimed in claim 1, wherein the idle fuel circuit comprises a first nozzle operable to delivery fuel to the throttle bore.

3. A carburettor as claimed in claim 2, comprising a first air delivery passage arranged to supply air to the first nozzle.

4. A carburettor as claimed in any preceding claim, wherein the high speed fuel circuit comprises a second nozzle operable to deliver fuel to the throttle bore.

5. A carburettor as claimed in claim 4, comprising a second air delivery passage arranged to supply air to the second nozzle.

6. A carburettor as claimed in any preceding claim, wherein the enrichment fuel circuit comprises a third nozzle operable to deliver fuel to the throttle bore.

7. A carburettor as claimed in claim 6, comprising a third air delivery passage arranged to supply air to the third nozzle.

8. A carburettor as claimed in any preceding claim, wherein the or each nozzle defines an airflow path arranged to combine air with fuel flowing through the nozzle.

9. A carburettor as claimed in any preceding claim, wherein one or more of the nozzles comprises a fixed jet arranged to control the flow of fuel or air into the nozzle.

10. A carburettor as claimed in any preceding claim, comprising a choke bore in communication with the throttle bore, at least one portion of a sidewall of the choke bore being adapted to modify air flow through the choke bore.

11. A carburettor as claimed in claim 10, wherein at least one portion of the choke bore sidewall is adapted to rotate about a longitudinal axis of the choke bore in order to modify the airflow.

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12. A carburettor as claimed in any of claim 11, comprising drive means operable to effect rotation of the at least one portion of choke bore sidewall.

13. A carburettor as claimed in any of claims 10 to 12, wherein the choke bore sidewall comprises multiple sidewall portions of different profiles.

14. A carburettor as claimed in any preceding claim, comprising a throttle valve operable to regulate air flow through the throttle bore, wherein the throttle valve is in operative association with an enrichment valve operable to regulate delivery of fuel to the fuel enrichment circuit.

15. A carburettor as claimed in claim 14, comprising a cam displaceable by a throttle valve shaft such as to effect regulation of the delivery of fuel to the fuel enrichment circuit, the cam being operable to displace a shuttle valve between a closed position disabling the fuel enrichment circuit and an open position enabling the fuel enrichment circuit.

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Claims

1. A carburettor comprising a throttle bore; a fuel chamber; an idle fuel circuit extending between the fuel chamber and the throttle bore and controllable by an idle adjustment member; a high speed fuel circuit extending between the fuel chamber and the throttle bore and controllable by a high speed adjustment member; and an enrichment fuel circuit extending between the fuel chamber and the throttle bore for supplying fuel to the throttle bore independently of the idle and high speed fuel circuits.

2. A carburettor as claimed in claim 1, wherein the idle fuel circuit comprises a first nozzle operable to delivery fuel to the throttle bore.

3. A carburettor as claimed in any preceding claim, wherein the high speed fuel circuit comprises a second nozzle operable to deliver fuel to the throttle bore.

4. A carburettor as claimed in any preceding claim, wherein the enrichment fuel circuit comprises a third nozzle operable to deliver fuel to the throttle bore.

5. A carburettor as claimed in any preceding claim, wherein the or each nozzle defines an airflow path arranged to combine air with fuel flowing through the nozzle.

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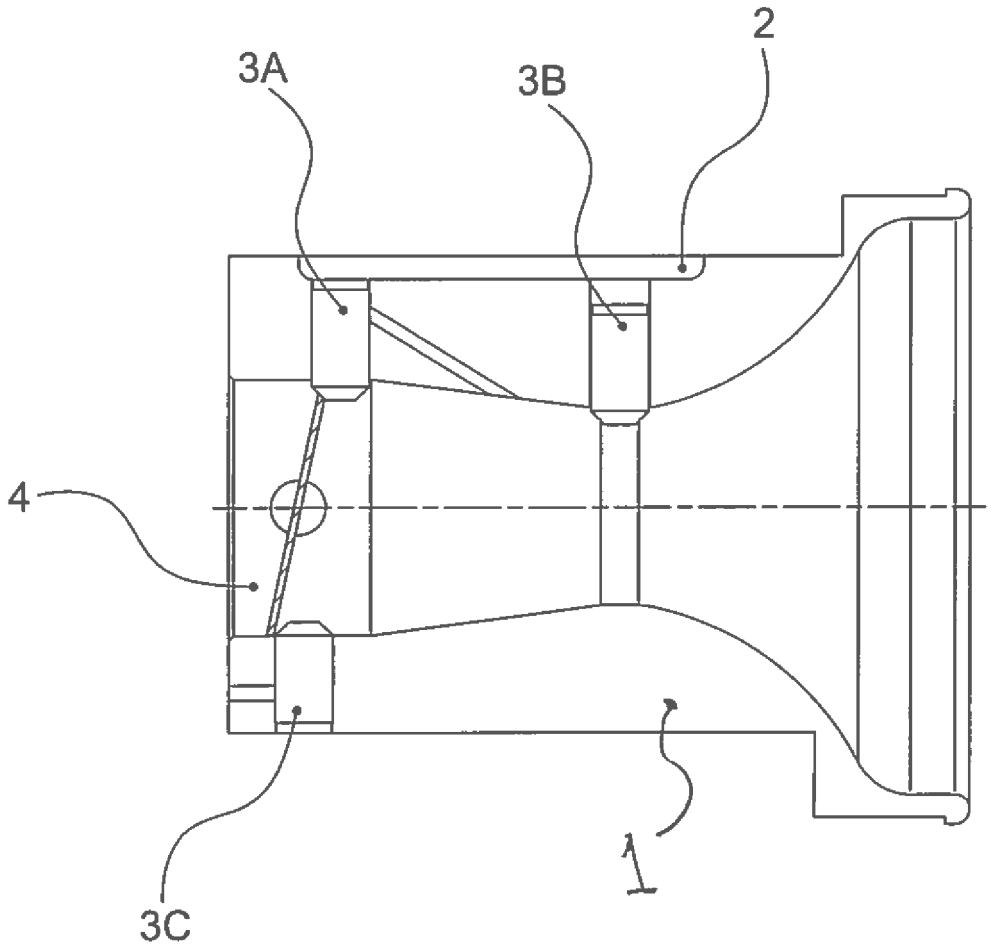


Figure 1

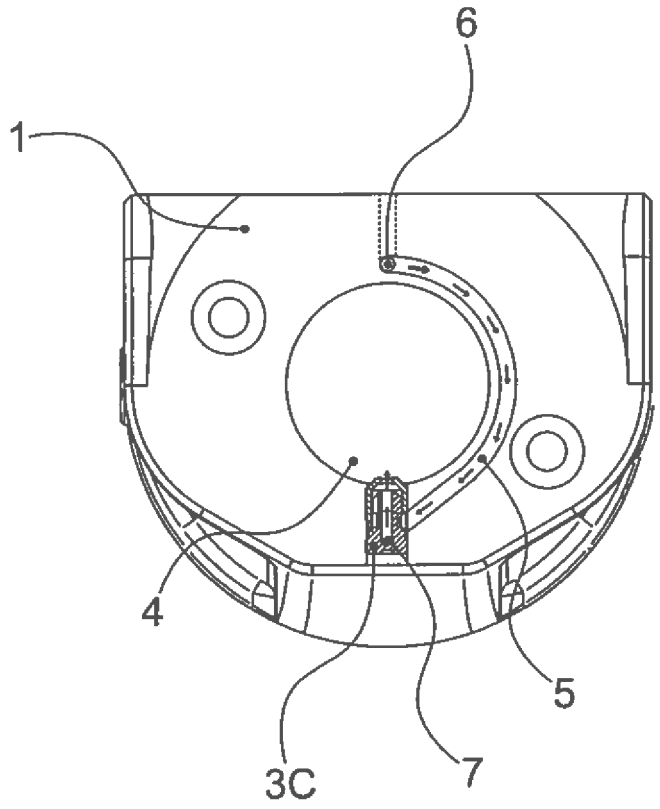


Figure 2

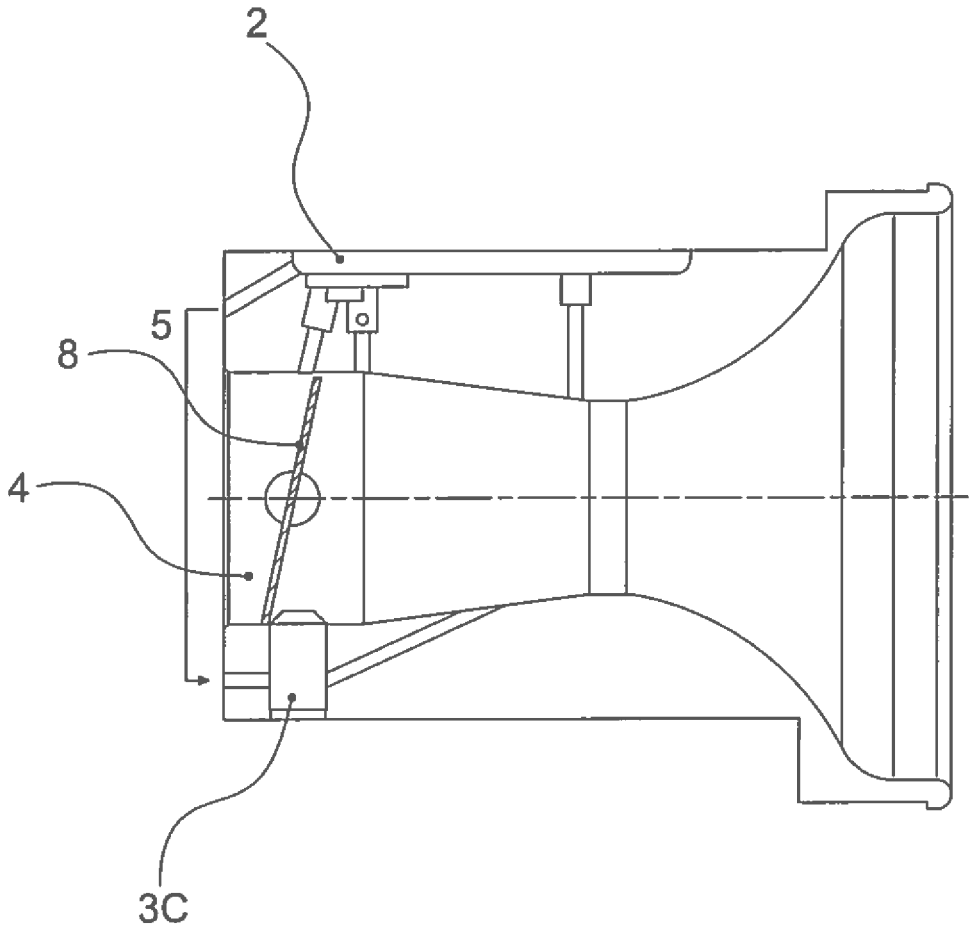


Figure 3

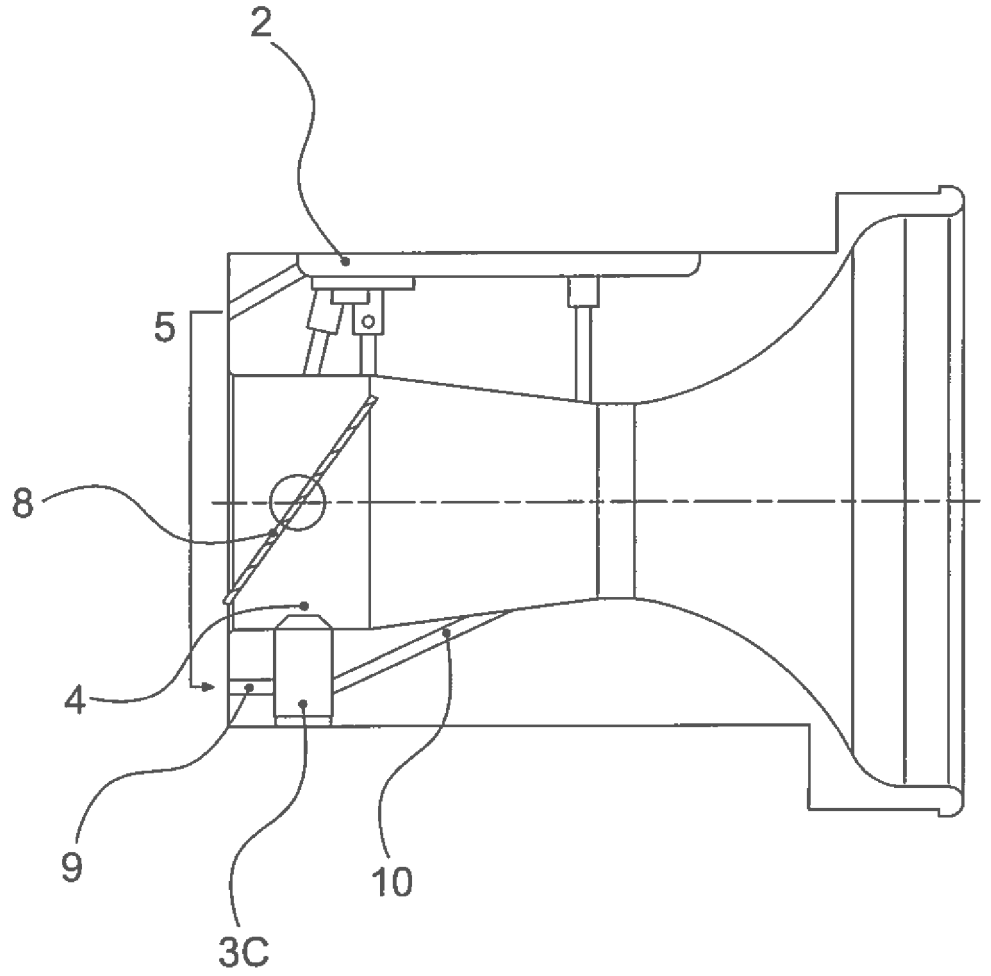


Figure 4

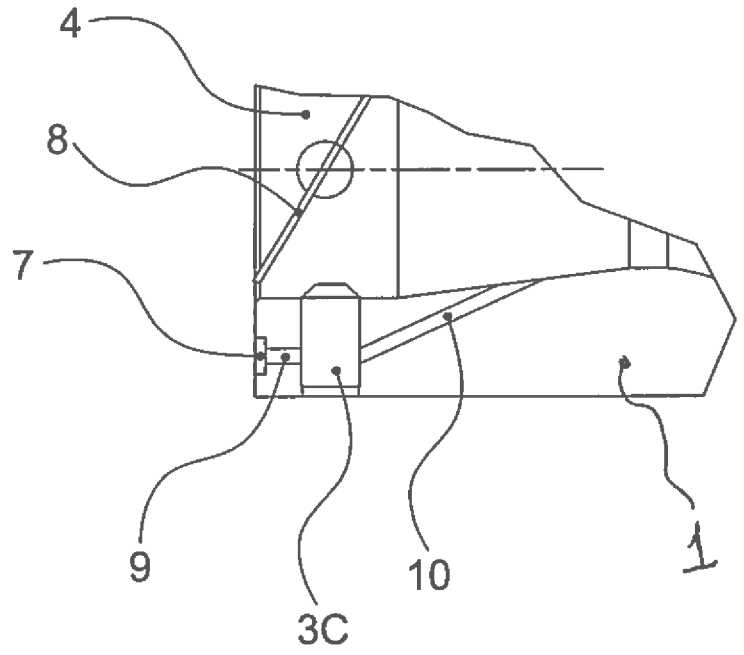


Figure 5

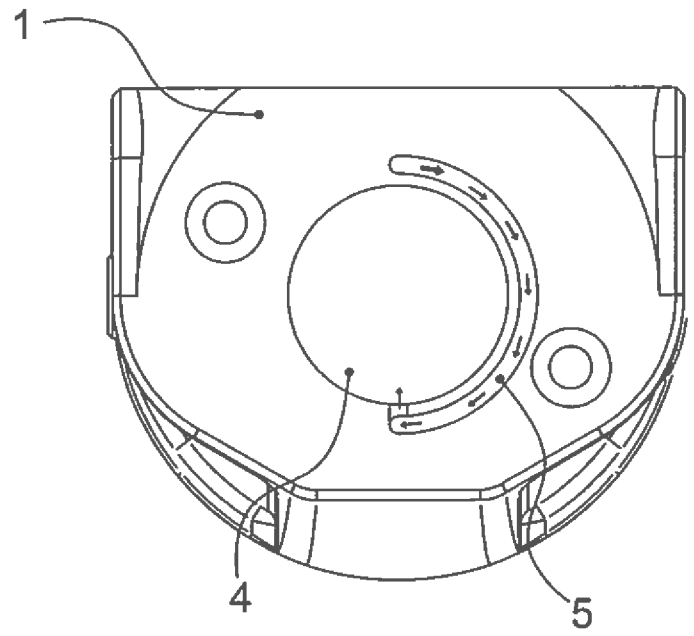


Figure 6

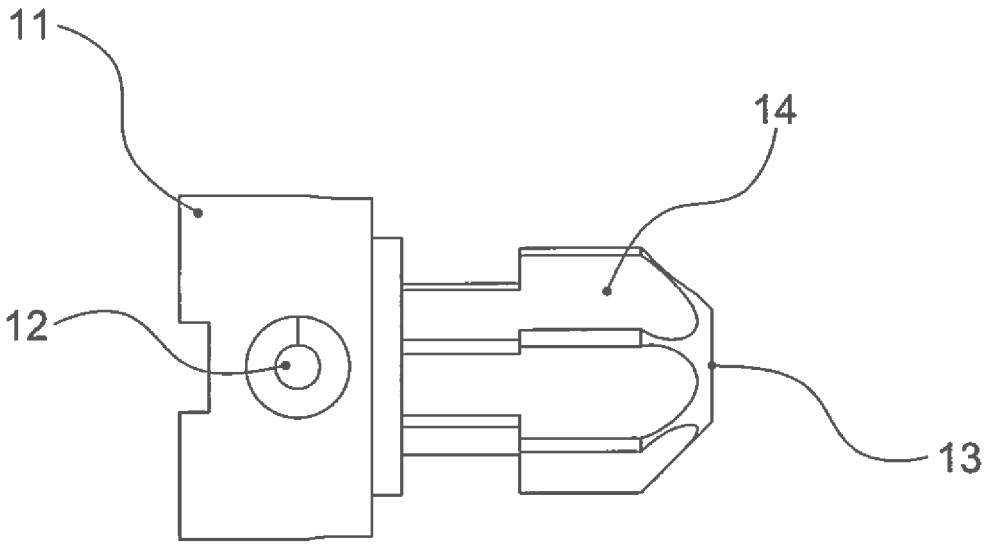


Figure 7

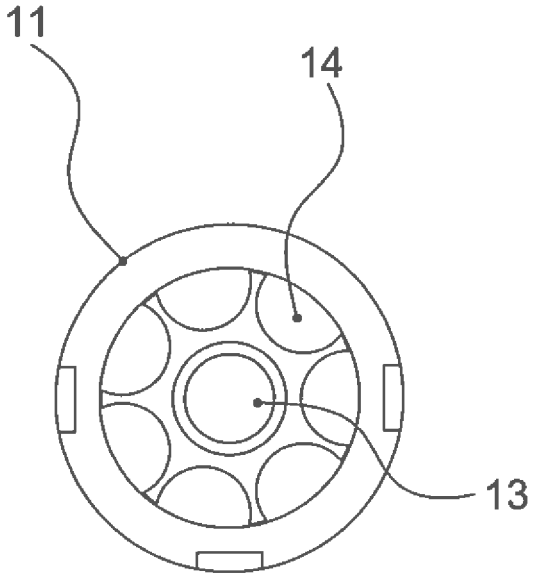


Figure 8

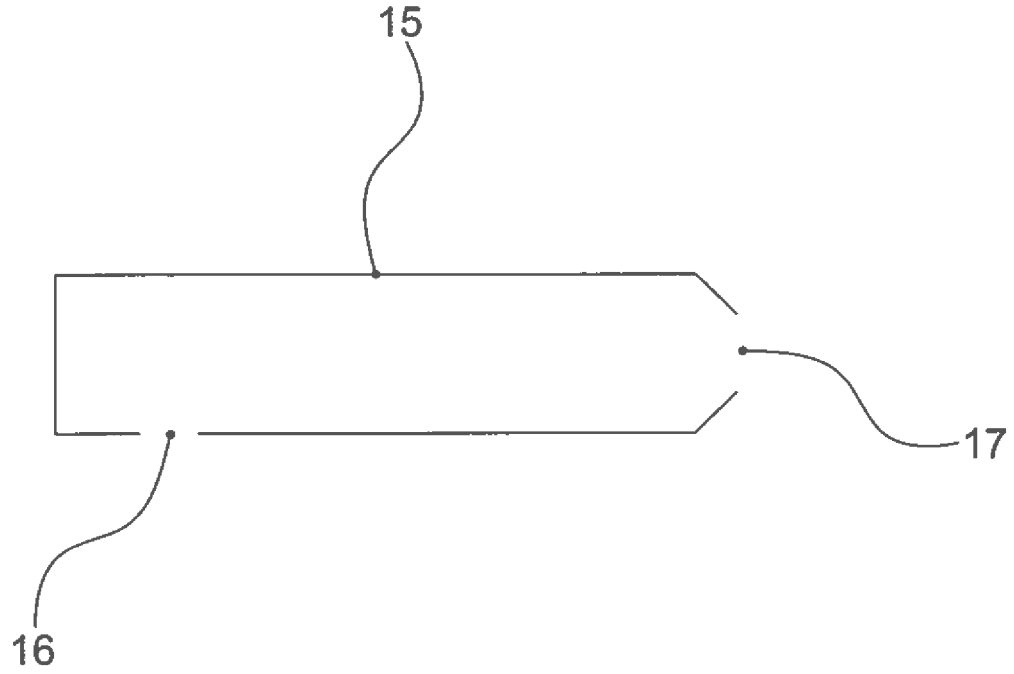


Figure 9

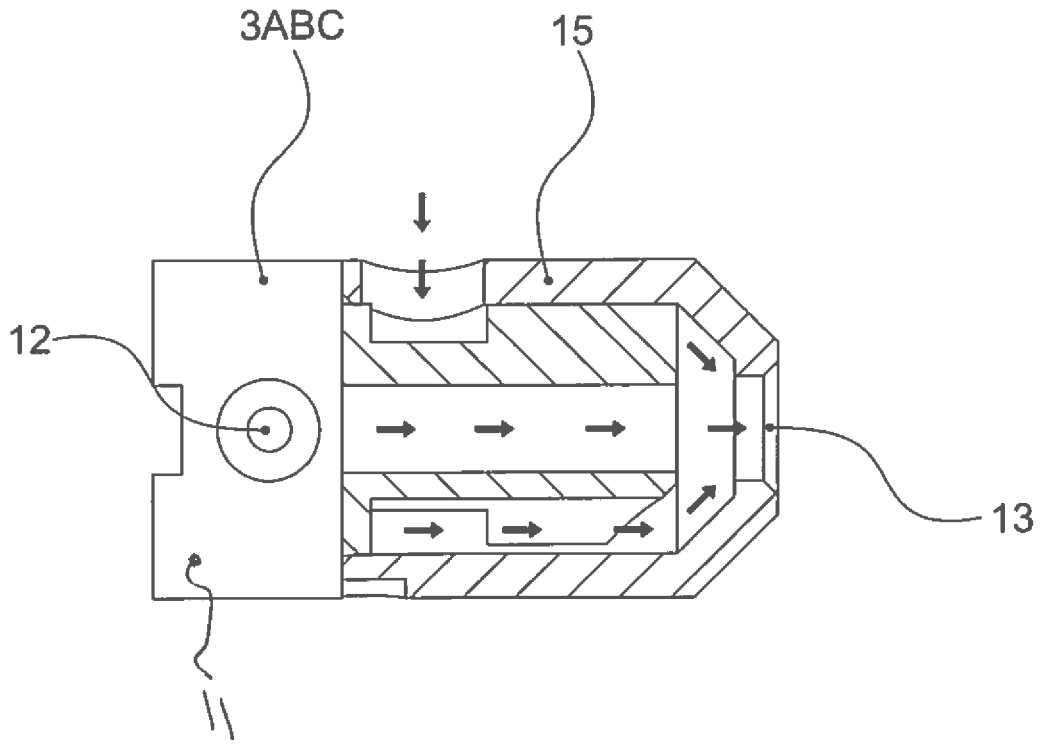


Figure 10

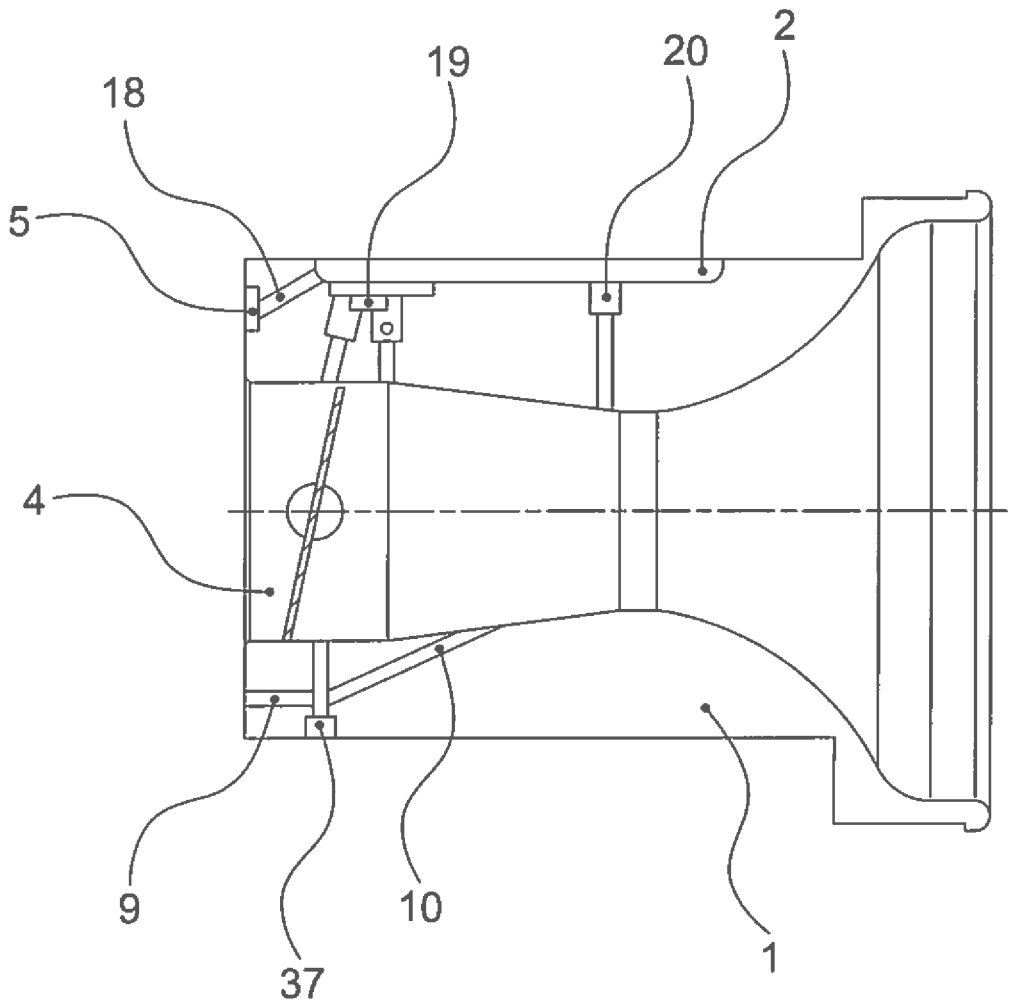


Figure 11

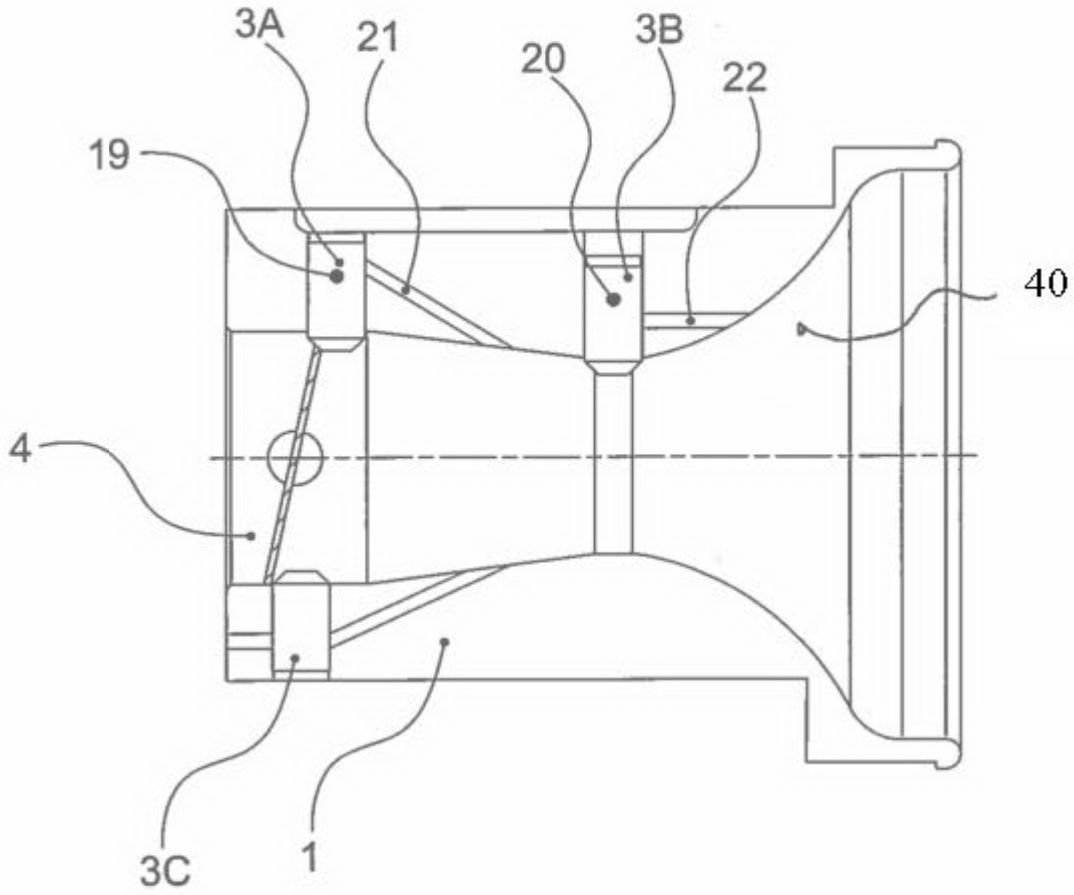


Figure 12

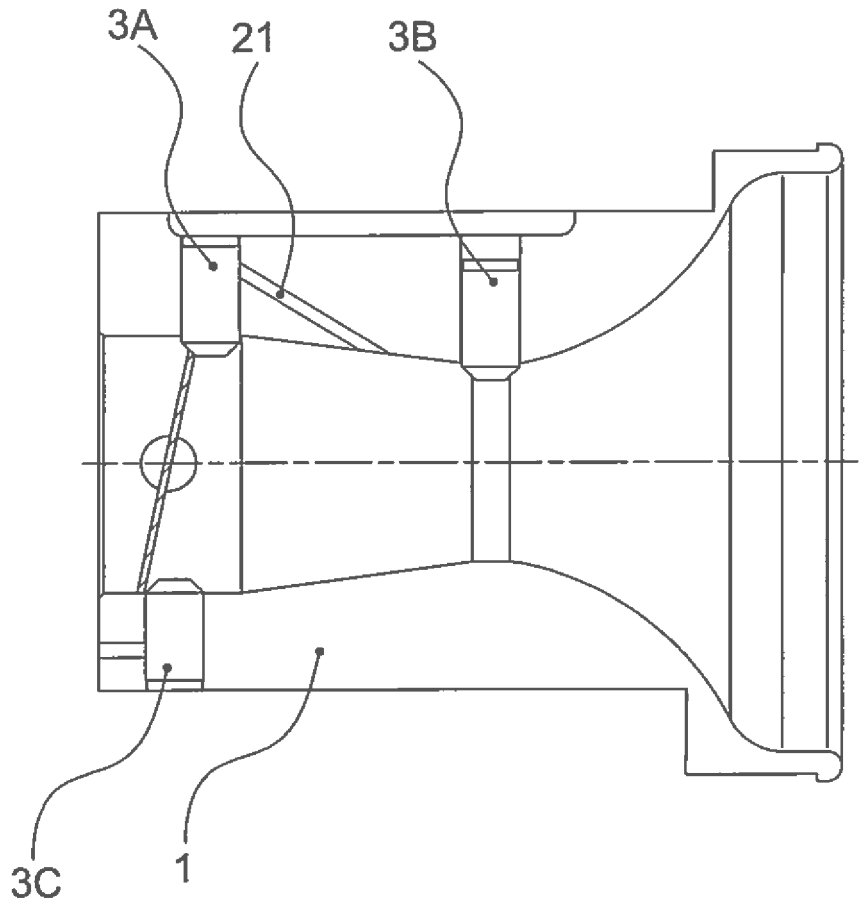


Figure 13

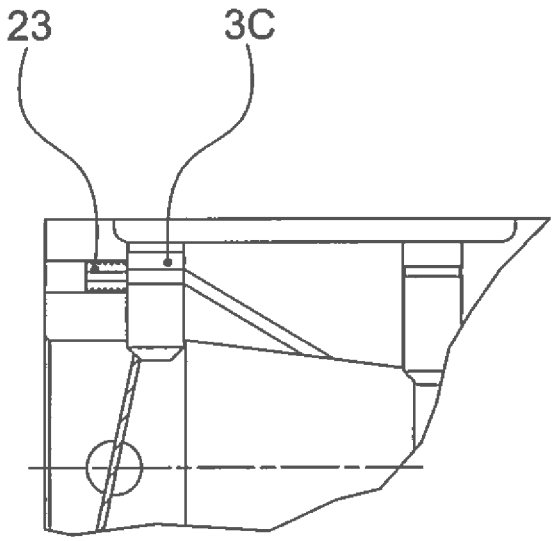


Figure 14

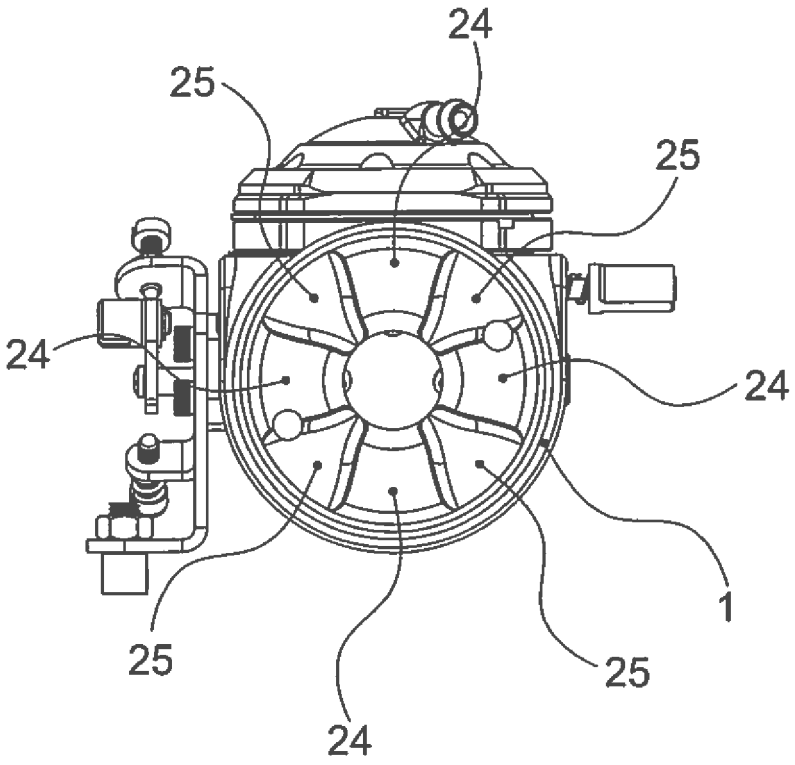


Figure 15

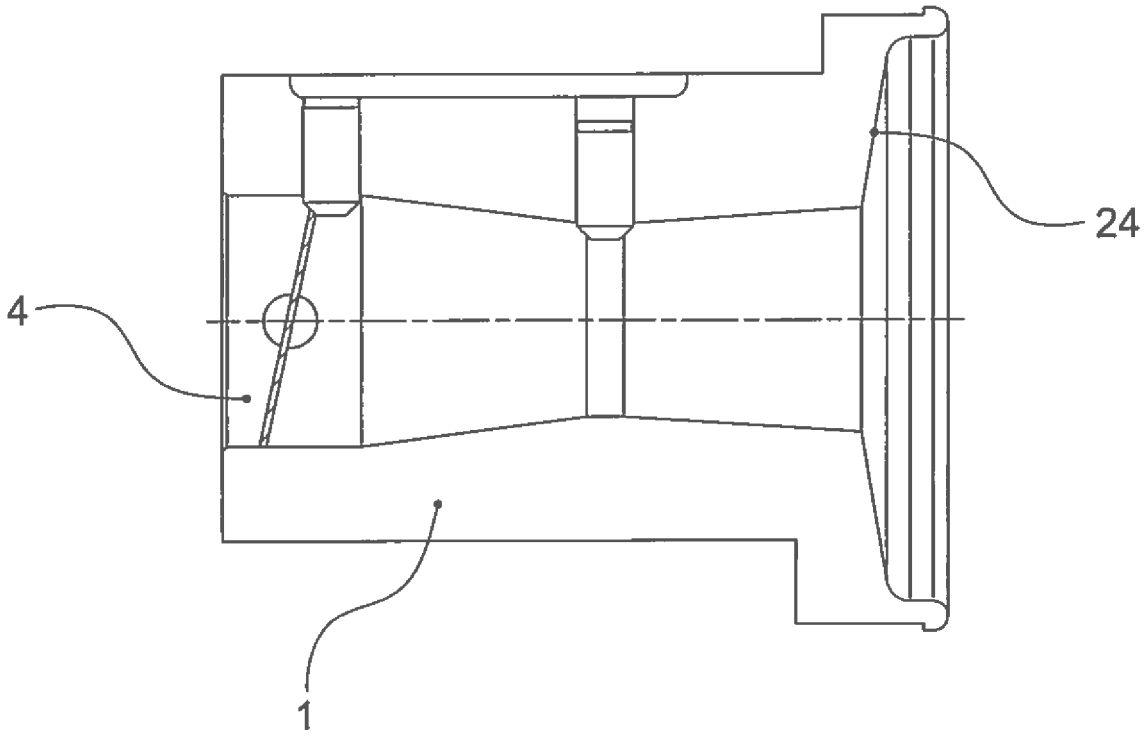


Figure 16

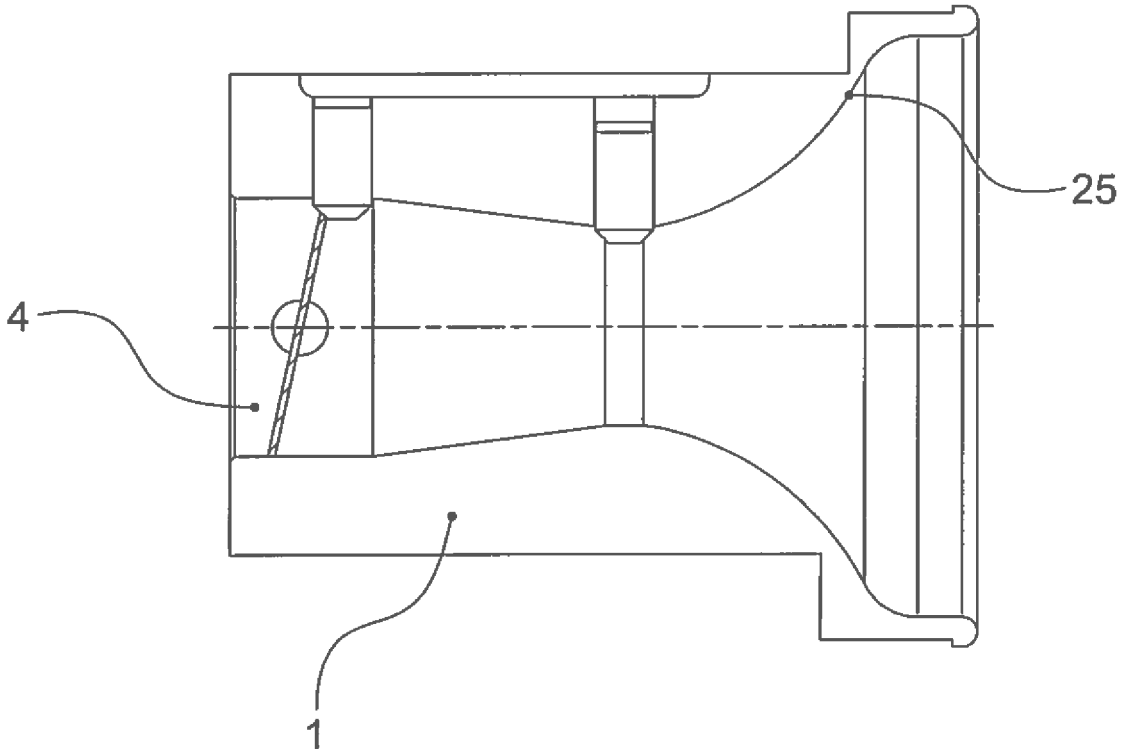


Figure 17

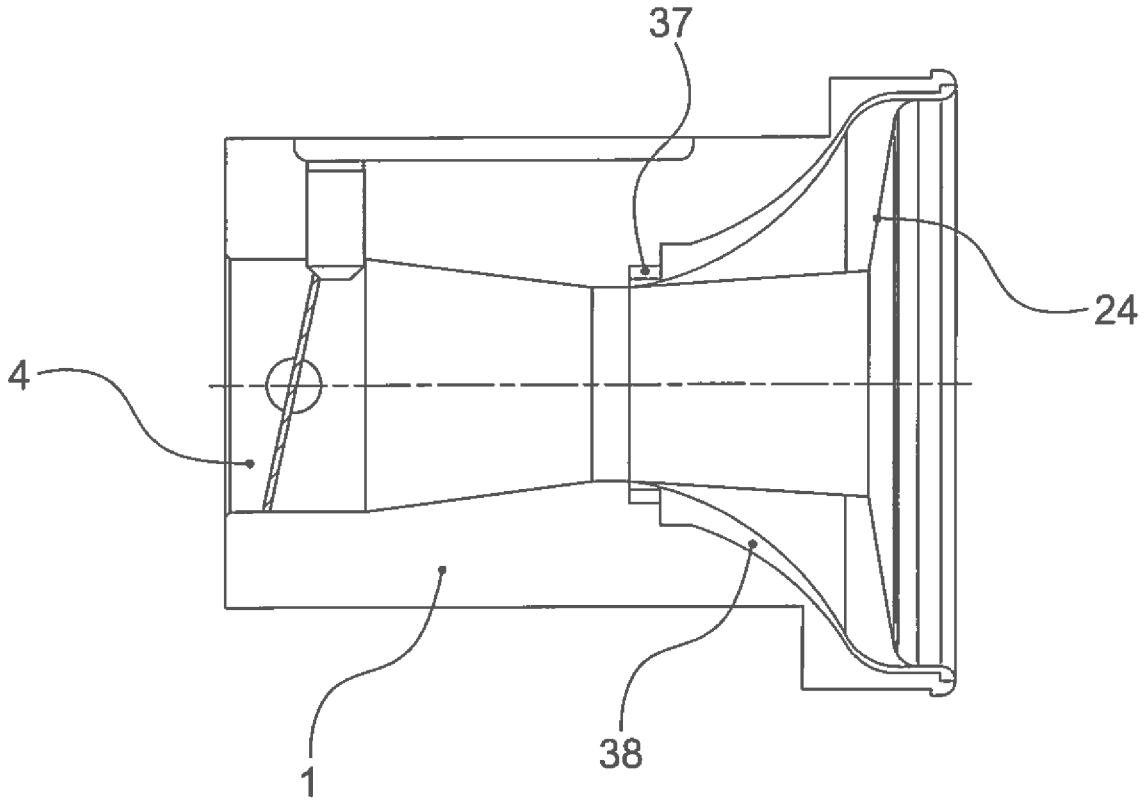


Figure 18

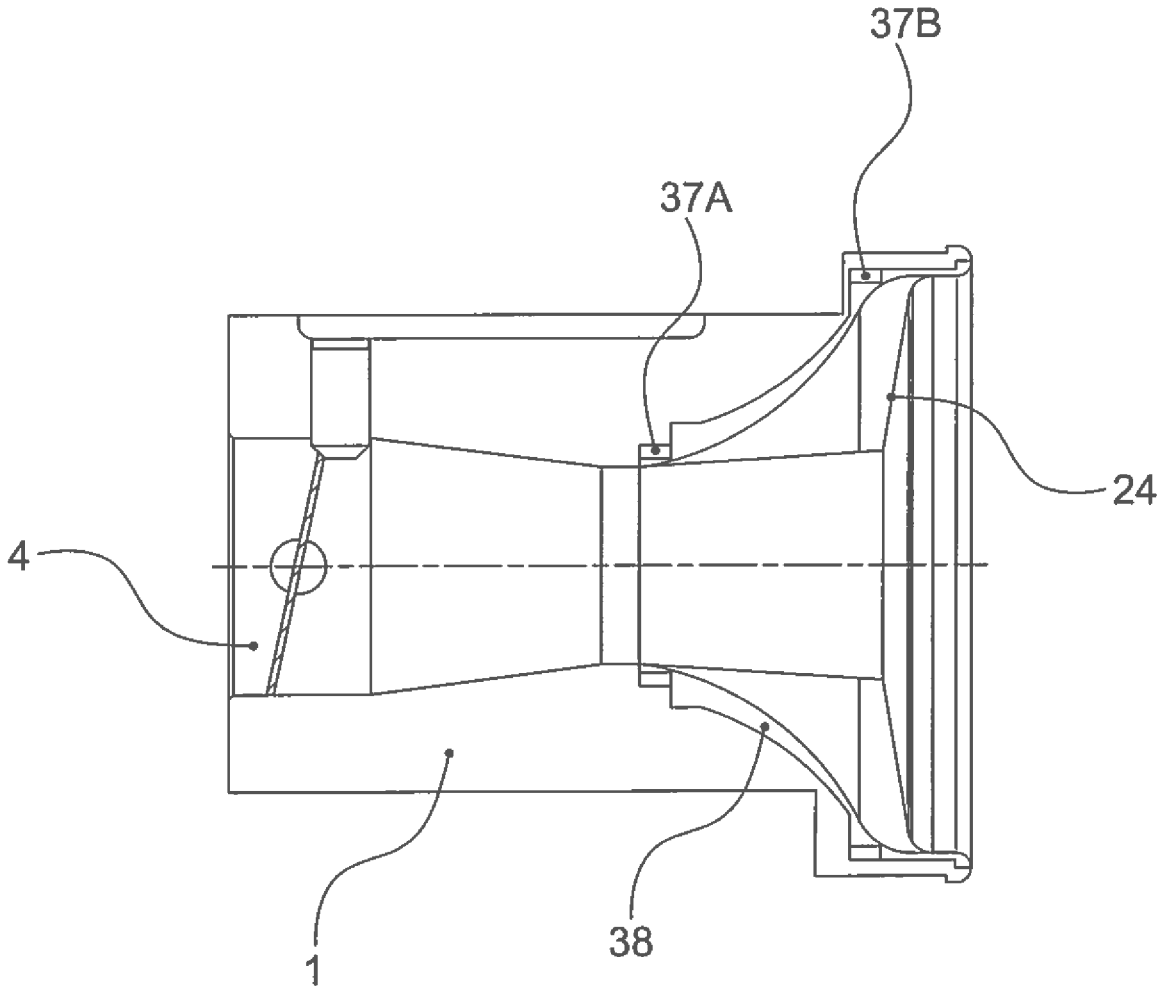


Figure 19

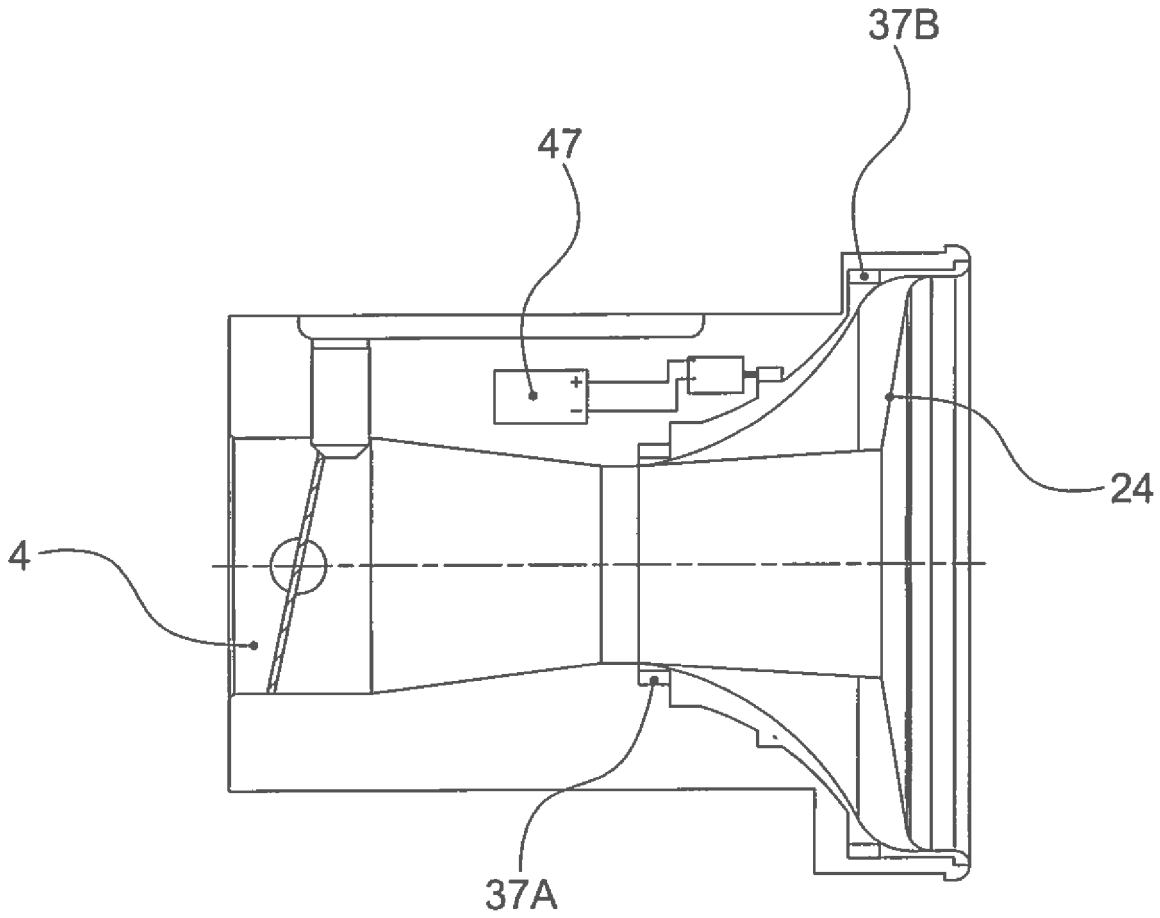


Figure 20

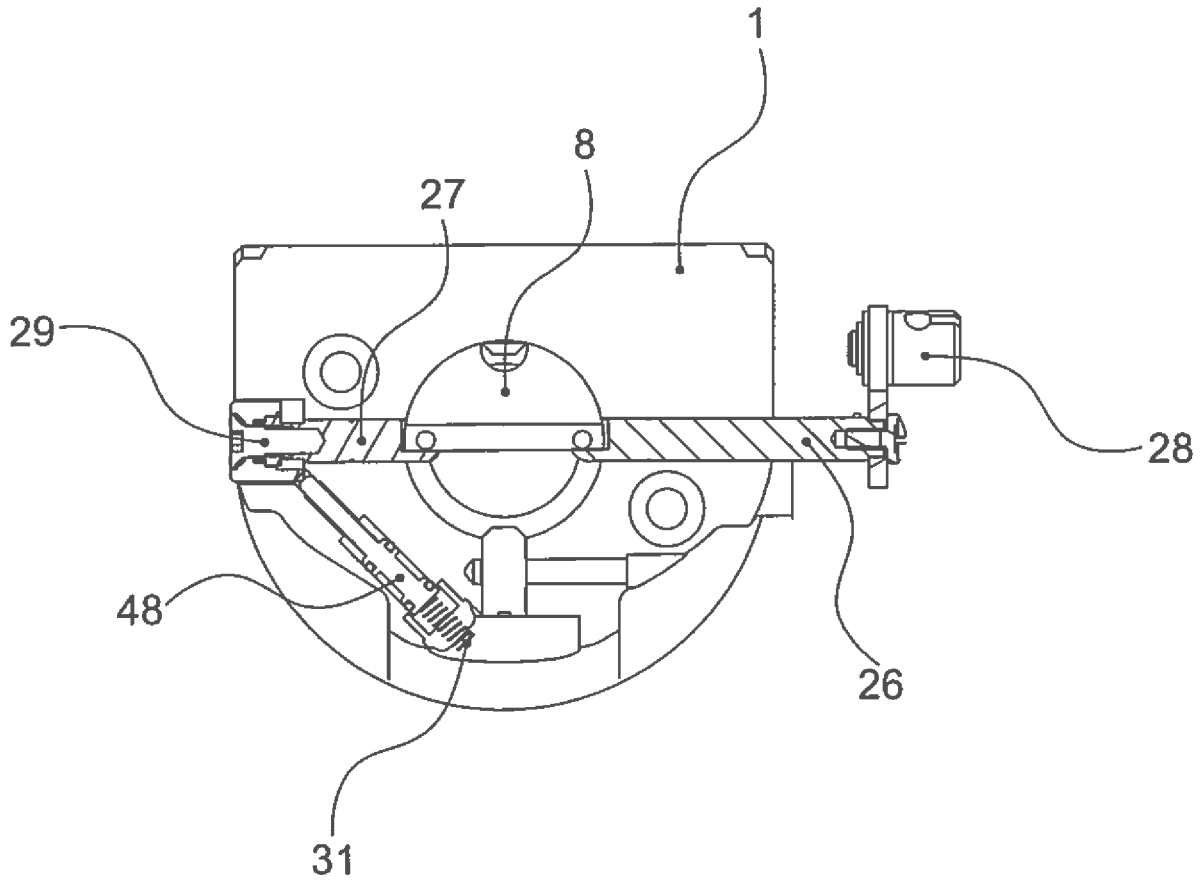


Figure 21

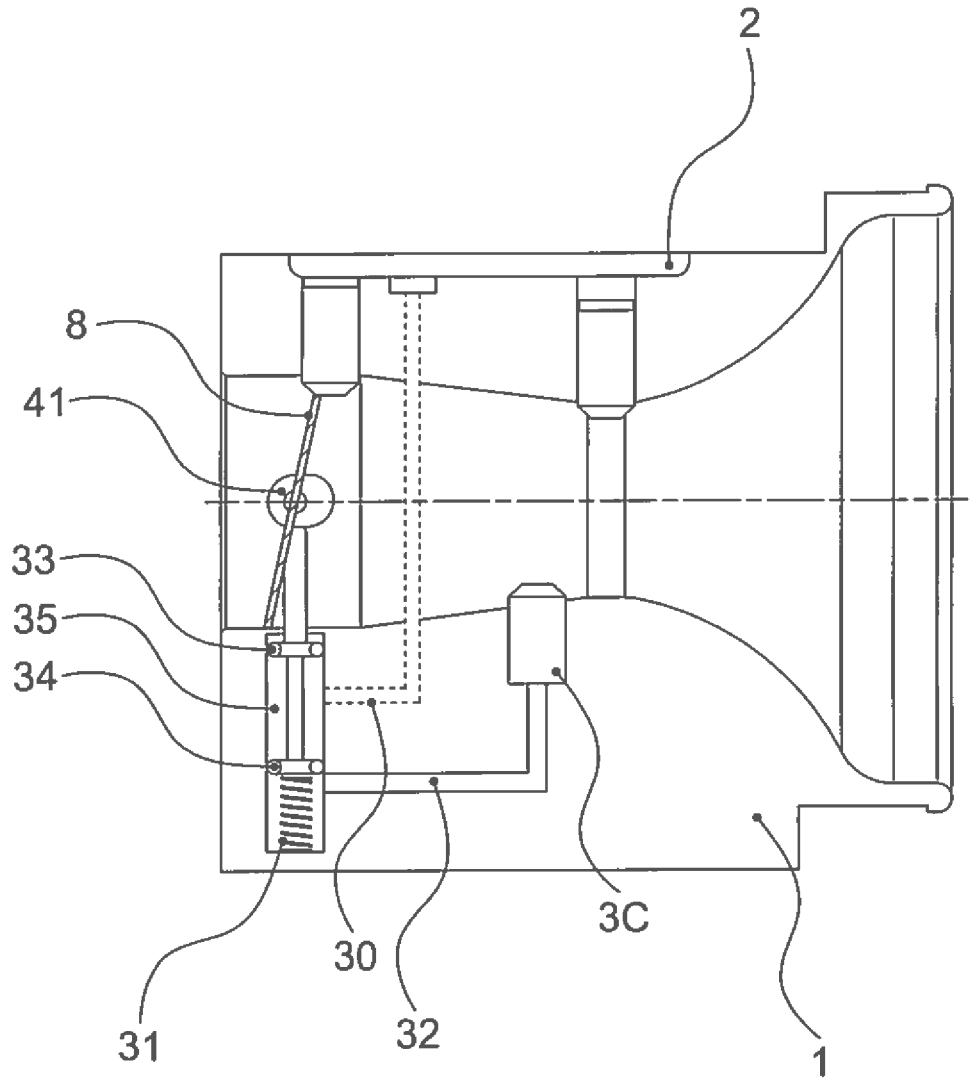


Figure 22

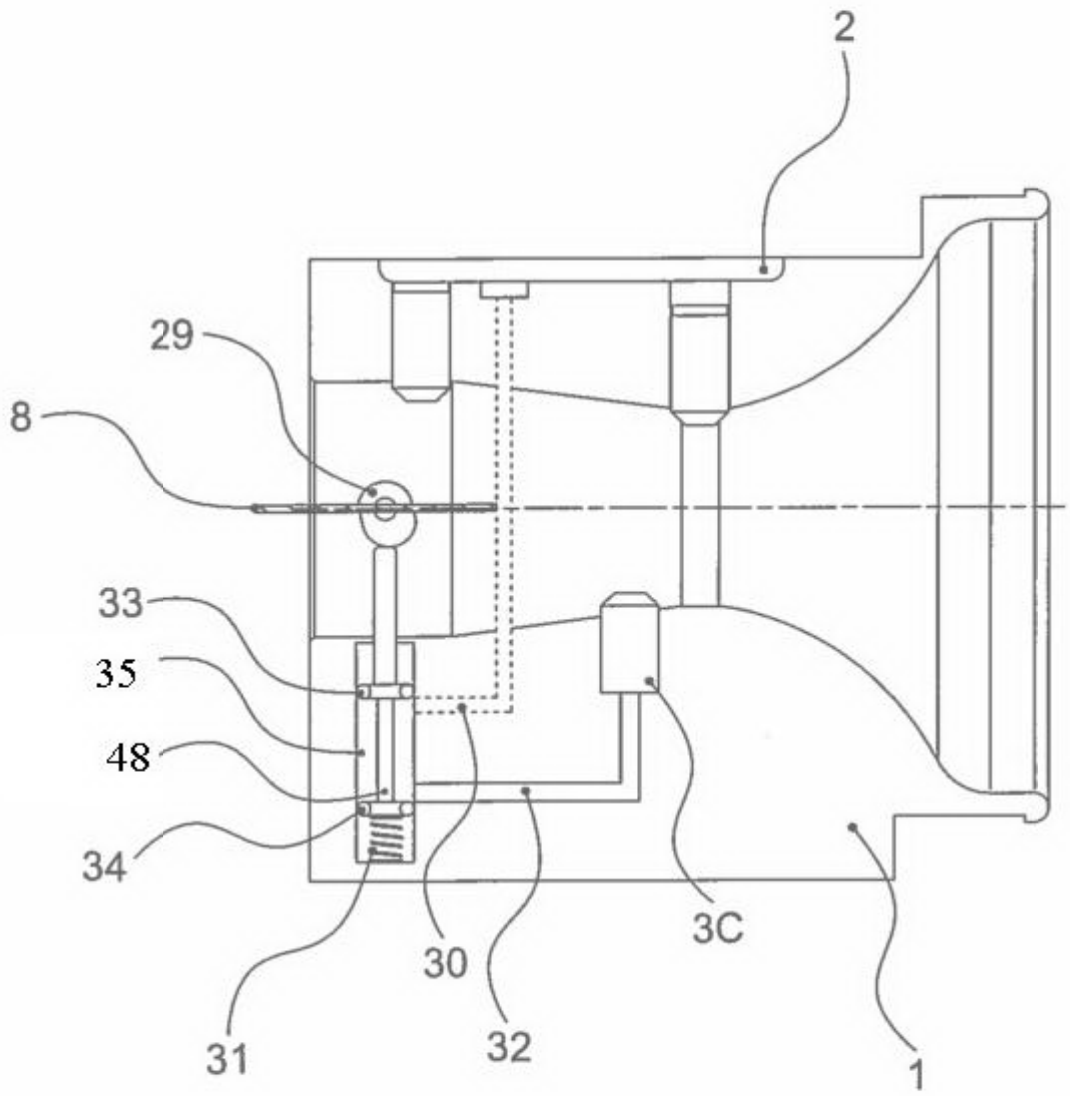


Figure 23

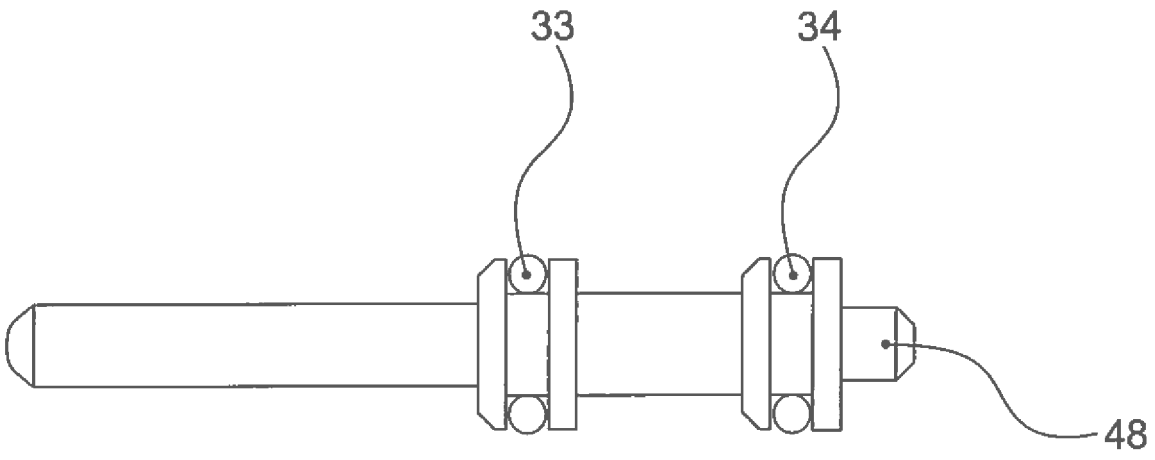


Figure 24

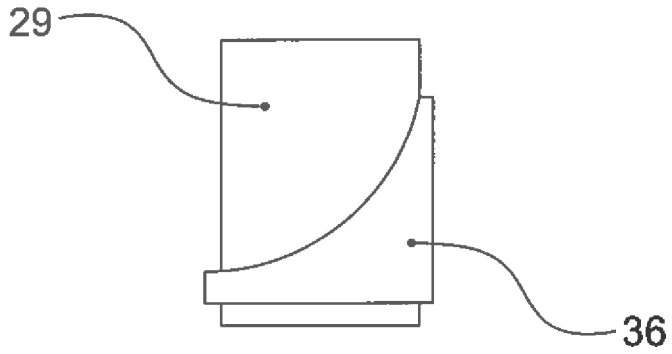


Figure 25