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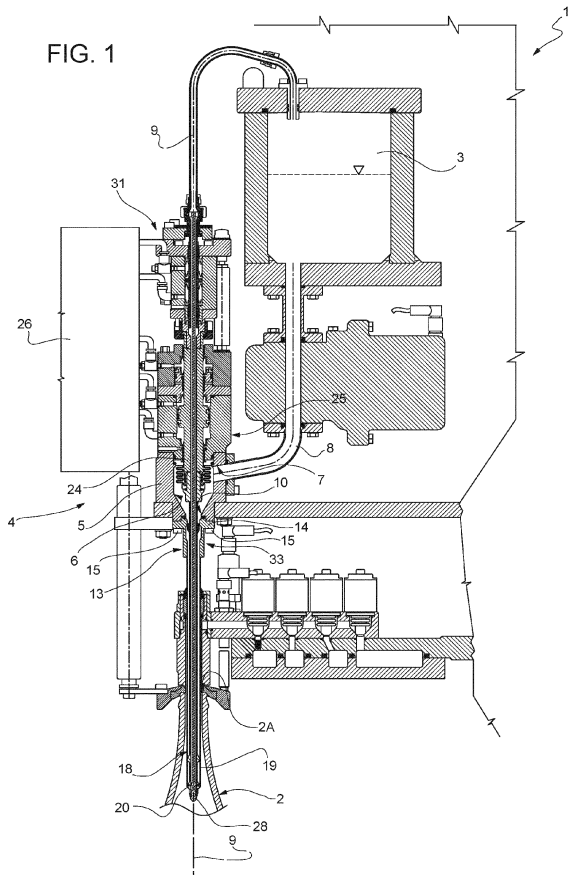
(54) FILLING METHOD AND ASSEMBLY FOR FILLING A CONTAINER, IN PARTICULAR A BOTTLE, WITH A FOOD LIQUID

(57) In a machine (1) for filling bottles (2), a filling assembly (4) has a fixed body (5) delimiting a delivery chamber (6) having a liquid inlet (7) and a liquid outlet (10) connected to a duct (22) for feeding the liquid into the bottle; the amount of liquid to be delivered and the delivery conditions are varied by using a flow control device having a shutter (20) for choking the duct (22) and an adjustable block (33) for throttling said duct (22) upstream of said shutter (20); the shutter (20) and the adjustable throttling block (33) being both controlled by a single common linear actuator (25) and being mutually synchronized by means of a single control rod (29) operated by the common actuator (25).

FIG. 1



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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian Patent Application no. 102022000006026 filed on March 28, 2022, the entire disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates to a filling method and assembly for filling a container, in particular a bottle, with a food liquid, to which the following specification will make explicit reference without thereby losing generality.

BACKGROUND

[0003] As is well known, the filling of a bottle is carried out by machines equipped with a filling assembly which is controlled in order to deliver the expected amount of liquid into the bottle.

[0004] The filling assemblies used vary according to the filling mode, i.e., whether a filling "by level" mode or filling "by volume" mode is used, in order to reach a desired liquid level or a desired liquid volume, respectively, in the bottle.

[0005] The known filling assemblies then differ from each other according to the characteristics of the liquid to be delivered, i.e., whether the liquid to be delivered is a so-called "still" liquid or a "sparkling" liquid.

[0006] Generally, the known filling assemblies comprise a delivery chamber into which the liquid to be introduced into the bottle is supplied by an overlying storage tank, a duct for feeding the liquid into the bottle connected to an outlet of the delivery chamber, and a device for controlling the liquid flow exiting the duct.

[0007] An example of these filling assemblies is described in Italian patent application IT 102021000016190 by the same Applicant as the present patent application.

[0008] In this filling assembly, the duct is an annular duct delimited externally by a tubular body and internally by a movable operating rod.

[0009] The rod has a free terminal portion, which protrudes downwards beyond the lower end of the outer tubular body and has, integrally connected thereto, a shutter for partially or fully closing the annular duct.

[0010] On the other hand, an upper section of the rod is connected to a linear actuator, which is configured to vertically translate the rod and thus the shutter between two extreme end-of-stroke positions, of which one is to open and the other is to close the annular duct, and through an intermediate or end-of-filling the bottle position.

[0011] When arranged in its opening position, the shutter allows the maximum flow rate of liquid to be delivered into the bottle, and thus enables a "quick" filling of the bottle body.

[0012] Instead, when arranged in its intermediate position, the shutter reduces the passage section of the annular duct, thus limiting the flow rate so as to allow a "slow" filling of the bottle neck.

[0013] The "slow" filling of the bottle is necessary in order to improve the filling accuracy, prevent liquid spillage at the end of the filling and, in general, prevent spattering and an arbitrary propagation of fluid trickles inside the bottle.

[0014] Although widely used, the filling assembly described above is not completely satisfactory because at the end of the slow filling and especially in the presence of "sparkling" liquids, a variable amount of foam forms on the bottle walls and particularly in the bottle neck.

[0015] As is well known, the presence of foam at the end of the filling should be avoided or minimized as much as possible as it affects the dosing accuracy and leads to waiting times for the dissolution or elimination of said foam before the bottle is closed.

[0016] Waiting times are downtime and do not allow the bottling and closing cycle time to be reduced, and therefore the machine productivity to be increased.

[0017] Experimentally, it has been established that foaming is the result of the choking of the passage section of the annular duct by the shutter, following which, inevitably, the speed at which the liquid flows out of the annular duct increases, as well as the speed at which the liquid being fed impacts the liquid already in the bottle.

[0018] With "sparkling" or carbonated liquids, the problem of the presence of foam is more accentuated by the fact that the impact of the liquid at high speed increases the instability of the gas dissolved in the liquid, resulting in an increase in the amount of foam.

[0019] Attempts to modify the shutter geometry to solve the above problem have not been effective or satisfactory mostly because the shutter geometry cannot be freely modified since, as is well known, the geometry defines the optimal entry path of the liquid into the bottle, particularly during the "quick" filling of the bottle body.

[0020] In addition to the filling assembly described above, other conceptually different solutions are known wherein the "quick" filling step and the subsequent "slow" filling step are carried out by providing additional controlled valves to intercept the flow of liquid entering the delivery chamber; these valves are driven and controlled by a unit acting on their respective actuators.

[0021] In some cases, the control is performed by seeking a synchronization between the commands of the different actuators, in others by keeping the shutter in its fully open position.

[0022] In still other solutions where a channel for the evacuation of the gas in the bottle is provided in addition to the annular channel of liquid supply, the transition from the "quick" filling condition to the "slow" filling condition is carried out by means of auxiliary control valves which are operated by a command and control unit in order to reduce the passage section of the channel for the evacuation of the gas from the bottle. Throttling the gas evac-

uation channel hinders the advance of the liquid into the bottle.

[0023] Still with gas evacuation, other solutions, which are much more complicated from a constructive point of view, use two different gas return or evacuation circuits. The return circuits are maintained at different pressures and selector valves are provided for switching from one to the other of the aforementioned return circuits. In other words, depending on the feed conditions, one or the other of the two return circuits is used.

[0024] One of these solutions is described, for example, in patent US2015/0191339A1.

[0025] The constructive solutions described above are constructive alternatives but have the common drawback of comprising a large number of controlled valves and are thus complex and costly to manufacture and, in general, difficult to control.

[0026] In addition to this, each valve, in addition to its own actuator, comprises its own baffle for isolating the food liquid from said actuator. The need for the baffle adds costs not only for construction but also for maintenance as each actuator needs to be constantly kept under control for its correct functionality and each baffle must periodically be monitored to check its integrity and be subjected to the necessary cleaning operations to prevent contamination of the liquid fed.

SUMMARY

[0027] One object of the present invention is to provide a filling assembly for filling a container, in particular a bottle, which allows the above problems to be solved in a simple and inexpensive way.

[0028] A particular object of the present invention is to provide a filling assembly, which allows, compared to the known solutions, the flow rate of the incoming liquid to be reduced by reducing as much as possible the increase in the speed at which the liquid enters the bottle as the throttling of the feed duct is increased by the shutter, thus eliminating or minimizing the formation of foam inside the bottle.

[0029] A further object of the present invention is to provide a filling assembly which is constructively simple, cost-effective and, at the same time, with high and efficient reliability and functional effectiveness.

[0030] According to the present invention, a filling assembly for filling a container, in particular a bottle, with a food liquid is provided as claimed in claim 1.

[0031] The present invention further relates to a method for filling a container, in particular a bottle, with a food liquid.

[0032] According to the present invention, a method for filling a container, in particular a bottle, with a food liquid is provided as claimed in claim 15.

[0033] The last object of the present invention is to provide a filling kit, which can be easily mounted on existing filling machines to replace the filling assemblies already on board the same so that the filling machines themselves can be retrofitted.

[0034] According to the present invention, a filling kit is provided as claimed in claim 20.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The invention will now be described with reference to the accompanying drawings, which illustrate a non-limiting embodiment thereof, in which:

- Figure 1 shows, in section and with parts removed for clarity, a bottle filling machine provided with a preferred embodiment of a filling assembly manufactured according to the teachings of the present invention;
- Figures 2 and 3 are figures similar to Figure 1 and show the filling assembly arranged in two different operating conditions;
- Figures 4, 5 and 6 show, on a greatly enlarged scale, a detail of Figures 1, 2 and 3, respectively;
- figures 7 and 8 show diagrams of the operation of the filling assembly according to the invention and of comparison with the operation of known filling assemblies; and
- Figure 9 shows, in enlarged scale, a portion of Figures 1 to 3.

DESCRIPTION OF EMBODIMENTS

[0036] In Figures 1 to 3, the reference numeral 1 shows, as a whole, a filling machine for filling bottles 2 (only one of which can be seen in the attached figures) with a food liquid contained in a tank or cistern 3.

[0037] The machine 1 comprises a bottle filling assembly, indicated as a whole with 4, in turn comprising a fixed body 5 delimiting a delivery chamber 6, which has an inlet 7 connected to the tank 3 via a continuous tube 8, extends vertically and coaxially with a vertical delivery axis 9 and has an outlet 10.

[0038] With specific reference to Figures 4 to 6, the outlet 10 also extends coaxially with the axis 9 and communicates with the inlet 12 of a tubular body 13, which also extends coaxially with the axis 9, has an externally flanged upper terminal section 14 stably fluid-tightly connected to the fixed body 5 by screws 15 and a lower section 16 stably connected, in a known way, to an upper section of a liquid-conveying outer tube 18 and also coaxial with the axis 9.

[0039] The outer tube 18 has a lower terminal section 19 which is configured to be inserted inside the bottle 2, as can be seen in Figures 1 to 3.

[0040] Alternatively, according to a variant, not shown, the terminal section 19 of the outer tube 18 is configured to feed the liquid but not to be inserted inside the bottle 2, i.e., to cooperate as much as possible with the free end or the mouth 2A of the neck of the bottle 2.

[0041] Again, with reference to Figures 1 to 3 and, in particular, to Figures 4 to 6, the terminal section 19 of

the tube 18 is closed or choked by a shutter 20, which extends, in a known way, outside the terminal section 19 and is stably connected to a lower terminal section of a control rod 21 extending coaxially with the axis 9.

[0042] In the above alternative solution, a shutter equivalent to the shutter 20 is arranged along the outer tube 18.

[0043] Again, with reference to Figures 1 to 6, the rod 21 passes through the tube 18 and the tubular body 13, delimiting with them an annular duct 22 for the forward movement of the liquid towards the bottle 2, and has an outlet 22A (Figures 5 and 6).

[0044] The rod 21 then has an upper terminal section extending inside the chamber 6 and, within the chamber 6 itself, is connected by a threaded coupling 23 to an axially movable member 24 of a double-acting pneumatic linear actuator 25, which is known per se and controlled by an electro-pneumatic command and control unit, which is also known per se and indicated as a whole with 26.

[0045] Conveniently, the linear actuator 25 is of the type described in Italian patent application IT 102021000016190 by the same Applicant as the present patent application, which is herein referred to in its entirety for the sake of completeness of description and for the necessary parts.

[0046] In any case, the linear actuator 25 is configured to move the shutter 20 between two extreme end-of-stroke positions, of which one is for a full opening, as shown in Figures 3 and 6, and the other is for a full closure, as shown in Figures 1 and 4. The linear actuator 25 can then be controlled to arrange the shutter 20 in a plurality of intermediate positions between the opening and closing positions, in each of which the shutter 20 chokes the annular duct 22 for the passage of the liquid directed into the bottle.

[0047] Conveniently, the rod 21 is tubular to allow the gas to flow back from the bottle 2 to the tank 9 during the filling of the same bottle 2.

[0048] In this case, the gas backflow may be free if the liquid fed is a still liquid or, conveniently, controlled by means of a shutter 28 which is arranged outside the terminal section of the rod 21 and is stably connected to one end of an additional support and movement rod 29 coaxial with the rod 21.

[0049] The rod 29 is movable in opposite directions within the rod 21 under the thrust of a linear actuator 31, between two extreme end-of-stroke positions, of which one is lowered, in which the shutter 28 allows the gas to enter the rod 21, as can be seen in Figures 2, 3, 5 and 6, and the other is raised, as shown in Figures 1 and 4, in which the shutter 28 prevents the gas from entering the rod 21.

[0050] Again, with reference to Figures 1 to 6, the filling assembly 4 comprises an adjustable throttling block 33 for throttling the duct 22 to create, in use, a localized and adjustable pressure drop.

[0051] With reference to Figures 4, 5 and 6, the adjustable block 33 is arranged upstream of the shutter 20 in the direction of movement of the liquid towards the bottle 2. Conveniently, the adjustable block 33 is arranged immediately downstream of the outlet 10, i.e., at the inlet of the tubular body 19 so that the pressure drop is substantially obtained at the inlet of the same duct 22.

[0052] With reference to Figures 4 to 6, the adjustable throttling block 33 comprises the tubular body 13, which delimits an inner cavity 35 coaxial with the axis 9 and, in turn, axially delimited, on the side facing the opening 10, by an inner annular flange 36.

[0053] The flange 36 has an internal diameter substantially equal to the internal diameter of the tube 18 and is delimited, on the side facing the cavity 35, by a conical surface 37 flared towards the cavity 35 and having a flare angle A.

[0054] Again, with reference to Figures 4 to 6, the cavity 35 is delimited laterally by a cylindrical surface 38 having a constant diameter greater than the internal diameter of the outer tube 18 and axially by the surface 37 and by a conical surface 37A flared towards the inside of the cavity 35 and having a flare angle B which is smaller than the angle A.

[0055] Again, with reference to Figures 4 to 6, the adjustable block 33 further comprises an annular choker 40 configured like an olive, which is housed in the cavity 35 in an axially sliding manner and surrounds the rod 21, to which it is stably connected to move in unison along the axis 9 with the same rod 21 and with the shutter 20.

[0056] The choker 40 has an intermediate portion laterally delimited by a cylindrical surface 41 coaxial with the axis 9 and having an external diameter approximating by default the internal diameter D1 of the tubular body 18 so that it can be inserted with clearance within the tubular body 18. The choker 40 is then axially delimited by two axial portions tapered in opposite directions and delimited by respective frustoconical surfaces 43 and 44. The surface 43 has a vertex angle C which is in the order of 100° and is greater than the angle A and the angle B, whereas the surface 44 has a vertex angle D which is smaller than the angles A, B and C.

[0057] In any case, the angle C must be greater than the angle D. This condition, on the one hand, makes it possible to have, with modest axial strokes of the choker, a sudden change in the passage section and thus a sudden change in the throttling degree and hence in the consequent pressure drop and, on the other hand, makes it possible to uniform the motion and generate very small turbulence in the fluid after it has passed the shutter 40.

[0058] The choker 40 is arranged along the rod 21 at a distance L from the shutter 20 such that when the shutter 20 is arranged in its closing position, the choker 40 is arranged in its upper extreme end-of-stroke or maximum throttling position, whereas when the shutter 20 is arranged in its opening position, the choker 40 is arranged in its lower end-of-stroke position in which it does not choke the duct 22 in any way. Whatever the position of the choker 40, it delimits inside the cavity a liquid stabi-

lization chamber arranged downstream of the same choker 40 in the direction of movement of the liquid.

[0059] Under the thrust of the actuator 25, both the shutter 20 and the choker 40 can be positioned in a plurality of intermediate positions between the aforementioned end-of-stroke positions, in each of which the choker 40 chokes the inlet of the duct 22 creating a corresponding localized pressure drop.

[0060] In the diagram in Figure 7, the curve H represents the flow rate of liquid delivered into the bottle 2 as the opening of the shutter 20 varies and in the absence of the choker block 33, i.e., according to the prior art.

[0061] On the other hand, the curve K represents the flow rate of liquid delivered into the bottle 2 as the opening of the shutter 20 varies and in the presence of the choker block 33, i.e., according to the present invention.

[0062] As can be seen in the diagrams, the liquid flow rate under the condition of maximum opening of the shutter 20, which occurs, for example, with a stroke of the shutter 20 of 3.3 - 4 mm starting from the end of the tubular body 18 (Figure 6), is substantially the same under both conditions. In other words, the presence of the adjustable throttling block 33 has no influence and reduces the flow rate negligibly (variation in the order of 4%-5%) during the "quick" filling, so the productivity is not limited thereby.

[0063] The diagrams in Figure 7 also show that under the condition of minimum opening of the shutter 20 (Figure 5), for example, with a stroke of the shutter 20 of 0.8 - 1.2 mm starting from the end of the tubular body 18, that is, under the condition of maximum choking of the duct 22 and therefore in the "slow" filling condition, the flow rate is further reduced.

[0064] In the diagram in Figure 8, the curve X represents the speed of the liquid exiting the opening 22A as the opening of the shutter 20 varies and in the absence of the adjustable throttling block 33, i.e., according to the prior art.

[0065] On the other hand, the curve Y represents the speed of the liquid exiting the opening 22A as the opening of the shutter 20 varies and in the presence of the adjustable throttling block 33, the other conditions being the same, i.e., according to the present invention.

[0066] Figure 8 shows an aspect of great importance. In particular, it appears that under the condition of maximum opening (3.5 - 4 mm) of the choker 20 and therefore in the "quick" filling condition, the liquid outflow speed, i.e., the speed of the liquid exiting the opening 22A of the duct 22, is almost equal in both solutions, but above all, it appears that the presence of the adjustable throttling block 33 allows a drastic reduction in the outflow speed under the minimum opening condition (0.8 - 1.2 mm), i.e., in the "slow" filling condition, resulting in a drastic reduction of foam at the end of the filling, both when delivering still liquids, but especially when delivering sparkling or carbonated liquids. A reduction of foam in the bottle entails a reduction in downtime waiting for the foam to dissolve and therefore a reduction in the bottling and closing cycle time and therefore an increase in the productivity of the machine.

[0067] It is clear from the above that in the assembly 4 the shutter 20 and the choker 40 are always perfectly synchronized with each other both being integral with the rod 21, which is in common, and are both operated by a single linear actuator, which is again in common, and, in particular, by the same actuator already present on known machines. This single actuator is then perfectly isolated from the liquid fed and therefore the possibility of contamination of the liquid is excluded.

[0068] The adjustable throttling block 33 is constructively simple and compact so that it can be installed downstream of the delivery cavity 35, i.e., inside the filling assembly and not on tubes outside the assembly, as in the known solutions.

[0069] From the above it is clear that modifications and variations can be made to the assembly 4 described above without thereby departing from the scope of protection of the present invention.

[0070] In particular, both the cavity 35 and the choker 40 may have different shapes and geometries from those indicated by way of example, e.g., to vary the fluidic behaviour of the liquid during its passage through the choker block 33 or downstream of the surface 44 where the surfaces 37A and 44 and the rod 21 define a stabilization chamber for the liquid before it continues in the duct towards the shutter 20.

[0071] Figure 9 shows an assembly 50 of the assembly 4, which comprises the adjustable throttling block 33, the outer tube 18, the rod 21 carrying the choker 20, on a threaded side 23° of the threaded coupling 23 that can be releasably connected to the movable member 24 of the actuator 25 (Figure 1). This assembly 50 defines a KIT which can be used for the modification or retrofitting of known filling machines and specifically of the filling machine object of patent application IT 102021000016190 referred to above and by the same Applicant. It should be noted that the replacement of the existing assembly with the assembly 50 only involves unscrewing the components on board and subsequently screwing the corresponding parts of the assembly 50.

Claims

1. A filling assembly for filling a container, in particular a bottle, with a food liquid contained in containment means; the assembly comprising:

   - a fixed body delimiting a delivery chamber having a liquid inlet connected to said containment means and an outlet for the liquid to be fed;
   - a feed duct for feeding the liquid into the container and connected at the top to said delivery chamber outlet and having a lower terminal section configured to guide the liquid into the container to be filled;

- an outer tube externally delimiting the liquid feed duct and having a lower terminal section configured to guide the liquid inside the container;
- a shutter for choking said duct;
- a control member for controlling said shutter;
- adjustable throttling means for throttling said feed duct arranged upstream of said shutter in the direction of movement of the liquid towards said container and controlled by said control member and by a linear actuator, wherein said adjustable throttling means comprise an inner cavity; and a movable member, which is integrally connected to said control member at a fixed distance from said shutter and delimits, in any position inside the inner cavity, a liquid stabilization chamber arranged downstream of the same movable member in the direction of movement of the liquid.

2. The assembly according to any one of the preceding claims, wherein said outer tube has a lower terminal section configured to be inserted inside the container, said control member being a tubular rod, and the shutter is stably connected to the lower end of the tubular rod and arranged on the outside of said outer tube and is configured to cooperate with a free terminal portion of the outer tube and open/close said feed duct at the bottom.

3. A method for filling a container, in particular a bottle, with a food liquid using a filling assembly as claimed in claim 1 or 2; the method comprising a first step of quick filling the container by feeding a first flow of liquid, and a subsequent step of slow filling the container by feeding a second flow of liquid smaller than said first flow; **characterized in that** it reduces the speed of exit of the liquid from said duct during the slow filling step, creating a variable localized pressure drop between the delivery chamber and the first movable member and synchronizing the variation in the pressure drop with the movement of the first movable member with respect to the outer tube.

4. **-** The method according to claim 3, wherein said variable pressure drop is obtained by varying the throttling degree of said feed duct.

5. **-** The method according to claim 3 or 4, wherein said synchronization is performed by moving together the shutter and the movable member for choking said feed duct.

6. **-** The method according to any one of the claims from 3 to 5, wherein said synchronization is performed by moving the shutter and the movable choking member by means of one single operating rod moved by a linear actuator.

7. **-** A kit for modifying a machine for filling containers, in particular bottles; the kit comprising an outer tube externally delimiting a liquid feed duct and having a lower terminal section configured to guide the liquid inside the container, first connection means for connecting in a releasable manner one end of the outer tube to an outlet of a delivery cavity containing the liquid to be delivered; a shutter for choking said duct, a control member for controlling said shutter and second releasable connection means for connecting said control member to a linear actuator; adjustable throttling means for throttling said feed duct arranged upstream of said shutter in the direction of movement of the liquid towards said container and controlled by said control member and by said linear actuator, wherein said adjustable throttling means comprise an inner cavity; and a movable member, which is integrally connected to said control member at a fixed distance from said shutter and delimits, in any position inside the inner cavity, a liquid stabilization chamber arranged downstream of the same movable choking member 40 in the direction of movement of the liquid.

FIG. 1

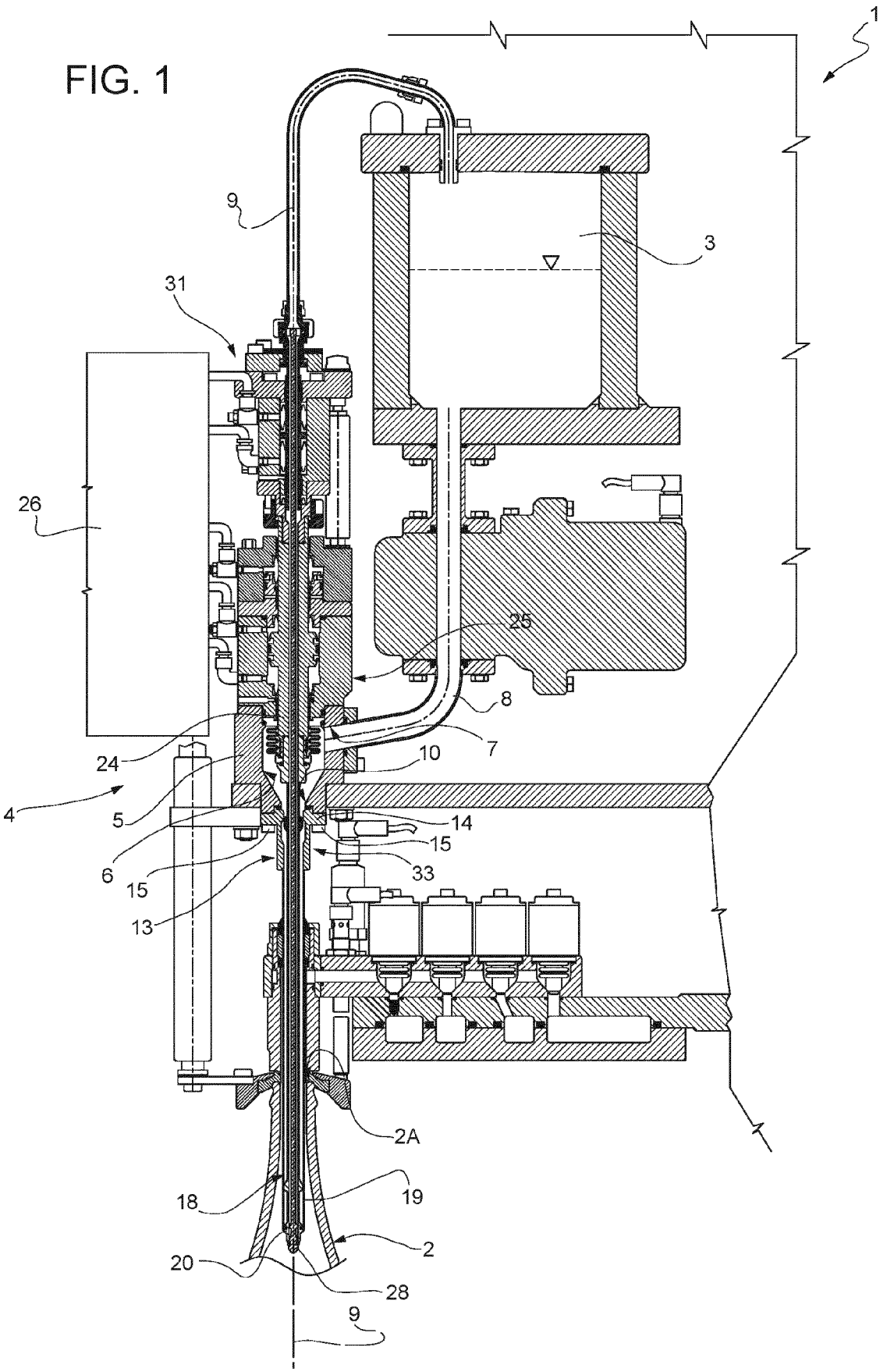

FIG. 2

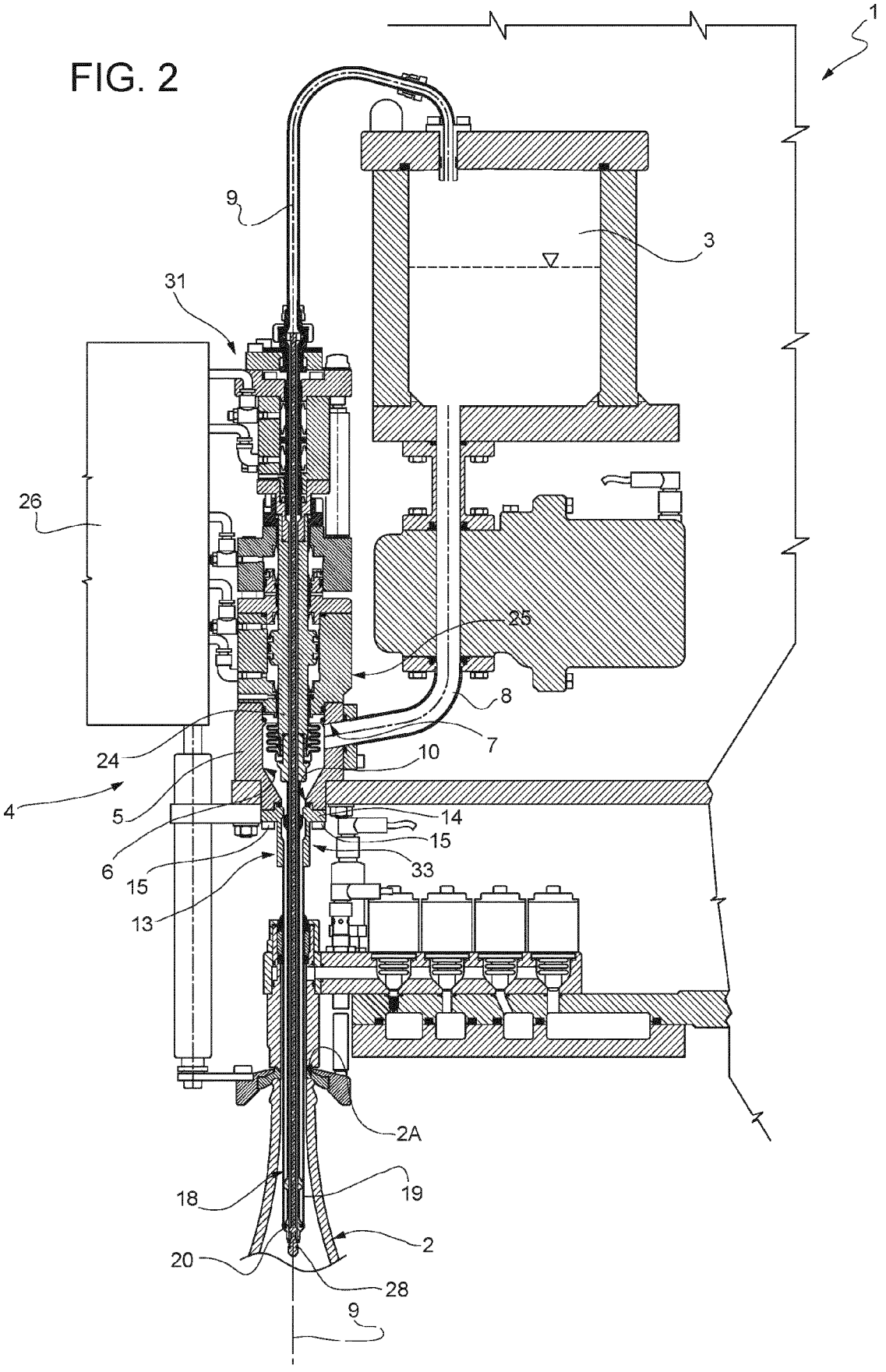

FIG. 3

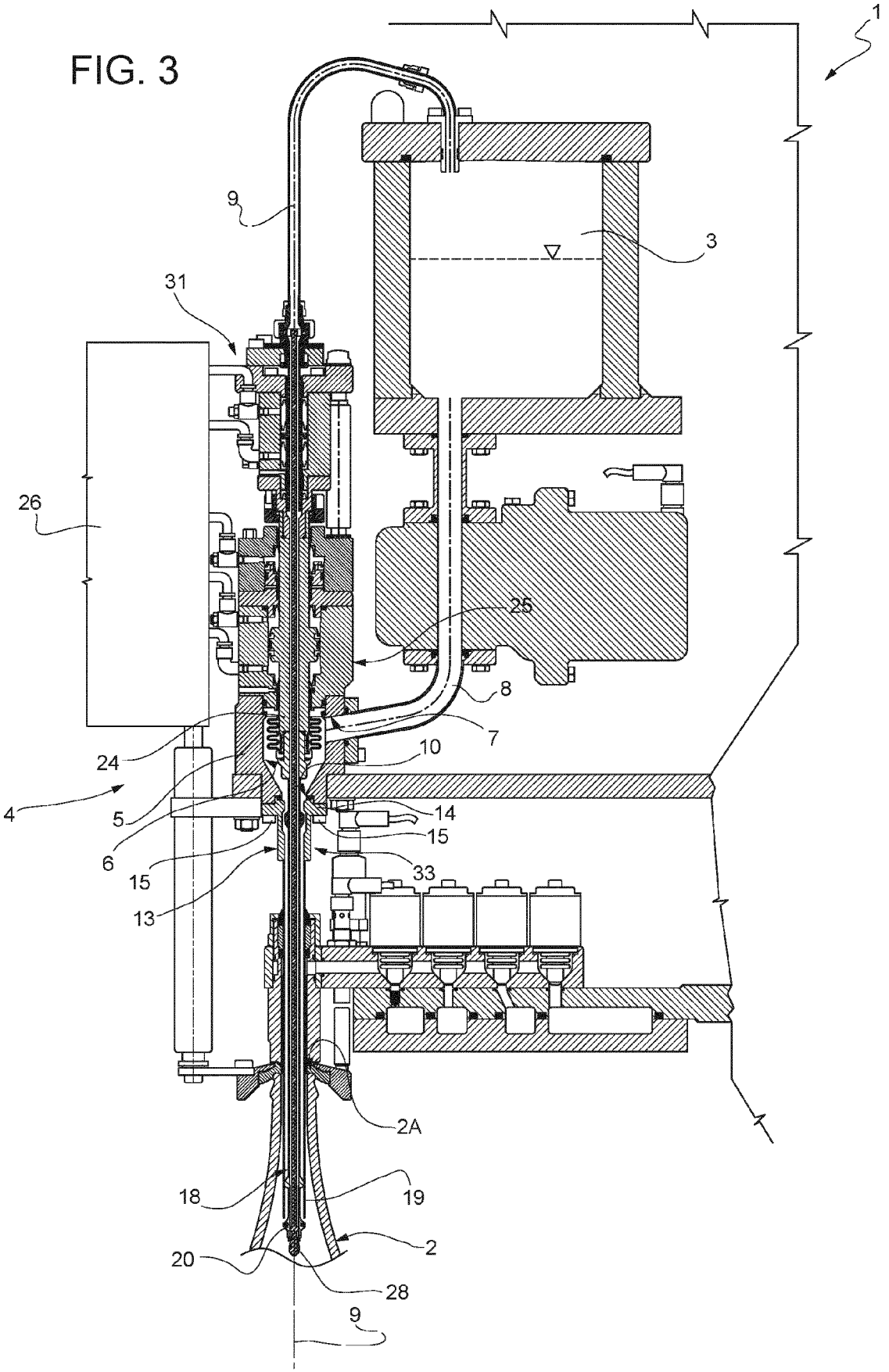

FIG. 4

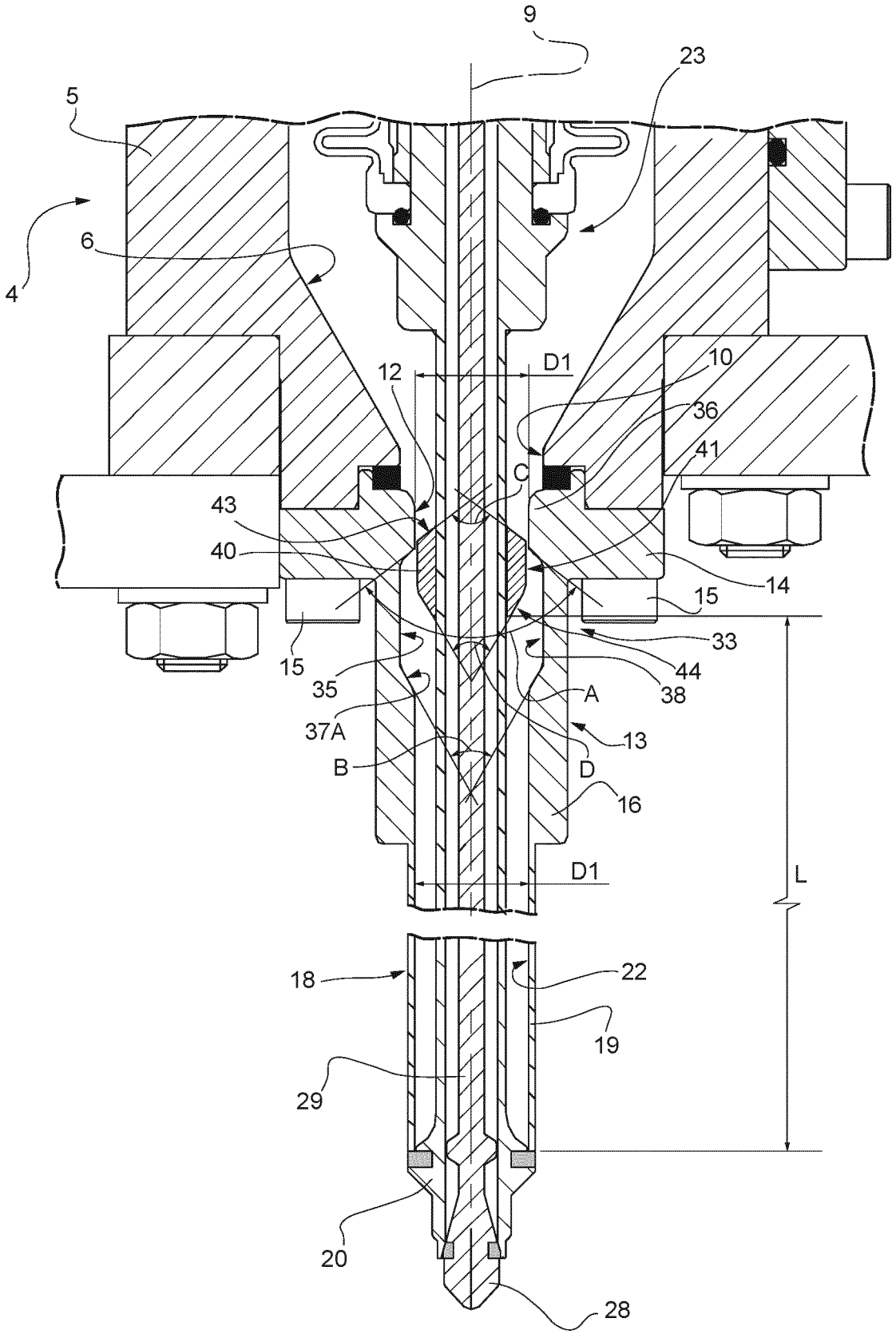
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FIG. 5

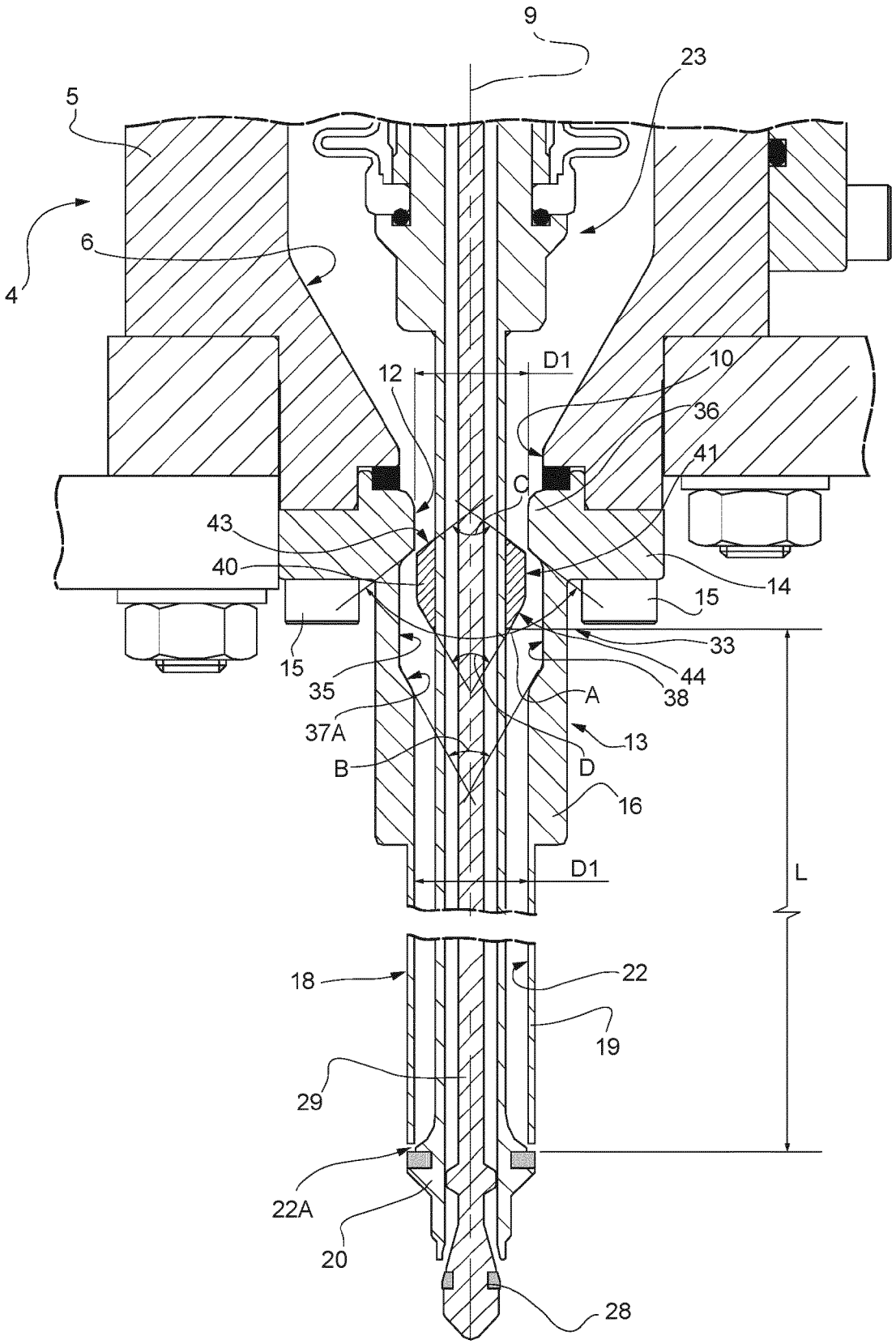
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FIG. 6

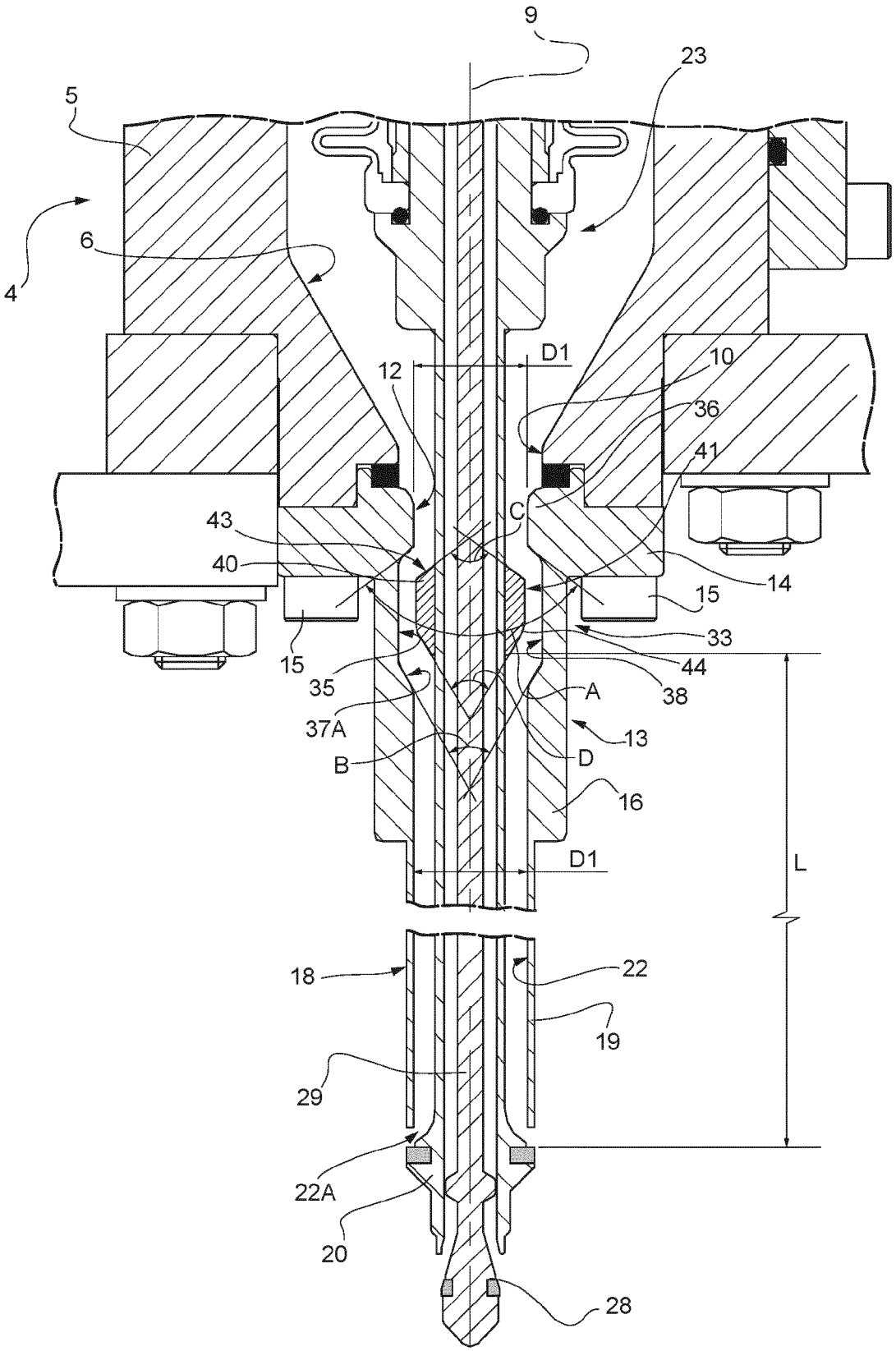
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FIG. 7

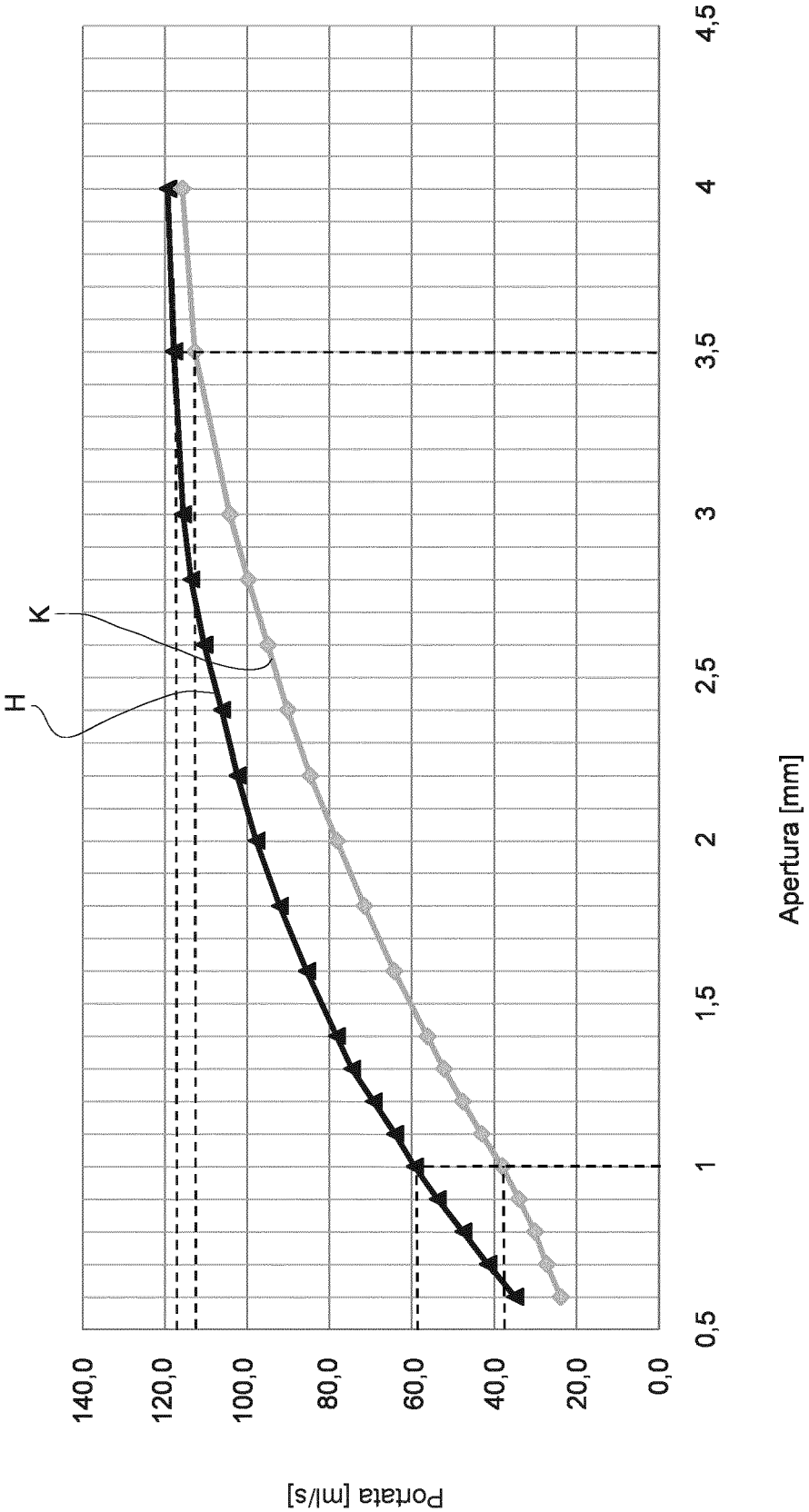
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FIG. 8

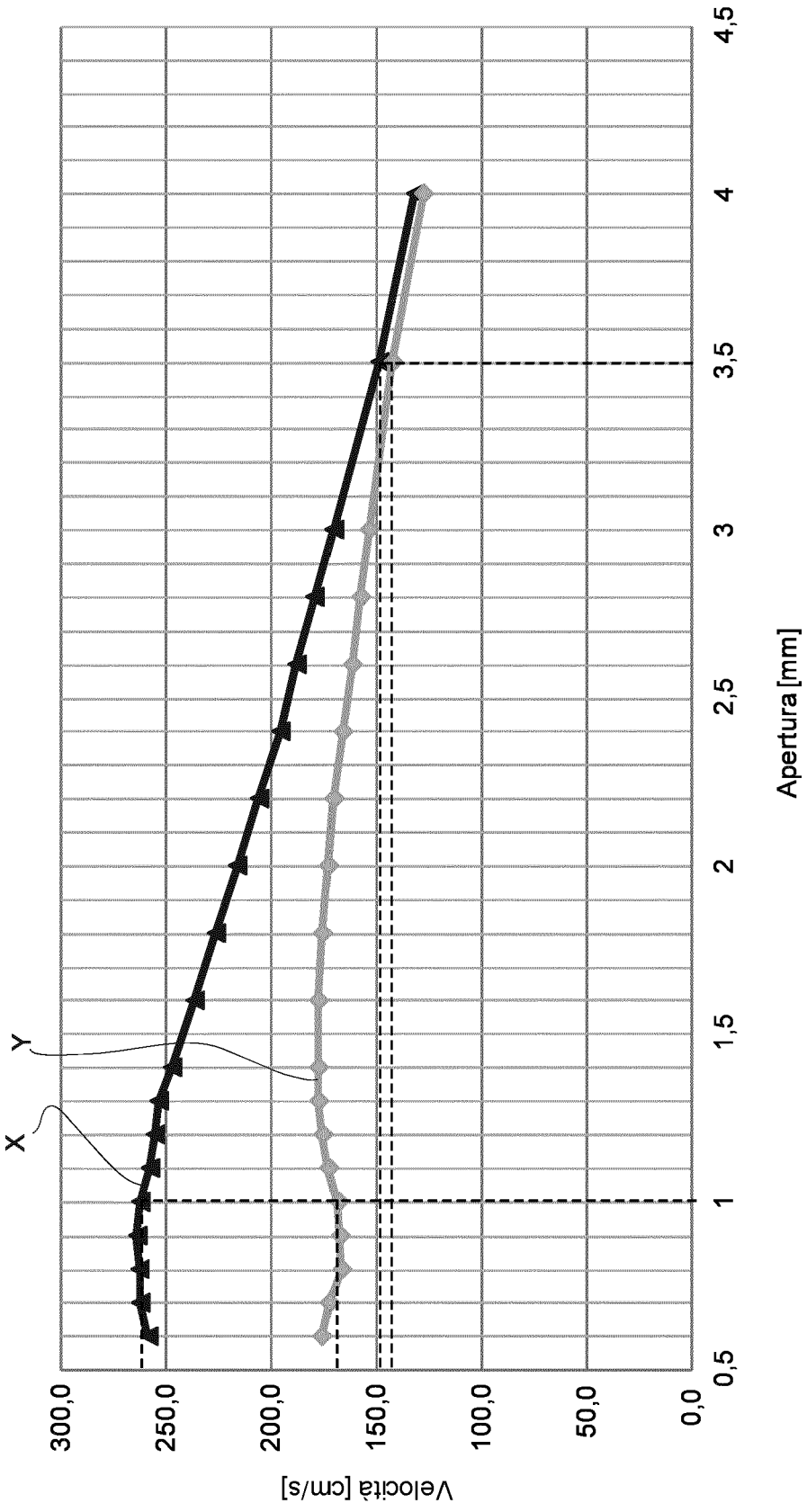
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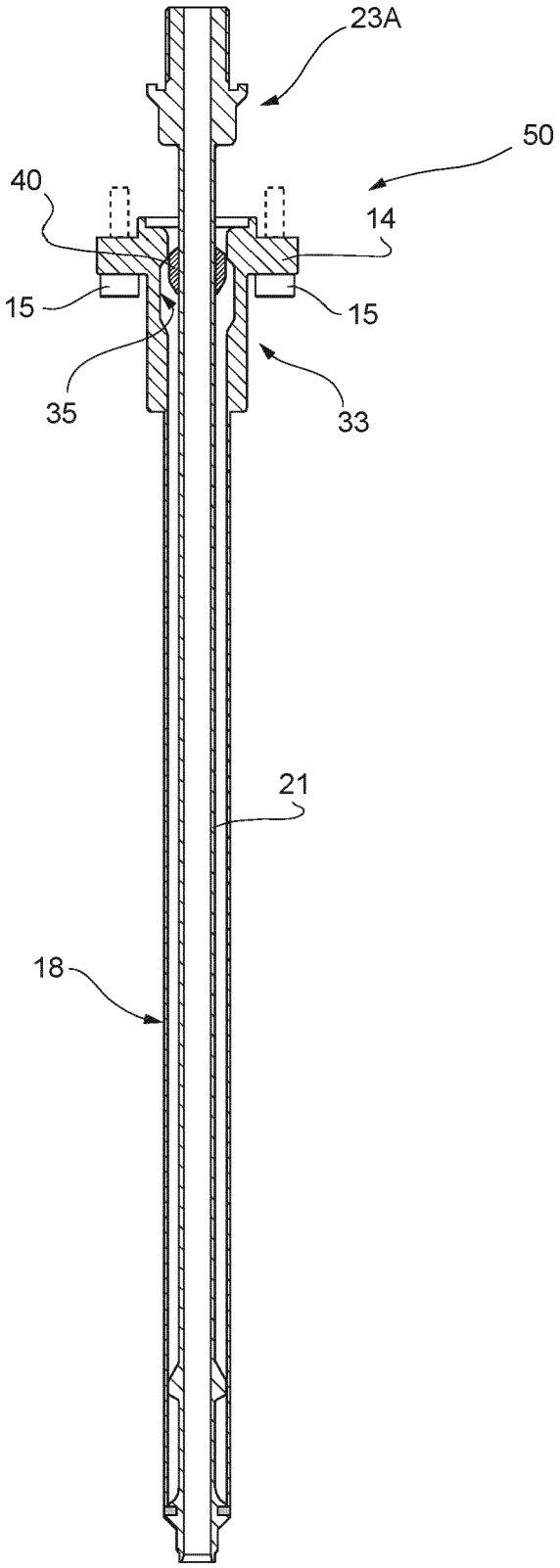
FIG. 9



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EUROPEAN SEARCH REPORT

Application Number
EP 23 16 4265

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	* paragraphs [0026], [0028]; figure 1 *	2	
Y	WO 2014/170812 A1 (GAI MACCHINE IMBOTTIGLIATRICI S P A [IT]) 23 October 2014 (2014-10-23) * page 2, line 11 - page 3, line 1; figures 2, 3 *	2	
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B67C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 July 2023	Luepke, Erik

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 16 4265

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