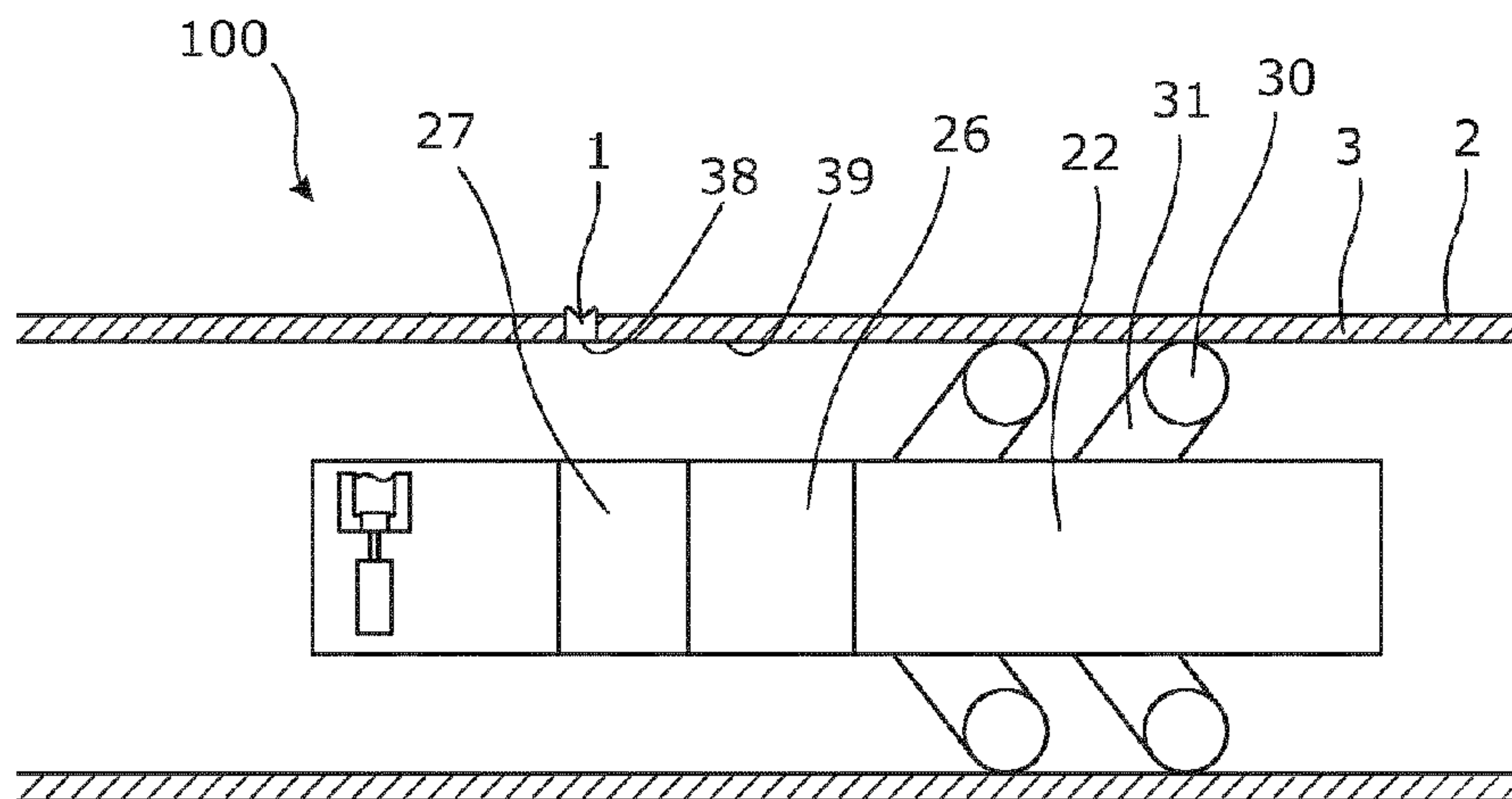




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(54) Title: DOWNHOLE PUNCH COMPONENT



(57) **Abrégé/Abstract:**

The present invention relates to a downhole punch for insertion into a wall of a casing. The downhole punch comprises a body having a first end and a second end and a through-bore forming an inner face of the body and an outer face of the body, wherein the first end comprises at least one cutting edge at least forming a leading tip or a leading edge for punching an opening in the casing, and a component is arranged in the through-bore. The present invention also relates to a downhole valve for insertion into a wall of a casing. The downhole valve comprises a housing having a first end and a second end and an inner face and an outer face. Furthermore, the invention relates to a downhole tool for inserting a downhole valve into a wall of a casing, to a downhole system comprising the downhole tool as well as to a downhole method for insertion of a downhole unit into a casing downhole.

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(54) Title: DOWNHOLE PUNCH COMPONENT

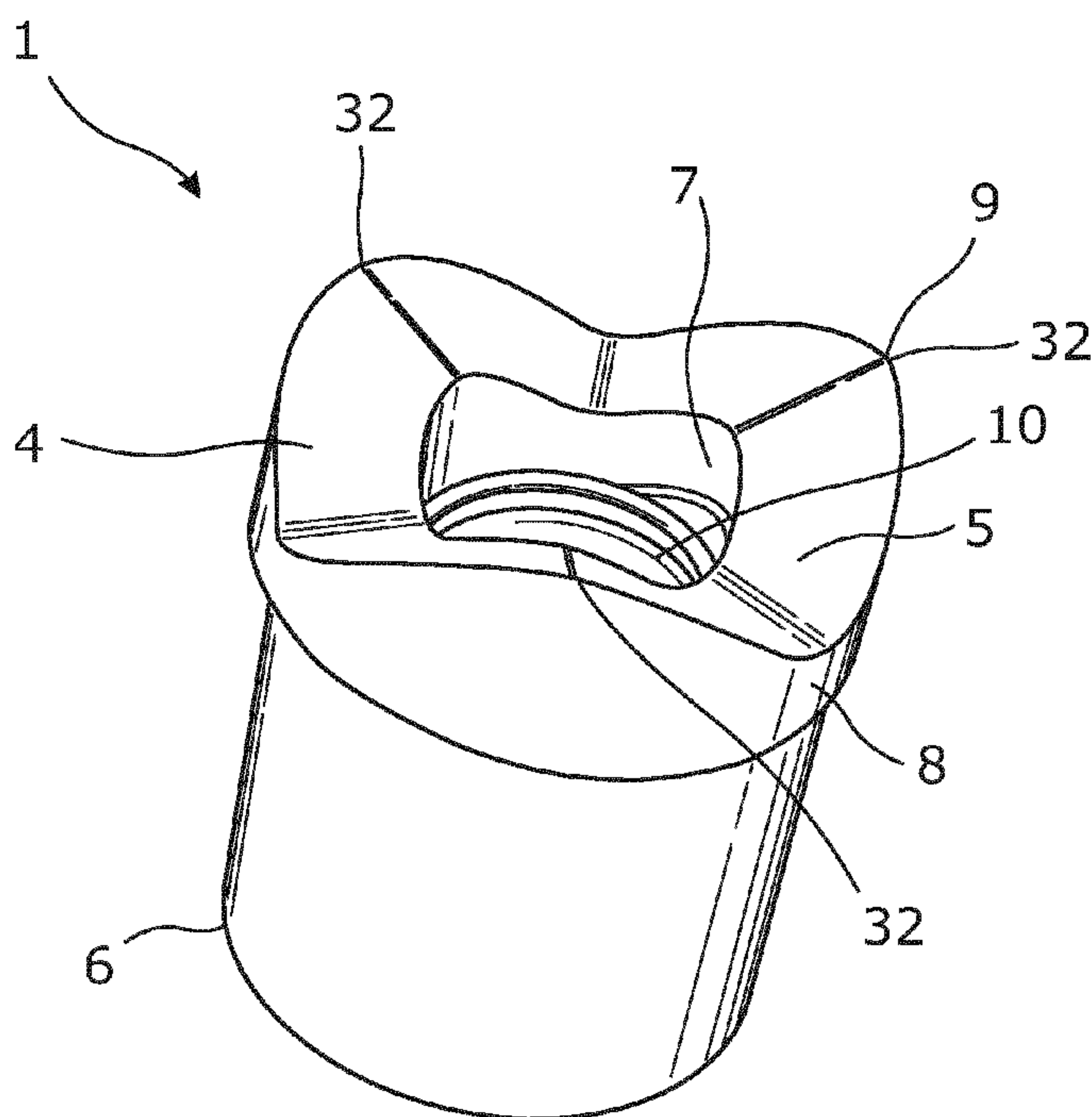


Fig. 1

(57) Abstract: The present invention relates to a downhole punch for insertion into a wall of a casing. The downhole punch comprises a body having a first end and a second end and a through-bore forming an inner face of the body and an outer face of the body, wherein the first end comprises at least one cutting edge at least forming a leading tip or a leading edge for punching an opening in the casing, and a component is arranged in the through-bore. The present invention also relates to a downhole valve for insertion into a wall of a casing. The downhole valve comprises a housing having a first end and a second end and an inner face and an outer face. Furthermore, the invention relates to a downhole tool for inserting a downhole valve into a wall of a casing, to a downhole system comprising the downhole tool as well as to a downhole method for insertion of a downhole unit into a casing downhole.

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DOWNHOLE PUNCH COMPONENT

Field of the Invention

The present invention relates to a downhole punch or valve for insertion into a wall of a casing. Furthermore, the invention relates to a downhole tool for inserting a downhole punch or valve into a wall of a casing, to a downhole system comprising the downhole tool and a driving unit as well as to a downhole method for insertion of a downhole punch or valve into a casing downhole.

10 Background Art

During production, it may be expedient to change the openings through which oil fluid can enter the casing, thus sealing the existing openings, and create new openings. However, such operations may be very difficult to perform in muddy fluid where visibility is low and the casing is narrow.

One type of opening may be a valve to be inserted at another position in the casing when the oil production zone is sealed off. Thus, there is a need for a simple solution for inserting new valves in the wall of a casing.

20

Summary of the Invention

It is an object of the present invention to wholly or partly overcome the above disadvantages and drawbacks of the prior art. More specifically, it is an object to provide an improved simple solution for inserting a downhole valve, and thus for a valve which can easily be inserted into the wall of a casing.

The above objects, together with numerous other objects, advantages, and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention by a downhole punch for insertion into a wall of a casing, comprising:

30

- a body having a first end and a second end and a through-bore forming an inner face of the body and an outer face of the body,

wherein the first end comprises at least one cutting edge at least forming a leading tip or a leading edge for punching an opening in the casing, and a component is arranged in the through-bore.

- 5 In an embodiment, the component may be a valve, a sensor, an emitter, a receiver, a probe or a communication device arranged in the through-bore.

By having a valve or a sensor in the through-bore, the punching tool can be punched into the casing without clearance so that the punching tool is fastened
10 to the casing, and thus the valve or sensor is fastened in the casing.

Further, the body in cross-section may have a periphery and the cutting edge may be arranged in the periphery.

- 15 Moreover, the valve may be an inflow control valve, a gas lift valve, a throttle or a pressure control valve.

Also, the sensor may be a temperature sensor, pressure sensor, resistivity sensor, electromagnetic sensor, acoustic sensor, capacitance sensor, or a density
20 sensor.

Additionally, the component may be a seismic transceiver or a detonation charge.

The cutting edge may be arranged as an extension of the outer face.
25

Furthermore, the cutting edge may extend from the inner face to the outer face.

Said cutting edge may have a meander shape.

- 30 Also, the body in cross-section may have a circumference and the cutting edge may extend partly or fully around the circumference.

The present invention further relates to a downhole valve for insertion into a wall of a casing, comprising:

- 35 - a housing having a first end and a second end as well as an inner face and an outer face,

wherein the first end of the housing comprises at least one cutting edge at least forming a leading tip or a leading edge for punching an opening in the casing.

5 In an embodiment, the housing in cross-section may have a periphery and the cutting edge may be arranged in the periphery.

In one embodiment, the housing may have an inlet at the first end and an outlet at the second end.

10 Furthermore, the housing may comprise a valve means for restricting the flow from the inlet to the outlet.

The valve may have an axial extension and an axial direction from the inlet to the outlet.

15 Moreover, the valve means may comprise a diaphragm.

Additionally, the valve means may comprise a spring acting on a piston.

20 The aforementioned cutting edge may be arranged as an extension of the outer face.

Also, the cutting edge may extend from the inner face to the outer face.

25 In addition, the cutting edge may be arranged at an angle in relation to a radial extension from the inner face to the outer face.

Further, the cutting edge may have a meander shape.

30 Moreover, the housing in cross-section may have a circumference, and the cutting edge may extend partly or fully around the circumference.

The wall of the housing may be made of a metal, such as cemented carbide, tungsten-carbide cobalt, hard metal or widia.

35 Further, the valve may be an inflow control valve, a gas lift valve, a throttle or a pressure control valve.

Also, the outer face of the housing may be provided with a thread.

The present invention furthermore relates to a downhole tool for inserting a downhole valve or the downhole punching device as described above into a wall
5 of a casing, comprising:

- at least one downhole valve, and
- a moving means for moving the valve to penetrate the wall of the casing.

In one embodiment, the casing may have an axial extension, and the tool may
10 move the valve so that the axial extension of the valve is transverse to the axial extension of the casing.

In addition, the downhole tool may further comprise a holder for holding the
15 valve.

The holder may comprise a contact surface.

Moreover, the moving means may comprise a piston punching the valve through
20 the casing.

Furthermore, the moving means may screw the valve through the casing.

In addition, the moving means may rotate the valve so that the valve drills itself
25 through the casing.

The downhole tool may further comprise a magazine comprising several valves to
be inserted into the wall of the casing.

Additionally, the downhole tool may further comprise a stop means for controlling
30 the moving means so that the valve penetrates the wall of the casing and the second end face is aligned with an inner face of the wall of the casing.

The present invention furthermore relates to a downhole system comprising the
downhole tool and a driving unit, such as a downhole tractor, for moving the tool
35 forward in the casing.

Finally, the present invention relates to a downhole method for insertion of a downhole unit, such as a punch or a downhole valve as described above, into a casing downhole, comprising the steps of:

- arranging the unit outside a predetermined position in the casing,
- 5 - punching a hole in the casing by means of the cutting edge of the unit,
- leaving the unit in the casing.

This method may further comprise the steps of arranging a second unit at the predetermined position, and pushing the second unit into the hole and replacing
10 the former unit.

Also, the second unit may have a larger outer diameter than the former unit.

Brief Description of the Drawings

15

The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which

20 Fig. 1 shows a downhole valve,

Fig. 2 shows another embodiment of the valve,

Fig. 3 shows a downhole tool in a casing,

25

Fig. 4 shows a partly cross-sectional view of part of another embodiment of the downhole tool,

Fig. 5 shows a partly cross-sectional view of part of yet another embodiment of
30 the downhole tool,

Fig. 6 shows a partly cross-sectional view of part of yet another embodiment of the tool,

35 Fig. 7 shows a downhole punch,

Fig. 8 shows another embodiment of the downhole punch, and

Fig. 9 shows the downhole tool in a casing.

All the figures are highly schematic and not necessarily to scale, and they show only those parts which are necessary in order to elucidate the invention, other parts being omitted or merely suggested.

Detailed description of the invention

Fig. 1 shows a downhole valve 1 for insertion into a wall 2 of a casing 3 in a well in order to let formation fluid into the casing. The valve 1 comprises a housing 4 having a first end 5 and a second end 6. The housing 4 has a cutting edge 9 arranged at the first end 5 of the housing. The housing 4 comprises an inner face 7 and an outer face 8, and in Fig. 1, the cutting edge 9 is arranged as an extension of the outer face 8 so that the outer face 8 terminates in the cutting edge at the first end. The cutting edge 9 has a meander shape when seen from the side. The cutting edge 9 curves up and down forming at least one leading tip being three tips 32 enabling the valve 1 to cut itself into the wall 2 of the casing 3 when being punched into the casing wall.

The housing 4 has an inlet at the first end 5 of the housing 4 and an outlet at the second end 6 of the housing 4. Inside the housing 4, the valve 1 comprises a valve means 10 providing a valve function and restricting free flow from the inlet to the outlet in an axial direction of the valve 1.

The valve means 10 comprises a diaphragm, a throttle, a spring acting on a piston or similar means providing controlled flow restriction in the axial direction of the valve 1. Thus, the valve 1 may be any kind of valve, such as a flow control valve, a gas lift valve, a throttle or a pressure controlled valve.

As shown in Fig. 2, the valve 1 has two cutting edges 9 which extend from the inner face 7 to the outer face 8, and between the cutting edges, a first end face of the first end 5 of the housing 4 inclines, causing the cutting edges 9 to form a tip 33 of the housing 4. When the valve is punched into the casing wall 2 by pushing the valve from a second 38 end face of the second end 6 of the housing 4, the cutting edges 9 cut through the wall. Each cutting edge 9 extends along the radius from the inner face 7 to the outer face 8. In another embodiment, the

cutting edge 9 is arranged at an angle in relation to a radial extension from the inner face 7 to the outer face 8.

When seen in cross-section, as in Fig. 1, the housing 4 has a circumference, and
5 the cutting edge 9 extends fully around the circumference. In Fig. 2, the cutting edge 9 forms only part of the circumference.

In order to be able to cut itself into the casing 3 when used as a punch, the housing wall is made of a metal, such as cemented carbide, tungsten-carbide
10 cobalt, hard metal or widia.

Fig. 7 shows a downhole punch 101 for insertion into a wall 2 of a casing 3 in a well in order to let formation fluid into the casing or to sense formation and/or fluid properties. The downhole punch 101 comprises a body 104 having a
15 through-bore in which a valve 111 or a sensor 112 is arranged. The body has a first end 105 and a second end 106, and in the first end the body 104 has a cutting edge 109. The body 104 comprises an inner face 107 and an outer face 108, and in Fig. 7, the cutting edge 109 is arranged as an extension of the outer face 108 so that the outer face 108 terminates in the cutting edge at the first
20 end. Thus, the first end has at least one leading tip 114 being three leading tips 114 in Fig. 7 or a leading edge 115 being two leading edges as shown in Fig. 8 leading in the punching process and thus being the first part of the punch to contact the casing when the punch is being punched into the casing. The leading tips form part of the cutting edge 109. The cutting edge 109 has a meander
25 shape when seen from the side. The cutting edge 109 curves up and down and forms the three tips enabling the punch 101 to cut itself into the wall 2 of the casing 3 when being punched into the casing wall.

The body 104 has an inlet at the first end 105 of the body 104 and an outlet at
30 the second end 106 of the body 104. Inside the body 4, the downhole punch 101 comprises a valve 111 restricting free flow from the inlet to the outlet in an axial direction of the downhole punch 101. In another embodiment, the body of Fig. 7 comprises a sensor.

35 The valve comprises a diaphragm, a throttle, a spring acting on a piston or similar means providing controlled flow restriction in the axial direction of the

valve 1. Thus, the valve 1 may be any kind of valve, such as a flow control valve, a gas lift valve, a throttle or a pressure controlled valve.

As shown in Fig. 8, the downhole punch 101 has two cutting edges 9 which
5 extend from the inner face 107 to the outer face 108, and between the cutting edges, a first end face of the first end 105 of the body 104 inclines, causing the cutting edges 109 to form a tip of the body 104, the tip being a leading tip or front tip and being the first part of the punch to contact the casing. When the downhole punch 101 is punched into the casing wall 2 by pushing the downhole
10 punch 101 from a second 38 end face of the second end 106 of the body 104, the cutting edges 109 cut through the wall. Each cutting edge 109 extends along the radius from the inner face 107 to the outer face 108.

In another embodiment, the cutting edge 109 is arranged at an angle in relation
15 to a radial extension from the inner face 107 to the outer face 108.

When seen in cross-section, the body 104 has a circumference. The cutting edge 109 of Fig. 7 extends fully around the circumference. In Fig. 8, the cutting edge 109 forms only part of part of the circumference.
20

The cutting edge 9 may be part of a bit welded or embedded into the first end 5 of the housing 4 or the body 104.

In another embodiment, the outer face 8 of the housing 4 or the body 104 is
25 provided with a thread, and the valve 1 or the punch 101 is screwed into the wall 2 of the casing 3. Hereby, the valve 1 or the punch 101 is mechanically secured into the wall of the casing 3 and can withstand direct pressure acting on the first end 5.

30 The valve 1 or the punch 101 is inserted in the casing 3 by means of a downhole tool 100 comprising a moving means 12 for moving the valve 1 or the punch 101 so that it penetrates the wall 2 of the casing 3, as shown in Figs. 3 and 9, respectively. The moving means 12 provides a movement transverse to the longitudinal extension of the tool 100 and the axial extension of the casing 3.

35 As shown in Fig. 4, the moving means 12 comprises a holder 11 for holding the valve 1 or the punch 101. The moving means 12 furthermore comprises a piston

13 which is activated by a cylinder 14 and which moves the holder 11 holding the valve 1 or the punch 101 through an opening 15 in the tool 100. The opening 15 is sealed by a blocking plate made of e.g. glass breaking when the moving means 12 punches the valve 1 or the punch 101 into the casing wall 2.

5

When the moving means 12 moves the valve 1 or the punch 101 towards the wall 2 of the casing 3, a contact surface of the holder 11 abuts the inner face 39 of the casing 3, providing a backstop and a measure of how far the moving means 12 has to punch and/or rotate into the casing wall in order for the second end 6 of the valve 1 to be aligned with the inner face 39 of the casing 3. This serves to ensure that the valve 1 or the punch 101 does not extend into the casing 3, thereby decreasing the inner diameter of the casing 3.

10 In order to move the valve 1 or the punch 101 to penetrate the casing wall 2, the moving means 12 comprises a piston 13 punching or pushing the valve 1 or the punch 101 through the casing 3.

15 As shown in Figs. 5 and 9, the tool 100 comprises two moving means 12 each moving a valve 1 or the punch 101 to penetrate the casing wall 2. The tool 100 comprises an electrical motor 26 for driving a pump 27 providing hydraulic power to the moving means 12, enabling the valve 1 to penetrate the casing wall 2. The moving means 12 may also be driven directly by the motor 26 without the use of hydraulics.

20 In another embodiment, the tool 100 comprises a magazine 20 holding several valves or punches ready to be inserted into the holder 11, as shown in Fig. 6. When one valve or punch is inserted in a position in the casing 3, the tool 100 moves and the holder 11 is loaded with a second valve or second punch from the magazine 20, and when the tool reaches a new position, the second valve or second punch is ready to be inserted into the casing wall 2.

25 While moving the valve 1 to penetrate the casing wall 2, the moving means 12 may also screw the valve 1 through the casing 3.

30 In another embodiment, the moving means 12 rotates the valve 1 so that the valve 1 drills itself through the casing 3.

The holder 11 acts as a stop means for controlling the moving means 12 to ensure that the valve 1 or punch 101 penetrates the wall 2 of the casing 3 and the second end face is aligned with an inner face 7 of the wall 2 of the casing 3. The tool 100 may also have a separate stop means if the holder 11 is not
5 designed to abut the inner face of the casing 3.

The downhole punch or downhole valve may be replaced by arranging a second downhole punch or downhole valve at the position of the former punch or valve which it is to replace, and pushing the second punch or valve into the hole and
10 replacing the former unit. The second punch or valve may have a slightly larger outer diameter than the former punch or valve in order that the second punch or valve can be properly fastened.

In order to fasten the downhole punch or downhole valve, it is designed having
15 no clearance and will consequently fasten itself by means of friction. The hole punched in the casing does not have to have an inner diameter as large as the outer diameter of the punch or valve as the cutting edge merely needs to make a hole in the casing in order to gain contact with fluid in the annulus surrounding the casing.
20

The downhole tool 100 may be connected with a driving unit 22, such as a downhole tractor, for moving the tool forward in the casing 3. The downhole tool 100 and the driving unit 22 together form a downhole system. The driving unit comprises four projectable and retractable wheel arms 31 each connected with a
25 wheel 30.

By fluid or well fluid is meant any kind of fluid that may be present in oil or gas wells downhole, such as natural gas, oil, oil mud, crude oil, water, etc. By gas is meant any kind of gas composition present in a well, completion, or open hole,
30 and by oil is meant any kind of oil composition, such as crude oil, an oil-containing fluid, etc. Gas, oil, and water fluids may thus all comprise other elements or substances than gas, oil, and/or water, respectively.

By a casing is meant any kind of pipe, tubing, tubular, liner, string etc. used
35 downhole in relation to oil or natural gas production.

In the event that the tool is not submergible all the way into the casing 3, a downhole tractor can be used to push the tool all the way into position in the well. A downhole tractor is any kind of driving tool capable of pushing or pulling tools in a well downhole, such as a Well Tractor®.

5

Although the invention has been described above in connection with preferred embodiments of the invention, it will be evident for a person skilled in the art that several modifications are conceivable without departing from the invention as defined by the following claims.

10

Claims

1. A downhole valve assembly for insertion into a wall of a casing, comprising:
 - a housing having a first end and a second end as well as an inner face and an
 5 outer face,
 wherein the first end of the housing comprises at least one cutting edge at least
 forming a leading tip or a leading edge for punching an opening in the casing,
 a downhole valve arranged in the housing, and
 wherein the housing, including the downhole valve, is structured and
 10 dimensioned so that neither the downhole valve nor the housing extends into an
 interior of the casing when disposed in the opening.
2. The downhole valve assembly according to claim 1, wherein the cutting
 edge is arranged as an extension of the outer face.
 15
3. The downhole valve assembly according to claim 1 or 2, wherein the cutting
 edge extends from the inner face to the outer face.
4. The downhole valve assembly according to any one of claims 1-3, wherein
 20 the housing in cross-section has a circumference and the cutting edge extends
 partly or fully around the circumference.
5. The downhole valve assembly according to any one of claims 1-4, wherein
 the downhole valve is an inflow control valve, a gas lift valve, a throttle or a
 25 pressure control valve.
6. A downhole punch for insertion into a wall of a casing, comprising:
 - a body having a first end and a second end and a through-bore forming an
 inner face of the body and an outer face of the body,
 30 wherein the first end comprises at least one cutting edge at least forming a
 leading tip or a leading edge for punching an opening in the casing, wherein a
 component in the form of a sensor, an emitter, a receiver, or a communication
 device is arranged in the through-bore, and
 wherein the body, including the component, is dimensioned and structured so
 35 that neither the body nor the component extends into an interior of the casing
 when disposed in the opening.

7. The downhole punch according to claim 6, wherein the component is the sensor, and the sensor is a temperature sensor, pressure sensor, resistivity sensor, electromagnetic sensor, acoustic sensor, capacitance sensor or density sensor.
- 5
8. The downhole punch according to claim 6 or 7, wherein the cutting edge is arranged as an extension of the outer face.
9. The downhole punch according to any one of claims 6-8, wherein the
- 10 cutting edge extends from the inner face to the outer face.
10. The downhole punch according to any one of claims 6-9, wherein the body in cross-section has a circumference and the cutting edge extends partly or fully around the circumference.
- 15
11. A downhole tool for inserting a downhole unit comprising one of a downhole valve assembly according to any one of claims 1-5 and a downhole punch according to any one of claims 6-10 into a wall of a casing, the downhole tool comprising:
- 20 - the downhole unit, and
- a moving means for moving the downhole unit to penetrate the wall of the casing.
12. The downhole tool according to claim 11, wherein the moving means
- 25 comprises a piston punching the downhole valve assembly through the casing.
13. The downhole tool according to claim 11, wherein the moving means screws the downhole valve assembly through the casing.
- 30 14. The downhole tool according to claim 11, wherein the moving means rotates the downhole valve assembly so that the downhole valve assembly drills itself through the casing.
15. The downhole tool according to any one of claims 11-14, further comprising
- 35 a magazine comprising several downhole valve assemblies to be inserted into the wall of the casing.

16. The downhole tool according to any one of claims 11-15, further comprising a stop means for controlling the moving means so that the downhole valve assembly penetrates the wall of the casing and a second end face of the second end of the housing is aligned with an inner face of the wall of the casing.
- 5
17. A downhole system comprising the downhole tool according to any one of claims 11-16 and a driving unit for moving the tool forward in the casing.
18. The downhole system according to claim 17, wherein the driving unit
- 10 comprises a downhole tractor.
19. A downhole method for insertion of a downhole unit, comprising one of a punch according to any one of claims 6-10 and a downhole valve assembly according to any one of claims 1-5 into a casing downhole, comprising the steps
- 15 of:
- arranging the unit outside a predetermined position in the casing,
 - punching a hole in the casing by means of the cutting edge of the unit,
 - leaving the unit in the casing.
- 20 20. The downhole method according to claim 19, further comprising the steps of arranging a second unit at the predetermined position, and pushing the second unit into the hole and replacing the former unit.
21. The downhole method according to claim 20, wherein the second unit has a
- 25 larger outer diameter than the former unit.

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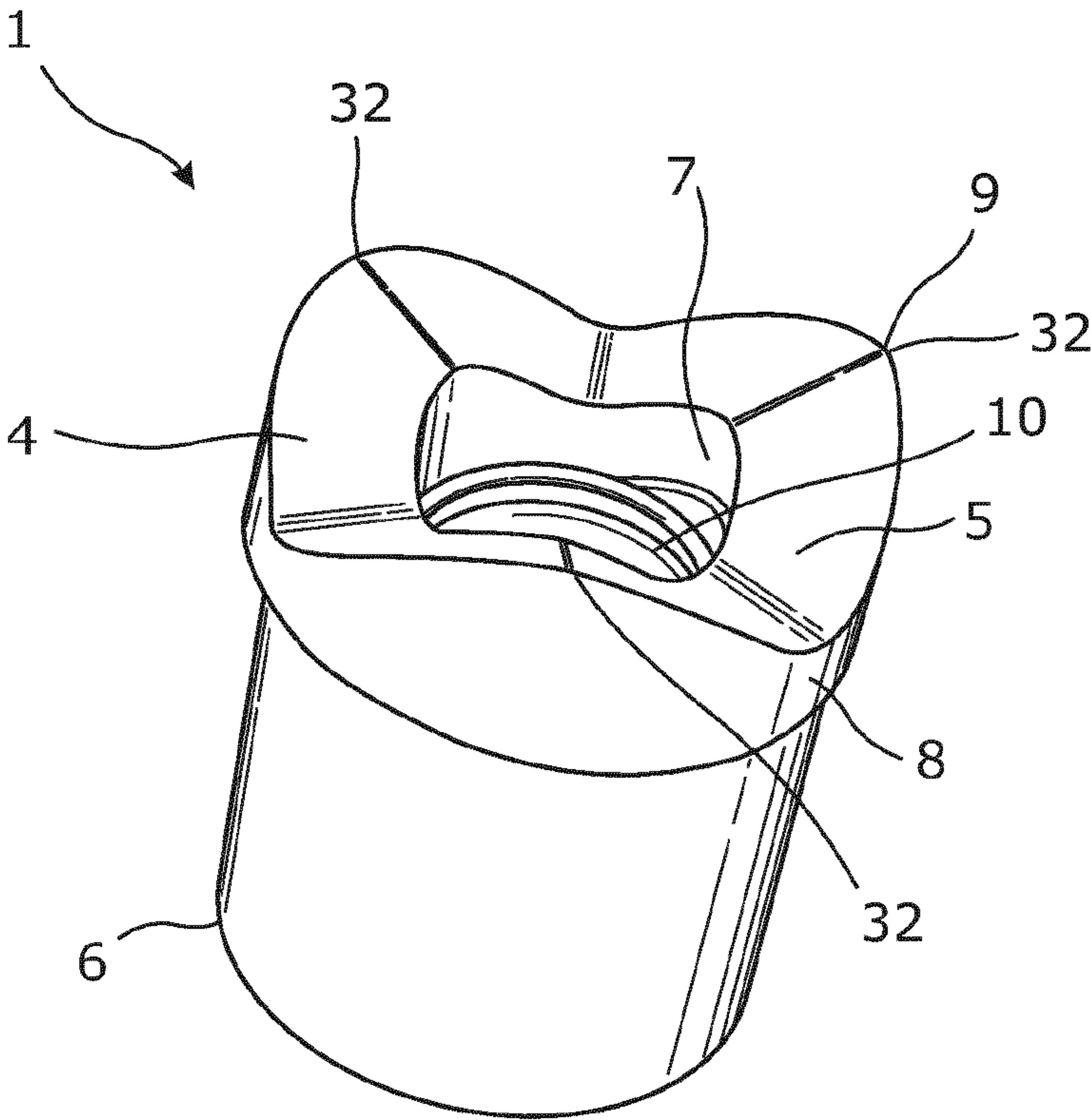


Fig. 1

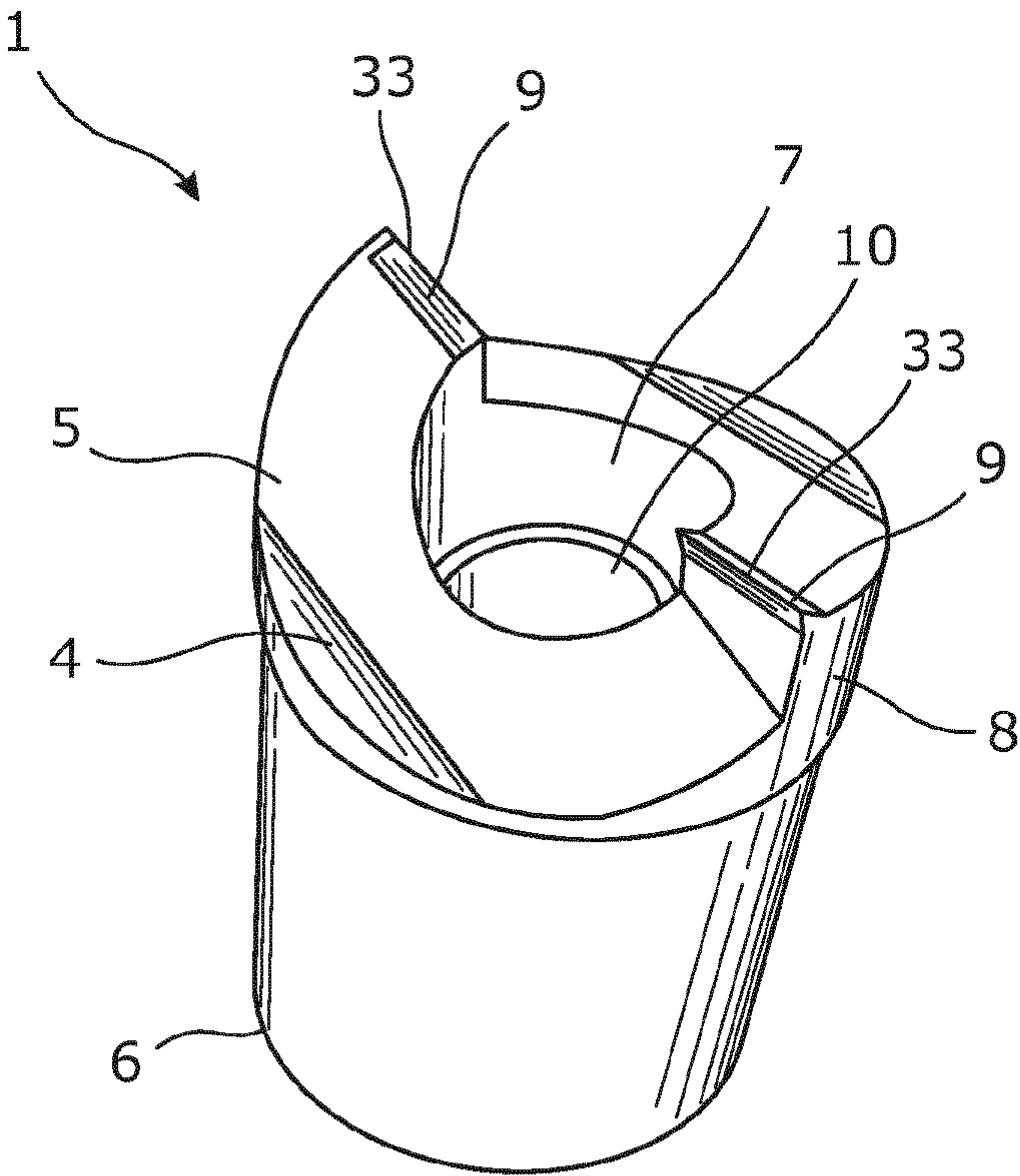


Fig. 2

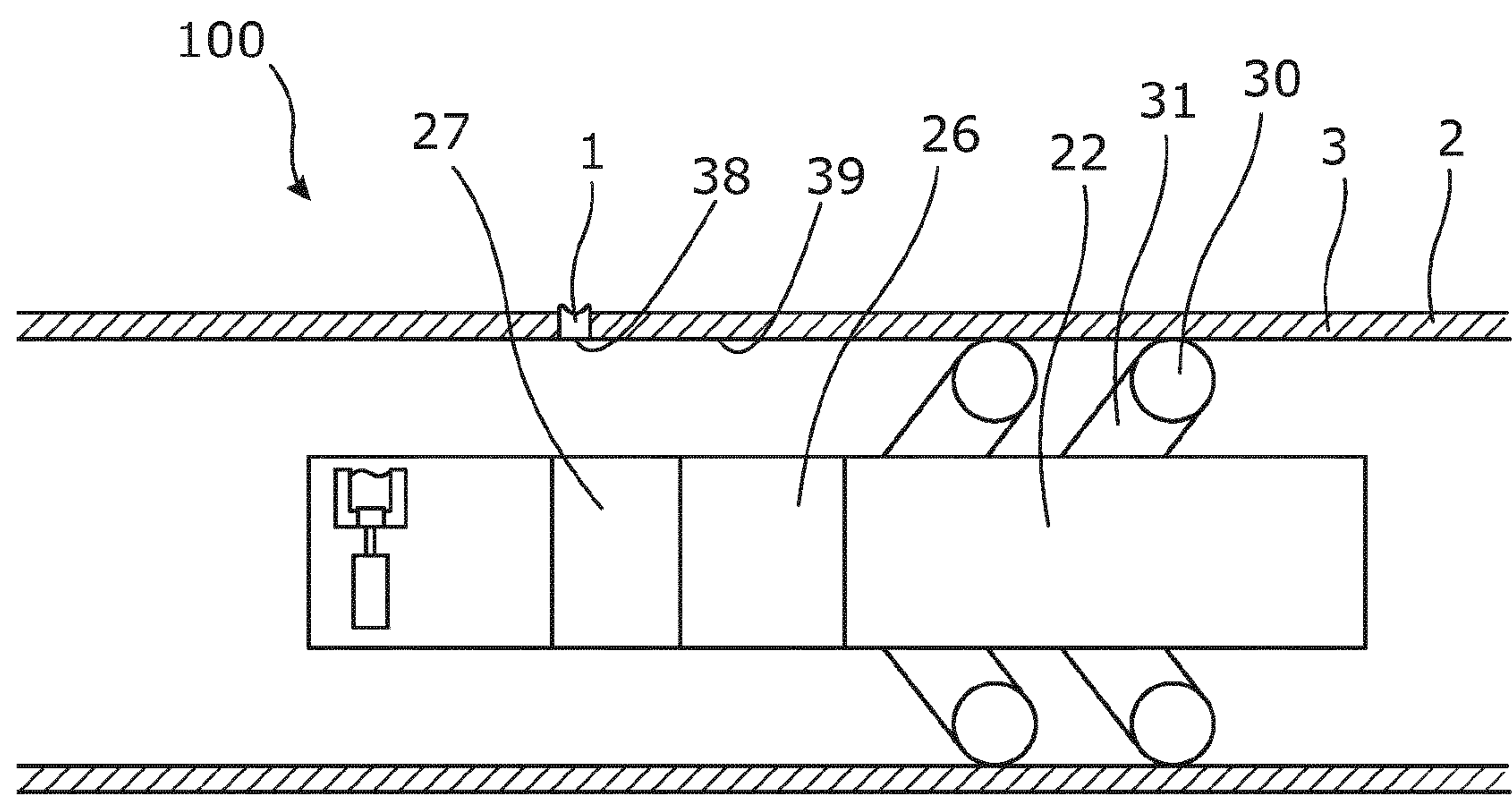


Fig. 3

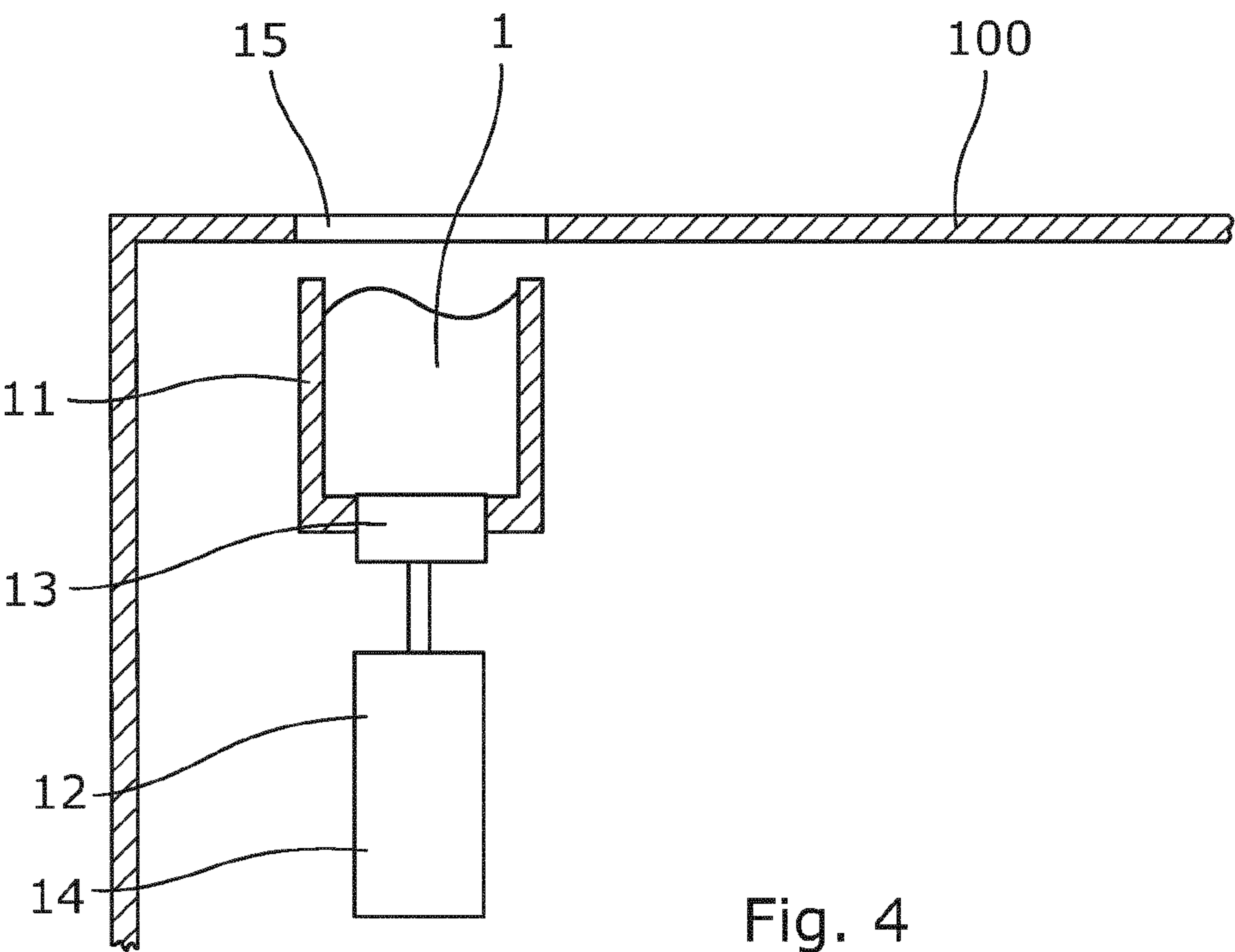


Fig. 4

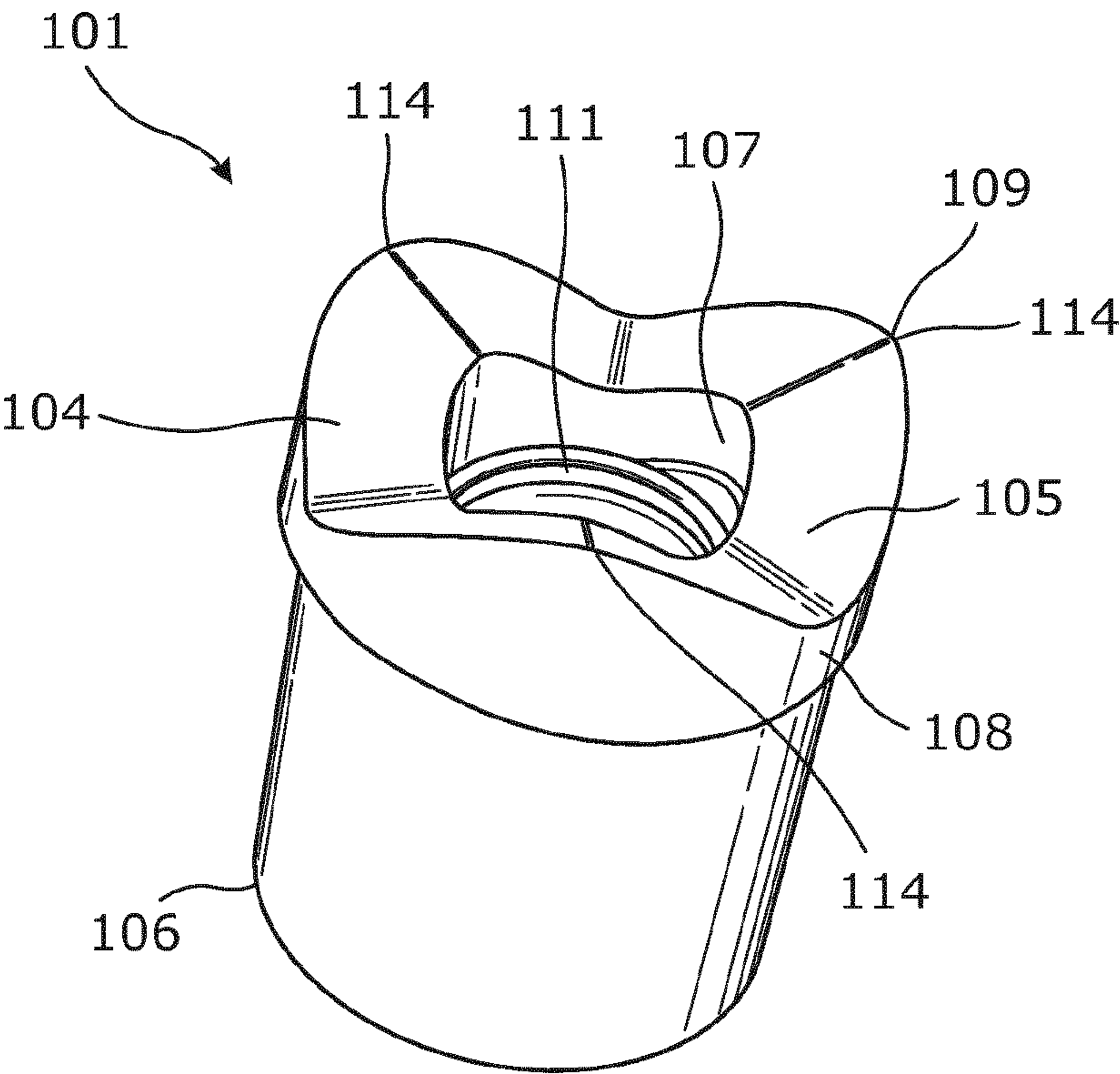


Fig. 7

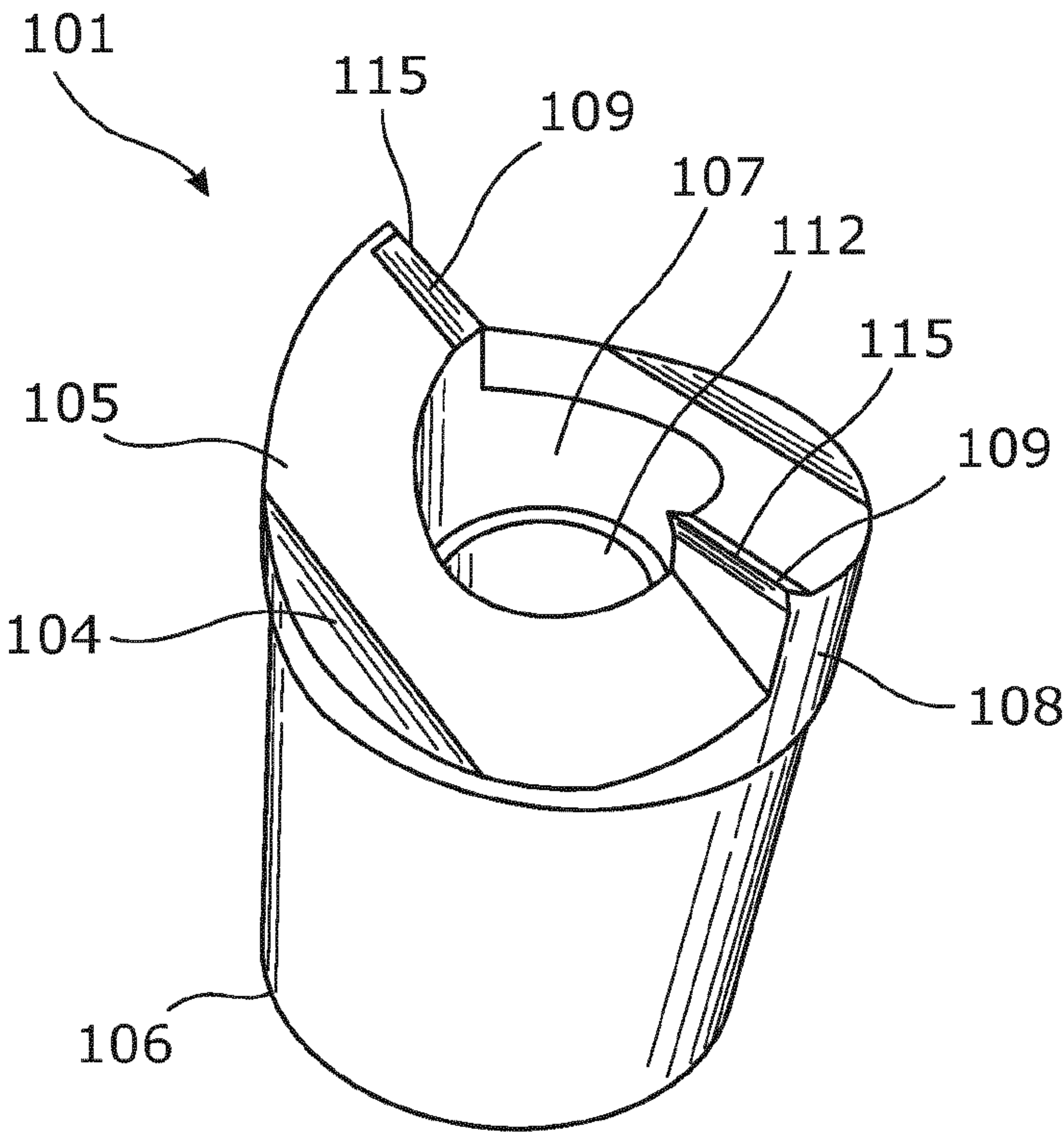


Fig. 8

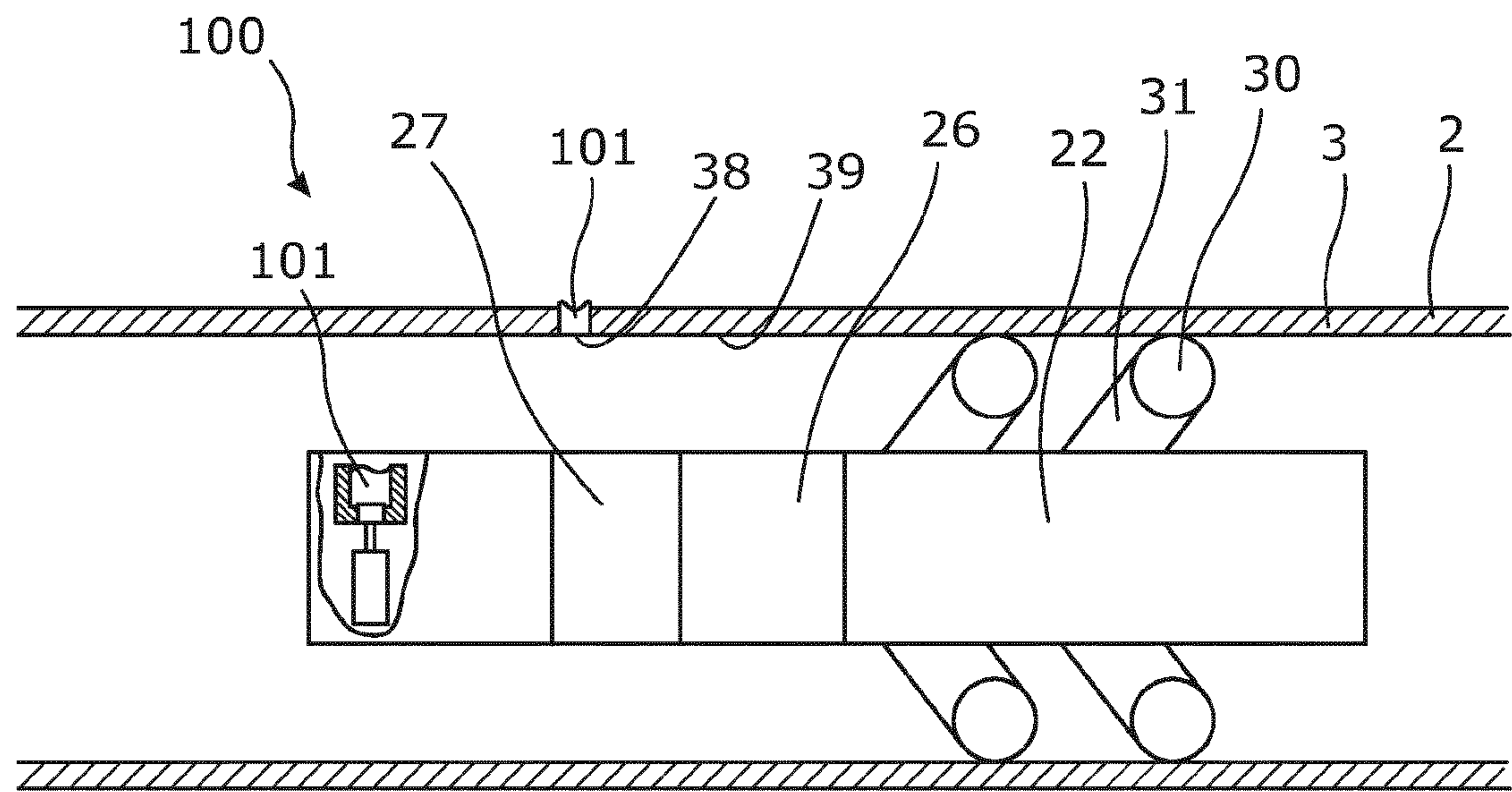


Fig. 9

