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D'UN SECOND FLUIDE ET UTILISATION DUDIT APPAREIL

(54) Title: APPARATUS AND METHOD FOR INTRODUCING A FIRST FLUID INTO THE FLOW PATH OF A SECOND
FLUID AND USE OF SUCH AN APPARATUS

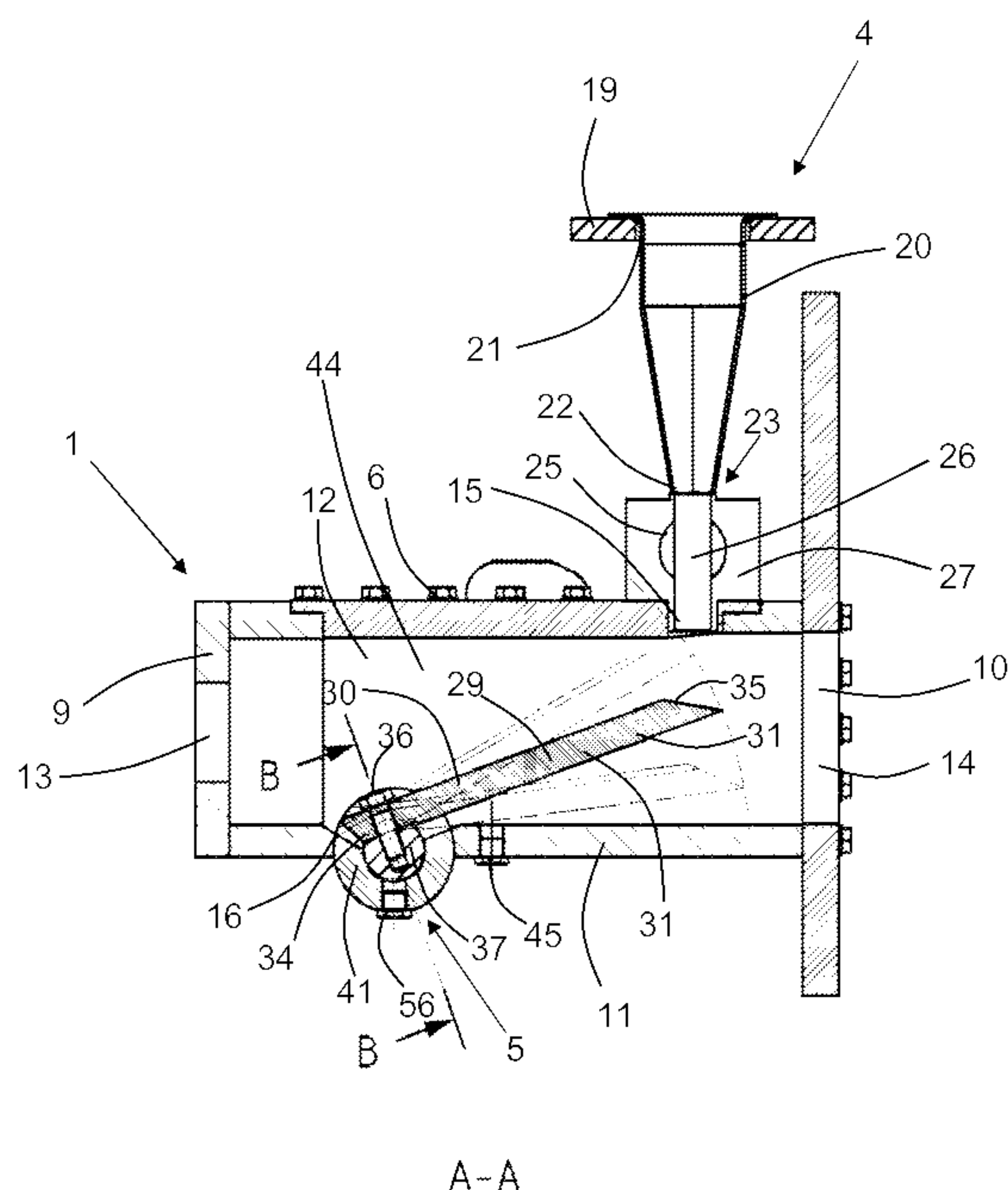


Fig. 5

(57) **Abrégé/Abstract:**

An apparatus for mixing a first fluid into a flow path (44) of a second fluid, said apparatus having a chamber (12), which encloses the flow path and exhibits a first inlet (13) for receiving the second fluid, a second inlet (15) arranged downstream of the first inlet for



(57) **Abrégé(suite)/Abstract(continued):**

receiving the first fluid, as well as an outlet arranged downstream of the second inlet for discharging a mixture of the first fluid and the second fluid, said flow path extending from the first inlet to the outlet and said second inlet opening into the flow path, a throttle body (29), which is pivotally arranged inside the chamber for controlling the flow area of the flow path, and pivoting means (50, 51) for pivoting the throttle body for said controlling of the flow area. According to the invention, the pivoting means is adapted to pivot the throttle body so that the flow area decreases with a decreasing flow rate of the second fluid and increases with an increasing flow rate of the second fluid, in order to maintain the flow velocity of the second fluid at the second inlet within a predetermined range.

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(54) Title: APPARATUS AND METHOD FOR INTRODUCING A FIRST FLUID INTO THE FLOW PATH OF A SECOND FLUID AND USE OF SUCH AN APPARATUS

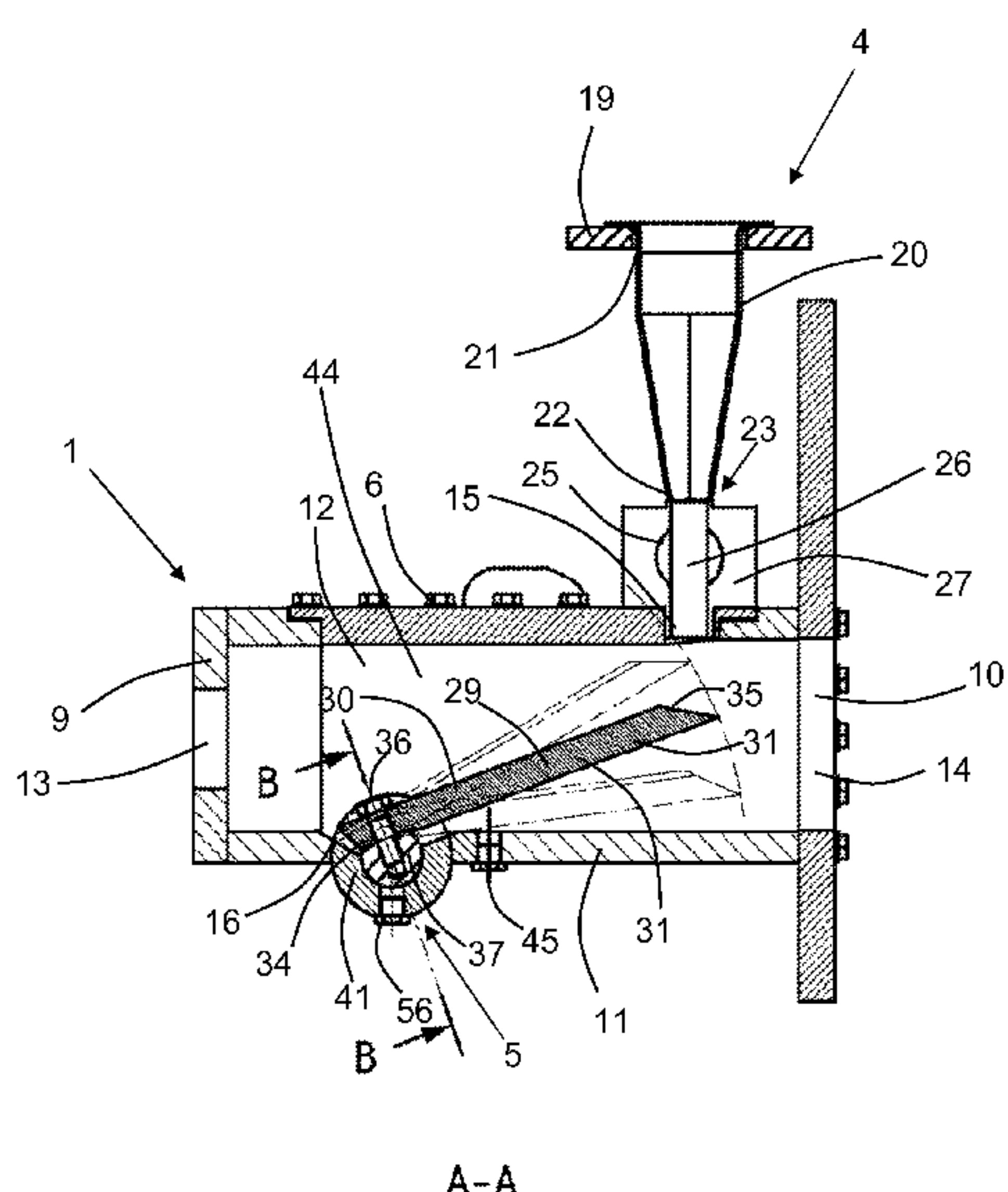


Fig. 5

(57) Abstract: An apparatus for mixing a first fluid into a flow path (44) of a second fluid, said apparatus having a chamber (12), which encloses the flow path and exhibits a first inlet (13) for receiving the second fluid, a second inlet (15) arranged downstream of the first inlet for receiving the first fluid, as well as an outlet arranged downstream of the second inlet for discharging a mixture of the first fluid and the second fluid, said flow path extending from the first inlet to the outlet and said second inlet opening into the flow path, a throttle body (29), which is pivotally arranged inside the chamber for controlling the flow area of the flow path, and pivoting means (50, 51) for pivoting the throttle body for said controlling of the flow area. According to the invention, the pivoting means is adapted to pivot the throttle body so that the flow area decreases with a decreasing flow rate of the second fluid and increases with an increasing flow rate of the second fluid, in order to maintain the flow velocity of the second fluid at the second inlet within a predetermined range.

Apparatus and method for introducing a first fluid into the flow path of a second fluid and use of such an apparatus

- 5 The present invention relates to an apparatus for mixing a first fluid into a flow path of a second fluid, said apparatus comprising:
- a chamber, which encloses the flow path and exhibits a first inlet for receiving the second fluid, a
10 second inlet arranged downstream of the first inlet for receiving the first fluid, as well as an outlet arranged downstream of the second inlet for discharging a mixture of the first fluid and the second fluid, said flow path extending from the first
15 inlet to the outlet and said second inlet opening into the flow path;
 - a throttle body, which is pivotally arranged inside the chamber for controlling the flow area of the flow path; and
 - 20 - pivoting means, for pivoting the throttle body for said controlling of the flow area.

- The present invention also relates to a method for mixing a first fluid into a flow path of a second
25 fluid, comprising the steps of:
- causing the second fluid to flow in a chamber from a first inlet to an outlet, said chamber enclosing said flow path;
 - supplying the first fluid to the flow path of the
30 second fluid via a second inlet of the chamber, said second inlet being arranged downstream of the first inlet and upstream of the outlet; and
 - causing pivoting means to pivot a throttle body arranged in the flow path, to control the flow area
35 of the flow path.

The present invention also relates to use of such an apparatus.

As used herein, fluid means a gas, a liquid, a steam,
5 or a mixture of these. As used herein, the notion fluid is also meant to include a system consisting of a mixture of solid particles and a liquid or gas, where the mixture has fluid-like properties. One example of such a system is a suspension, e.g. a cellulose pulp
10 suspension.

As used herein, introducing a first fluid into the flow path of second fluid means injection, mixing, dispersion or other admixing of the first fluid, which
15 is also called the admixture fluid, into the flow path of the second fluid.

It is not unusual in industrial processes that fluids are mixed with each other. In e.g. the paper industry,
20 it is not unusual that process chemicals, e.g. oxygen gas, chlorine dioxide or ozone, are introduced into a flow of pulp suspension. It is also common in this industry that steam is introduced into the flow of pulp suspension with the purpose of heating the pulp
25 suspension.

When introducing a first fluid into the flow path of a second fluid, it is generally always desirable to obtain a mixing or dispersion of the first fluid which
30 is as effective and uniform as possible.

A number of apparatuses for introducing a first fluid into the flow path of a second fluid are previously known.

35

SE 468 341 C discloses an apparatus for mixing a fluid, such as e.g. gases in the form of ozone, oxygen and

chlorine, and liquids containing various active substances, e.g. chlorine dioxide, into the flow path of a suspension of a cellulosic fiber material. The apparatus has a funnel-shaped part and a cone-shaped, movable part arranged therein. Between the funnel-shaped part and the cone-shaped part, there is an adjustable gap through which the fiber suspension passes, wherein also the fluid is supplied in said gap. The apparatus comprises a pneumatic cylinder for displacing the cone-shaped part, to control the flow area of the gap. A control device continuously measures the pressure in the pulp suspension upstream and downstream of the gap, compares the recorded pressure difference with a predetermined set value, and controls the flow area of the gap via the cylinder, so that the predetermined set value is maintained.

SE 502 393 discloses another apparatus for mixing a first fluid, e.g. steam, oxygen, ozone or chlorine dioxide, into the flow path of a second fluid, e.g. a pulp suspension. The apparatus has a flow chamber for the second fluid. A double wedge-shaped restrictor member is arranged in this chamber, so that a gap for the second fluid is formed between the inside walls of the chamber and the wedge member, wherein also the first fluid is supplied in said gap. The restrictor member can be operated via cylinders for controlling the width of the gap, and thus also the flow through the apparatus. Pressure-sensing sensors are mounted upstream and downstream of the apparatus for measuring the pressure difference across the apparatus, and a control device is adapted to control the width of the gap, via the cylinders and the restrictor member, so that a predetermined set value of the pressure difference is maintained.

SE 514 543 discloses yet another apparatus for mixing a first fluid into a second fluid. The apparatus has a flow chamber for the second fluid, which can be a pulp suspension. Inlet passages for supplying the first
5 fluid, which can be steam, open directly upstream of, or into the flow chamber. A throttle body is arranged in the flow chamber. The throttle body has a circle segment-shaped cross-section and is pivotally arranged by means of a cylinder relative to an opposite filling
10 body, so that a gap having a controllable flow area is formed. By means of adjusting the size of the gap by pivoting the throttle body, the amount of suspension passing the steam inlet passages can be controlled, and thus the amount of steam in the pulp suspension can be
15 controlled.

Apparatuses comprising a rotating part, which ensures that the fluid is mixed into the pulp suspension, are also used for mixing a fluid into a pulp suspension. If
20 the fluid is steam, a problem associated with these apparatuses is that the rotation leads to large pressure fluctuations, which create local zones of very low pressure into which the steam tends to flow. Accordingly, there is a risk of accumulation of steam
25 in these zones, with steam implosions as a result. Another problem with these devices is that they are relatively energy intensive and that they require relatively much maintenance.

30 One problem with the previously known systems mentioned above is that they have difficulty in producing an effective mixing or dispersion of the admixture fluid in case of sudden variations in the flow of the fluid in which the mixing is to occur. This is especially a
35 problem when heating a liquid or a suspension by means of steam, where the steam is injected or mixed into the liquid or suspension and is then allowed to condense.

The objective of such an injection is to admix, i.e. to mix and disperse, the added steam, and simultaneously to keep the liquid or suspension in such a movement, that a slow and continuous condensation of the steam occurs. If the mixing or dispersion is not sufficient, there is a risk of steam bubbles forming in the liquid or suspension, wherein said steam bubbles may subsequently implode. In case of sudden flow rate fluctuations of the liquid or suspension, there is a risk of the mixing of the steam becoming insufficient, wherein there is a risk of intermittent steam implosions occurring. These steam implosions cause pressure shocks in the liquid or suspension, which in their turn may propagate to machine supports, apparatuses and other process equipment and cause knocks and vibrations, which can be so powerful that mechanical damage results. This is especially a problem when a large amount of steam is added to a cellulose pulp suspension and especially to a cellulose pulp suspension of medium consistency. As used herein, a pulp suspension of medium consistency means a pulp suspension having a dry solids content in the range of approx. 8-14 %.

Accordingly, there is a general need for an apparatus and a method which enable an effective mixing and dispersion of a first fluid into the flow path of a second fluid even if the flow rate of the second fluid fluctuates. There is especially a need for an apparatus and a method which enable an effective mixing and dispersion of steam into a liquid or suspension, e.g. a cellulose pulp suspension, even if the flow rate thereof fluctuates.

It is thus the main object of the present invention to solve the above-mentioned problems and to produce an apparatus and a method which enable a simple and

effective mixing of a first fluid into the flow path of a second fluid, even if the flow rate of the second fluid fluctuates.

5 Another object of the present invention is to produce an apparatus and a method which enable an effective mixing of steam into a liquid or a suspension, e.g. a cellulose pulp suspension, even if the flow rate of the liquid or suspension fluctuates.

10

Still another object of the present invention is to produce an apparatus and a method which enable mixing of steam into a liquid or a suspension, e.g. a cellulose pulp suspension, without the occurrence of
15 powerful steam implosions.

Another object of the present invention is to produce an apparatus and a method which are capable of effectively mitigating the negative effect of steam
20 implosions, should they still occur.

Yet another object of the present invention is to produce an apparatus and a method which enable an effective mixing of a process chemical in gaseous form,
25 e.g. oxygen gas, chlorine gas and ozone, or in liquid form, e.g. a pH-adjusting liquid, chlorine dioxide or other treatment liquid, into the flow path of a second fluid, e.g. process liquor or a cellulose pulp suspension, even if the flow rate of the second fluid
30 fluctuates.

Still another object of the present invention is to produce an apparatus and a method which prevent clogging of the inlet openings for the first fluid and
35 the flow path of the second fluid.

The above-mentioned and other objects are achieved by means of an apparatus according to the invention, which is characterized in that the pivoting means is adapted to pivot the throttle body so that the flow area
5 decreases with a decreasing flow rate of the second fluid and increases with an increasing flow rate of the second fluid, in order to maintain the flow velocity of the second fluid at the second inlet within a predetermined range.

10

The above-mentioned and other objects are also achieved by means of a method according to the invention, which is characterized in the step that the pivoting means is caused to pivot the throttle body so that the flow area
15 decreases with a decreasing flow rate of the second fluid and increases with an increasing flow rate of the second fluid, in order to maintain the flow velocity of the second fluid at the second inlet within a predetermined range.

20

Accordingly, by means of the invention, an effective mixing of fluids is achieved even if the flow rate of the fluid in which the mixing is to occur fluctuates. In case the admixture fluid is steam, the further
25 advantage relative to the prior art that the occurrence of steam implosions can be eliminated, or at least substantially reduced, is obtained. This, in its turn, means that failures of the apparatus and associated process equipment (piping etc.) causing shutdowns are
30 avoided. Furthermore, the heavy and over-dimensioned foundations and/or piping that were previously needed to handle the mechanical stresses caused by the steam implosions are no longer needed.

35

In the following, the invention will be described more closely with reference to accompanying drawings.

Figure 1 shows a perspective view of a first, preferred embodiment of an apparatus according to the invention.

Figure 2 shows the apparatus of Figure 1 in a side view.

Figure 3 shows the apparatus of Figure 1 in a top view.

Figure 4 shows the apparatus of Figure 1 in a view from behind.

Figure 5 shows the apparatus of Figure 1 in a side view, in cross-section, wherein a control unit of the apparatus is shown in greater detail.

Figure 6 shows an axle and a flap of the control unit in cross-section.

Figure 7 shows an embodiment where the apparatus comprises a second conduit.

Figures 8-10 show an embodiment of a flap according to Figure 6.

The embodiment of the invention that will be described in the following is intended to be used in a process plant for mixing a first fluid, in the form of steam, into the flow path of a second fluid, in the form of a cellulose pulp suspension, wherein the hot steam is intended for heating the pulp suspension to a desired temperature, e.g. to a temperature that is suitable for a subsequent bleaching step. It will be appreciated, however, that the principle of the invention can be used for mixing other fluids, such as gases, e.g. oxygen gas, chlorine gas or ozone, or liquids, e.g. pH-adjusting liquids, chlorine dioxide or other treatment liquid, into a pulp suspension. It will also be appreciated that the second

fluid may be of another type than a pulp suspension, e.g. process liquor.

The apparatus comprises a substantially parallelepipedic housing 1, for receiving a pulp suspension from a first conduit 2 located upstream, as well as for discharging the pulp suspension into a second conduit 3 located downstream. The apparatus further comprises a supply means 4 for supplying steam to the flow of pulp suspension. The apparatus further comprises a control unit 5, which ensures that there is a suitable flow velocity in the pulp suspension when supplying the steam, in order to avoid the occurrence of steam implosions. Accordingly, the control unit 5 ensures that the flow velocity of the pulp suspension exceeds a certain predetermined minimum value when supplying the steam.

The housing 1 is delimited externally by an upper delimiting surface, constituted by a roof portion 6, lateral delimiting surfaces, constituted by side walls 7 and 8 and by a short side wall 9 located upstream and a short side wall 10 located downstream, and a lower delimiting surface, constituted by a base portion 11.

Internally, the housing 1 comprises a substantially parallelepipedic chamber 12, which is approx. 500-700 mm long, approx. 200-250 mm wide, and approx. 150-300 mm high. The chamber 12 exhibits a circular first inlet 13 for receiving the pulp suspension from the first conduit 2 disposed upstream, and a rectangular outlet 14 for discharging the pulp suspension into the second conduit 3 disposed downstream. The first inlet 13 is formed by an opening in the short side wall 9 located upstream and has a diameter of approx. 80-200 mm. Accordingly, the inlet 13 has an area that is smaller than the cross-sectional area of the chamber 12. The rectangular outlet 14 is

substantially equally large as the cross-sectional area of the chamber 12.

5 Accordingly, the chamber 12 encloses a flow passage 44 for the pulp suspension, said flow passage 44 extending from the first inlet 13 to the outlet 14.

10 Furthermore, the chamber 12 exhibits an elongated second inlet 15 for receiving the pressurized, hot steam from the supply means 4, said inlet 15 opening into the flow passage 44. The inlet 15 is arranged in the roof portion 6 of the housing and is located approx. 100-150 mm from the outlet 14 of the chamber. The supply means 4 connects to the second inlet 15 from the top side of the roof
15 portion 6. The second inlet 15 is arranged with its longitudinal direction transversely to the chamber 12 and the flow passage 44, i.e. transversely to the flow direction of the pulp suspension, and extends across substantially the entire width of the flow passage 44. In
20 other words, the second inlet 15 has a length that is substantially equal to the width of the chamber 14. The width of the inlet 15, i.e. its extension in the longitudinal direction of the chamber 14, is approx. 25-70 mm.

25 The base portion 11 exhibits an elongated recess 16, which extends transversely to the longitudinal direction of the chamber 12 close to the first inlet 13, and each of the side walls 7 and 8 exhibit a respective crescent-shaped opening 17, which connects to the recess 16 at the
30 ends thereof. A tubular cover 41 is fixedly disposed in these recesses 16, 17, as is evident from Figures 5 and 6. The cover 41 has a length that exceeds the width of the housing 1, for which reason the cover projects
35 outwardly on both sides of the housing 1, as is evident from Figure 1. The lower portion 45 of the cover 41 protrudes below the chamber 12 and from the base portion

11 of the housing 1. As is most clearly evident from Figure 6, the central portion of the upper part of the cover 41 has been cut out, so that no part of the cover 41 projects into the chamber 12. Furthermore, this
5 cut-out makes the axial space of the cover 41 accessible from the chamber 12 via the recess 16.

Two removable stoppers 45 and 56 are arranged in the base portion 11 of the housing 1 and in the cover 41. The
10 stoppers 45, 56 enable rinsing of the housing 1 and the cover 41 in case of so-called plugging, i.e. that the pulp suspension clogs the housing 1 and the cover 41.

The supply means 4, for supplying the pressurized, hot
15 steam to the chamber 12 and the flow passage 44 via the second inlet 15, comprises a pipe flange 19 that connects to a steam conduit (not shown) for feeding pressurized steam to the supply means 4. Furthermore, the supply means 4 comprises a pipe part 20, which exhibits a first
20 end 21 and a second end 22. The first end 21 connects to the pipe flange 19 and the second end 21 connects to an elongated valve 23 of the supply means 4. The second end 22 is compressed, as is evident from Figure 1, making the pipe opening of the second end 22 elongated. The valve 23
25 connects to the second inlet 15 of the chamber 12 via a screw joint 24. The valve 23 comprises, on the one hand, a pivotal valve spindle 25, exhibiting an elongated longitudinal gap 26 for passage of the steam, and, on the other hand, a valve spindle housing 27, enclosing the
30 valve spindle 25. By turning the valve spindle 25, the valve 23 can be adjusted to a fully open position, to a fully closed position, or to a desired position therebetween. The gap 26 extends across the entire length of the second inlet 15. The position of the valve spindle
35 25 is controlled by a control means 28, which is disposed on the valve spindle housing 27 at one end of the valve spindle 25.

The distance between the valve spindle 25 and the orifice of the inlet 15 is relatively short, approx. 20-50 mm. This, together with the simple geometry of the outlet, ensures that any pulp suspension, which may have accumulated in the inlet during an interruption of the steam supply, easily can be pushed out by the steam when the steam supply is resumed, which provides for good operating reliability.

The control unit 5 comprises a throttle body in the form of a flap or lip 29, a pivotal axle 37, two lever arms 48 and 49, and pivoting means in the form of two pneumatic cylinders 50 and 51.

The axle 37 is pivotally arranged inside the axial space of the cover 41 by means of self-lubricating bearings 43, as is evident from Figure 6. The axle 37 is longer than the cover 41 and exhibits axle journals 46, 47, projecting outwardly through end plates 42, which are arranged at the ends of the cover 41. Accordingly, the outer portions of the axle journals 46 and 47 constitute projecting ends of the axle 37.

The flap 29 is arranged inside the chamber 12 and has the shape of a substantially rectangular plate, having a thickness of approx. 25-35 mm. The flap 29 exhibits a top side 30, facing away from the base portion 11 of the housing, a bottom side 31, facing toward the base portion 11 of the housing, two parallel long sides 32, 33, facing toward the side walls of the housing, a first end 34 or short side 34 located upstream, and second end 35 or short side 35 located downstream.

The flap 29 has its first end 34 fixedly connected to the pivotal axle 37 by means of bolts 36 and extends, through the recess 16 in the base portion 11, downstream in the

flow direction of the pulp suspension. The second end 35 of the flap 29 is free, and its connection to the top side 30 is chamfered, as is evident from Figure 5. The flap 29 has a length that is approx. 300-450 mm, i.e. slightly longer than the height of the chamber 12 and slightly shorter than the length of the chamber 12, so that its free end 35, located downstream, is substantially aligned with the second inlet 15.

The lever arms 48, 49 are fixedly disposed on the free ends of the axle journals 46, 47 of the axle 37, at right angles to the longitudinal direction of the axle 37. Accordingly, the lever arms 48, 49 rotate together with the axle 37 and the flap 29, when these are turned. The respective lever arm 48, 49 abuts against one of said pneumatic cylinders 50, 51. In the shown embodiment, these pneumatic cylinders are constituted by piston rod-free bellows cylinders 50, 51, which exhibit end plates 52, 53 abutting against the lever arms 48, 49. In the shown embodiment, the respective bellows cylinder 50, 51 is fixedly disposed on a respective side wall 7, 8 of the housing 1.

The flap 29 is pivotable between a lower end position, where the bottom side 31 of the flap abuts against the base portion 11 of the chamber 12, and an upper end position, where the free end 35 of the flap 29 abuts against the roof portion 6 of the chamber 12. The flap 29 has a width that is substantially equal to the width of the chamber 12. Accordingly, when using the apparatus, the pulp suspension is forced to pass over the top side 30 of the flap 29. Thus, the upper end position of the flap 29 constitutes a fully closed position, where the flow passage 44 is fully closed, and the lower end position of the flap 29 constitutes a fully open position, where the flow passage 44 is fully open. Accordingly, when the flap 29 is located between its end

positions, the flap 29 forms a constriction in the flow passage 44, where the flow area of the flow passage decreases continuously from the end 34 of the flap 29 located upstream to the free end 35 thereof located downstream. Immediately downstream of the flap 29, i.e. directly downstream of its free end 35, the flow area of the flow passage 44 suddenly increases to its initial value, i.e. to the same value as directly upstream of the flap 29. The inlet 15 opens near the free end 35 of the flap 29, and the steam is thus supplied in the region where the cross-section of the flow passage 44 suddenly increases, which is advantageous for the mixing and dispersion of the steam into the pulp suspension.

While the pulp suspension passes over the flap 29, the pulp suspension exerts a torque about the axle 37 on the flap 29, which tends to push the flap 29 down, i.e. to pivot the flap 29 clockwise about the axle 37 in Figure 5. Accordingly, the top side 30 of the flap 29 constitutes a guiding or diverting surface, which diverts the direction of flow of the flow path 44, with which surface the pulp suspension interacts to produce said downward torque. The bellows cylinders 50, 51, in their turn, are pressurized to a predetermined pressure. When they are compressed, they exert a torque on the flap 29, via the lever arms 48, 49 and the axle 37, which strives to push the flap up, i.e. to pivot the flap 29 anti-clockwise about the axle 37 in Figure 5.

At a constant flow rate of the pulp suspension, the flap 29 adjusts itself to an equilibrium position, where the torque that the flow of pulp suspension exerts on the flap 29 is balanced by the torque that the bellows cylinders 50, 51 exert on the flap 29. In other words, the bellows cylinders 50, 51 are adapted to continuously exert a torque on the flap 29, which balances the torque

that the pulp suspension exerts on the flap 29 at every flow rate of the pulp suspension.

If the flow rate of the pulp suspension increases, the flap 29 is pushed down, so that the smallest flow area of the flow passage 44, i.e. its flow area at the end 35, increases. If the flow rate of the pulp suspension stabilizes at this new, higher level, the flap 29 adjusts itself to a new equilibrium position, where the flow area of the flow passage 44 at the end 35 is larger than in the previous equilibrium position. If the flow rate of the pulp suspension decreases, the flap 29 is pushed up by the bellows cylinders 50, 51, so that the flow area of the flow passage 44 at the end 35 decreases. If the flow rate of the pulp suspension stabilizes at this new, lower level, the flap 29 thus adjusts itself to a new equilibrium position, where the flow area of the flow passage 44 at the end 35 is smaller than in the previous equilibrium position. Accordingly, an increasing flow rate of the pulp suspension causes the flow area of the flow passage at the end 35 to increase, and a decreasing flow rate causes the flow area to decrease.

It will be appreciated that this controlling of the flow area compensates for the decrease and increase, respectively, in the flow velocity of the pulp suspension that results from a decrease and an increase, respectively, of its flow rate. If e.g. the flow rate of the pulp suspension decreases, also the flow velocity of the pulp suspension in the region upstream of the flap 29 decreases, since the flow area in this region is unchanged. However, due to the decreasing pressure of the pulp suspension on the flap 29 in this situation, the flap is pivoted 29 upward and the flow area at the flap 29 decreases. This, in its turn, implies that the flow velocity of the pulp suspension at the end 35 is maintained at substantially the same level as before the

flow rate decrease. If the flow rate of the pulp suspension increases, an adjustment is effected in the other direction, i.e. due to the increasing pressure of the pulp suspension on the flap 29, the flap 29 is pushed down, the flow area above the flap 29 increases, and the flow velocity of the pulp suspension at the end 35 is maintained substantially at the same level as before the flow rate increase. Accordingly, the flap 29 acts as a throttle body, which controls the flow area of the flow passage 44 while being actuated by the cylinders 50, 51, so that the flow velocity of the pulp suspension is maintained within a desired range. Accordingly, the control unit 5 ensures that a decrease of the flow rate of the pulp suspension does not lead to a situation, where the flow velocity of the pulp suspension at the steam supply position falls below a level where the mixing of the steam risks becoming so inadequate that there is a risk of damaging steam implosions occurring.

In addition to the fact that the bellows cylinders 50, 51 abut against the lever arms 48, 49 with a pushing force, the bellows cylinders 50, 51 also dampen any pressure waves which may occur in the pulp suspension, e.g. when the pulp suspension passes over the flap 29, or if damaging steam implosions still occur. Accordingly, the bellows cylinders 50, 51 also constitute spring or damping means.

Accordingly, the flap 29 adjusts itself to an equilibrium position, where the flow of pulp suspension imposes a pushing force on the flap 29, which is balanced by the force from the bellows cylinders 50, 51. Thus, the flap 29 is self-adjusting and its actual angle relative to the base portion 11 is dependent on the magnitude of the pulp flow. The predetermined flow velocity range can be set by adjusting the abutting force of the bellows cylinders 50, 51 against the lever arms 48, 49, whereby the desired

equilibrium position can be set. By increasing the abutting force of the bellows cylinders 50, 51 against the lever arms 48, 49, the axle 37 is rotated so that the flap 29 is pushed up to a new equilibrium position. This
5 implies that the cross-sectional area above the flap decreases, which causes the flow velocity of the pulp suspension at the second inlet 15 to increase.

Accordingly, the apparatus is self-adjusting in that the
10 control unit 5 ensures that the flow velocity of the pulp flow at the second inlet 15 is always sufficiently high to avoid, or at least reduce the occurrence of steam implosions. The control unit 5 also ensures that an increase of the flow rate of the pulp suspension does not
15 lead to an undesirably high flow resistance across the apparatus.

It will be appreciated that the minimum allowable flow velocity of the pulp suspension at the steam supply
20 position is dependent on a number of factors, e.g. the concentration of the pulp suspension, the steam flow rate, i.e. the amount of steam supplied, etc. As an example of a suitable flow velocity range when supplying steam to a pulp suspension, it may be mentioned that,
25 when mixing steam at a flow rate of approx. 2-20 kg/s into a pulp suspension of medium consistency, the flow velocity of the pulp suspension at the free end 35 should be within the range of approx. 30-35 m/s, if the embodiment shown in the figures is used.

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Figure 7 shows an embodiment of the apparatus that is especially advantageous when supplying steam to a pulp suspension. In this embodiment, the apparatus comprises the second conduit 3 disposed downstream of the chamber
35 12. The outlet 14 of the chamber 12 connects to the inlet of the second conduit 3 by means of a pipe flange 55, which is fitted to a pipe flange of the second conduit 3.

The flow area or cross-sectional area of the second conduit 3 is larger than the cross-sectional area of the outlet 14. In a preferred embodiment, the cross-sectional area of the second conduit 3 is at least 50 % larger than the cross-sectional area of the outlet 14. The area increase between the cross-sectional area of the outlet 14 and the cross-sectional area of the second conduit 3 occurs suddenly, in a single step. The length of the second conduit 3 is advantageously from two times all the way up to ten times the diameter, or any other equivalent cross-sectional dimension of the second conduit 3.

Since the cross-sectional area of the second conduit 3 is larger than the cross-sectional area of the outlet 14, the pulp suspension will decelerate after the outlet 14 in those regions of the second conduit 3 which are located radially outside the outlet 14, and be retained against the inside surface of the second conduit 3. Therefore, a volume of fibers will be built up successively by stagnant pulp, along the inside shell surface of the second conduit 3, which can absorb pressure waves in the pulp suspension which may occur due to any steam implosions. The pulp suspension in the middle of the second conduit 3, on the other hand, will continue at a high velocity through the second conduit 3 to a subsequent third conduit 54, which has a diameter that is substantially smaller than the diameter of the second conduit 3.

Figures 8-10 show one embodiment of the flap 29 in greater detail. As is evident from the figures, each long side 32, 33 exhibits an angled portion 60 and a planar portion 61, wherein the planar portion 61 is adapted to slidably interact with an opposite side wall 7, 8 of the chamber 12, with a good fit, to prevent the pulp suspension from passing between the long sides 32, 33 of the flap 29 and the side walls 7, 8 of the chamber.

However, the fit must be such that the pivoting movement of the flap 29 is not impeded by frictional forces between the portions 61 and the side walls 7, 8 of the chamber 12.

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The chamfer of the free end 35 is also clearly evident from Figures 8-10. According to one embodiment of the flap 29, this chamfer exhibits a planar surface 62 forming an angle of approx. 30 degrees with the top side 30 of the flap 29.

10

According to one embodiment of the flap 29, which is particularly preferred when the apparatus is to be used for mixing a gas, e.g. ozone, into a pulp suspension, the flap 29 exhibits turbulence-generating means, which are adapted to promote the formation of turbulence in the pulp suspension when it leaves the free end 35 of the flap 29. In the shown embodiment, these turbulence-generating means have the shape of elongated, parallel grooves or recesses 63, which are disposed at the free end 35 of the flap 29 and which extend in the longitudinal direction of the flap 29 from directly upstream of the planar surface 62, and which open into this surface 62. Each groove 63 exhibits a U-shaped cross-section and is approx. 80-100 mm long, approx. 5-15 mm wide and approx. 10-20 mm deep. The grooves are arranged at a mutual distance of approx. 15-25 mm and each has a bottom forming an angle of approx. 10 degrees with the top side 30 of the flap 29. During operation, a first group of partial flows of the pulp suspension will be guided in the grooves 63, whereas a second group of partial flows will be guided along the surface 62 between the grooves 63. At the mouths of the grooves 63, these partial flows will intersect and mix, resulting in the formation of turbulence.

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In the foregoing, the invention has been described based on a specific embodiment. It will be appreciated, however, that further embodiments and variants are possible within the scope of the following claims. With
5 reference to the above-described embodiment, for example another type of pneumatic cylinder can be used, e.g. cylinders of piston rod-type. It will also be appreciated that another pushing means can be used, e.g. a piston rod cylinder, a spring-loaded cylinder, or a mechanical
10 spring, e.g. a torsion spring.

It will also be appreciated that the apparatus can be provided with other elements or means than the above-described grooves 63, said other elements or means
15 contributing to increasing the turbulence in the pulp suspension at the outlet 15, which in its turn increases the mixing and dispersion of the supplied fluid.

It will also be appreciated that the apparatus does not
20 necessarily have to comprise a conduit in accordance with the second conduit 3 of Figure 7. The apparatus can of course be fitted to conduits of any dimensions whatsoever which transport pulp suspensions.

25 It will also be appreciated that the throttle body may have a different design than the above-described flap 29. The throttle body can e.g. be wedge-shaped.

C L A I M S

1. An apparatus for mixing a first fluid into a flow path (44) of a second fluid, said apparatus comprising:
- 5 - a chamber (12), which encloses the flow path (44) and exhibits a first inlet (13) for receiving the second fluid, a second inlet (15) arranged downstream of the first inlet (13) for receiving the first fluid, as well as an outlet (14) arranged downstream of the
- 10 second inlet (15) for discharging a mixture of the first fluid and the second fluid, said flow path (44) extending from the first inlet (13) to the outlet (14) and said second inlet (15) opening into the flow path (44);
- 15 - a throttle body (29), which is pivotally arranged inside the chamber (12) for controlling the flow area of the flow path (44); and
- pivoting means (50, 51), for pivoting the throttle body (29) for said controlling of the flow area,
- 20 **characterized in** that the pivoting means (50, 51) is adapted to pivot the throttle body (29) so that the flow area decreases with a decreasing flow rate of the second fluid and increases with an increasing flow rate of the second fluid, in order to maintain the flow
- 25 velocity of the second fluid at the second inlet (15) within a predetermined range.
2. The apparatus according to claim 1, **characterized in** that the pivoting means (50, 51) is adapted to
- 30 continuously exert a first torque on the throttle body (29), which balances a second torque exerted by the second fluid on the throttle body (29) at every flow rate of the second fluid, wherein the throttle body (29) is adapted to adjust itself around an equilibrium
- 35 position, which is a function of the flow rate of the second fluid.

3. The apparatus according to claim 2, **characterized in** that the throttle body (29) exhibits a surface (30) for diverting the direction of flow of the flow path (44), with which surface (30) the flowing second fluid
5 is adapted to interact to produce said first torque.
4. The apparatus according to any one of the claims 1-3, **characterized in** that the throttle body (29) is disposed at, or immediately upstream of, the second
10 inlet (15).
5. The apparatus according to any one of the claims 1-4, **characterized in** that the throttle body (29) comprises a flap (29), which has a first end (34) that
15 is pivotally arranged at the chamber (12) and a second end (35) that is free.
6. The apparatus according to claim 5, **characterized in** that the first end (34) is pivotally arranged, via
20 an axle (37), at a base portion (11) of the chamber (12).
7. The apparatus according to claim 6, **characterized in** that the second end (35) is arranged substantially
25 aligned with the second inlet (15).
8. The apparatus according to any one of the claims 6 and 7, **characterized in** that the apparatus comprises at least one compressively loaded lever arm (48, 49)
30 arranged on the axle (37).
9. The apparatus according to claim 8, **characterized in** that the pivoting means comprises a pneumatic cylinder (50, 51), which is adapted to produce the
35 compressive load on the lever arm (48, 49).

10. The apparatus according to any one of the claims 1-9, **characterized in** that the apparatus comprises a second conduit (3), which connects to the outlet (14) on the downstream side of the outlet (14), wherein the cross-sectional area of the second conduit (3) is at least 50 % larger than the cross-sectional area of the outlet (14).

11. The apparatus according to any one of the claims 1-10, **characterized in** that the throttle body (29) exhibits turbulence-generating means (63), which are adapted to promote the formation of turbulence in the second fluid when it leaves the throttle body (29).

12. The apparatus according to claim 11, wherein the throttle body (29) comprises a flap according to claim 5, **characterized in** that said turbulence-generating means have the shape of elongated, parallel grooves or recesses (63), which are disposed at the second end (35) of the flap (29) and extend in the longitudinal direction of the flap (29).

13. A use of an apparatus according to any one of the claims 1-12 for mixing steam into a pulp suspension.

14. A use of an apparatus according to any one of the claims 1-12 for mixing a process chemical into a pulp suspension.

15. A method for mixing a first fluid into a flow path (44) of a second fluid, comprising the steps of:

- causing the second fluid to flow in a chamber (12) from a first inlet (13) to an outlet (14), said chamber (12) enclosing said flow path (44);
- supplying the first fluid to the flow path (44) of the second fluid via a second inlet (15) of the chamber (12), said second inlet (15) being arranged

downstream of the first inlet (13) and upstream of the outlet (14); and

- causing pivoting means (50, 51) to pivot a throttle body (29), arranged in the flow path (44), to control the flow area of the flow path (44),

characterized in the step:

- that the pivoting means (50, 51) is caused to pivot the throttle body (29) so that the flow area decreases with a decreasing flow rate of the second fluid and increases with an increasing flow rate of the second fluid, in order to maintain the flow velocity of the second fluid at the second inlet (15) within a predetermined range.

16. The method according to claim 15, **characterized in** that the pivoting means (50, 51) is caused to continuously exert a first torque on the throttle body (29), which balances a second torque exerted by the second fluid on the throttle body (29) at every flow rate of the second fluid, wherein the throttle body (29) is caused to adjust itself around an equilibrium position, which is a function of the flow rate of the second fluid.

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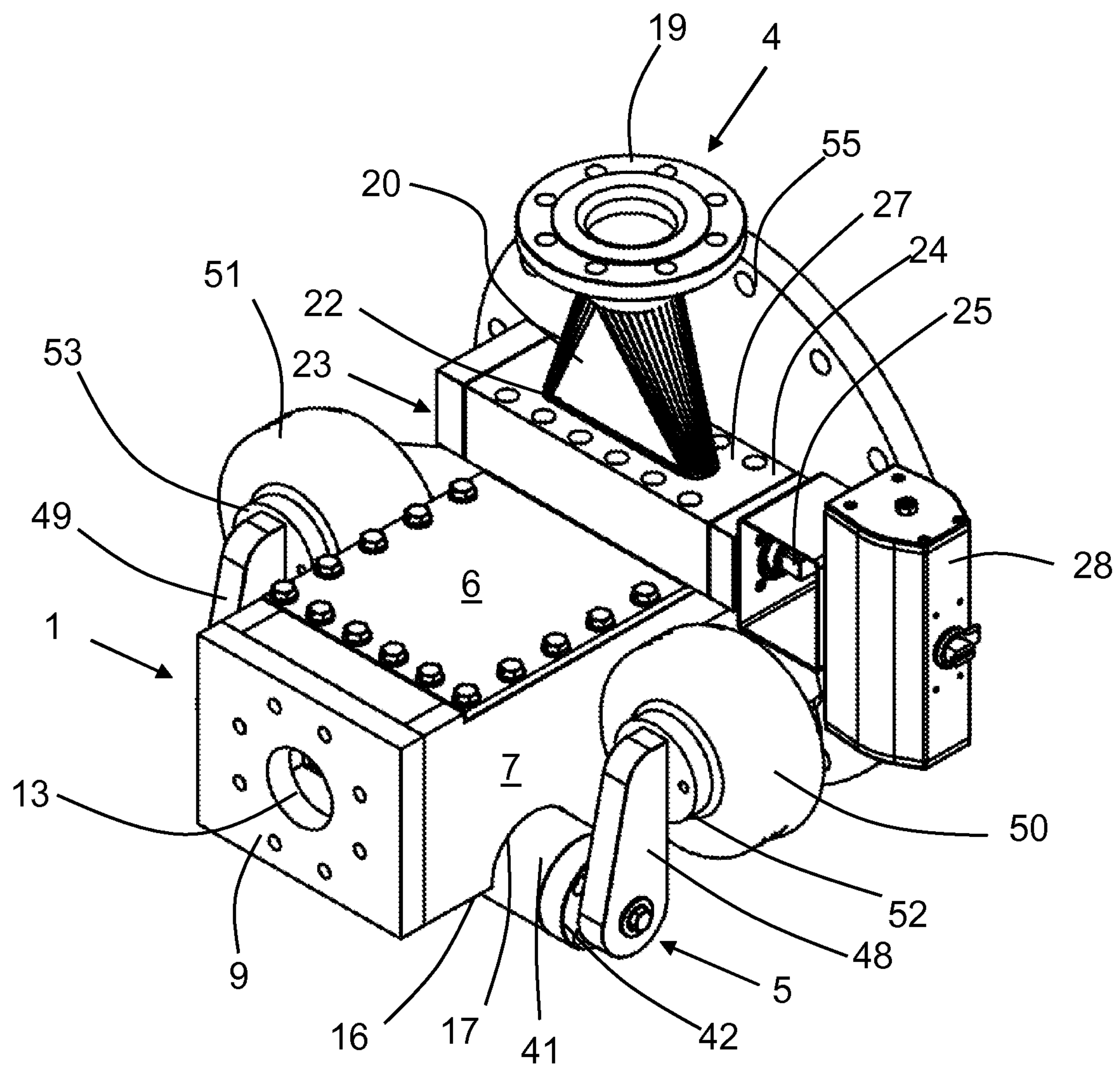


Fig. 1

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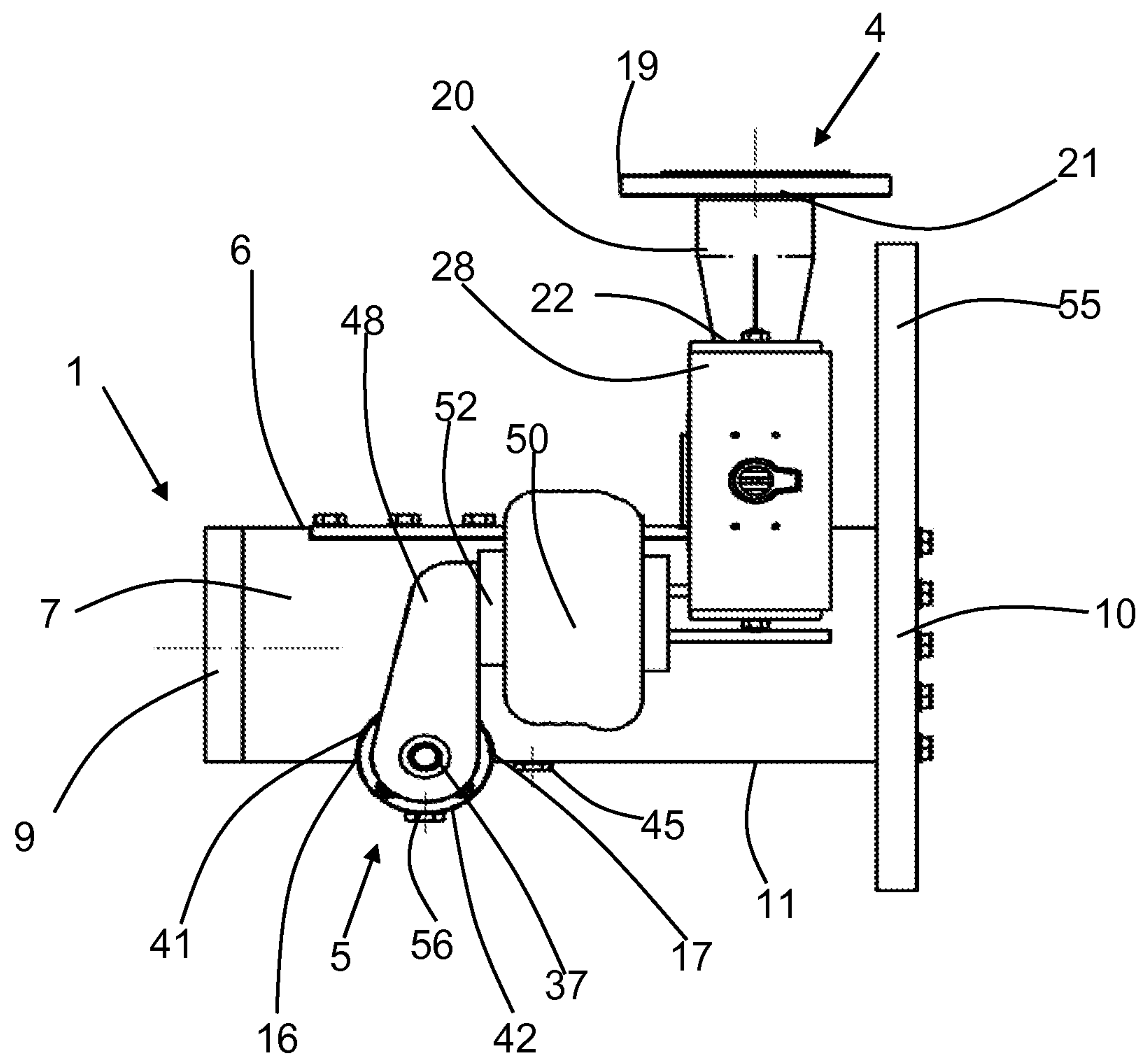


Fig. 2

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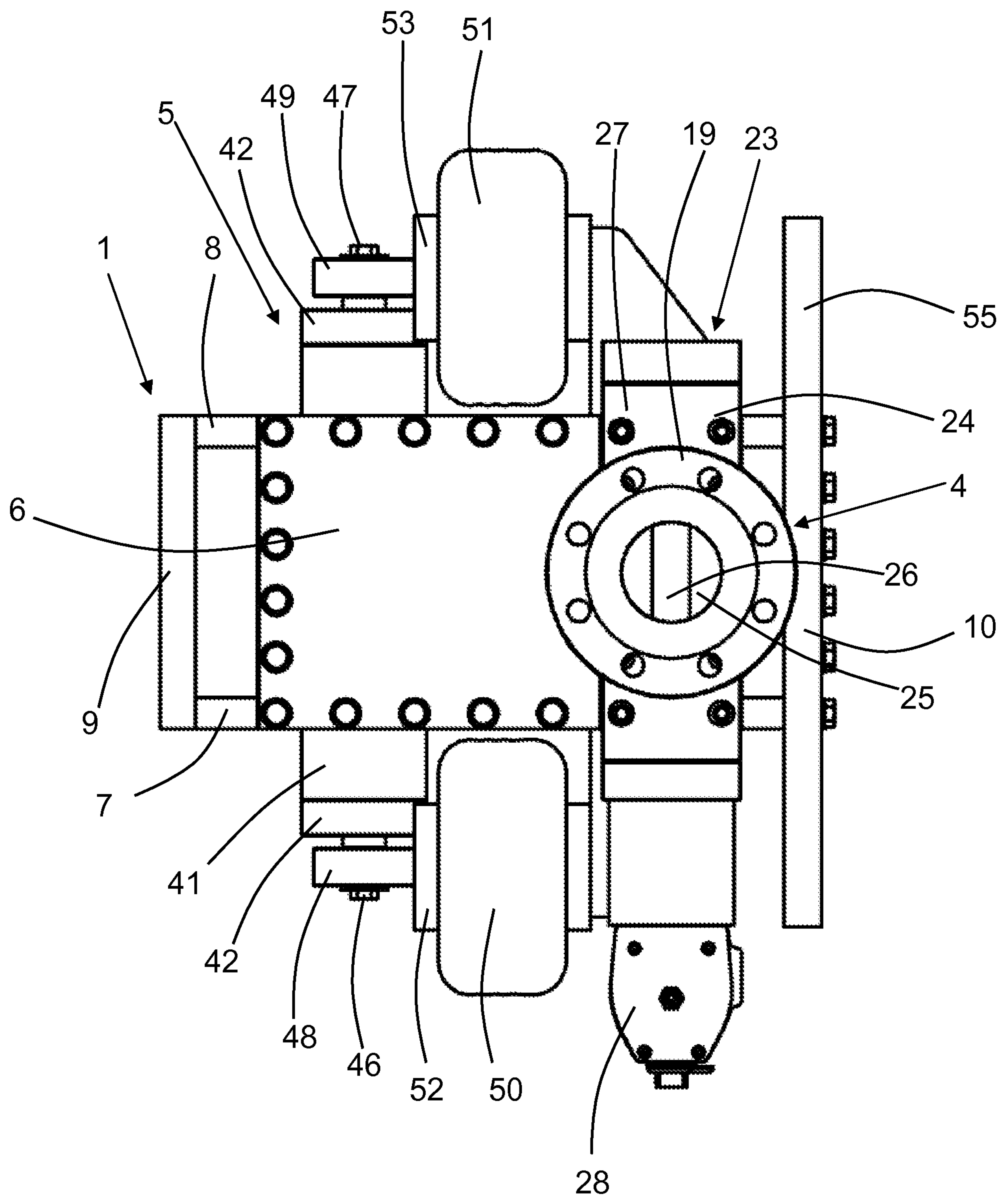


Fig. 3

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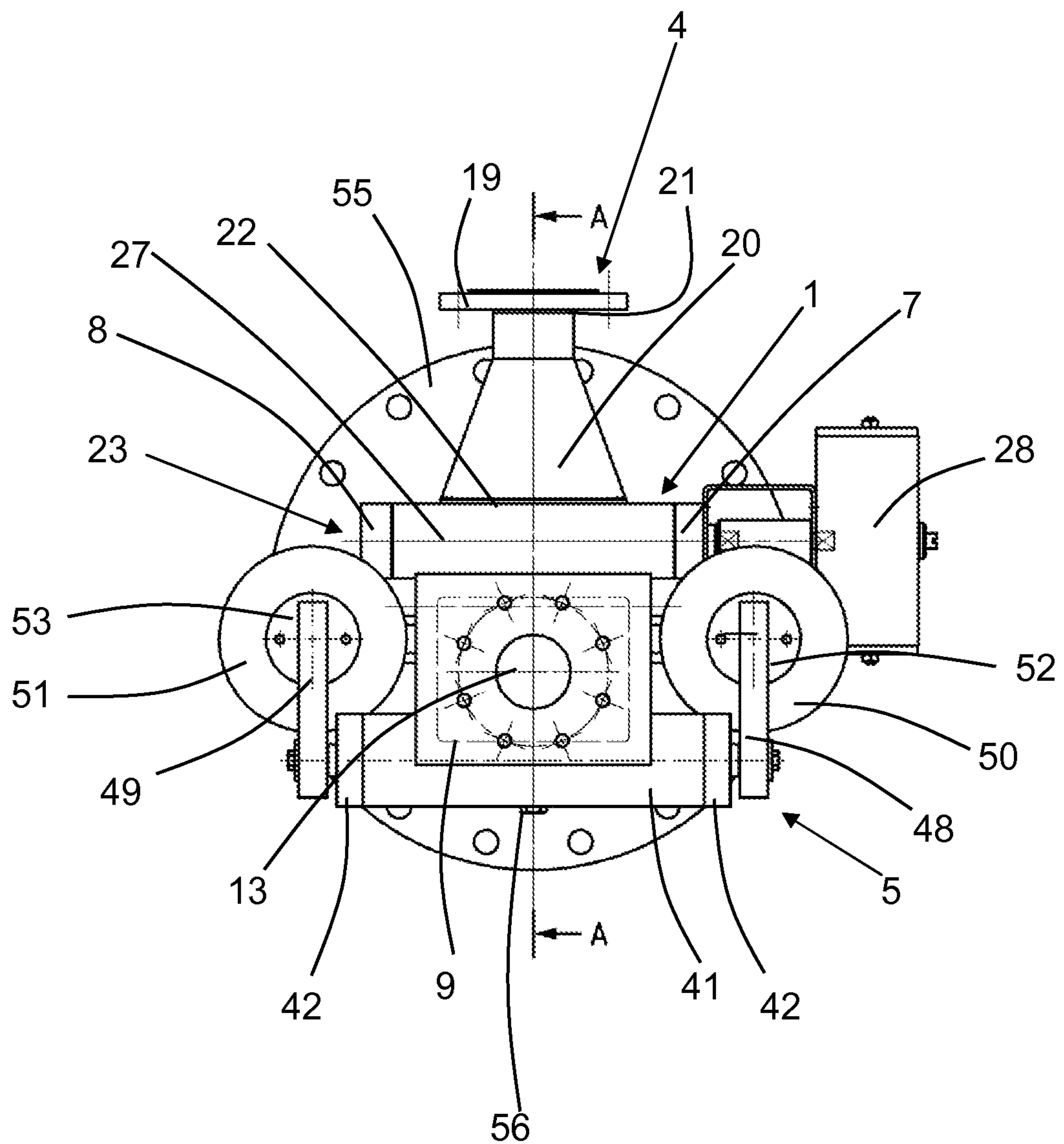


Fig. 4

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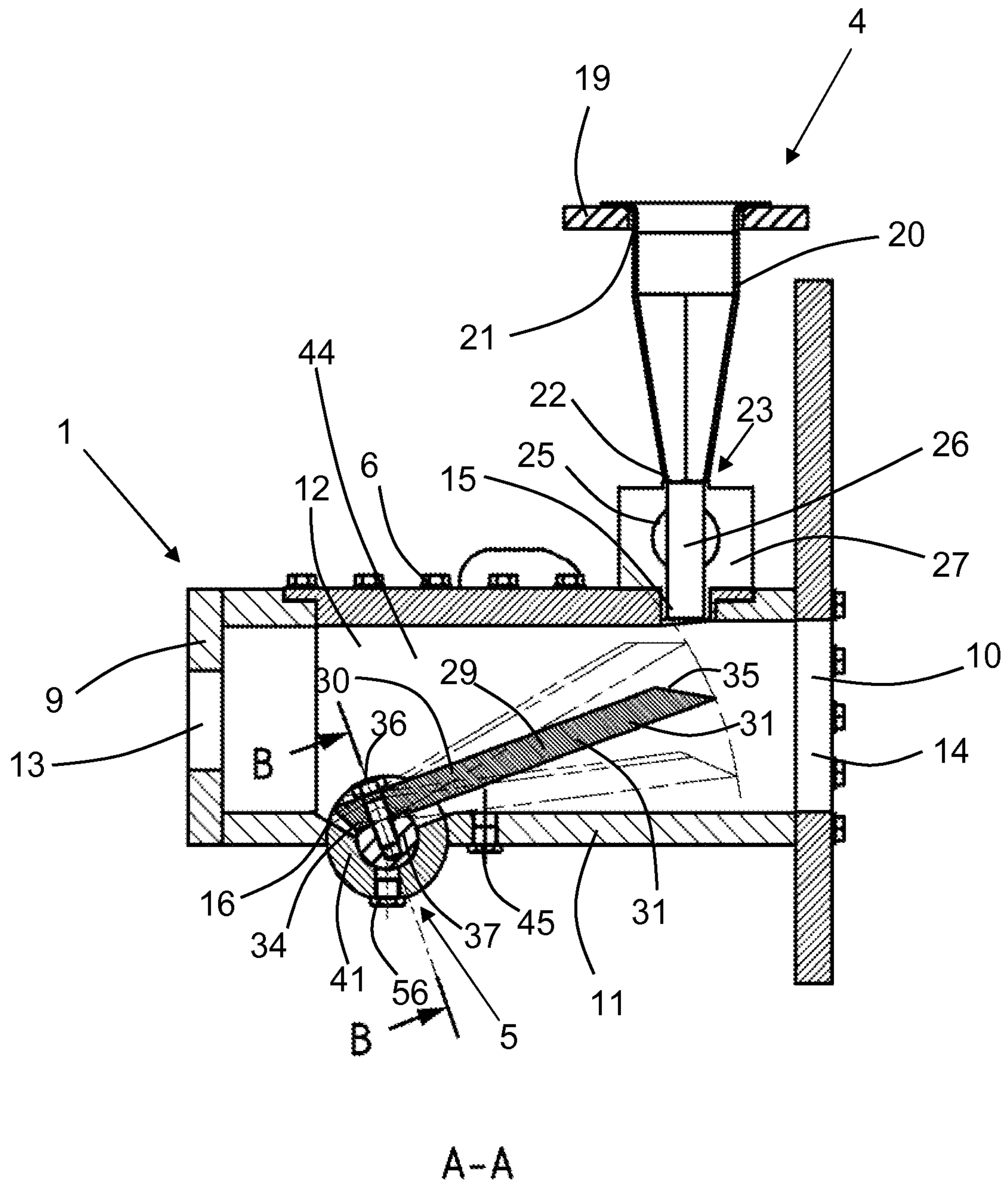


Fig. 5

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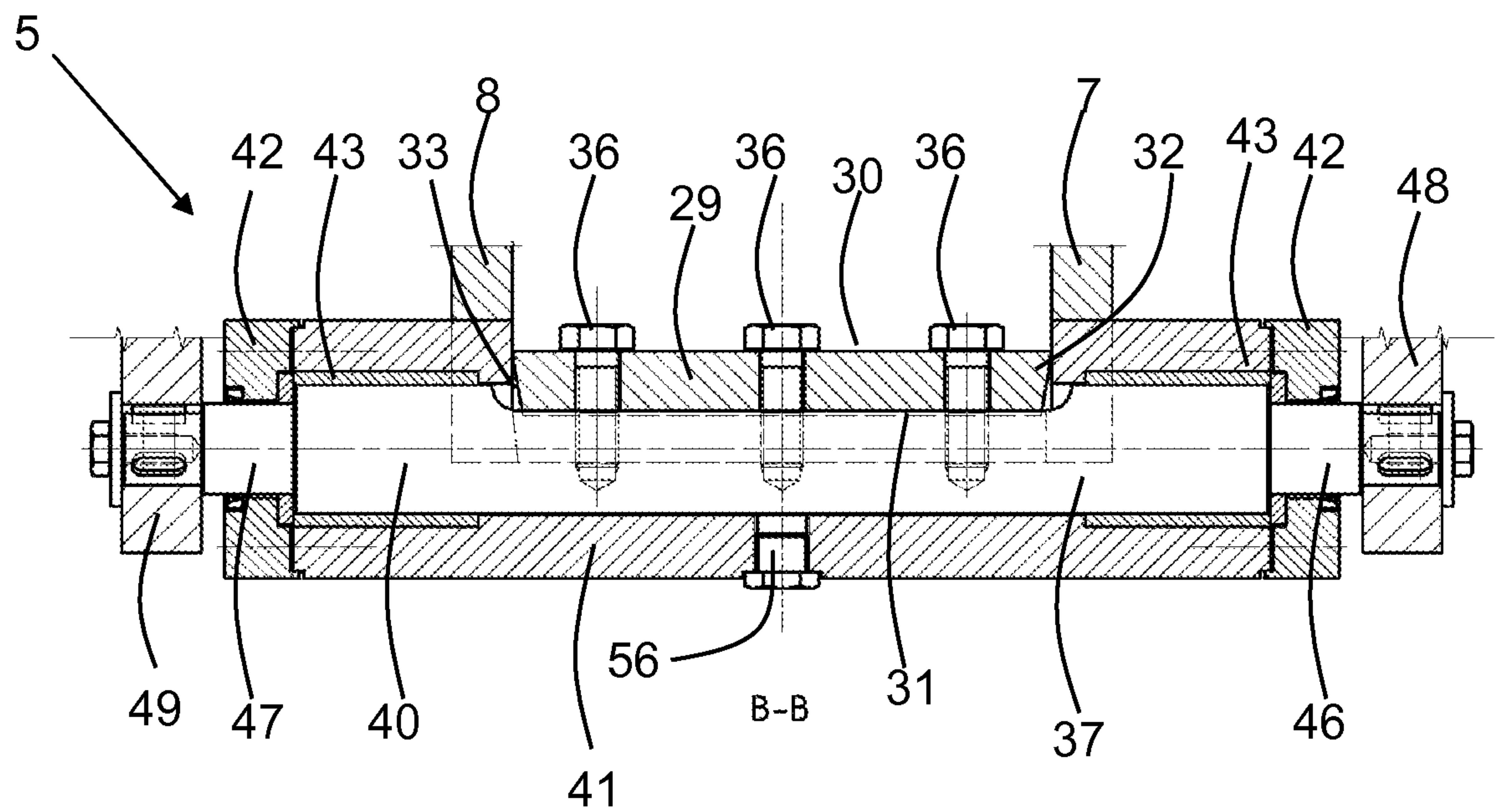


Fig. 6

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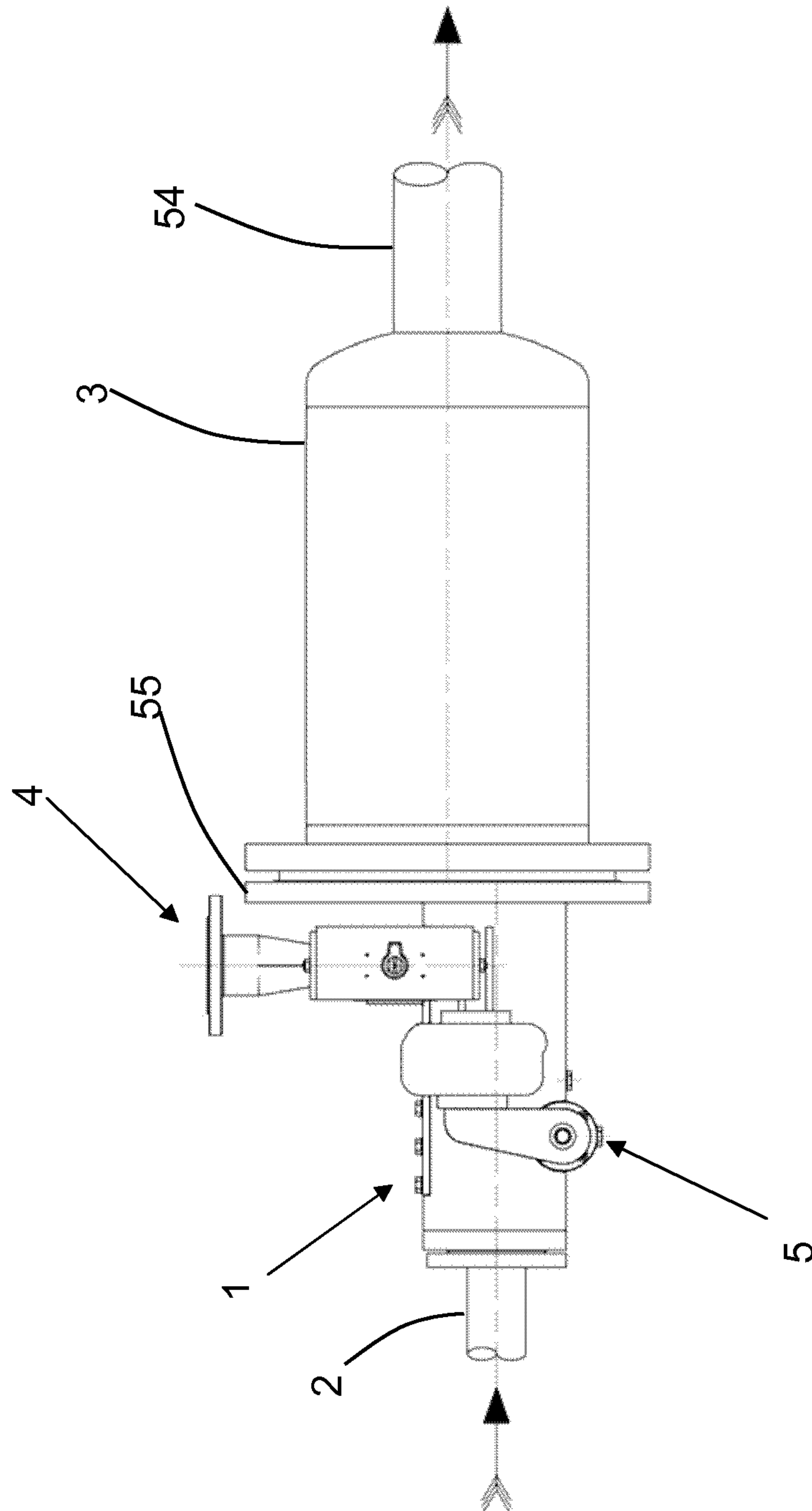
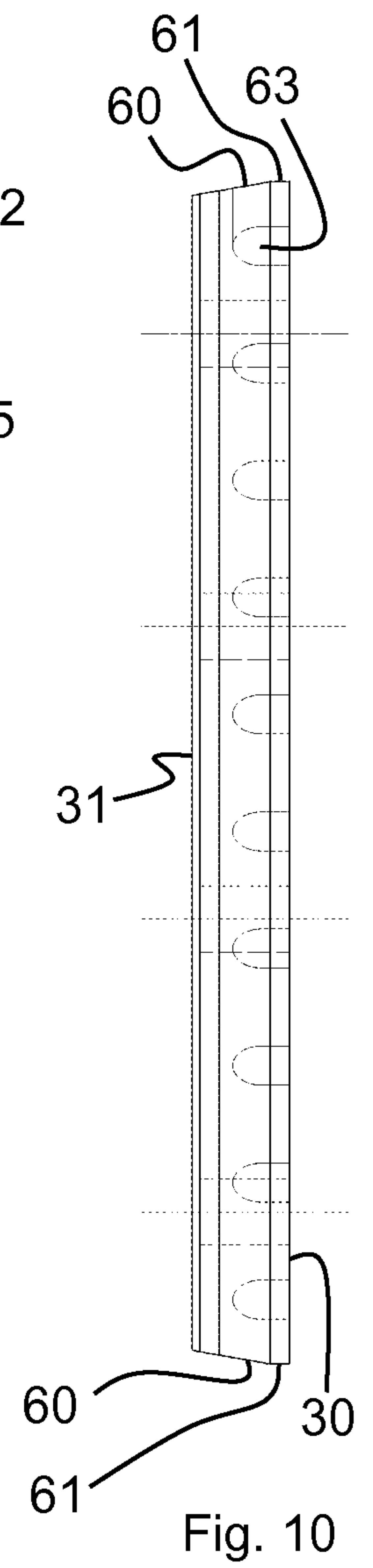
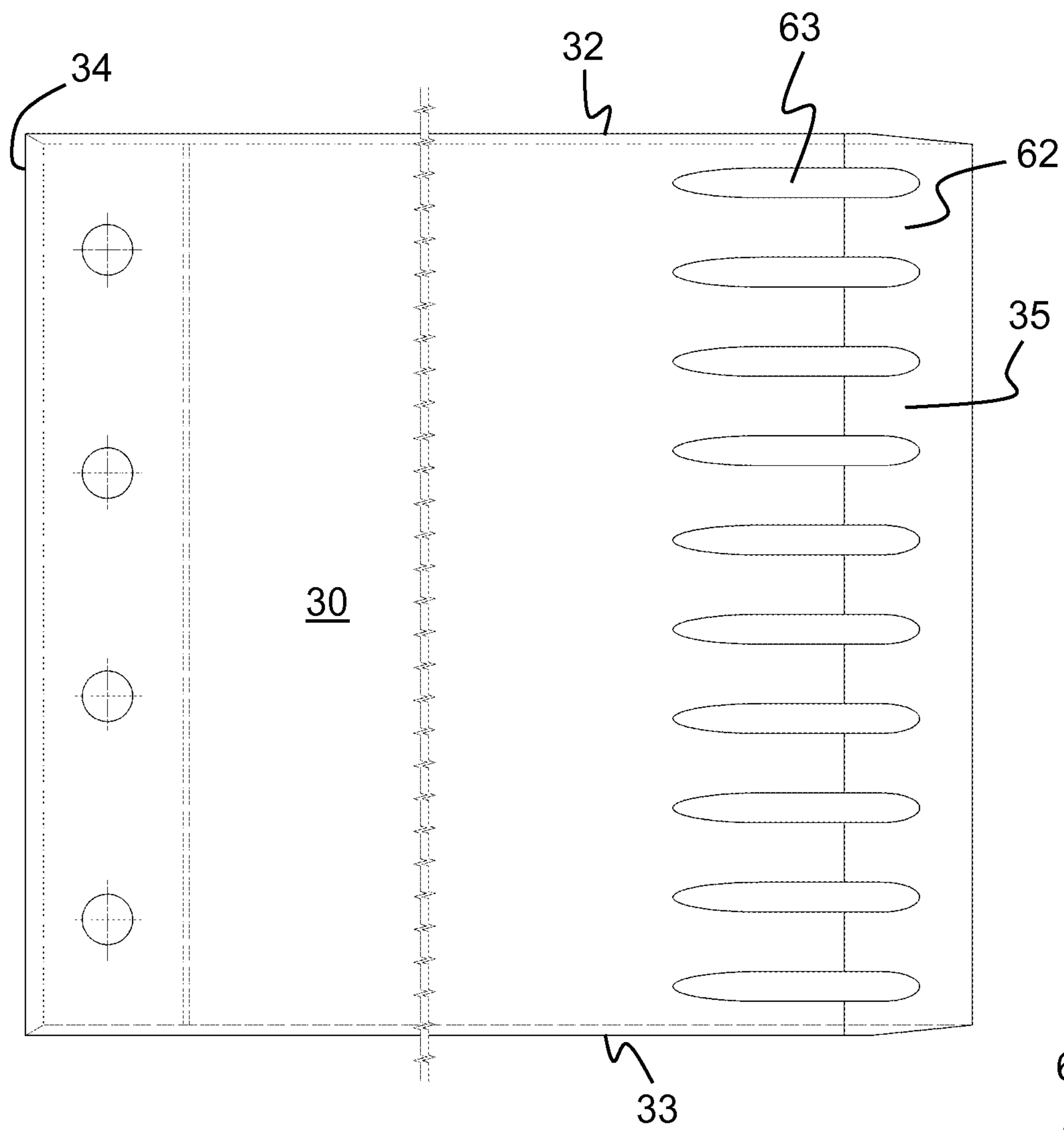
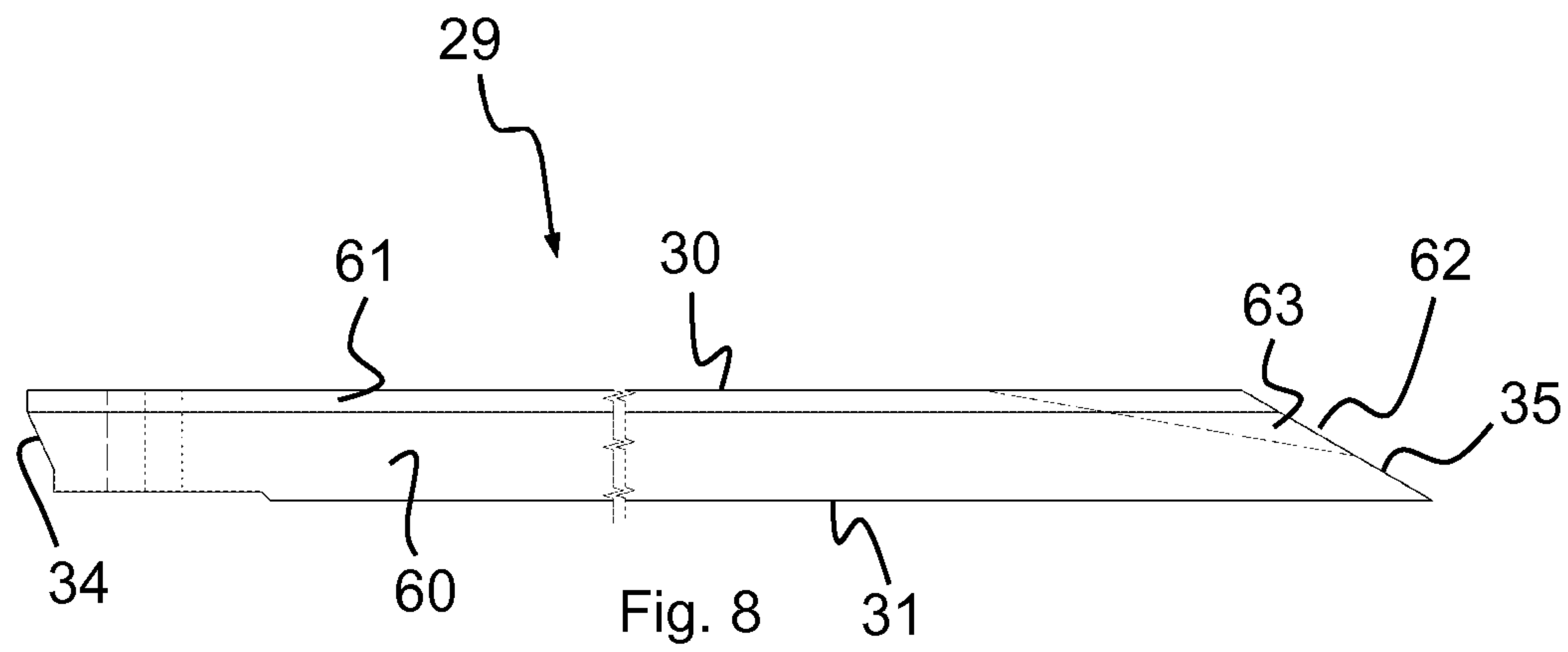


Fig. 7

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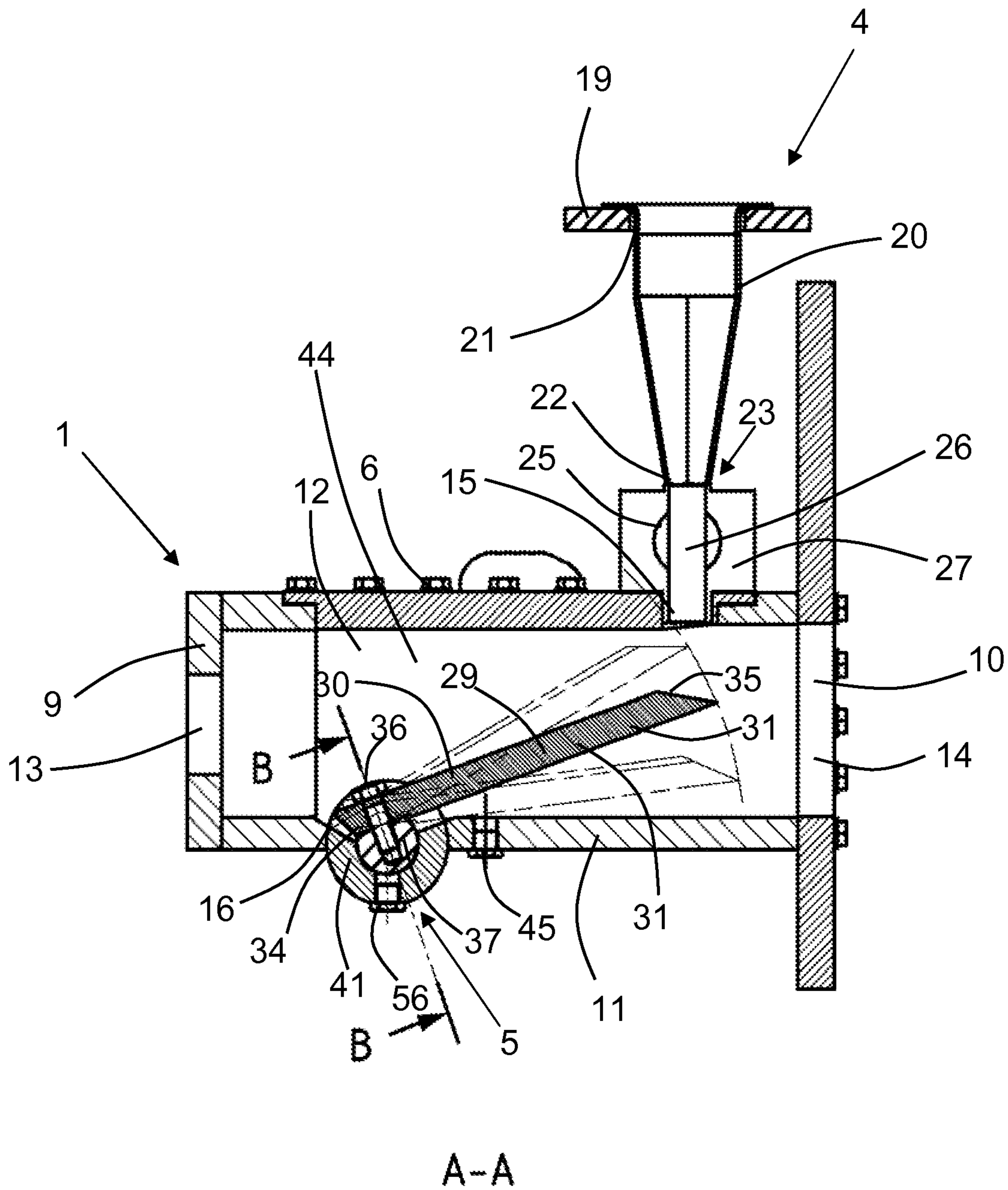


Fig. 5