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(54) **Title**: NOZZLE FOR A LIQUID HEAT BARRIER

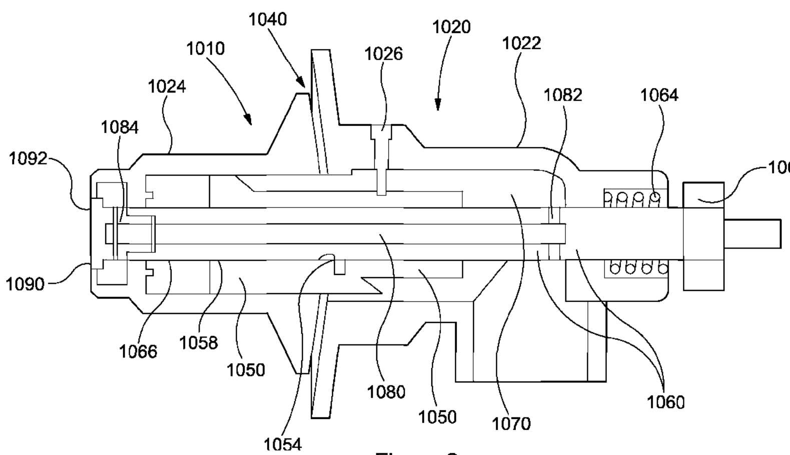

Figure 2

(57) **Abstract**: A nozzle for a heat suppression system comprises a nozzle body, the nozzle body defining an inlet, a first outlet, and a passageway, the passageway providing fluid communication between the inlet and the first outlet, and the first outlet extending at least partially around a perimeter of the body. The nozzle comprises a flow regulator located at least partially within the passageway and being movable with respect to the body, movement of the flow regulator selectively opening or closing at least one portion of the first outlet. Such a nozzle may be configured for use in particularly, but not exclusively, heat suppression systems for hydrocar - bon extraction and processing installations.

WO 2013/132269 A1

NOZZLE FOR A LIQUID HEAT BARRIER

FIELD OF THE INVENTION

The present invention relates to nozzles and particularly, but not exclusively, to nozzles in the field of heat suppression systems for hydrocarbon extraction and processing installations.

BACKGROUND TO THE INVENTION

During well completion, a surface well test package is used to evaluate well reservoir parameters and hydrocarbon properties. The evaluation of hydrocarbon properties requires the flow of hydrocarbon fluid to the well test package from the well. Once the test has been made it is necessary to dispose of the hydrocarbon fluid. This is done by igniting the hydrocarbon fluid and flaring it off a burner boom extending from infrastructure such as a drilling rig, a drill vessel, platform or land rig. The flaring operation may generate intense heat which can cause temperatures in the environment surrounding a flare to reach levels at which the integrity of the infrastructure and/or safety equipment such as life boats, life rafts etc is compromised and/or at levels which are hazardous for personnel. One way of reducing the temperature around the flaring hydrocarbons is to form a water wall around the flare. Such a wall of water may form part of or be provided by a heat suppression and/or deluge system.

Systems of this type provide an outer wall of water designed to surround the flare which mimics the flare profile and/or shields the flare. The outer wall of water can take the form of a solid flat or conical shield or curtain. Known systems may also have a central outlet which has a secondary function of generating a very fine mist of water. The mist of water is designed to remove energy from the flare. The outer wall of water may be designed to create a barrier which separates the infrastructure and/or safety equipment from the flare and which serves to at least partially suppress the transfer of heat from the flare to the infrastructure and/or safety equipment. In order to produce a suitable jet of water, it may be necessary to connect a nozzle to a high pressure water source and to design the nozzle such that an outer wall of water is formed.

As deeper wells producing hydrocarbons of greater pressure come online, the intensity of the flaring becomes greater. This may increase the heat suppression requirement of the system.

The flares generated from these high pressure wells have a greater structural integrity than the low pressure wells for which conventional nozzles were designed. Conventional nozzles work relatively well with less structural flares because when it is windy, the flare and the water wall move together in the wind, such that the water wall is still providing a barrier between the flare and the infrastructure and/or safety equipment to be protected.

However, with the more structured flares generated from high pressure wells, the flare moves less in the wind, with the result that the infrastructure and/or safety equipment may be exposed to heat if the water wall moves in the wind by a greater distance than the flare.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention there is provided a nozzle for a heat suppression system, the nozzle comprising:

a nozzle body, the nozzle body defining an inlet, a first outlet and a passageway, the passageway providing fluid communication between the inlet and the first outlet, the first outlet extending at least partially around a perimeter of the body; and a flow regulator located at least partially within the passageway and being movable with respect to the body, movement of the flow regulator selectively opening or closing at least one portion of the first outlet.

In an embodiment of the invention, when a nozzle is being used singularly or in conjunction with other nozzles to create a water barrier around a flare, being able to selectively allow flow through only a portion of an outlet extending around the perimeter of a particular nozzle allows the nozzle to create a water wall segment to enhance the structure of the water wall generated by the nozzle, or collectively by all of the nozzles, at a particular location. This may be necessary due to high winds, for example, damaging the water wall resulting in an additional requirement for protection. In some embodiments, the nozzle provides the ability to change the shape of the water wall generated without requiring rotation of the entire nozzle and/or boom to which it is mounted.

The body may comprise a first body portion and a second body portion.

The inlet may be defined by the first body portion.

The first outlet may be defined by the first and second body portions.

The first outlet may define an opening, the size of the first outlet opening may be adjustable.

Particularly, the first outlet opening may be defined by a gap between the first and second body portions.

The first and second body portions may be adapted to move relative to one another. Relative movement of the first and second body portions, where the first outlet is defined by the first and second body portions, allows for the size of the first outlet opening to be increased or decreased.

Where there are first and second body portions, the flow regulator may be adapted to engage one of the body portions such that further movement of the flow regulator may move the body portion with respect to the other body portion, thereby increasing the size of the outlet.

Alternatively, relative movement between the first and second body portions may be achieved through the use of motors, for example linear or pulley, pneumatics, hydraulics or any combination of these or, indeed, any suitable method of generating relative movement.

The flow regulator may define a surface profile adapted to sealingly engage an internal surface of the nozzle body to regulate the flow.

In a first position, the surface profile may sealingly engage the internal surface of the nozzle body such that the first outlet is closed.

Alternatively or additionally, in the first position, the surface profile may sealingly engage the internal surface of the nozzle body such that the inlet is closed.

In a second position, the surface profile may be displaced from the first outlet permitting, in use, the fluid to flow from the passageway through the first outlet.

Where the body comprises a first body portion and a second body portion, in the first position the flow regulator may be sealingly engaged with the first body portion.

In this embodiment, in the second position the flow regulator may be sealingly disengaged from the first body portion.

The surface profile may also define a surface section adapted to direct fluid from the body passageway through the first outlet. Movement of the flow regulator from the first position towards, and in some embodiments, beyond, a second position permits flow through different parts or regions of the first outlet or through an increasing part or region of the outlet.

In this embodiment, the fluid directed through the first outlet forms a fluid flow pattern extending away from the nozzle.

In an embodiment, the at least one fluid flow pattern may change in shape as the flow regulator moves from the first position towards, and in some embodiments beyond, the second position.

The fluid flow pattern may be an at least one arc.

Alternatively the fluid flow pattern may be an at least one segment.

In a further alternative the fluid flow pattern may be a finger or any pre-determined shape.

Where the fluid exiting the first outlet forms a flow pattern in the form of, for example, an at least one arc, the arc may increase in length as the flow regulator moves from the first position to the second position and/or beyond the second position.

Alternatively or additionally, the fluid exiting the first outlet may form a flow pattern in the form of a body of fluid which rotates around the nozzle body longitudinal axis. The flow pattern may be rotatable to a specific position. Similar variations in shape of other flow patterns may also be achieved by movement of the flow regulator and/or relative movement of the first and second body portions. For example, the flow pattern may change in one or more of three dimensions, that is a circumferential extent of the flow pattern, depth of the flow pattern or the distance the flow pattern extends from the nozzle, by relative movement of the nozzle's component parts.

The flow pattern may increase in length or decrease in length during rotation.

The nozzle body may define a longitudinal axis. The longitudinal axis may be the same as a longitudinal axis of the flow regulator.

The nozzle may comprise a second outlet.

The second outlet may be defined by the nozzle body and/or the flow regulator. Where the second outlet is at least partially defined by the nozzle body, the part of the nozzle body defining the second nozzle outlet may be the second body portion.

The nozzle defines an internal geometry, the internal geometry may be adapted to create a turbulent flow in the nozzle. Turbulent flow may be generated by any feature of the internal geometry such as the angle of the inlet with respect to the nozzle body, the internal geometry of the inlet, the external geometry of the flow regulator, the internal geometry of the passageway etc. Turbulent flow may be used to create a specific flow pattern, for example tear or petal shaped.

The nozzle inlet may be angled with respect to the nozzle body longitudinal axis.

In one embodiment, the nozzle inlet may be at right angles to the nozzle body longitudinal axis.

In an alternative embodiment, the nozzle inlet may be at an acute angle to the longitudinal axis.

The inlet may be movable with respect to the nozzle body longitudinal axis.

The inlet may be movable in a plane which lies along the nozzle body longitudinal axis.

Alternatively or additionally the inlet may be movable in a plane which is perpendicular to the nozzle body longitudinal axis.

The inlet may be connected to the nozzle body by means of a universal-type joint.

The nozzle inlet may define a flowpath. The flowpath may be linear. Alternatively, the flowpath may be helical. Providing a helical flowpath causes the flow to rotate as it enters the nozzle body passageway, this may create a centrifugal force which improves the flow and may prevent blockages due to the turbulent effect.

Flow through the nozzle may also be used to drive a motor, for example, or the nozzle may include an energy storage device which is adapted to harness and store energy from the flow for use later. The energy storage device may be a spring for example.

The nozzle may be fabricated from metal and/or polymeric materials.

The nozzle body passageway may be defined by an internal surface of the body portion and an external surface of the flow regulator.

The nozzle may further comprise an internal support member extending at least partially into the passageway.

The internal support member may extend the full length of the passageway.

The internal support member may be elongate.

The internal support member may be axially aligned with the nozzle body longitudinal axis.

The internal support member may be adapted to support the flow regulator.

The internal support member may define at least one throughbore.

The internal support member throughbore may be adapted to carry services. These services may include, but are not limited to, water, steam, probes, wires or cables etc.

The internal support member throughbore may be in fluid communication with the nozzle passageway.

The internal support member may define an external surface adapted to cooperatively engage with the flow regulator throughbore surface.

The flow regulator may be movable with respect to the internal support member.

The flow regulator may be fixed axially and/or rotationally with respect to the internal support member. Such an arrangement permits, for example, rotational and axial movement of the internal support member to result in only axial movement of the flow regulator or vice versa.

In a further alternative, rotational and axial movement of the internal support member may result in rotational and axial movement of the flow regulator.

In one embodiment, the nozzle body passageway may be defined by an internal surface of the body, an external surface of the flow regulator and a portion of the external surface of the internal support member.

The internal support member and the flow regulator may be in a sliding relationship.

The flow regulator may slide along the internal support member external surface.

The internal support member may be integral with the nozzle body. Alternatively, they may be separate.

In one embodiment, the internal support member may be integral with the second body portion. By integral it is meant they are fixed relative to one another such that if one component moves the other moves. The internal support member and the second body portion may be machined from the same piece of material or cast as a single unit.

In some embodiments, the internal support member and the second body portion may be moulded as a single unit.

The flow regulator may be adapted to move axially and or rotationally with respect to the nozzle body.

The flow regulator may be adapted to move axially with respect to the first body portion.

The flow regulator may alternatively or additionally be adapted to move rotationally with respect to the first body portion.

The flow regulator may be adapted to move axially with respect to the second body portion.

The flow regulator may, alternatively or additionally, be adapted to move rotationally with respect to the second body portion.

In an embodiment, the flow regulator is adapted to move axially with respect to the first and second body portions, the second body portion and the internal support member moving rotationally with respect to the first body portion and the flow regulator.

The internal support member and the flow regulator may be connected by means of a threaded connection.

Alternatively and/or additionally, the flow regulator may be connected to the internal support member by means of cooperation between a male member and a female member. For example the connection may be a pin in groove type arrangement.

In a second, alternative embodiment, the flow regulator rotates with respect to the second body portion and the internal support member and moves axially with respect to the nozzle body and the internal support member. This movement may be due to the flow regulator travelling along a threaded connection between the internal support member and flow regulator.

In alternative embodiments, other methods of creating relative movement between the internal support member and flow regulator may be used such as, for example, a pneumatic, electric or hydraulic motor could be employed.

The first body portion may have a rotating part and a fixed part, the rotating part adapted to rotate with respect to the fixed part.

In an embodiment, rotation of the rotating part may be adapted to rotate the flow regulator. In this embodiment, the body portion rotating part may rotate with the flow regulator.

Where the internal support member and the second body portion are integral, the first outlet opening may be adjustable by application of a force to the internal support member.

The force may be an axial force.

Alternatively or additionally, the force may be a rotational force.

The first outlet opening may be adjustable between a number of predetermined settings.

In some embodiments, the nozzle includes an adjustment mechanism adapted to adjust the first outlet opening.

The adjustment mechanism may be adapted to set the first outlet opening in one of the plurality of predetermined positions.

Alternatively, the adjustment mechanism may be adapted to set the first outlet opening to any position desired by an operator within a range.

The adjustment mechanism may be operated manually or automatically.

The adjustment mechanism may be responsive to a linear force.

The linear force may be applied along the body longitudinal axis.

The adjustment mechanism may be responsive to a rotational force.

The rotational force may be applied in a plane transverse to the body longitudinal axis.

In some embodiments, the adjustment mechanism may be responsive to a combination of rotational and linear force.

In these or alternative embodiments, the adjustment mechanism may be adapted to close the first outlet opening.

The adjustment mechanism may be an index. The index may have a plurality of settings each defining a first outlet opening.

The index may be biased to a position in which the first outlet opening is open.

In an embodiment, an outlet surface defined by the first body portion may be adapted to engage an outlet surface defined by the second body portion.

One of the outlet surfaces may define a profile adapted to clean the other of the outlet surfaces. Cleaning is facilitated by scraping one surface across the other. Cleaning may be facilitated by rotation of one of the body portions with respect to the other of the body portions.

The surface profile may be at least one protrusion.

The surface profile may be retractable.

The surface profile may be at least one recess.

In alternative embodiments, a cleaning medium may be introduced to the nozzle to facilitate cleaning.

The cleaning medium may be an abrasive fluid.

Alternatively or additionally the cleaning medium may be hot water or steam.

Where the cleaning medium is an abrasive fluid, the abrasive fluid may be heated.

According to a second aspect of the present invention there is provided a nozzle for a heat suppression system, the nozzle comprising:

a body having an inlet, an outlet and a passageway, the passageway providing fluid communication between the inlet and outlet, the outlet extending at least partially around a perimeter of the nozzle, the nozzle body defining an internal geometry,

wherein, in use, as a fluid flows through the nozzle body, the internal geometry is adapted to create a non-uniform flow pattern of fluid exiting the nozzle outlet.

In at least one embodiment of the present invention, providing a non-uniform internal geometry allows for a non uniform flow pattern to be generated. For example, if the deflector surface was biased to one side of the nozzle, a user could send a larger volume of water out of one side of a nozzle than the other.

In an embodiment, a non uniform internal geometry can be adjusted. A plurality of non uniform geometries may be selectable by a user.

The internal geometry of the inlet, passageway, flow regulator, or outlet may be changeable. In one embodiment, the inlet may be moveable with respect to the nozzle body.

The inlet may define a helical flow path.

The external geometry defined by the flow regulator may be non-symmetrical about a flow regulator longitudinal axis.

The internal geometry may be such that the non uniform flow pattern generated is elongate.

According to a third aspect of the present invention there is provided a nozzle for a heat suppression system, the nozzle comprising:

a body having an inlet, an outlet and defining a passageway providing fluid communication between the inlet and outlet,

wherein, the outlet is defined by at least a first body surface section and a second body surface section, one of the first or second body surface sections defining a profile.

In an embodiment of the invention, providing a surface profile on the sections of one or both of the first body surface or second body surface, can be used to clean the outlet surfaces either directly by the profiled surface section acting on the other surface, or indirectly by creating turbulence in the flow of fluid as it passes over the surface profile. By surface profile it is meant a non-planar surface profile. That is a surface profile including protrusions or recesses.

According to a fourth aspect of the present invention there is provided a nozzle for a heat suppression system, the nozzle comprising:

a body having an inlet, and outlet and defining a passageway providing fluid communication between the inlet and outlet, the outlet being defined by a first body portion and a second body portion, the outlet being adjustable in size by relative movement between the first and second body portions;

wherein, in use, a variation in volume of flow in the passageway creates relative movement between the first and second body portions to maintain a constant volume of flow through the outlet.

In an embodiment of the invention, an arrangement in which relative movement between the first and second body portions allows for a constant flow volume to be pumped from the flow pumps supplying the nozzles, resulting in less back pressure in the system.

According to a fifth aspect of the present invention there is provided a nozzle for a heat suppression system, the nozzle comprising:

a nozzle body, the nozzle body defining an inlet, a first outlet and a passageway, the passageway providing fluid communication between the inlet and the first outlet, the first outlet extending at least partially around a perimeter of the body; and

a flow regulator,

wherein the flow regulator is movable with respect to the body, movement of the flow regulator selectively opening or closing at least one portion of the first outlet.

According to a sixth aspect of the present invention there is provided a method of suppressing heat emitted by a flare at an installation, the method comprising:

providing a nozzle having a nozzle body and a flow regulator, the nozzle body defining an inlet, a first outlet and a passageway, the first outlet extending at least partially around a perimeter of the body,

flowing a flow of fluid through the nozzle body and

moving the flow regulator with respect to the body to selectively open or close at least one portion of the first outlet to generate a flow pattern adapted to provide a heat suppression barrier between a flare and an installation.

It will be understood that the non-essential features associated with one aspect may be equally applicable to another

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described with reference to the accompanying Figures, in which:

Figure 1 is a perspective view of a nozzle for a heat suppression system according to a first embodiment of the present invention;

Figure 2 is a section view of the nozzle Figure 1;

Figure 3 is a perspective view of the flow regulator of the nozzle of Figure 1;

Figure 4 is an end view of the flow regulator of Figure 3;

Figure 5 is a longitudinal section of the nozzle of Figure 1 with the flow regulator in an outlet closed position;

Figure 6 is a longitudinal section of the nozzle of Figure 1 in an outlet partially open position;

Figure 7 is a longitudinal section of the nozzle of Figure 1 in an outlet fully open position;

Figure 8 comprising Figures 8a to 8d are a series of end views of the nozzle of figure 1 showing the flow pattern of fluid leaving the nozzle outlet with the flow regulator in different positions;

Figure 9 is a perspective view of a nozzle for a heat suppression system according to a second embodiment of this present invention;

Figure 10 is a section view of the nozzle of Figure 9;

Figure 11 is a perspective view of the nozzle of Figure 9, with part of the nozzle body removed;

Figure 12 comprising Figures 12a – 12b, are perspective, top and side views of the flow regulator of the nozzle of Figure 9;

Figure 13 is a perspective view of the inner support member of the nozzle of Figure 9;

Figure 14, comprising Figures 14a – 14e are a series of section views of the nozzle of Figure 9 showing the flow regulator moving from an outlet closed position to an outlet fully open position;

Figure 15 is an end view of the nozzle of Figure 9 showing the flow pattern from the nozzle outlet at a particular configuration of the flow regulator;

Figure 16 is an end view of the nozzle of Figure 9 showing the flow pattern from the nozzle outlet at a particular configuration of the flow regulator;

Figure 17 is an end view of the nozzle of Figure 9 showing the flow pattern from the nozzle outlet at a particular configuration of the flow regulator;

Figure 18 is an end view of the nozzle of Figure 9 showing the flow pattern from the nozzle outlet at a particular configuration of the flow regulator;

Figure 19 is an end view of the nozzle of Figure 9 showing the flow pattern from the nozzle outlet at a particular configuration of the flow regulator;

Figure 20 is an end view of the nozzle of Figure 9 showing the flow pattern from the nozzle outlet at a particular configuration of the flow regulator;

Figure 21 is a perspective view of a nozzle for a heat suppression system according to a third embodiment of the present invention;

Figure 22 is an enlarged close up of the part of the nozzle of Figure 21;

Figure 23 is an enlarged close up top view of part of the nozzle of Figure 21 showing the cap removed;

Figure 24 comprising figures 24a, 24b and 24c, are a series of sections of the nozzle of Figure 21 in an outlet smallest gap position, purged position and largest gap position;

Figure 25 is an end view of the nozzle of Figure 21 showing a flow pattern at a particular configuration of the flow regulator;

Figure 26 is a perspective view of a nozzle for a heat suppression system according to a fourth embodiment of the present invention;

Figure 27 is a longitudinal section of the nozzle of Figure 27 in an outlet closed position;

Figure 28 is a longitudinal section of the nozzle of Figure 27 in a purge position;

Figure 29 is a longitudinal section of part of the nozzle of Figure 27 in a failsafe position;

Figure 30 is a perspective view of the flow regulator of the nozzle of Figure 27;

Figure 31 is a partially cut away perspective view of the flow regulator of Figure 30;

Figure 32 is an end view of the flow regulator of Figure 30 showing the flow of fluid around the flow regulator;

Figure 33 is a top view of the nozzle of Figure 27;

Figure 34 is a top view of a nozzle for a heat suppression system according to a fifth embodiment of the present invention;

Figure 35 is a section view of the nozzle of Figure 34 shown in a outlet closed position; and

Figure 36 is a section view of the nozzle of Figure 34 shown in a outlet open position.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is firstly made to Figures 1 and 2, perspective and section views of a nozzle for a heat suppression system, generally indicated by reference numeral 1010, according to an embodiment of the present invention.

The nozzle 1010 comprises a nozzle body 1020 having a first body portion 1022 and a second body portion 1024. The nozzle 1010 further comprises an inlet 1030 defined by the first body portion 1022 and a first outlet 1040 defined by the first body portion 1022 and the second body portion 1024. The nozzle body 1020 defines a passageway 1070 extending between the inlet 1030 and the outlet 1040.

Within the passageway 1070 is a flow regulator 1050 which is mounted around an internal support member 1060. The internal support member 1060 is integral with the second body portion 1024. The internal support member 1060 and the second body portion 1024 are, in normal use, substantially axially fixed with respect to the first body portion 1022 by means of a compression spring 1064.

The flow regulator 1050 is rotationally fixed to the first body portion 1022 by means of a first pin 1026. Referring to Figure 3, a perspective view of the flow regulator 1050 of the nozzle 1010 of Figure 1, the flow regulator 1050, defines an external groove 1052 for receiving the first pin 1026.

Referring back to Figure 2, the internal support member external surface 1066 defines a second pin 1054 which is received within a complementary internal helical path 1056 defined by the flow regulator internal surface 1058 (best seen in Figure 4).

The internal support member 1060 also has an internal passageway 1080 having an inlet port 1082 and an outlet port 1084. Fluid flowing through the nozzle 1010 can enter the support member passageway 1080 through the inlet port 1082 and travel down the passageway 1080 and exits through the outlet port 1084 before passing through a second nozzle outlet 1090 defined by the second body portion 1024. Mounted to the second nozzle outlet 1090 is a fogger 1092 adapted to generate a fog of spray from the liquid leaving the internal support member passageway 1080.

Movement of the flow regulator 1050 will now be described. The flow regulator 1050 is movable from a first position, shown in Figure 5, in which the flow regulator internal surface 1058 covers the internal support member passageway inlet port 1082, preventing flow entering the passageway 1080. Similarly, a raised section 1057 of the flow regulator external surface (best seen on Figure 3) sealingly engages and prevents flow through the first body outlet 1040.

A rotational force is applied to an internal support member end cap 1062 to rotate the internal support member 1060 and the second body portion 1024. As the flow regulator 1050 is rotationally fixed to the first body portion 1022 by the pin 1026, the flow regulator 1050 cannot rotate with the internal support member 1060. However, the rotation of the internal support member 1060 creates axial movement of the flow regulator 1050 due to the pin 1054 connecting the external surface 1066 of the support member 1060 and the internal surface 1058 of the flow regulator 1050. As the flow regulator 1050 moves, the internal passageway inlet port 1082 is uncovered allowing flow to enter the internal passageway 1080 and leave through the second outlet nozzle 1090 (as shown in Figure 6). Similarly, as the flow regulator 1050 travels, the first nozzle outlet 1040 is uncovered. Referring to Figure 3, it will be noted that the flow regulator 1050 defines an angled deflection surface 1100. Referring back to Figure 6, the deflection surface 1100 deflects flow through the first nozzle outlet 1040. However, as the deflection surface 1100 is angled, the first nozzle outlet 1040 which extends around a perimeter of the nozzle body 1020 is opened gradually as flow regulator raised section 1057 has a longer bottom surface 1102 than top surface 1104 in the orientation shown in Figure 6. The effect of the angled deflection surface 1100 is to create a wall of water which gradually increases in size as the flow regulator moves from the first position shown in Figure 5 to the second position which is shown in Figure 7. In the second position both the inlet port 1082 and the nozzle outlets 1040, 1090 are fully open.

Referring to Figure 8, comprising Figures 8a to 8d, the flow of fluid through the first outlet 1040 is shown schematically with Figure 8a showing the flow at the position in which the flow regulator raised section top surface 1104 has passed by the first nozzle outlet 1040 and shows the increasing volume of flow through the outlet 1040 to the position shown in Figure 8d in which the entire flow regulator raised section 1057 has passed the outlet 1040 and there is full flow through the first nozzle outlet 1040. This is the flow regulator position shown in Figure 7. The flow pattern shown in Figure 8b is created by an intermediate position of the flow regulator 1050 similar to the position shown in Figure 6. The flow pattern shown in Figure 8c is another intermediate position generated by a flow regulator position somewhere between the positioning in Figures 6 and 7.

Reference is now made to Figures 9 and 10, perspective and section views of a heat suppression system nozzle 2010 according to a second embodiment of the present invention. Similar to the nozzle 1010 of Figures 1 to 8, the nozzle 2010 of this second embodiment comprises a nozzle body 2020 having a first body portion 2022 and a second body portion 2024. The nozzle 2010 comprises an inlet 2030 defined by the first body portion 2022 and an outlet 2040 defined by the first body portion 2022 and the second body portion 2024. The nozzle body 2020 defines a passageway 2070 extending between the inlet 2030 and the outlet 2040.

The first body portion 2022 comprises a rotating section 2022a and a fixed section 2022b. The rotating section 2022a is adapted to rotate with respect to the fixed section 2022b driven by a motor 2700 (shown in Figure 10) mounted to four fixing members 2200a-d defined by the first body fixed section 2022b, the motor 2700, in use, engaging with a gear surface 2204 defined by the first body rotating section 2022a, rotation of the motor 2700 resulting in rotation of the first body rotating section 2022a. It will be seen, particularly from Figure 10, the outlet 2040 is defined by the first body portion rotating section 2022a and the second body portion 2024.

Within the nozzle passageway 2070 is a flow regulator 2050 which is mounted around an internal support member 2060. The internal support member 2060 is integral with the second body portion 2024. The internal support member 2060 extends, at an end 2025 distal to the second body portion 2024, through an opening defined by the first body portion 2022 where it is attached to an end cap 2062. Mounted to the end of the internal support member 2060, adjacent the end cap 2062, is a compression spring 2064. The compression spring 2064 is retained in a chamber 2065 defined by the internal support member 2060, the end cap 2062 and the first body portion 2022, the purpose of the compression spring 2064 will be discussed in due course.

Referring to Figure 10, and introducing Figure 11, a perspective view of the nozzle 2010 of Figure 9 with the first body portion rotating section 2022a removed, a bearing race 2300 is provided between the first body portion rotating section 2022a and the first body portion fixed section 2022b to facilitate rotation of the first body portion rotating section 2022a around the first body portion fixed section 2022b. The bearing race 2300 allowing the first body portion rotating section 2022a to be fixed to the first body portion fixed section 2022b, while still ensuring axial load can be transferred between the two.

Referring back to Figure 10, the flow regulator 2050 is adapted to move, upon rotation of the first body member rotating section 2022a, axially along the internal support member 2060.

Reference is now made to Figures 12 and 13, perspective views of the flow regulator 2050, and the second body portion 2024 and the internal support member 2060 respectively. From Figure 12 it will be noted that the flow regulator 2050 defines an internal thread 2250 and from Figure 13, the internal support member 2060 defines an external thread 2252, the threads 2250, 2252 adapted to cooperate to create relative movement between the flow regulator 2050 and the inner support member 2060. Referring back to Figure 12, the flow regulator 2050 defines an external groove 2052 adapted to receive a pin 2026. The pin 2026 is shown on Figure 10 and is fixed relative to the first body member rotating section 2022a. As the first body portion rotating section 2022a rotates, the pin 2026 rotates the flow regulator 2050. As the flow regulator 2050 is threadedly attached to the internal support member 2060, the flow regulator 2050 moves in an axial direction as it rotates about the internal support member 2060. This rotation is used to create and control the flow patterns generated by fluid flowing through the nozzle 2010.

The operation of the nozzle 2010 and the flow pattern generated, will now be discussed with reference to Figures 14a to 14e, a series of longitudinal sections showing the operation of the nozzle 2010 of Figure 9. In Figure 14a, the flow regulator 2050 is in an outlet closed position in which a raised profile 2057 defined by the flow regulator 2050 is covering the nozzle outlet 2040. The flow regulator 2050 also covers an internal support member inlet 2082 which connects the nozzle passageway 2070 to an internal passageway 2080 defined by the internal support member 2060. Rotation of the first body portion rotating section 2022a results in rotation of the flow regulator 2050 which, as shown in Figure 14b creates movement of the flow regulator 2050 away from the end cap 2062. This movement allows for an increasing portion of the flow regulator raised profile 2057 to pass by the nozzle outlet 2040 with each rotation thereby increasing the length of the flow pattern generated.

Referring to Figure 15, an end view of the nozzle 2010 showing a first flow pattern, when the narrowest portion of the flow regulator raised profile 2057 passes the outlet 2040, a jet 2500 of water will be emitted from the nozzle outlet 2040. Referring to Figure 16, an end view of the nozzle 2010 showing a second flow pattern, as the flow regulator 2050 rotates this jet 2500 of water will rotate around the outlet 2040 increasing only slightly in width. Referring to Figure 17, after a few revolutions the jet 2500 has become a wedge which, as shown in Figure 18, can also be rotated to a desired position. This permits the creation of, for example, a water wall in specific areas or provides strength in specific regions of a water wall mosaic which can be used, for example, in high winds to create stronger sections. Further flow patterns can be seen in Figure 19 demonstrating the ability to direct up, down, left or right an arc of a particular width.

Figure 14b also shows that the internal support member passageway inlet 2082 has been opened allowing fluid to flow down the internal support member passageway 2080 and exit through a fogger 2092 mounted within a fogger chamber 2094 defined by a fogger housing 2097.

Figure 14c shows the nozzle 2010 in the outlet 2040 fully open position (the flow pattern 2500 being shown in Figure 20, an end view of the nozzle 2010 of Figure 1 showing the flow pattern 2500 in the outlet fully open in configuration).

Referring to Figure 14c once more, in this outlet 2040 fully open position the flow regulator 2050 is engaged with a series of pins 2096 connected to the fogger housing 2097. Referring to Figure 14d, continued rotation of the first body portion rotating section 2022a applies a force to pins 2096 allowing increased water flow through the fogger chamber 2094, thereby purging the fogger chamber 2094 and the fogger 2092 of any debris which may be introduced into the nozzle 2010 through the flow of fluid into the inlet 2030.

At this point the flow regulator 2050 is tight up against the second body portion 2024, and further travel of the flow regulator 2050 with respect to the second body portion 2024 is not possible. Referring back to Figure 12b, the pin 2026 has reached the end (indicated by position ‘x’) of the linear portion 2052b of the groove 2052. Further rotation of the flow regulator 2050 is possible however if the flow regulator 2050 and second body portion 2024 move together, this movement is accommodated by the flow regulator 2050 by a helical section 2052a of the groove 2052.

This additional movement is used to purge the nozzle outlet 2040 as shown in Figure 14e. In this configuration, continued rotation of the flow regulator 2050 pushes the second body portion 2024 and internal support member 2060 away from the first body portion 2022 against the action of the spring 2064. This opens the outlet 2040 allowing the flow of water to clear the outlet 2040.

Rotation of the first body rotating section 2022a in the opposite direction or just releasing the motor will create movement of the flow regulator 2050 towards the end cap 2062 allowing the second body portion 2024 and the purged fogger chamber 2094 to return to the position shown in Figure 14a under the action of their respective springs 2064.

A third embodiment of the present invention will now be described. The nozzle 3010 of the third embodiment is shown in perspective view in Figure 21. Essentially the nozzle 3010 is similar to the nozzle 2010 of the second embodiment however this nozzle 3010 includes an index mechanism 3061 to allow for the outlet gap 3041 to be set at one of three predetermined positions. The outlet gap 3041 is the gap between the opposed surfaces 3352, 3354 of the first and second body portions 3022, 3024 which define the first nozzle outlet 3040.

Reference is made to Figures 22 and 23, perspective and side views of a portion of the nozzle 3010 of Figure 21, Figure 22 showing the end of the nozzle 3010 with a nozzle end cap 3062 in place and Figure 23 showing the end of the nozzle 3010 with the end cap 3062 removed. The end cap 3062 is part of an index mechanism 3061 and supports three index pins 3063 of which two are visible in Figure 22. The index pins 3063 extend radially inwardly into the interior of the end cap 3062 and cooperate with an index path 3067 defined by the surface of the first body portion 3022 (Figure 23).

The operation of the nozzle 3010 and the effect of the index mechanism 3061 is shown in Figures 24a to 24c, a series of longitudinal sections showing part of the operation cycle of the nozzle 3010 of Figure 21.

The sequence starts with Figure 24a which shows the nozzle 3010 in the outlet 3040 open configuration at a smallest outlet gap 3041 position. The steps prior to this part of the sequence, that is the opening of the nozzle outlet 3040 from a fully closed position to the fully open position, are substantially the same as shown in Figures 14a to 14c which refer to the second embodiment of the nozzle 2010. Referring to Figure 24a, rotation of the first body portion rotating section 3022a by the motor 3070 advances the flow regulator 3050 due to the interaction between the internal support member 3060 and the flow regulator 3050 through the threaded connection 3250, 3252. The flow regulator 3050 presses on to push the fogger chamber 3094 away from the second body section 3024 to purge the fogger 3092. In the position shown in Figure 24a, the flow regulator 3050 has reached the end of the passageway 3070.

As shown in Figure 24b, continued further rotation of the flow regulator 3050 by the motor 3700 applies a push force to the second body section 3024 by the flow regulator 3050. Referring back to Figure 23 this will move the index mechanism 3061 from position A to position B as a linear movement and then cause rotation of the second body member 3024 as the index moves from position B to position C which purges the nozzle outlet 3040. This is the position shown in Figure 24b. Removal of the drive force by the motor 3700 will draw the second body portion 3024 towards the first body portion 3022 under the action of the spring 3064, firstly in a linear movement from position C to position D and then rotationally to position E, which is 5 millimetres axially advanced from position A for a larger gap 3041 as shown in Figure 24a. Once locked in position E, with the 5 millimetre larger outlet gap 3041, the flow regulator 3050 can be moved by further rotation of the first body portion rotating section 3022a to a desired segment shape which will be of significantly greater volume due to the larger outlet gap 3041. An example of a flow pattern is shown in Figure 25 an end view of the nozzle 3010 of Figure 21 showing a flow pattern with the outlet gap set at position E. Referring back to Figure 23 and Figure 24c, further rotation in the rotating direction of the motor 3700, will repeat the previously described movement of the second body portion 3024 away from the first body portion 3022, however, starting from position E, the next rest point is position F which is 10 millimetres axially advanced from position A providing a still larger operating gap 3041.

Clearly, although only three positions are shown on the index path 3067, any number of positions could be predetermined to set the gap.

A further feature of the third embodiment are protrusions 3350, which are, for clarity, shown only in Figure 24b, a perspective view of the first body portion rotating section 3022a, which extend outwardly from the outlet surface 3352 defined by the first body portion 3022 towards the second body portion 3024. These protrusions 3350 are provided to prevent debris and scale collecting between the outlet surfaces 3352, 3354 defined by the first and second body portions 3022, 3024. In the minimum flow gap position shown in Figure 24a, these protrusions 3350 scrape the second body portion outlet surface 3354 as the first body portion rotating section 3022a rotates under the action of the motor 3700. It will be understood that the features of this embodiment such as the index mechanism 3061 and the scraper protrusions 3350 could be applied to any of the embodiments and are not considered to be necessarily grouped together in a single embodiment.

Reference is now made to Figure 26, a perspective view of a nozzle for a heat suppression system generally indicated by reference numeral 4010, and Figure 27, a section view of the nozzle 4010 of Figure 26 in a nozzle closed configuration.

The nozzle 4010 comprises a nozzle body 4020 having a first body portion 4022 and a second body portion 4024. The nozzle first body portion 4022 has a rotating section 4022a and a fixed section 4022b. The rotating section 4022a is adapted to rotate with respect to the fixed section 4022b driven by a motor 4700 mounted to four fixing members 4200 defined by the first body fixed section 4022b. The motor 4700, in use engages with a gear surface 4202 defined by the first body rotating section 4022a, rotation of the motor 700 resulting in rotation of the first body rotating section 4022a.

The nozzle 4010 further comprises an inlet 4030 and a first outlet 4040, the first outlet 4040 being defined by the first body portion rotating section 4022a and the second body portion 4024. The outlet 4040 is particularly defined by a first body portion surface 4352 and a second body portion surface 4354, the surfaces 4352 and 4354 being opposed and separated by an outlet gap 4041. The nozzle body 4020 defines a passageway 4070 extending between the inlet 4030 and the first outlet 4040. Within the passageway 4070 is a flow regulator 4050 which is mounted around an internal support member 4060, the flow regulator 4050 and internal support member

4060 connected by a threaded connection 4052. The flow regulator 4050 comprises a flow regulator body 4051a and a flow regulator cone 4051b. As in earlier embodiments the first body portion rotating section 4022a is connected and rotationally fixed to the flow regulator 4050 by a first pin 4026.

The internal support member 4060 defines a passageway 4080 which in contrast to the earlier embodiments has an inlet 4082 external of the nozzle body 4022. An external inlet 4082 permits connection of a high pressure water line for example. The support member passageway 4080 also includes a services conduit 4080a for carrying services through the nozzle 4010.

The second body portion 4024 comprises an internal section 4024a and an external section 4024b, the internal and external sections 4024a, 4024b connected by a course thread 4025 the external section 4024b defining a part of the first outlet 4040. The flow regulator body 4051a is pinned to the flow regulator cone 4051b by means of a second pin 4053a. The pin 4053a engages a circumferential groove 4055a defined by the flow regulator cone 4051b. This arrangement allows rotation of the flow regulator body 4051a with respect to the flow regulator cone 4051b but prevents axial movement of the flow regulator body 4051a with respect to the flow regulator cone 4051b. A third pin 4053b is provided between the internal support member 4060 and the flow regulator cone 4051b and engages an axial groove 4055b defined by the internal support member 4060. This relationship rotationally locks the flow regulator cone 4051b and the inner support member 4060 but allows axial movement between the flow regulator cone 4051b and the inner support member 4060. The flow regulator cone 4051b defines an external detent 4059 which engages an internal surface groove 4099 defined by the second body portion internal section 4024a. The purpose of these arrangements described will become clear in due course.

The nozzle further includes a fogger 4092 attached to the end of the internal support member 4060 and an end cap 4062 which is connected to the second body portion internal section 4024a by a key 4800 which engages a complementary groove 4802 defined by the second body portion internal section 4024a. The key and groove 4800, 4802 between the end cap 4062 and the second body portion internal section 4024a allows rotational but not axial movement between these two components.

Figure 33, a top view of the nozzle 4010 of Figure 26, shows the end cap 4062 is also engaged with the second body portion external section 4024b by a series of extending fingers 4804 which permit relative movement in an axial direction between the second body portion external section 4024b and the end cap 4062, but prevents axial movement between these two components.

The flow regulator 4050 is shown in perspective view in Figure 30, in a perspective cut away view in Figure 31 and in an end view, in use, in Figure 32. As can be seen from these figures, the flow regulator body 4051a defines a raised section 4057 having a radius geometry profile 4850 adapted to catch the flow of fluid as it flows around the flow regulator body 4051a and eject the flow through the nozzle outlet 4040. Referring to Figure 31, it will be noted that the flow regulator body 4051a defines an internal thread 4052a adapted to engage an external thread defined by the internal support member 4060 to form the threaded connection 4052.

The operation of the nozzle 4040 will now be described with reference to Figure 27 to 29 side views of the nozzle in the closed, purge and failsafe positions. As the motor 4700 rotates the first body portion rotating section 4022a, the engagement between the first pin 4026 and the flow regulator body 4051a causes rotation of the flow regulator body 4051a and axial movement of the flow regulator 4050 along the internal support member 4060 due to the threaded connection 4052, providing an opening at the outlet 4040. As fluid flows through the nozzle passageway 4070, it will hit the upstanding radius geometry section 4850 and be directed out of the nozzle outlet 4040. The angle of the arc generated depends on how much of the first outlet

4040 is covered by the flow regulator raised section 4057. An arc of anything between 60 and 360 degrees can be generated in this embodiment.

As the flow regulator 4050 is rotated, the deflector cone 4051b which is rotationally fixed by the third pin 4053b, travels axially with the flow regulator body 4051a and forces rotation of the second body portion internal section 4024a due to the interaction between the deflector cone detent 4059 and the second body portion internal section helical groove 4099. Rotation of the internal section 4024a, which is axially fixed relative to the end cap 4062 by virtue of key 4800, creates axial movement of the external section 4024b due to the coarse threaded connection 4025 between the two components allowing for adjustment of the outlet gap 4041. Further movement of the flow regulator 4050 results in a purge position, similar to the nozzles of earlier embodiments, in which the fogger 4092 is purged, as shown in Figure 28.

The nozzle 4010 includes a failsafe mode in which, in the event of failure of the motor, the flow of fluid will engage with bosses 5000 defined by an internal surface 5001 of the first body portion rotating section 4022a creating rotation of the first body portion rotating section 4022a in the opposite direction to the motor 4700 direction, winding the flow regulator 4050 back into the first body section 4022, returning the outlet gap 4041 to its largest size, as shown in Figure 29, section of the nozzle 4010 in failsafe mode.

Referring now to figures 34, 35 and 36; top section (outlet closed) and section (outlet open) views of a nozzle 5100 according to a fifth embodiment of the present invention. The nozzle has many identical features to nozzles of the second and third embodiment however this nozzle 5100 includes an external collar 5110 to selectively open or close this portion of the nozzle outlet 5140. The collar 5110 is mounted to a collar frame 5112 and adapted to slide from an outlet open position shown in figures 34 and 36 to an outlet closed position shown in figure 35. It can be seen from figure 35 that the collar 5110 is a cylinder 5114 with a leading edge 5116 which is cut at an angle to the sides of the cylinder 5114. This means that the sides of the cylinder 5114 have a shortest length “G” and a longest length “F”.

The effect of this arrangement is that the outlet 5140 can be partially closed or, indeed, fully closed by the positioning of the collar 5110 with respect to the outlet 5140. The collar 5110 is moved by means of a motor 5700 rotating the frame 5112 and collar 5110, a detent 5118 on the nozzle outlet 5140, engaging a helical groove 5120 defined by the collar 5110, the interaction between the detent 5118 and the collar 5110 converting the rotational movement of the collar 5110 into an additional axial movement.

Various improvements and modifications can be made to the above described embodiments without departing from the scope of the invention. For example, the surface protrusions of the third embodiment may be applicable to any of the other embodiments to facilitate cleaning of a nozzle outlet. Similarly features described in relation to one or more embodiments are not restricted to the one or more embodiments in relation to which they are described and may be taken in isolation from one embodiment and applied to another embodiment within the scope of the following claims.

CLAIMS

1. A nozzle for a heat suppression system, the nozzle comprising:

a nozzle body, the nozzle body defining an inlet, a first outlet, and a passageway, the passageway providing fluid communication between the inlet and the first outlet, the first outlet extending at least partially around a perimeter of the body; and

a flow regulator located at least partially within the passageway and being movable with respect to the body, movement of the flow regulator selectively opening or closing at least one portion of the first outlet.

2. A nozzle according to claim 1, wherein the first outlet defines an opening which is adjustable in size.

3. A nozzle according to claim 1 or 2, wherein the body comprises a first body portion and a second body portion.

4. A nozzle according to claim 3, wherein the inlet is defined by the first body portion.

5. A nozzle according to claim 3 or 4, wherein the first outlet is defined by the first and second body portions.

6. A nozzle according to any of claims 3 to 5, wherein the first outlet defines an opening defined by a gap between the first and second body portions, and the first and second body portions may be adapted to move relative to one another so as to adjust a size of the first outlet opening.

7. A nozzle according to any of claims 3 to 6, wherein the flow regulator is adapted to engage one of the first and second body portions such that further movement of the flow regulator moves the engaged body portion with respect to the other body portion, thereby increasing the size of the outlet.

8. A nozzle according to any of claims 3 to 7, comprising a motor for generating relative movement between the first and second body portions.

9. A nozzle according to any of claims 3 to 8, wherein the flow regulator defines a surface profile adapted to sealingly engage an internal surface of the nozzle body to regulate the flow.

10. A nozzle according to claim 9, wherein, in a first position, the surface profile sealingly engages the internal surface of the nozzle body such that the first outlet is closed.

11. A nozzle according to claim 10, wherein, in the first position, the surface profile sealingly engages the internal surface of the nozzle body such that the inlet is closed.

12. A nozzle according to claim 10 or 11, wherein, in the first position, the flow regulator is sealingly engaged with the first body portion.

13. A nozzle according to any of claims 10 to 12, wherein, in a second position, the surface profile is displaced from the first outlet permitting, in use, the fluid to flow from the passageway through the first outlet.

14. A nozzle according to claim 13, wherein, in the second position the flow regulator may be sealingly disengaged from the first body portion.

15. A nozzle according to any of claims 9 to 14, wherein the surface profile defines a surface section adapted to direct fluid from the passageway through the first outlet.

16. A nozzle according to claim 15, wherein the fluid directed through the first outlet forms at least one fluid flow pattern extending away from the nozzle.

17. A nozzle according to claim 16, wherein the at least one fluid flow pattern changes in shape as the flow regulator moves from the first position towards the second position.

18. A nozzle according to claim 17, wherein the at least one fluid flow pattern changes in shape as the flow regulator moves beyond the second position.

19. A nozzle according to any of claims 16 to 18, wherein the fluid flow pattern comprises at least one arc, at least one segment or at least one finger.

20. A nozzle according to any of claims 16 to 19, wherein a circumferential extent of the fluid flow pattern increases as the flow regulator moves from the first position to the second position and/or from the first position beyond the second position.

21. A nozzle according to any of claims 16 to 20, wherein the fluid exiting the first outlet forms a flow pattern in the form of a body of fluid which is rotatable around a longitudinal axis of the nozzle body.

22. A nozzle according to any of claim 21, wherein a circumferential extent of the flow pattern increases or decreases during rotation around the longitudinal axis of the nozzle body.

23. A nozzle according to any of claims 16 to 22, wherein the flow pattern is changeable in one or more of three dimensions, that is a circumferential extent of the flow pattern, depth of the flow pattern or the distance the flow pattern extends from the nozzle, by relative movement of component parts of the nozzle.

24. A nozzle according to any of claims 3 to 23, comprising a second outlet.

25. A nozzle according to claim 24, wherein the second outlet is defined by the nozzle body and/or the flow regulator.

26. A nozzle according to claim 24 or 25, wherein the second outlet is at least partially defined by the second body portion.

27. A nozzle according to any of claims 3 to 26, wherein the nozzle defines an internal geometry which is adapted to create a turbulent flow in the nozzle.

28. A nozzle according to any of claims 3 to 27, wherein the nozzle inlet is angled with respect to a longitudinal axis of the nozzle body, the nozzle inlet is at right angles to the longitudinal axis of the nozzle body or the nozzle inlet is at an acute angle to the longitudinal axis of the nozzle body.

29. A nozzle according to any of claims 3 to 28, wherein the nozzle inlet is movable with respect to the nozzle body longitudinal axis.

30. A nozzle according to any of claims 3 to 29, wherein the nozzle inlet defines a linear or helical flowpath.

31. A nozzle according to any of claims 3 to 30, wherein flow through the nozzle is used to drive a motor.

32. A nozzle according to any of claims 3 to 31, wherein the nozzle comprises an energy storage device which is adapted to harness and store energy from the flow for use later.

33. A nozzle according to claim 32, wherein the energy storage device comprises a spring.

34. A nozzle according to any of claims 3 to 33, wherein the nozzle body passageway is defined by an internal surface of the body and an external surface of the flow regulator.

35. A nozzle according to any of claims 3 to 34, comprising an internal support member extending at least partially into the nozzle body passageway.

36. A nozzle according to claim 35, wherein the internal support member extends the full length of the passageway.

37. A nozzle according to claim 35 or 36, wherein the internal support member is axially aligned with a longitudinal axis of the nozzle body.

38. A nozzle according to any of claims 35 to 37, wherein the internal support member supports the flow regulator.

39. A nozzle according to any of claims 35 to 38, wherein the internal support member defines at least one throughbore which is adapted to carry services including at least one of water, steam, probes, wires and cables.

40. A nozzle according to claim 39, wherein the internal support member throughbore is in fluid communication with the nozzle body passageway.

41. A nozzle according to any of claims 35 to 40, wherein the internal support member defines an external surface adapted to co-operatively engage with a surface of a throughbore of the flow regulator.

42. A nozzle according to any of claims 35 to 41, wherein the flow regulator is movable with respect to the internal support member.

43. A nozzle according to claim 42, wherein the flow regulator is fixed axially or rotationally with respect to the internal support member.

44. A nozzle according to any of claims 35 to 43, wherein the nozzle body passageway is defined by an internal surface of the body, an external surface of the flow regulator and a portion of the external surface of the internal support member.

45. A nozzle according to any of claims 35 to 44, wherein the internal support member is integral with or separate from the nozzle body.

46. A nozzle according to any of claims 35 to 45, wherein the internal support member is integral with the second body portion.

47. A nozzle according to any of claims 35 to 46, wherein the flow regulator is adapted to move axially and/or rotationally with respect to the nozzle body.

48. A nozzle according to claim 47, wherein the flow regulator is adapted to move axially and/or rotationally with respect to the first body portion.

49. A nozzle according to claim 47 or 48, wherein the flow regulator is adapted to move axially and/or rotationally with respect to the second body portion.

50. A nozzle according to any of claims 35 to 49, wherein the flow regulator is adapted to move axially with respect to the first and second body portions, the second body portion and the internal support member being adapted to move rotationally with respect to the first body portion and the flow regulator.

51. A nozzle according to any of claims 35 to 49, wherein the flow regulator is rotatable with respect to the second body portion and the internal support member, and the flow regulator is movable axially with respect to the nozzle body and the internal support member.

52. A nozzle according to any of claims 35 to 51, wherein the first body portion has a rotating part and a fixed part, the rotating part adapted to rotate with respect to the fixed part so as to rotate the flow regulator.

53. A nozzle according to any of claims 35 to 52, wherein the internal support member and the second body portion are integral and the first outlet opening is adjustable by application of an axial and/or a rotational force to the internal support member.

54. A nozzle according to any of claims 3 to 53, wherein an outlet surface defined by the first body portion may be adapted to engage an outlet surface defined by the second body portion.

55. A nozzle according to claim 54, wherein at least one of the outlet surfaces defines a profile adapted to clean the other of the outlet surfaces as a consequence of rotation of one of the first and second body portions with respect to the other of the body portions.

56. A nozzle according to any of claims 2 to 55, wherein the first outlet opening is adjustable between a plurality of predetermined settings or within a predetermined range.

57. A nozzle according to claim 56, comprising an adjustment mechanism adapted to adjust the first outlet opening.

58. A nozzle according to claim 57, wherein the adjustment mechanism comprises an indexing mechanism having a plurality of settings each defining a first outlet opening.

59. A nozzle according to claim 58, wherein the indexing mechanism is biased to a position in which the first outlet opening is open.

60. A method of suppressing heat emitted by a flare at an installation, the method comprising:

providing a nozzle having a nozzle body and a flow regulator, the nozzle body defining an inlet, a first outlet and a passageway, the first outlet extending at least partially around a perimeter of the body;

flowing a flow of fluid through the nozzle body; and

moving the flow regulator with respect to the body to selectively open or close at least one portion of the first outlet to generate a flow pattern adapted to provide a heat suppression barrier between a flare and an installation.

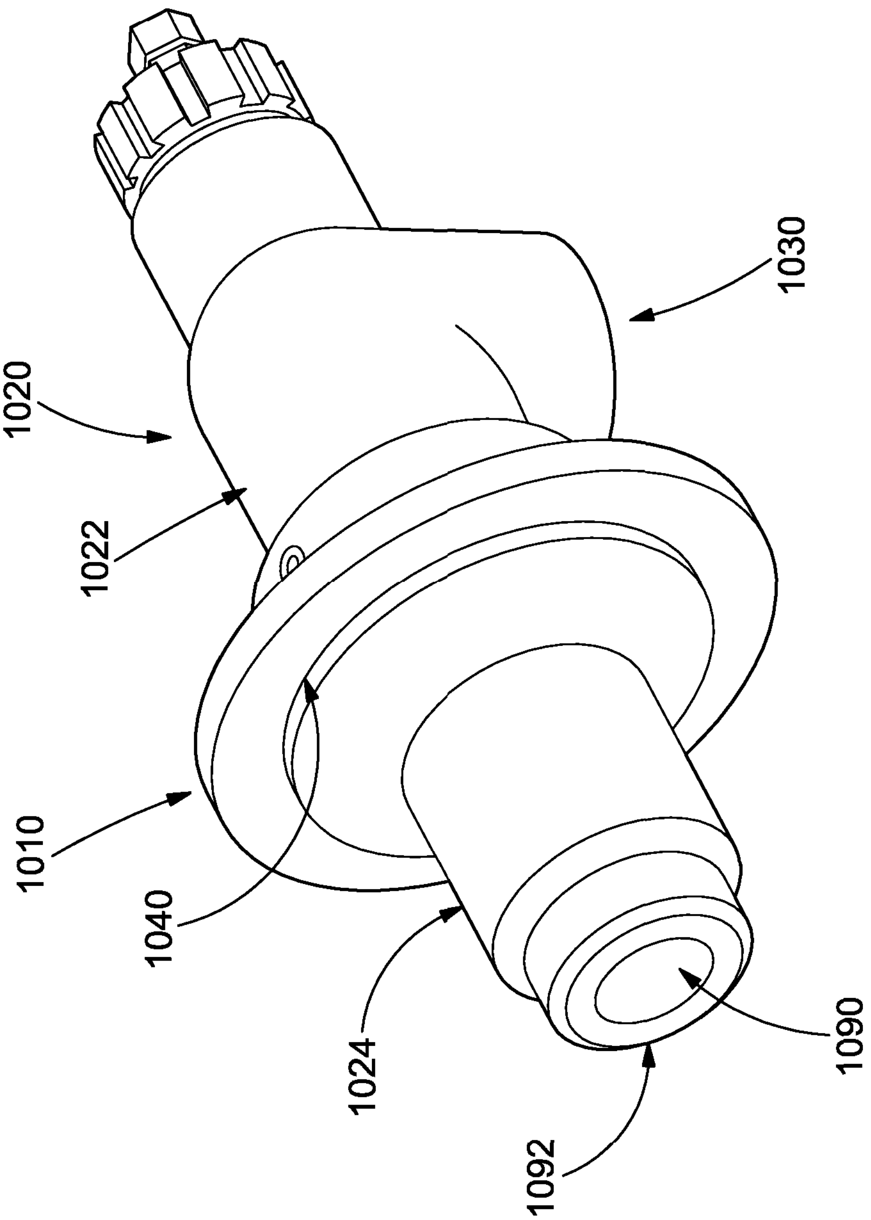

Figure 1

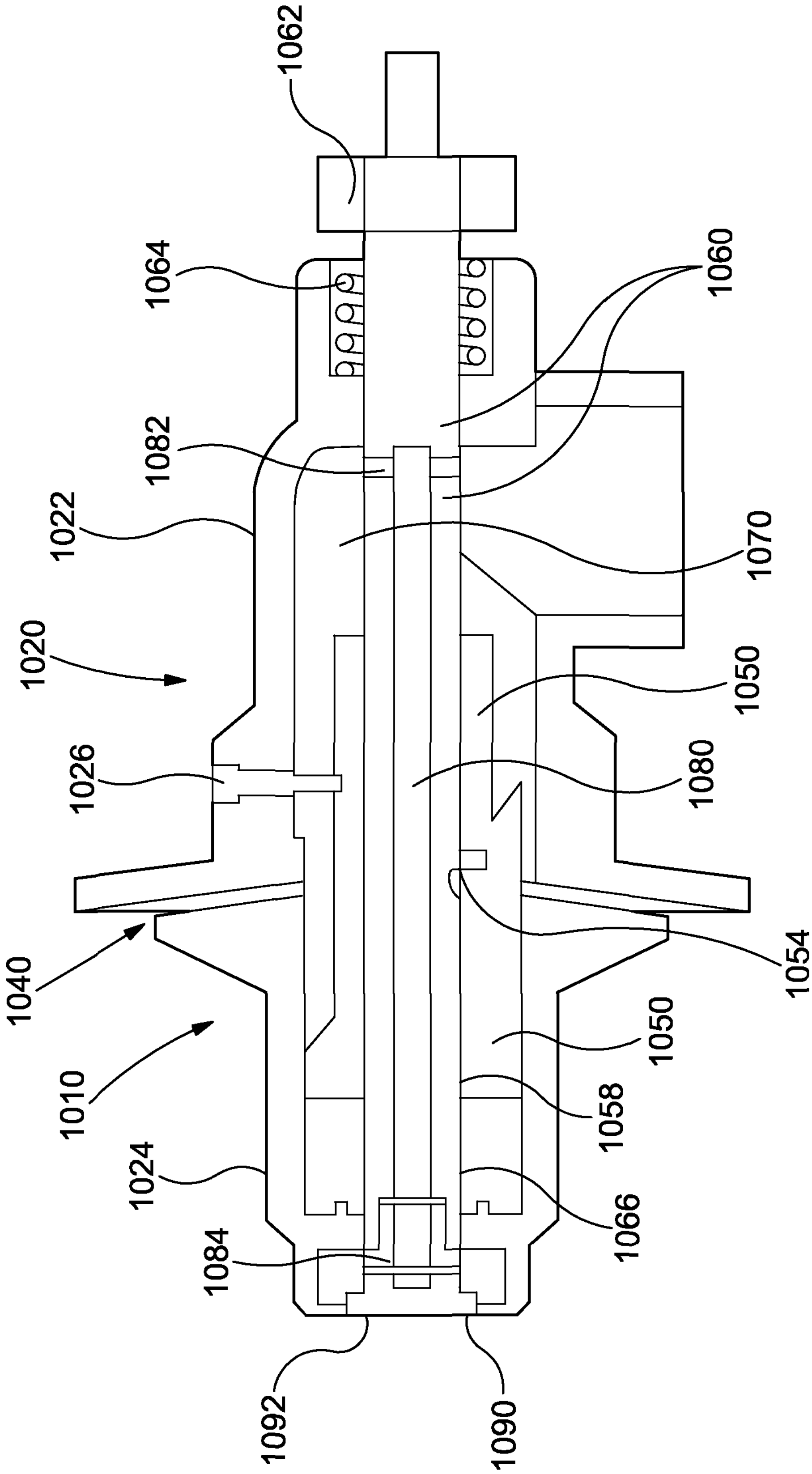
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Figure 2

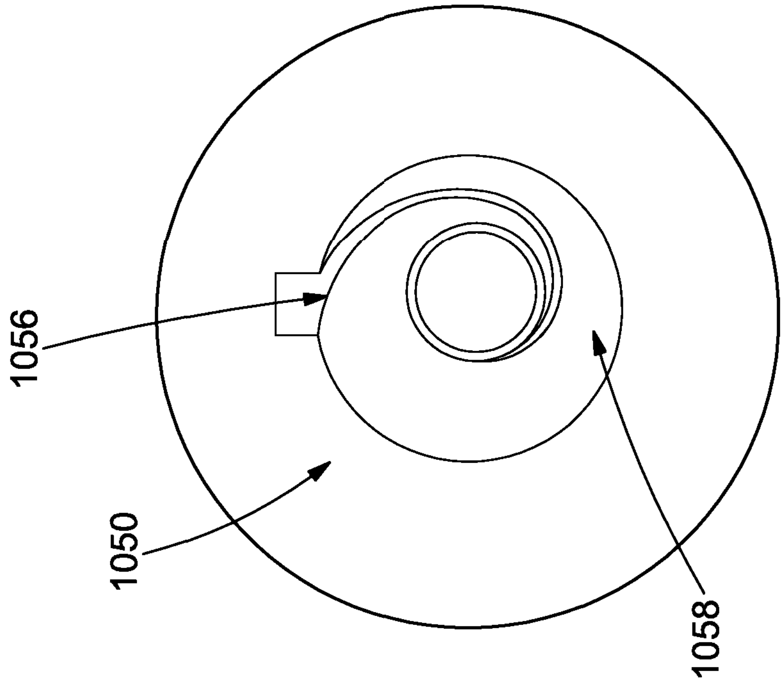

Figure 4

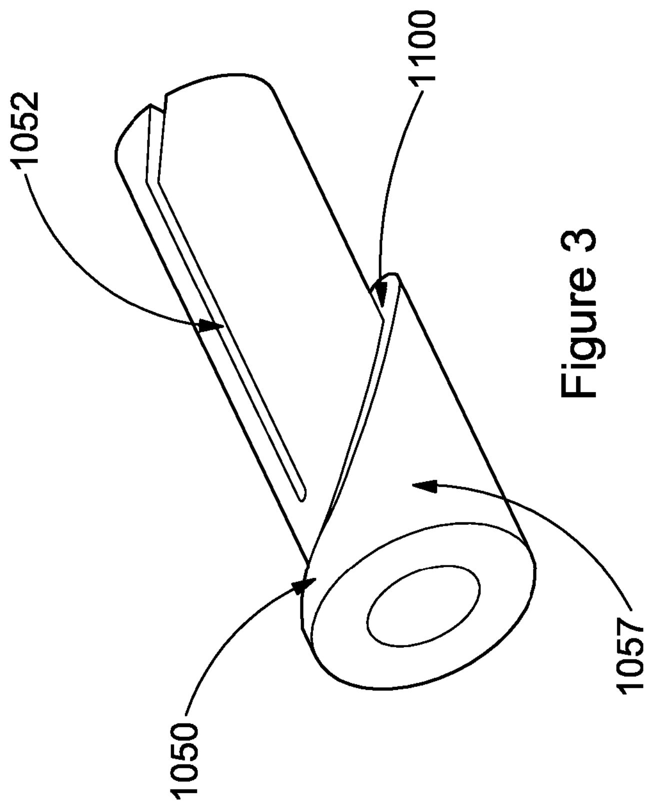

Figure 3

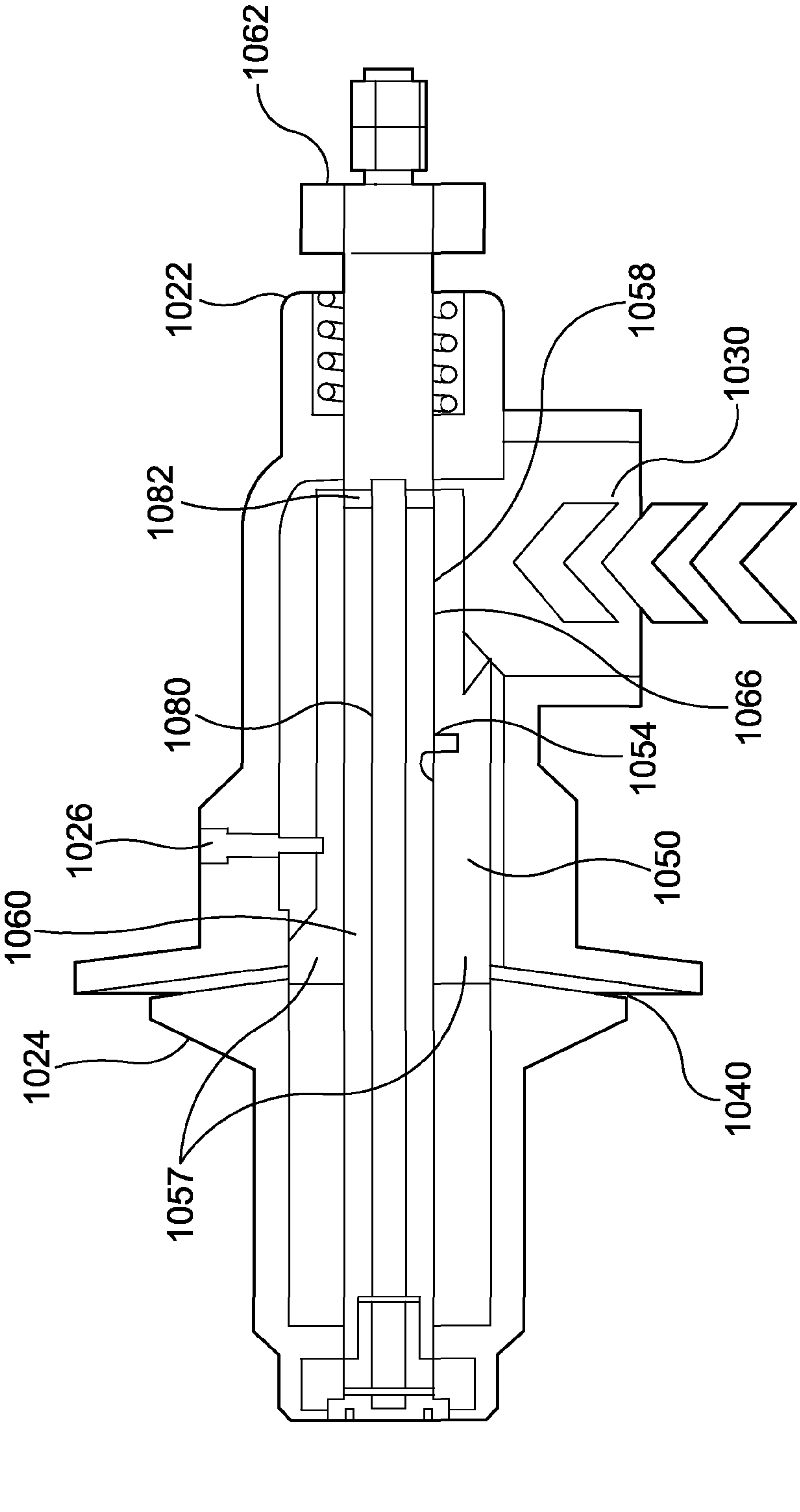
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Figure 5

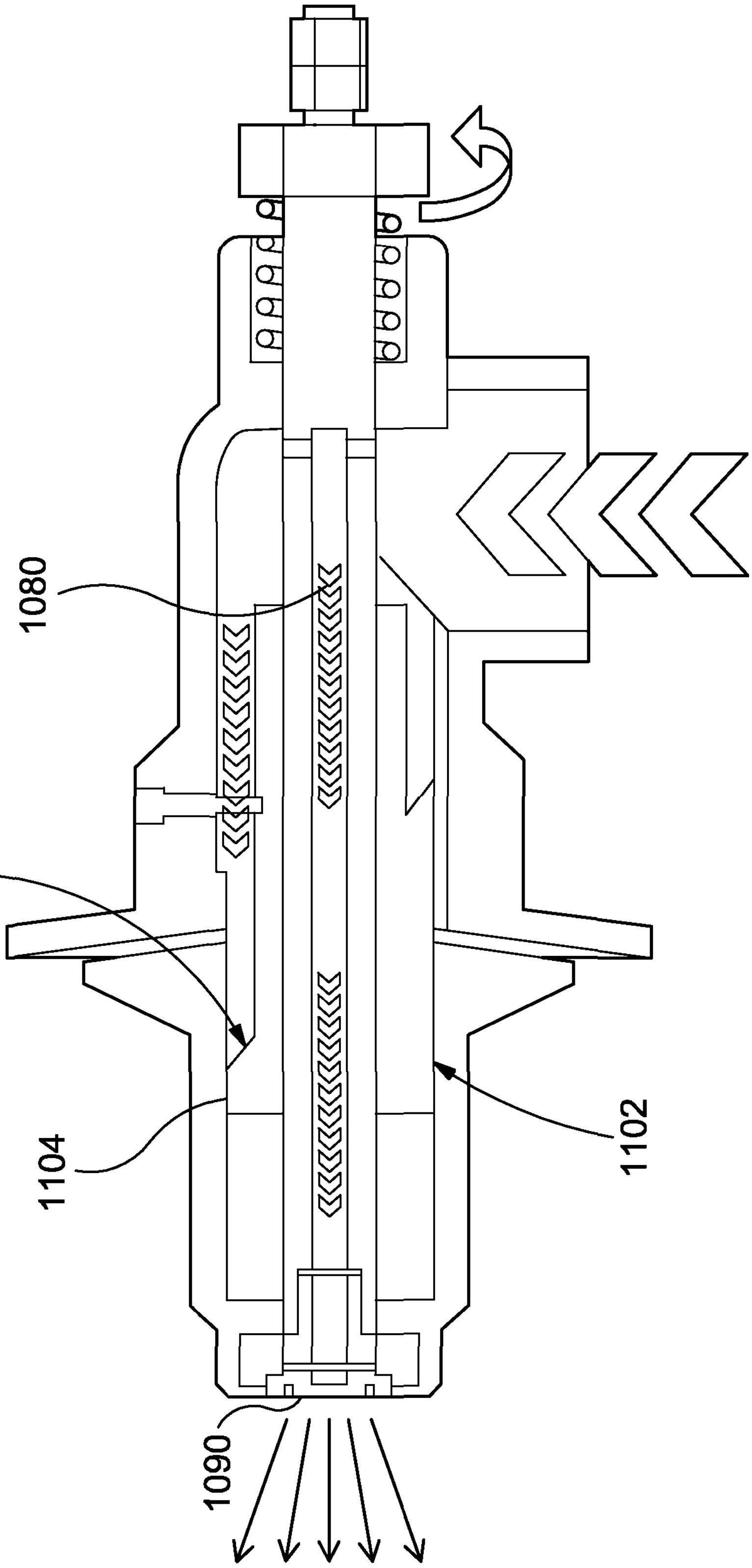

Figure 6

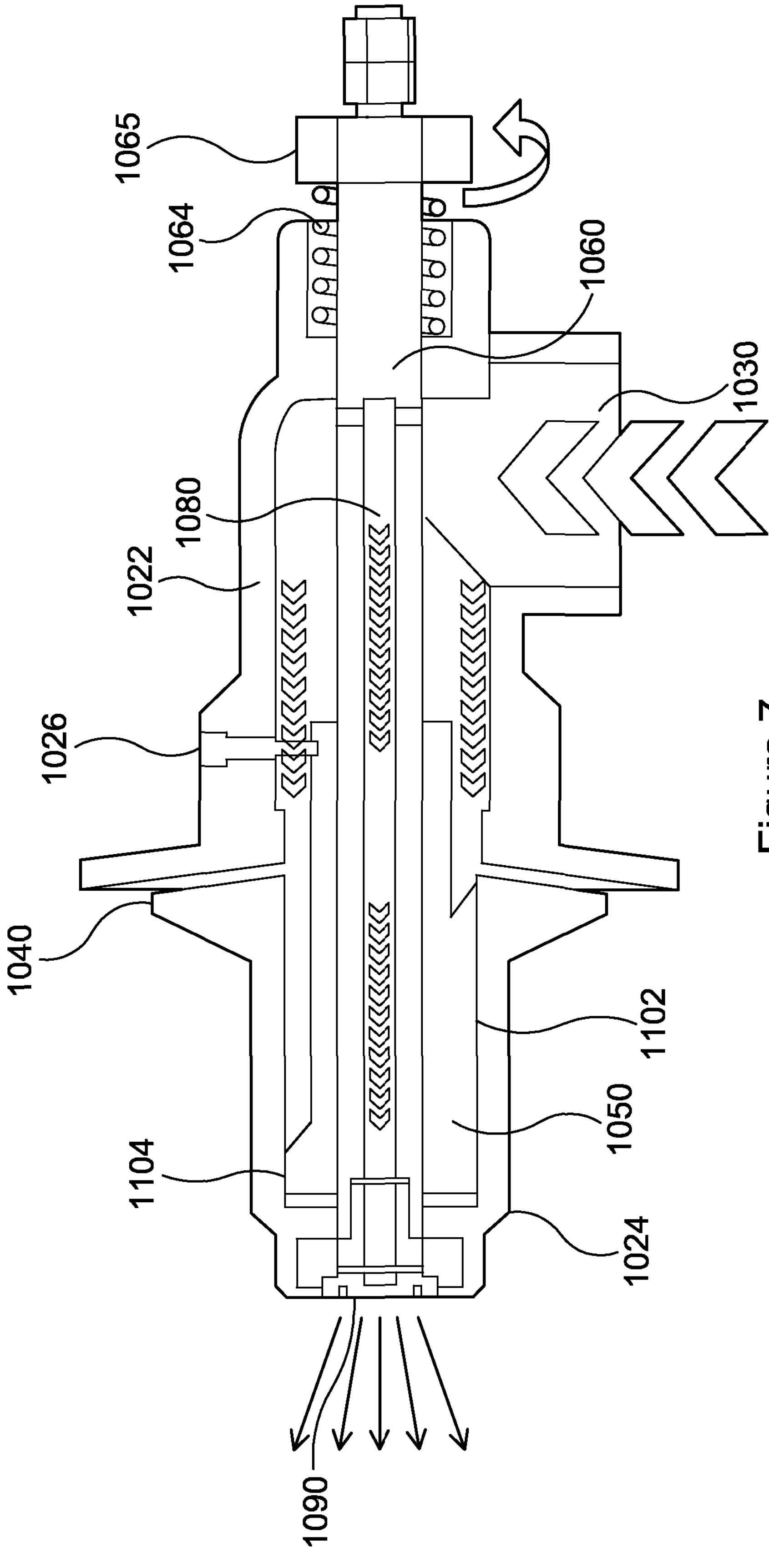
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Figure 7

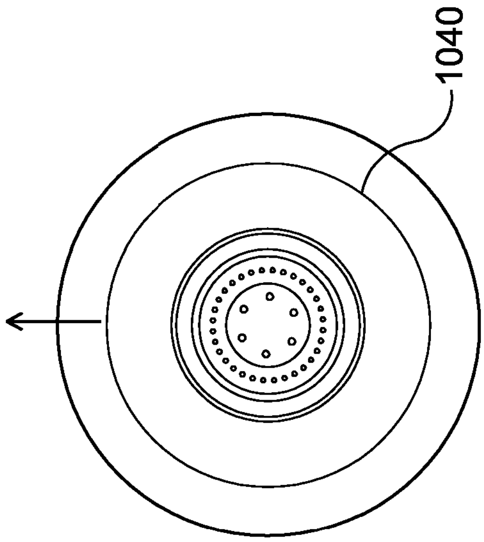


Figure 8a

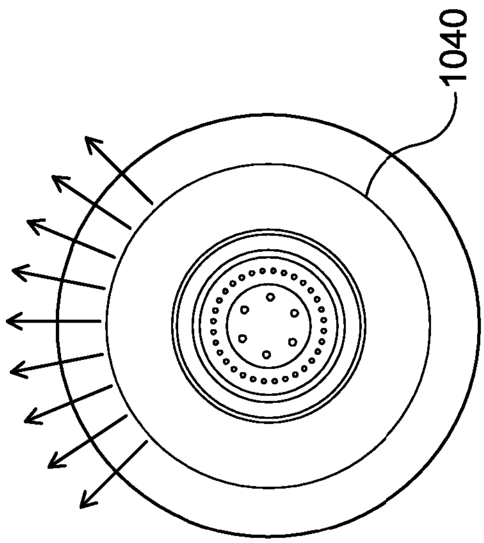


Figure 8b

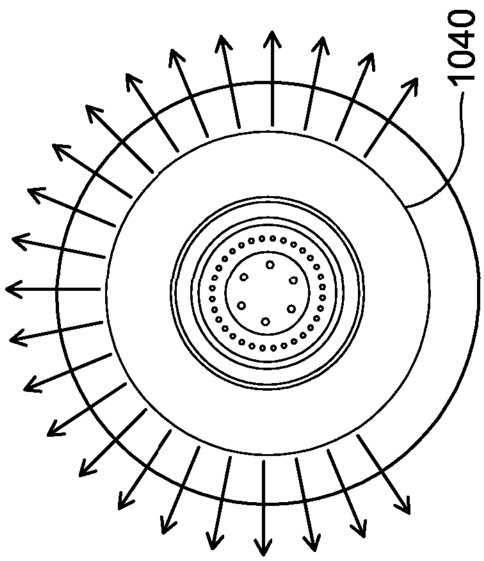


Figure 8c

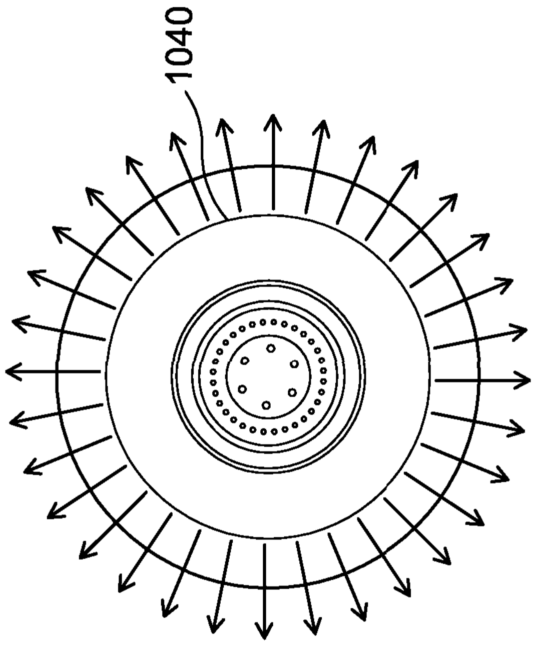
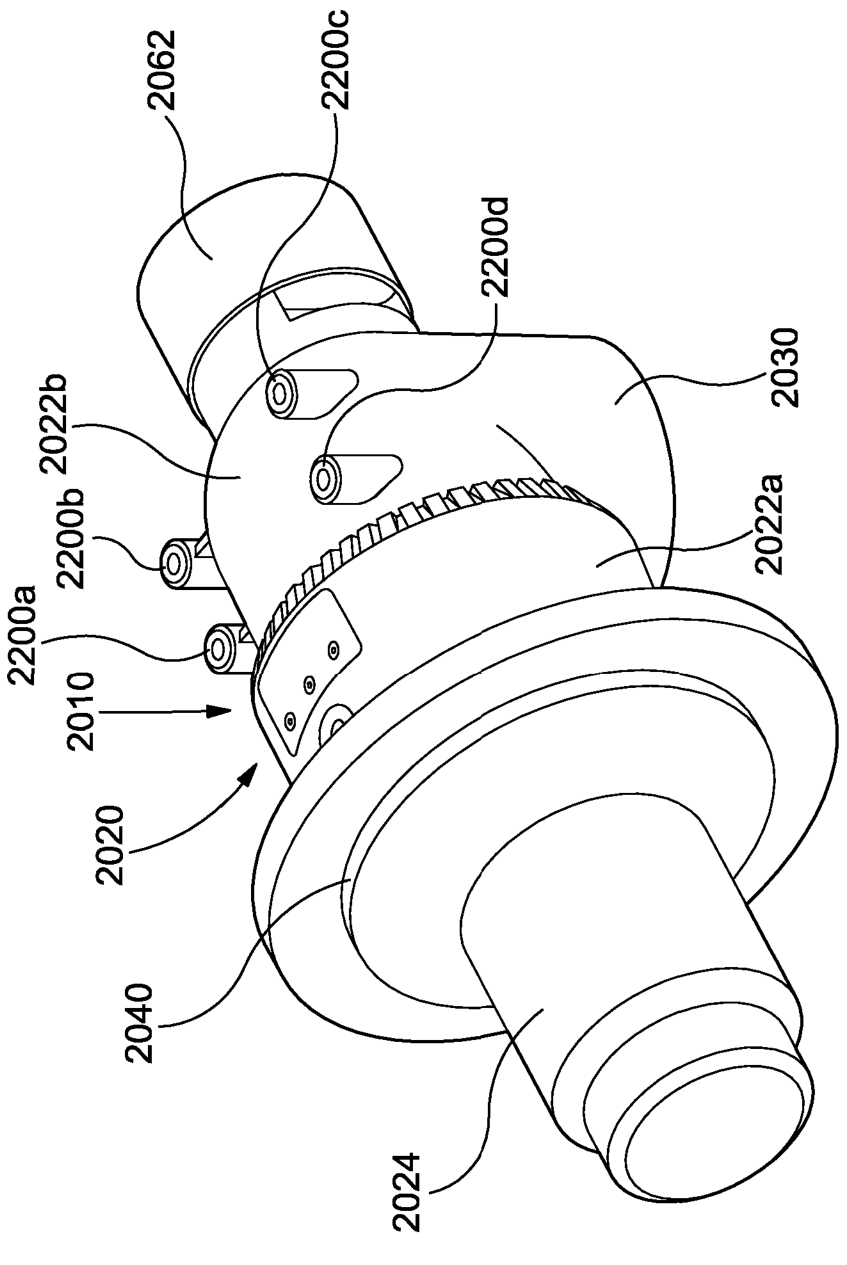


Figure 8d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2024

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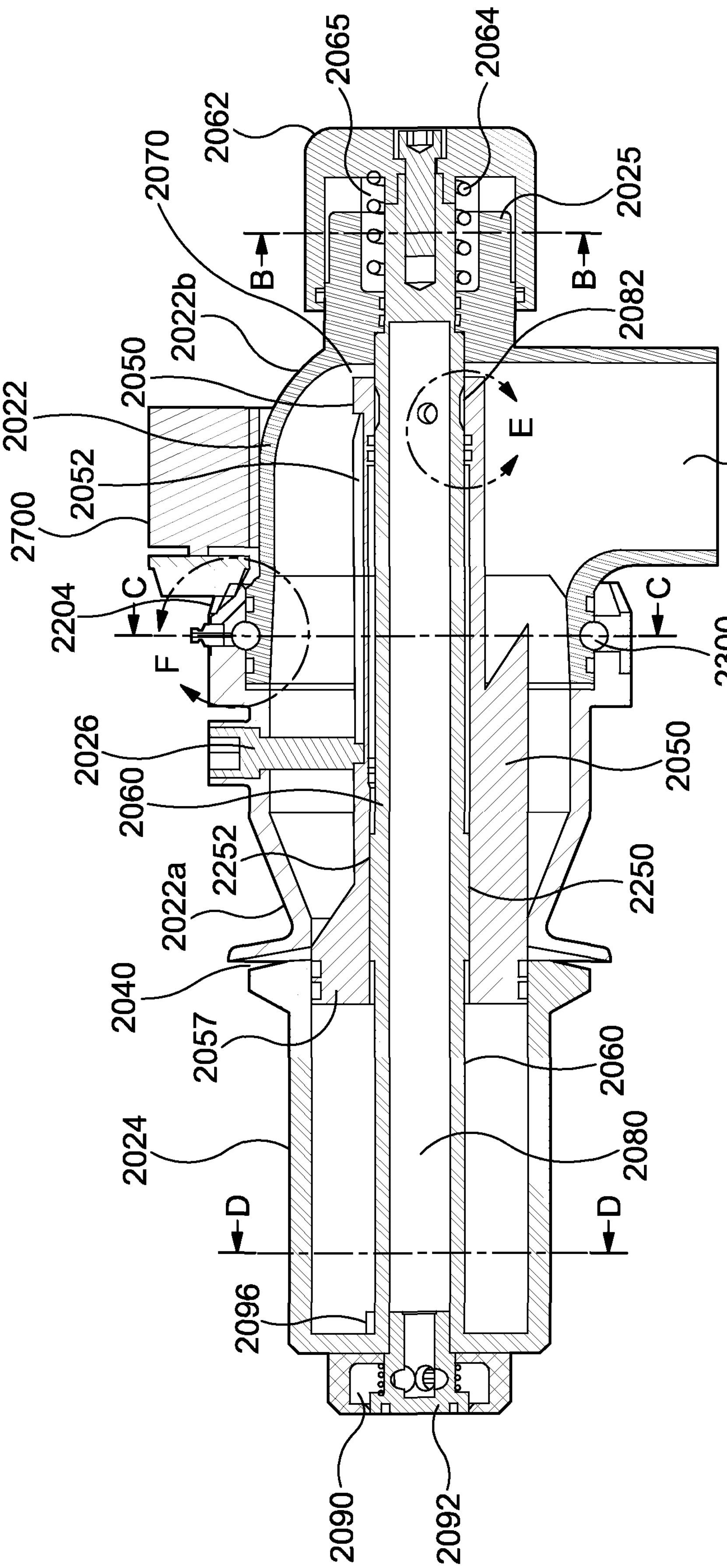
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C
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F
2300
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D
D
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2090
2092

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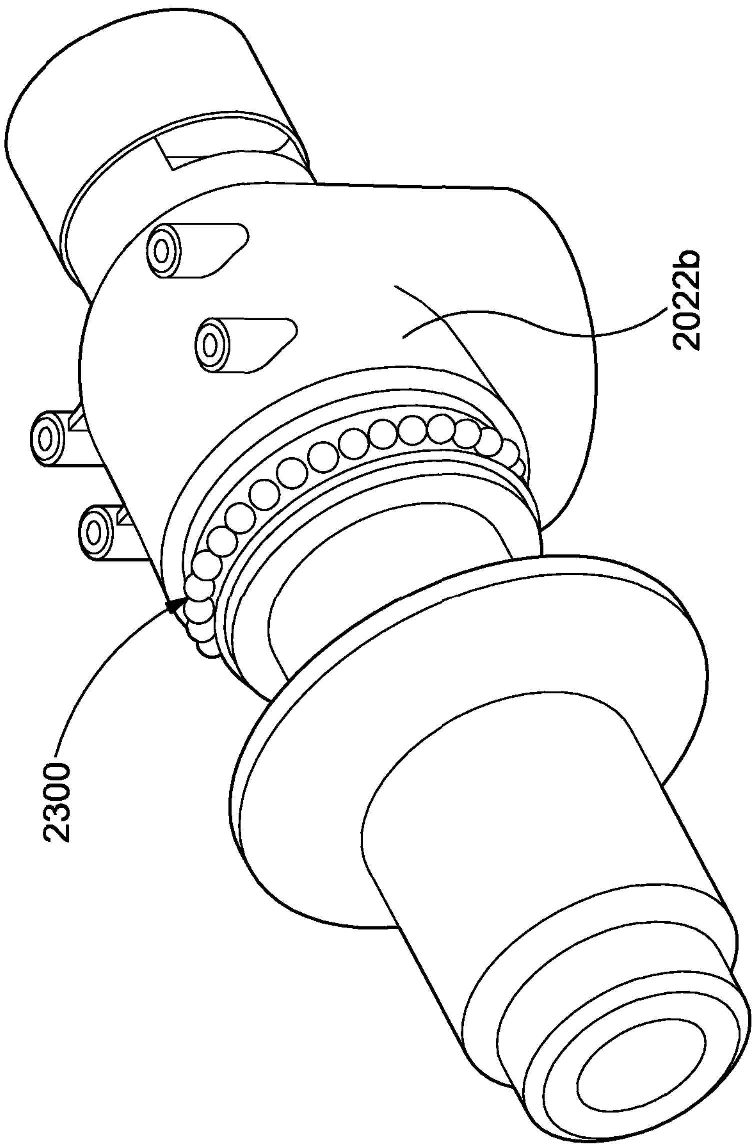

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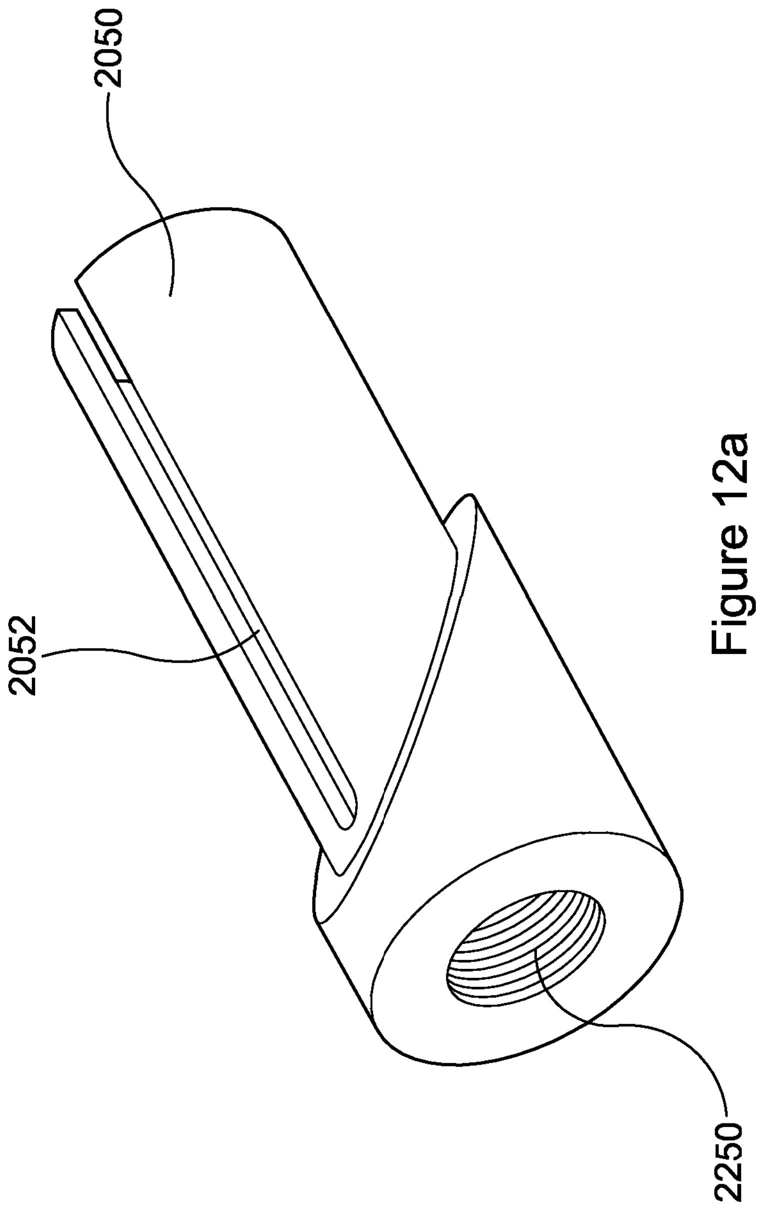


Figure 12a

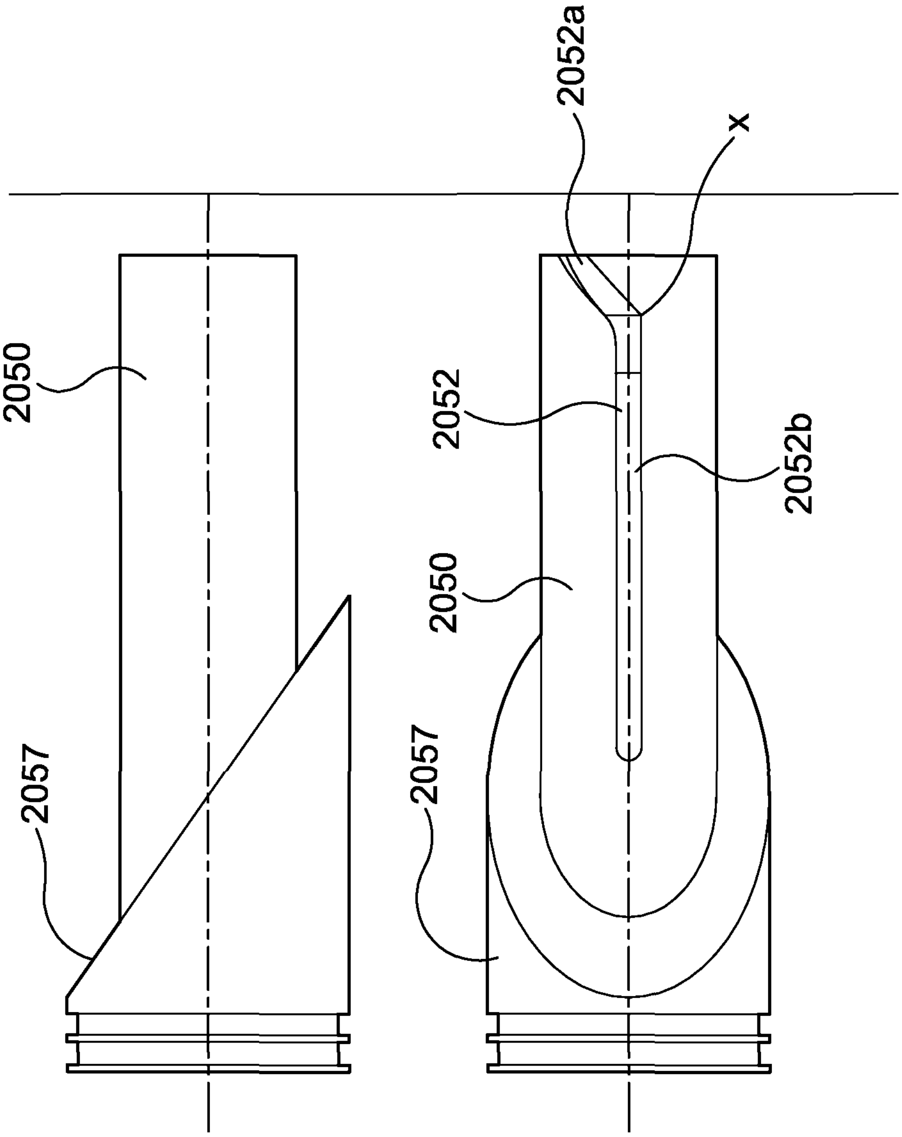


Figure 12c

Figure 12b

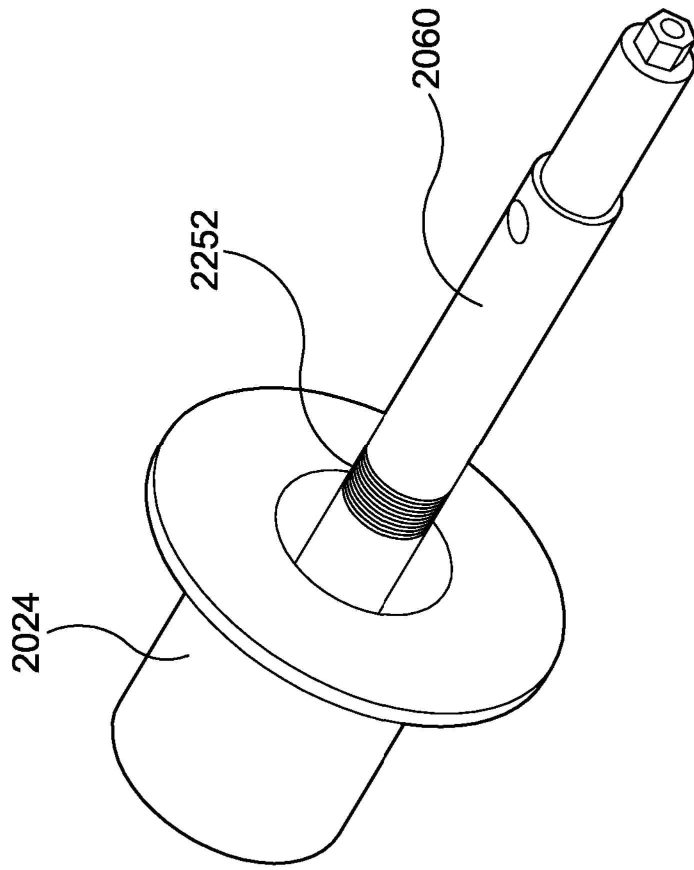
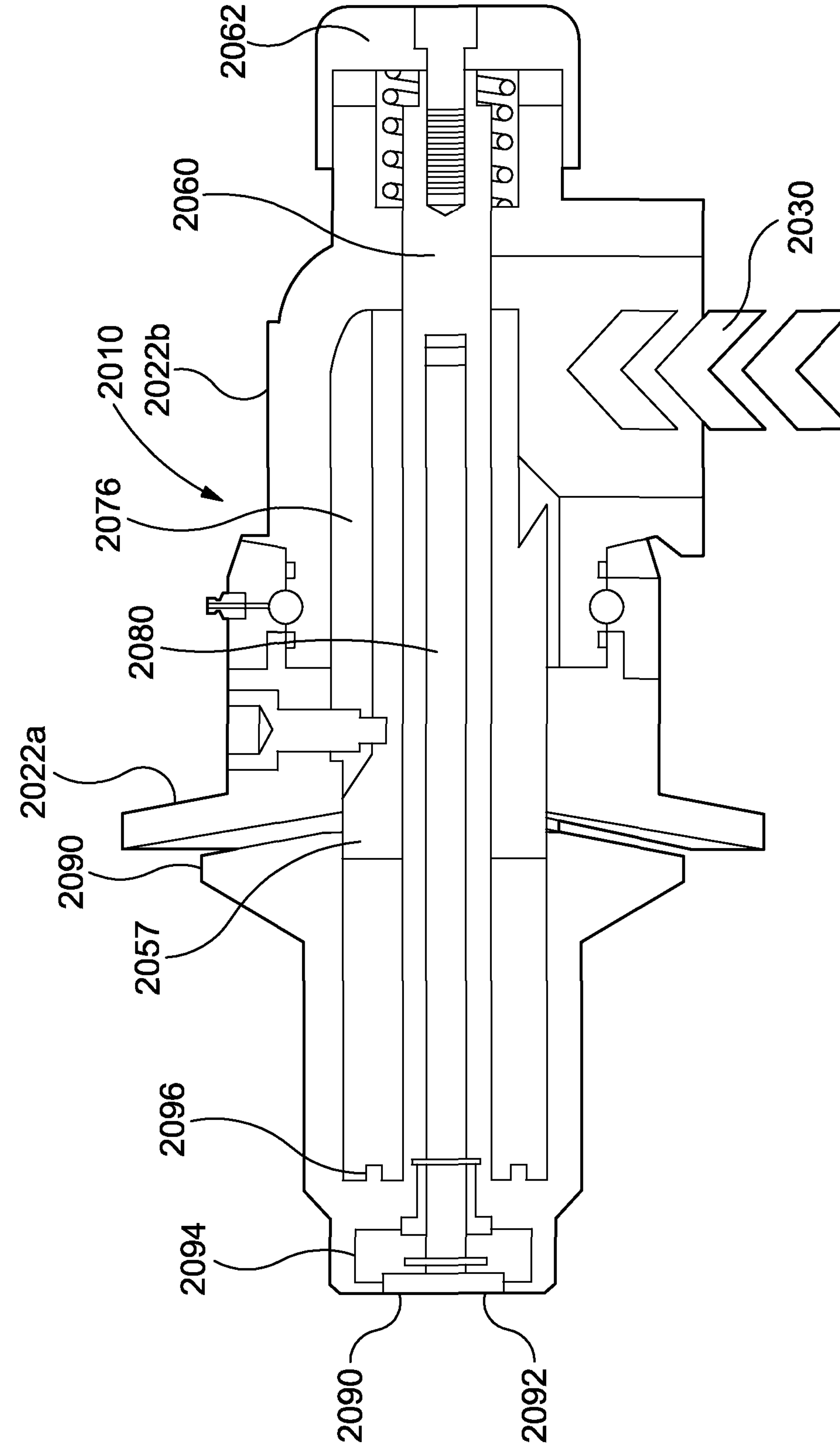


Figure 13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2092

Figure 14a

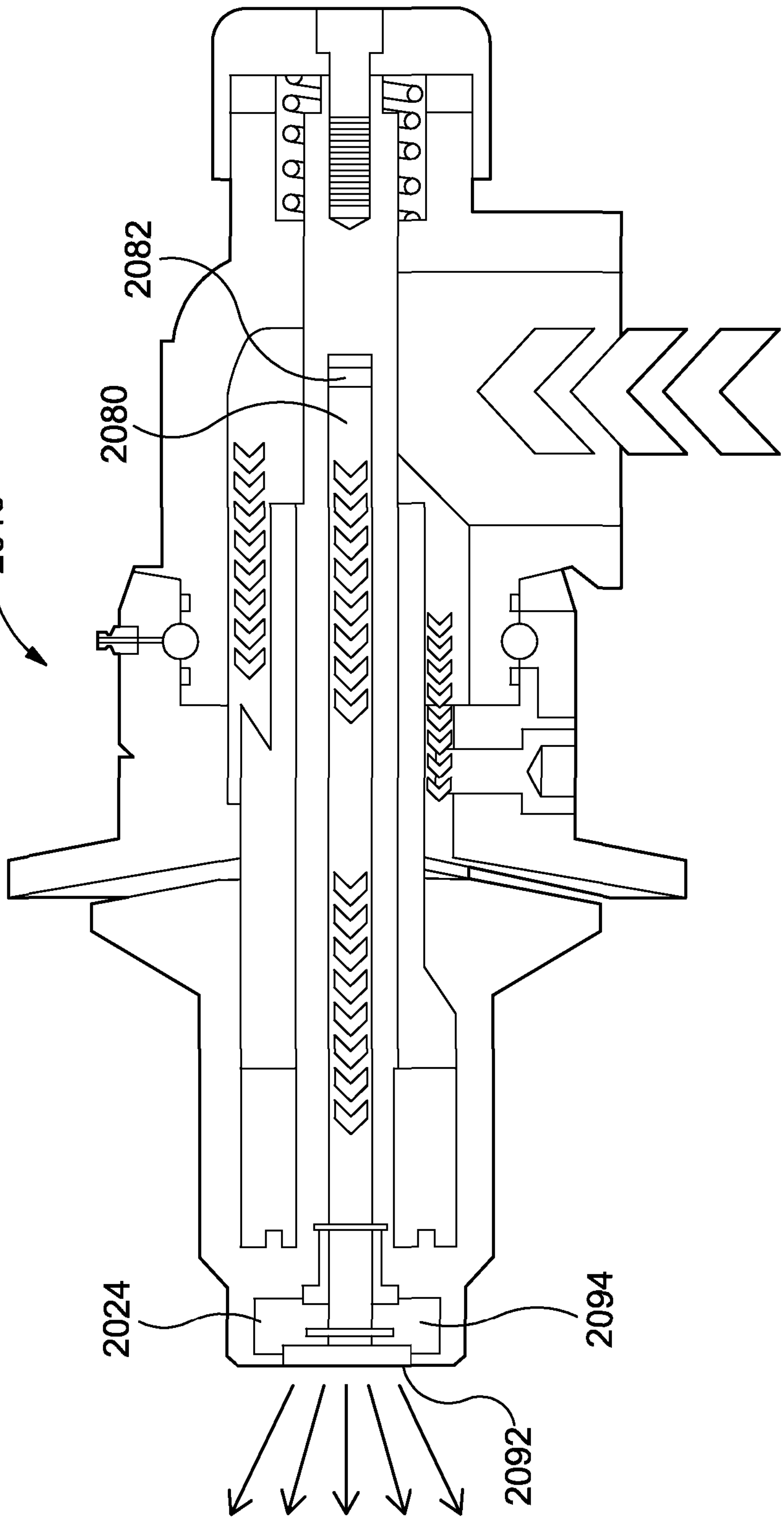

Figure 14b

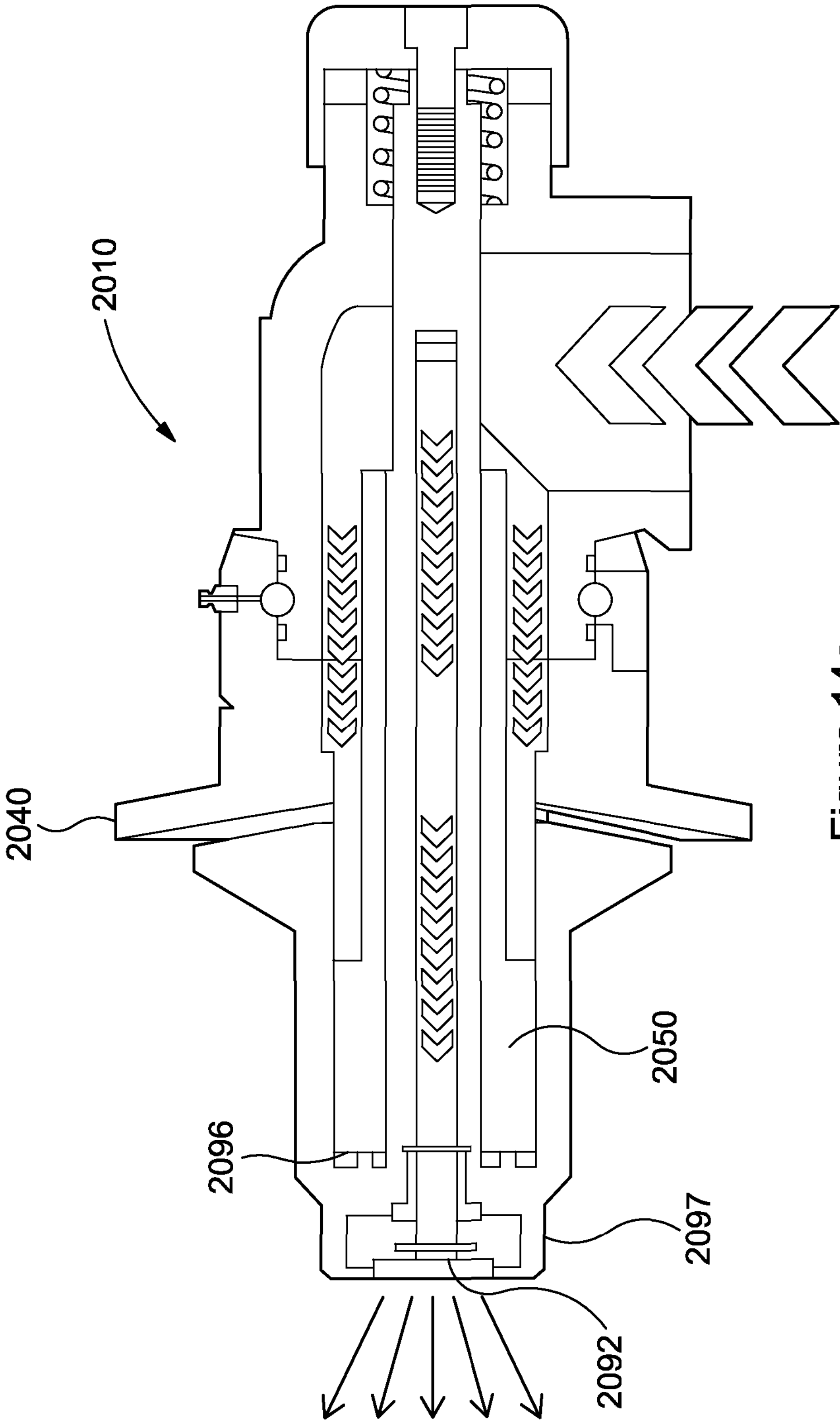

Figure 14c

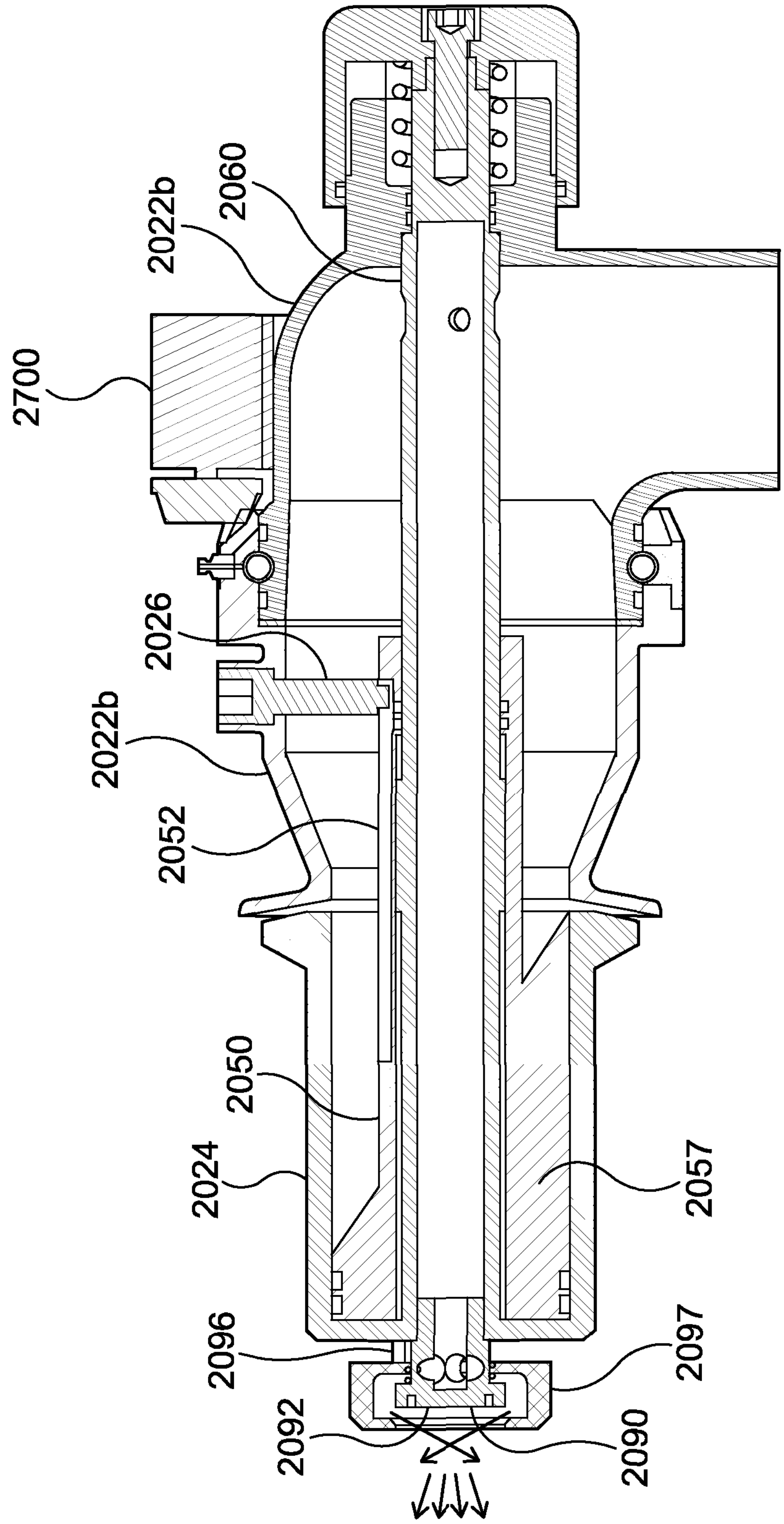
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Figure 14d

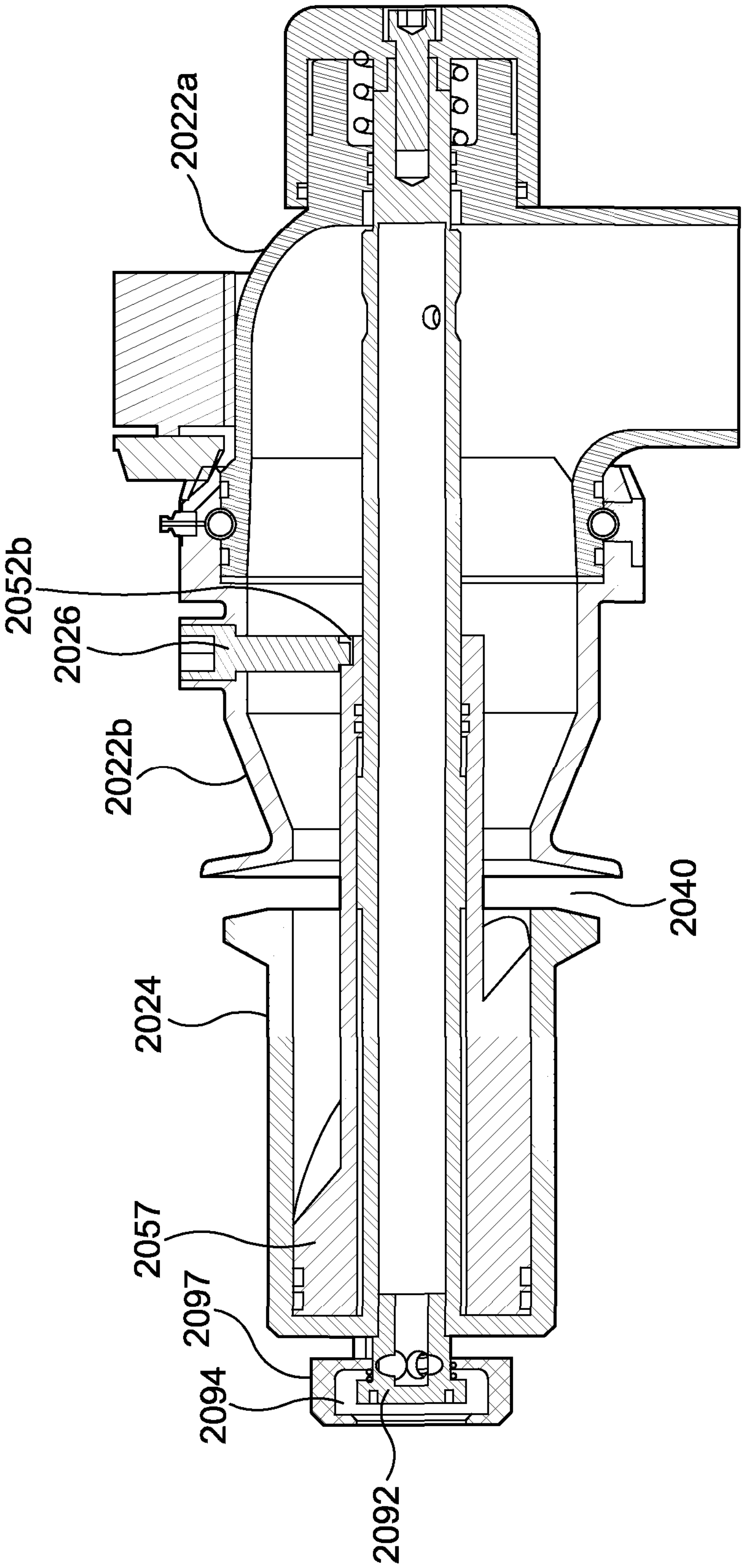
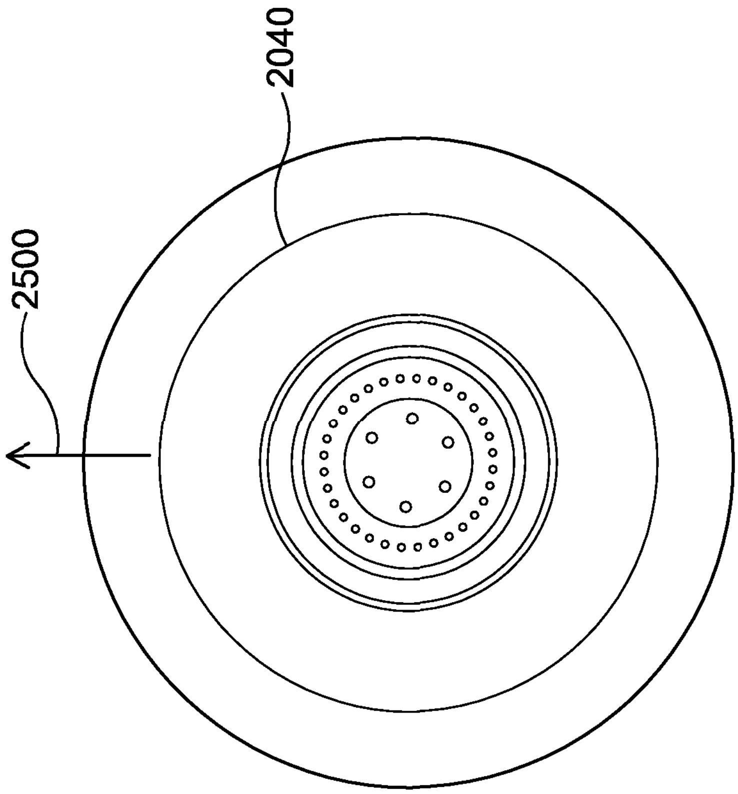


Figure 14e



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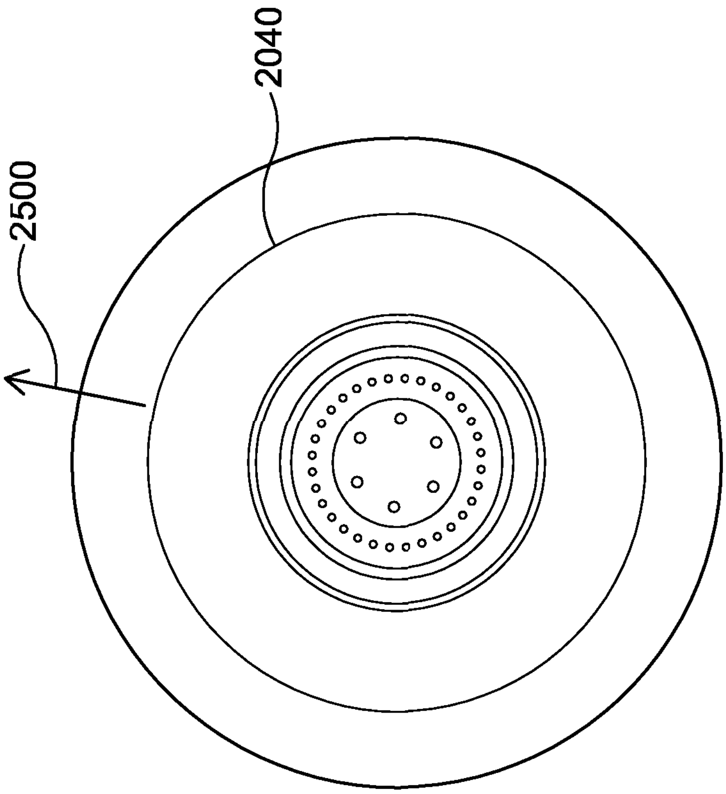

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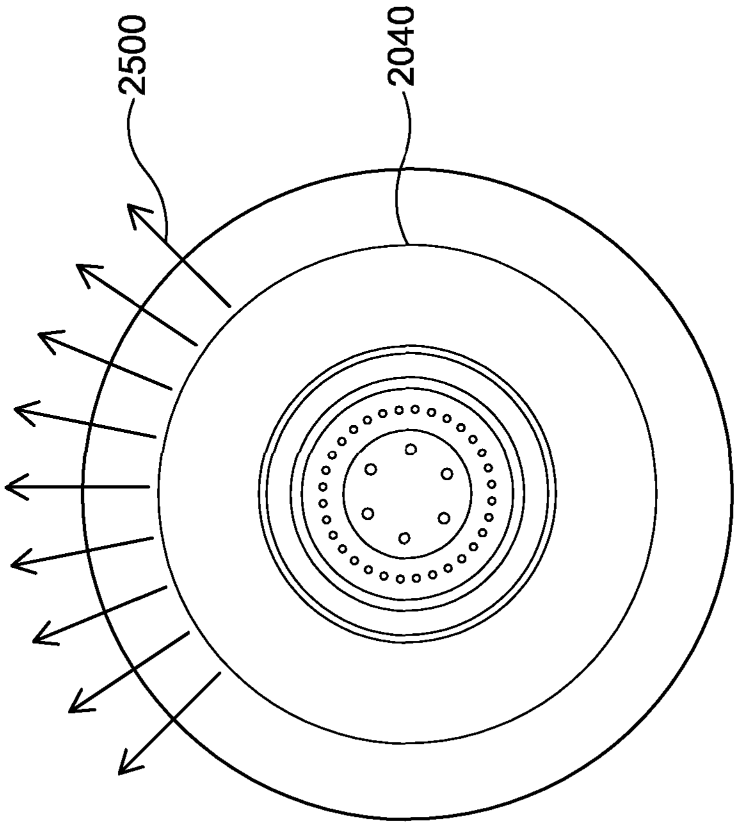

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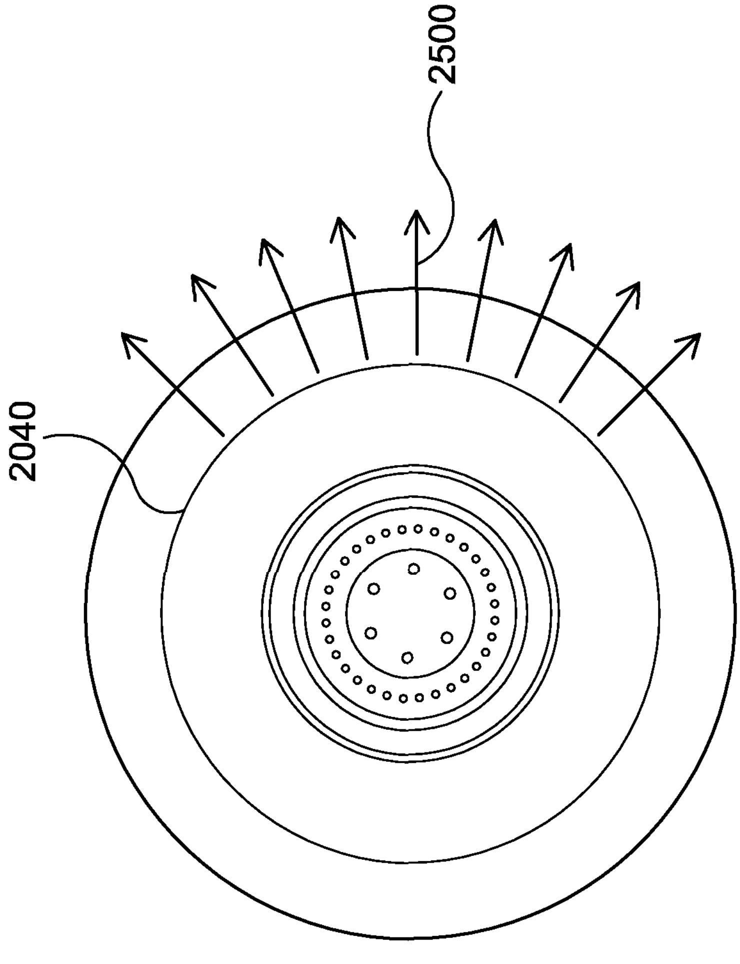

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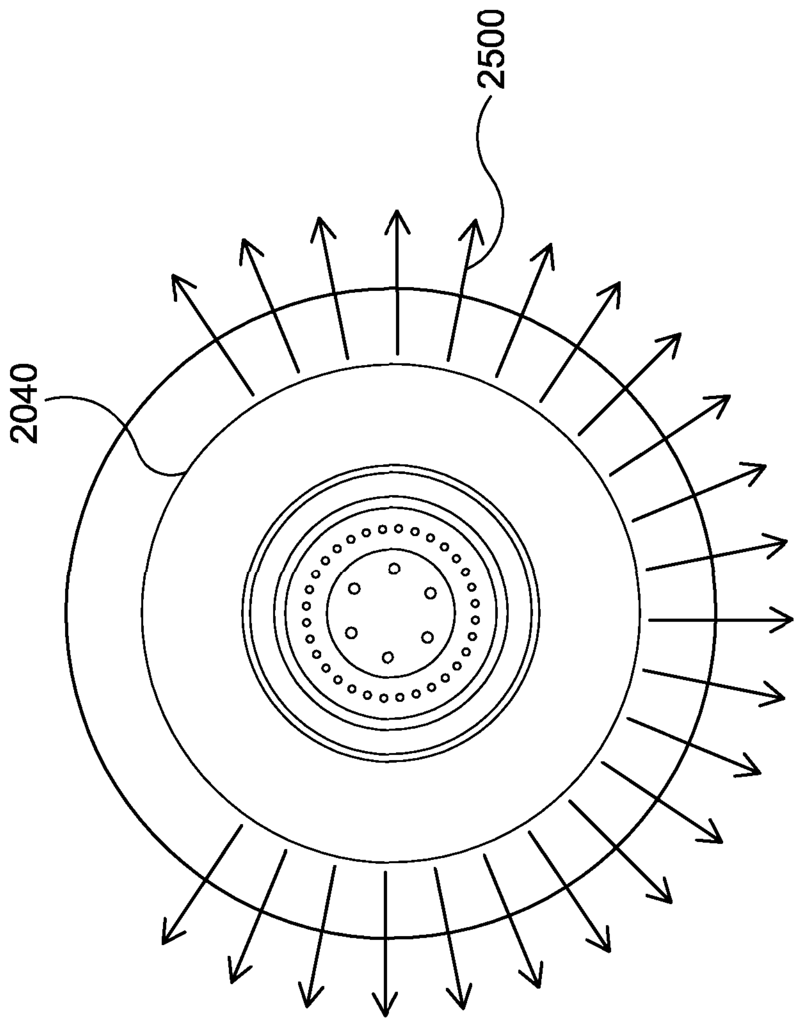

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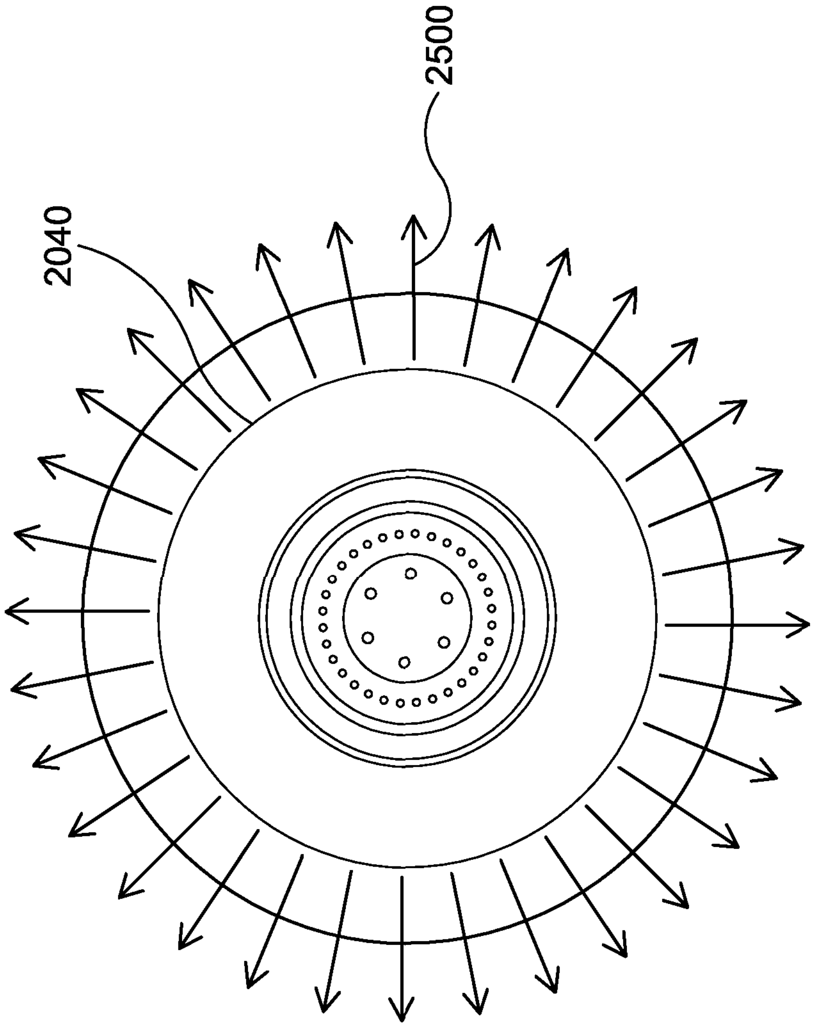

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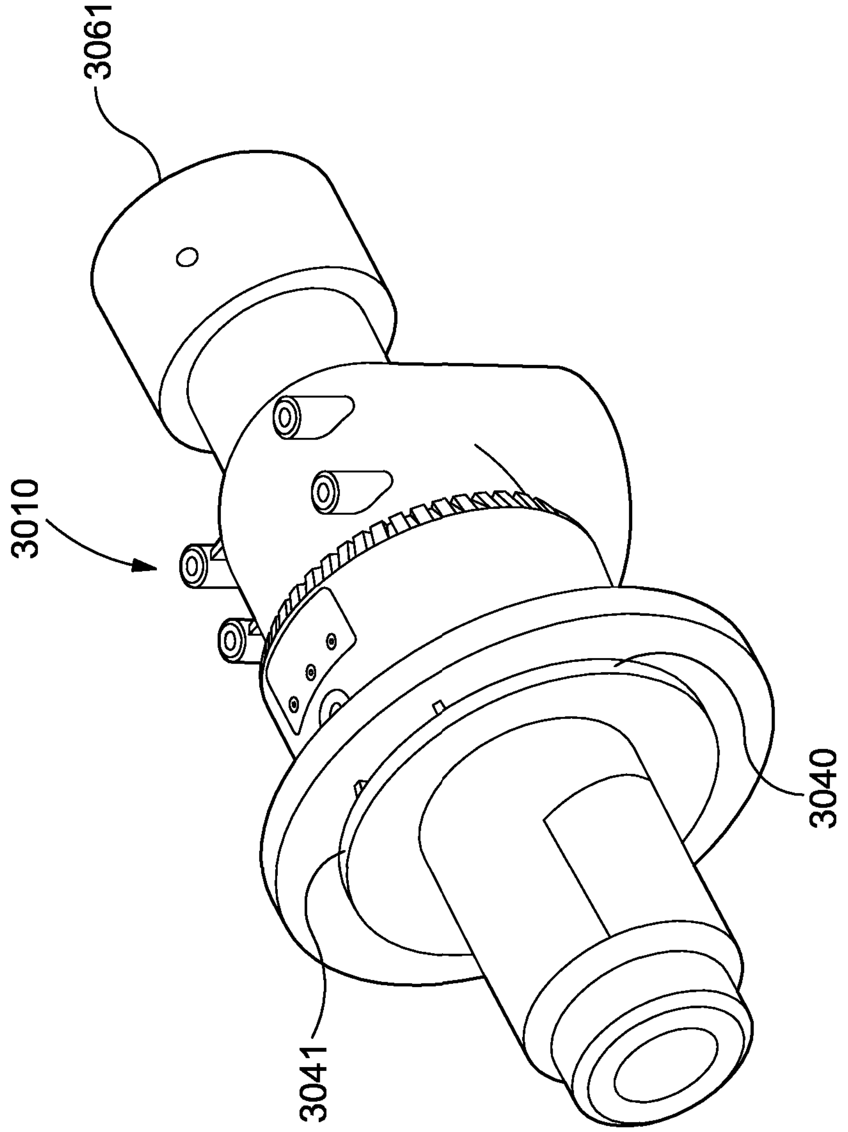

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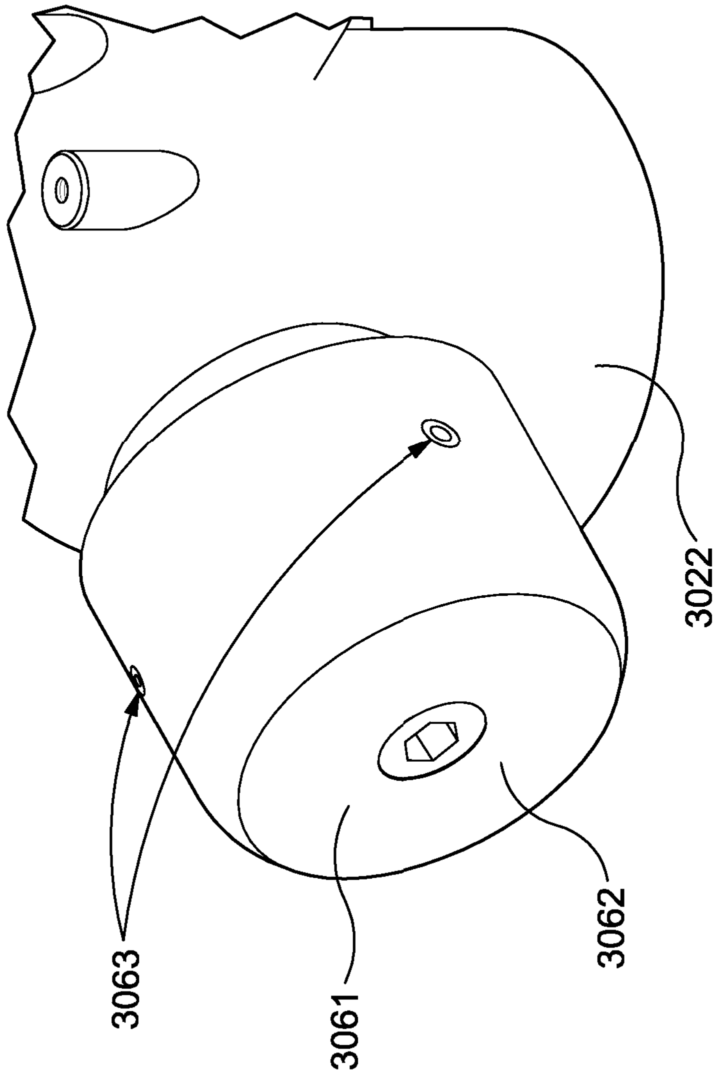

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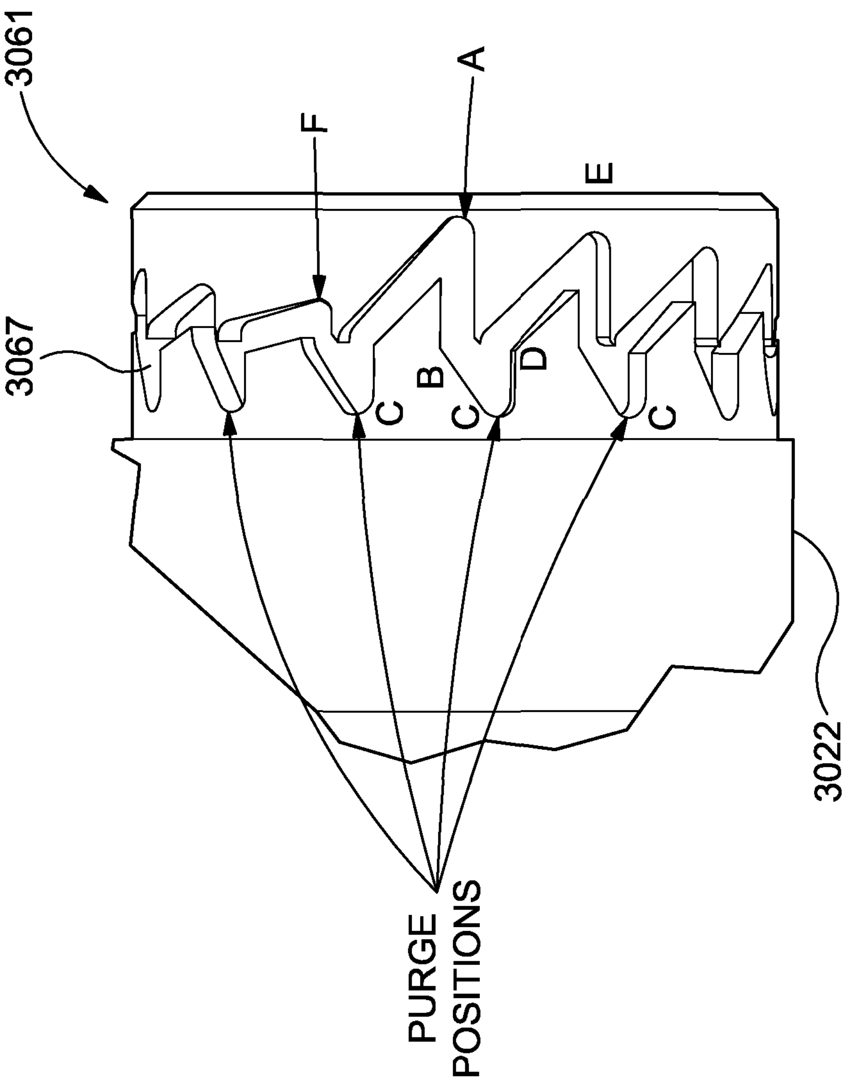

INDEX PATH (D)

Figure 23

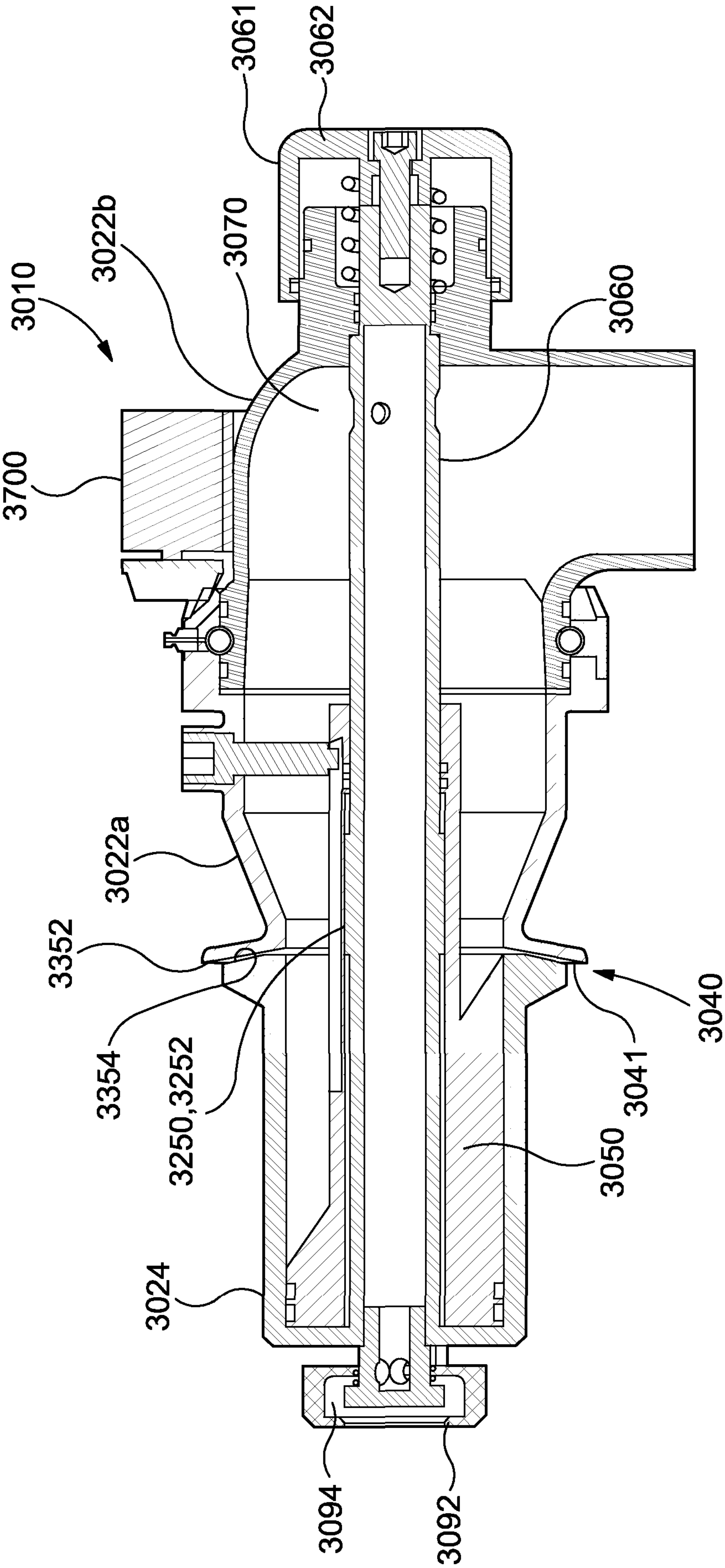
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Figure 24a

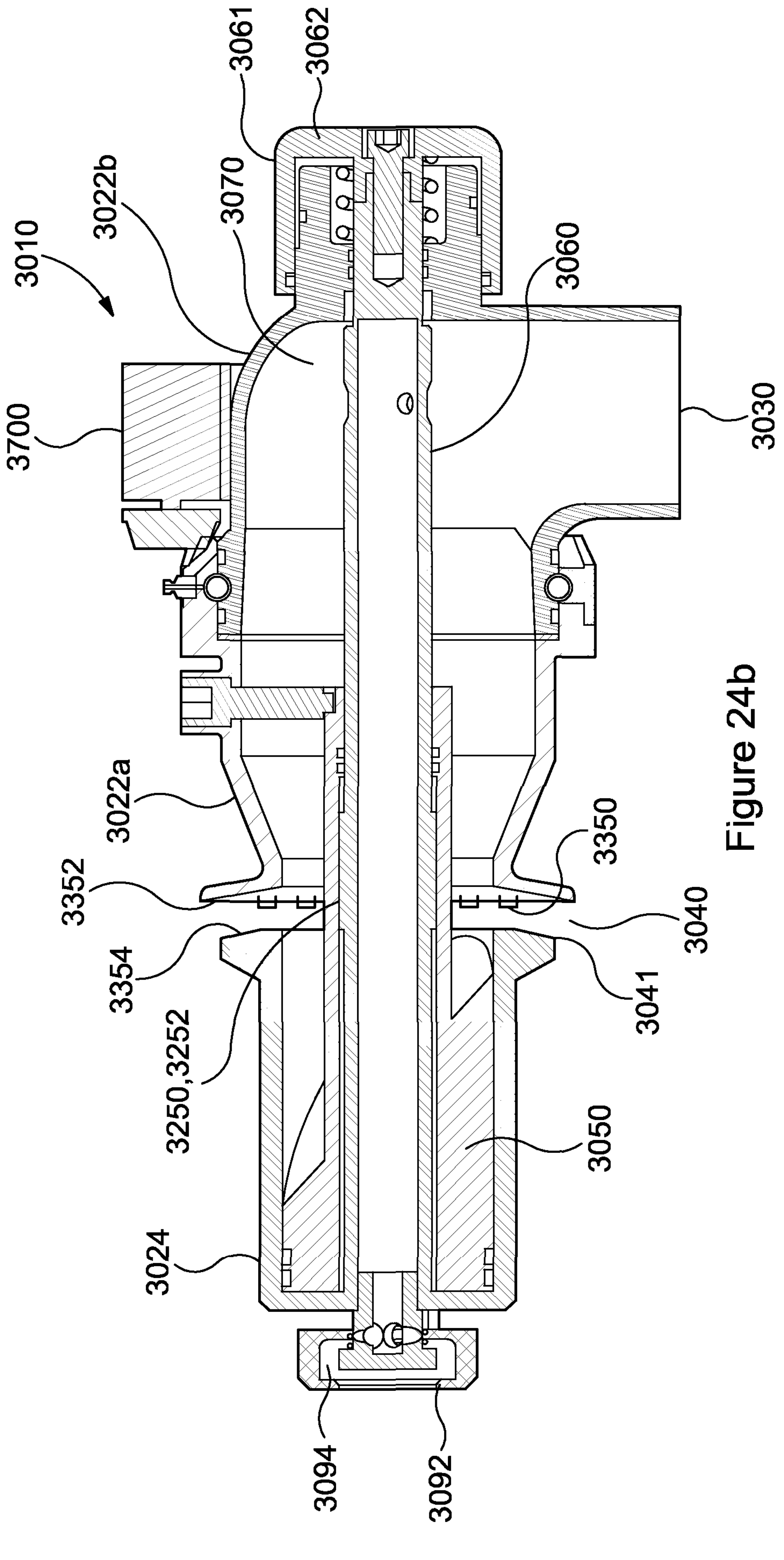
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Figure 24b

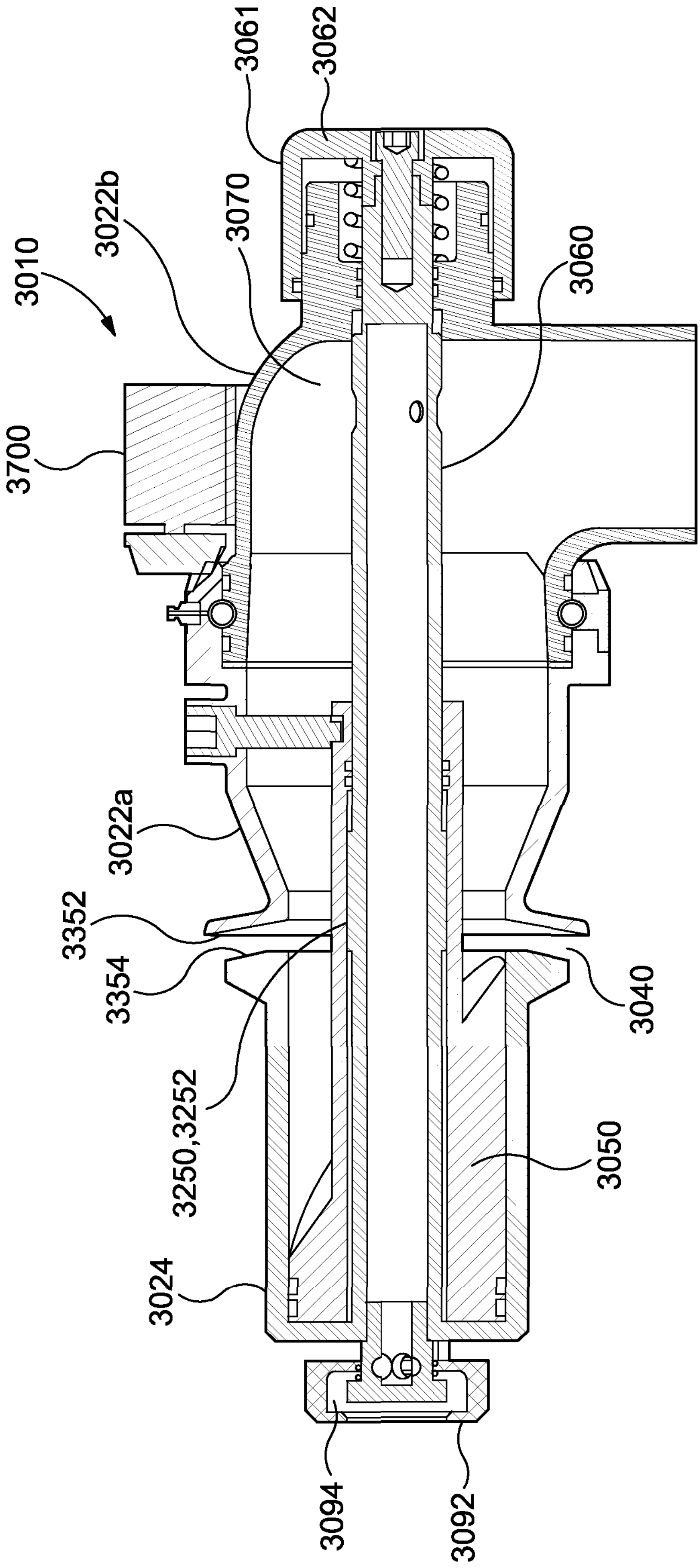
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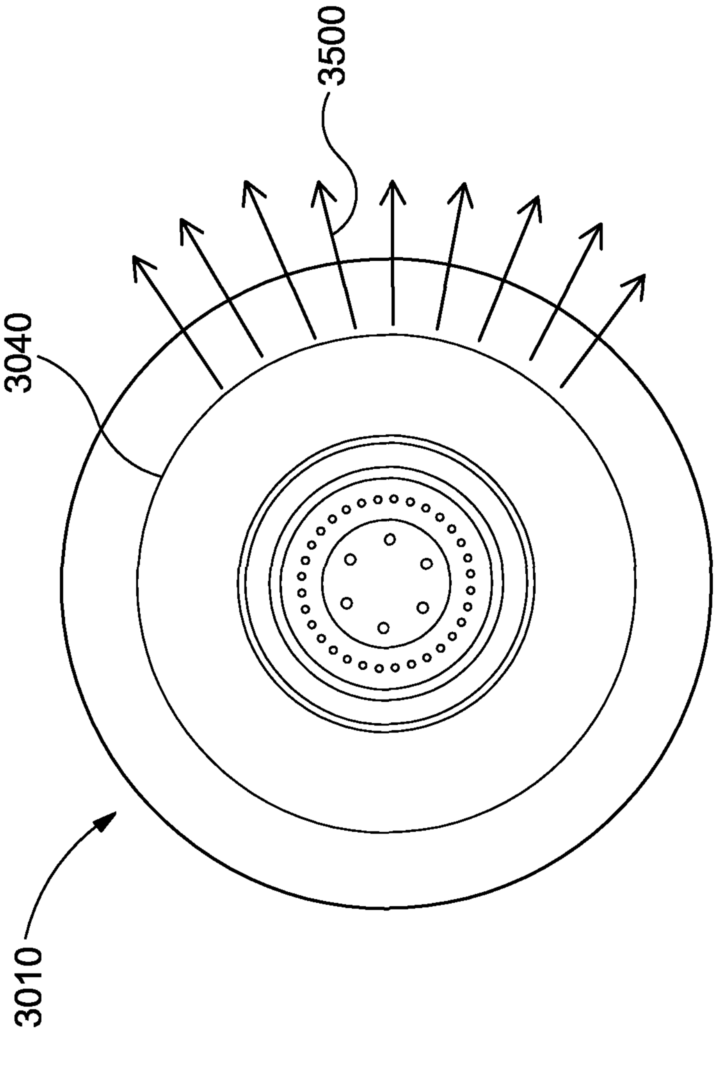
Figure 24c



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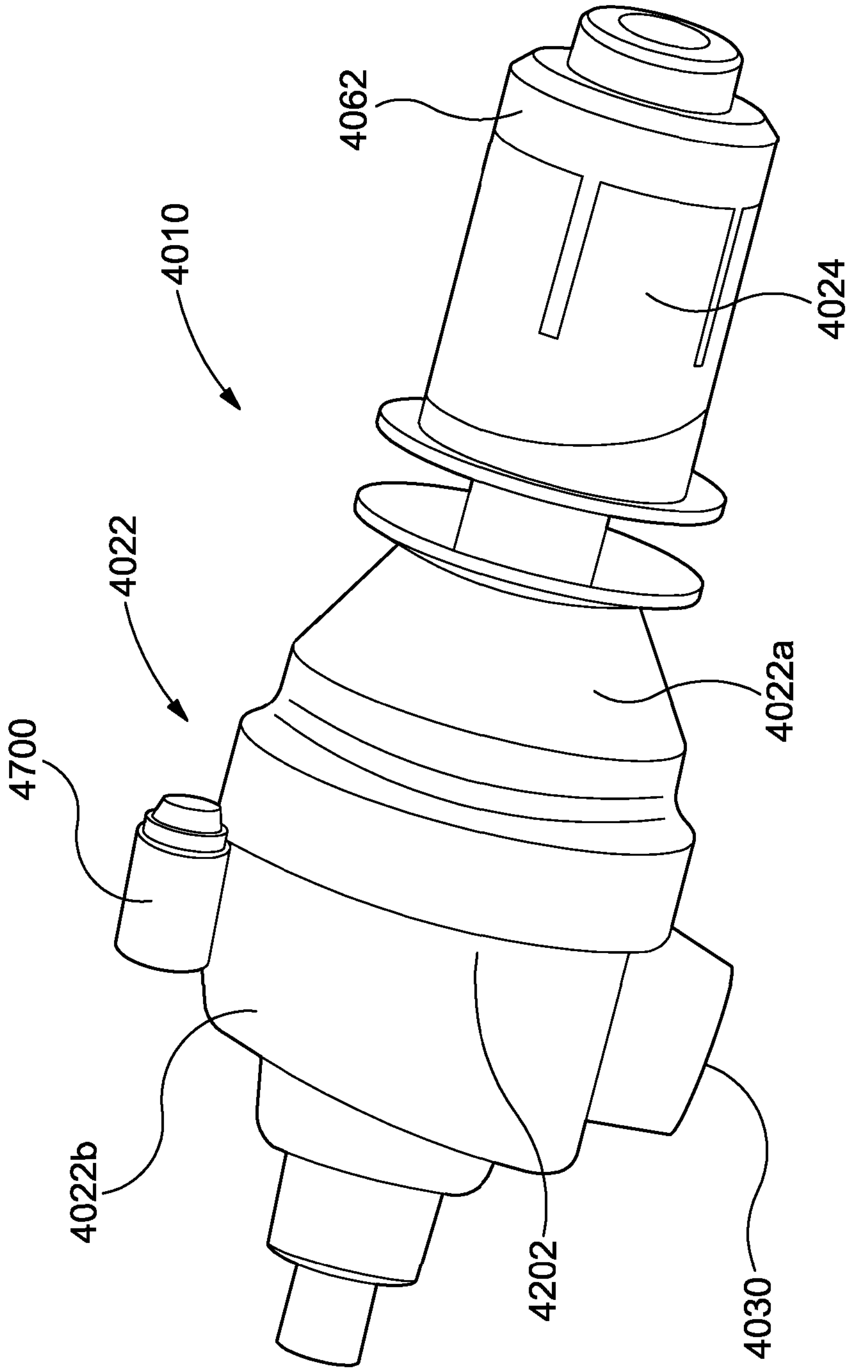

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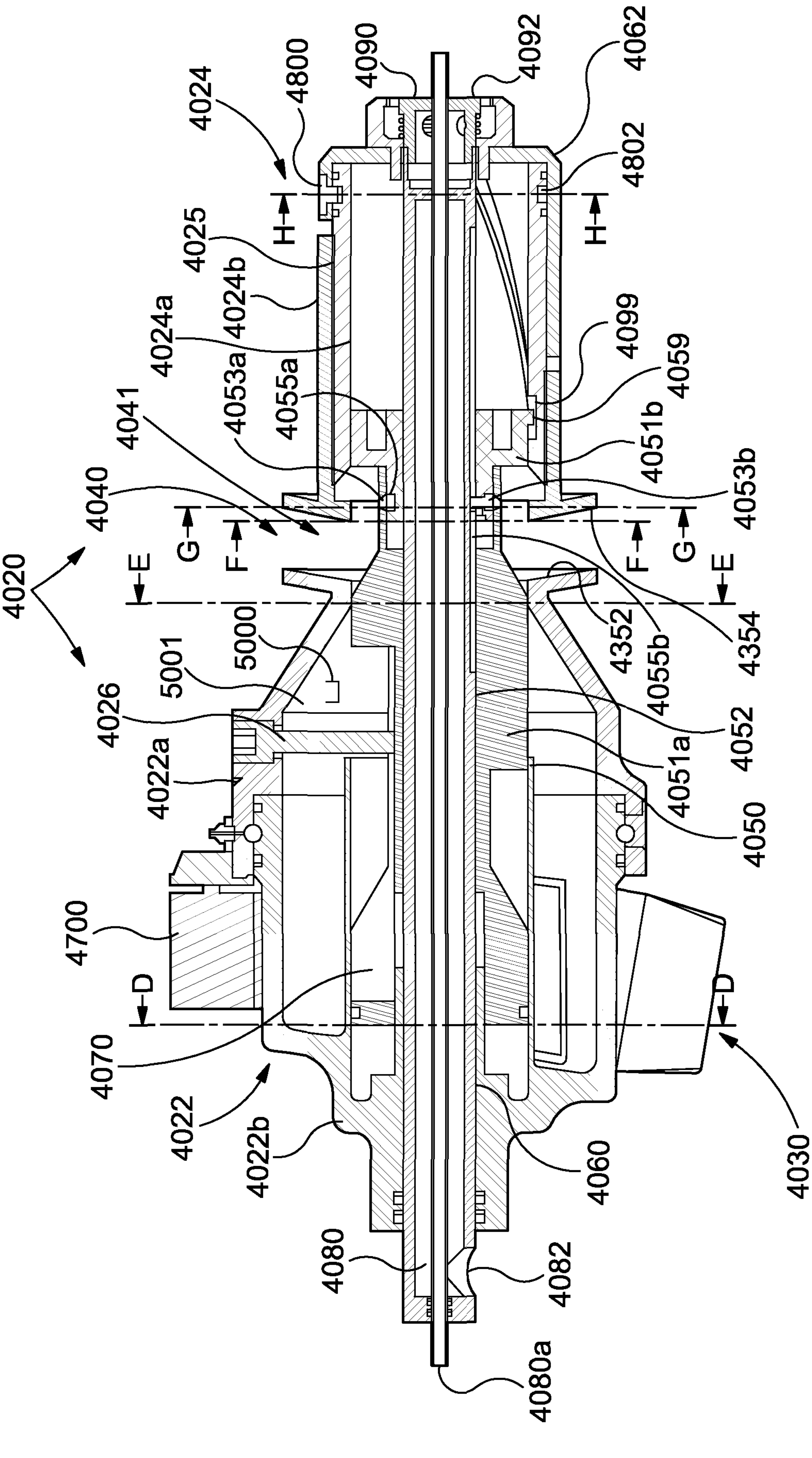
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Figure 27

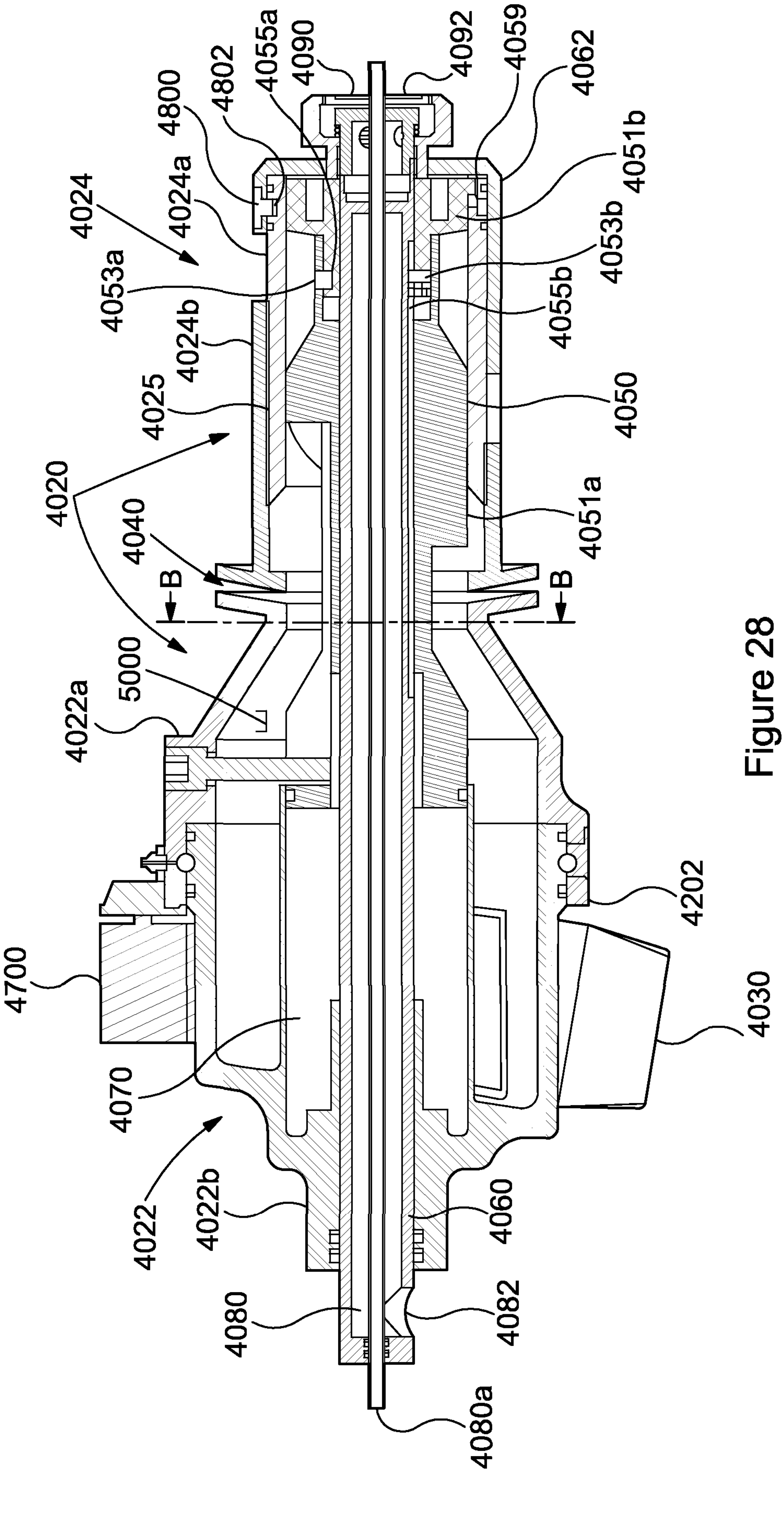
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Figure 28

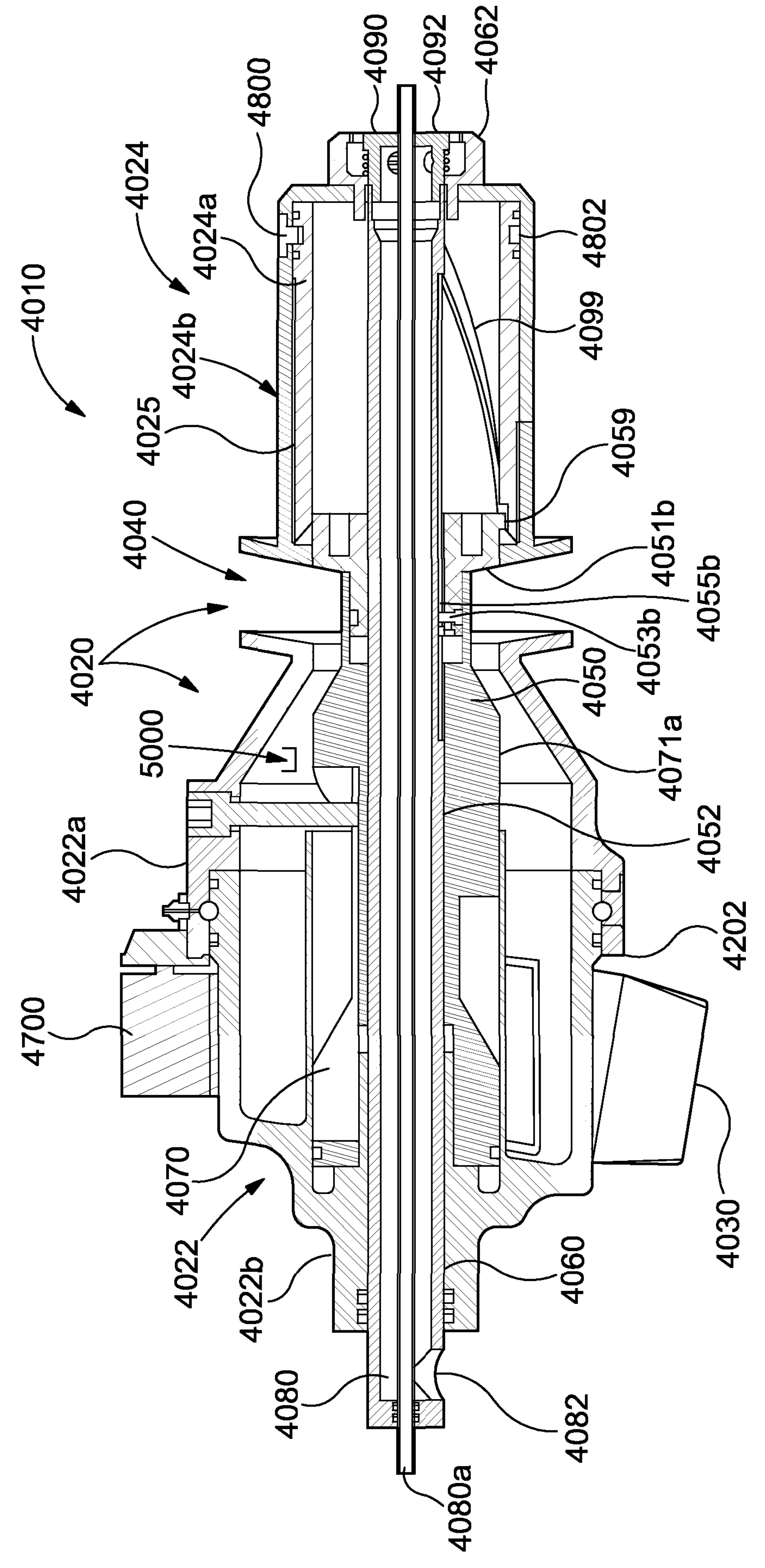
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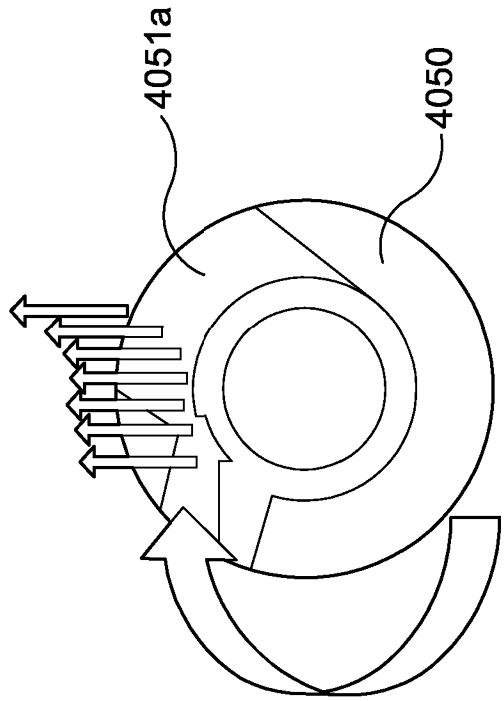
Figure 29



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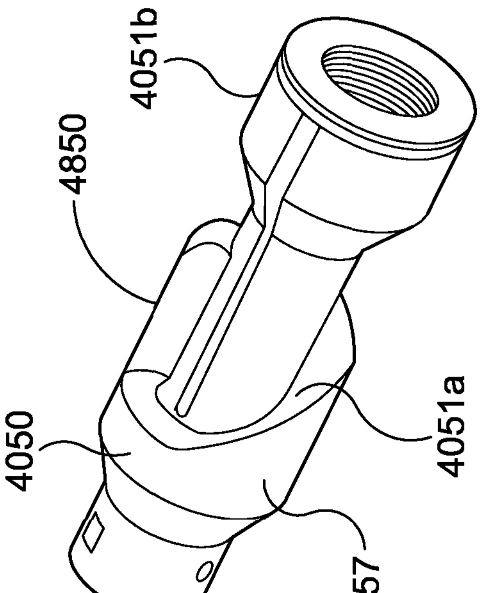

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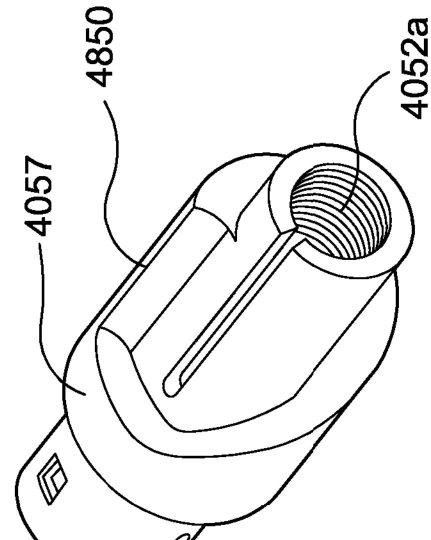

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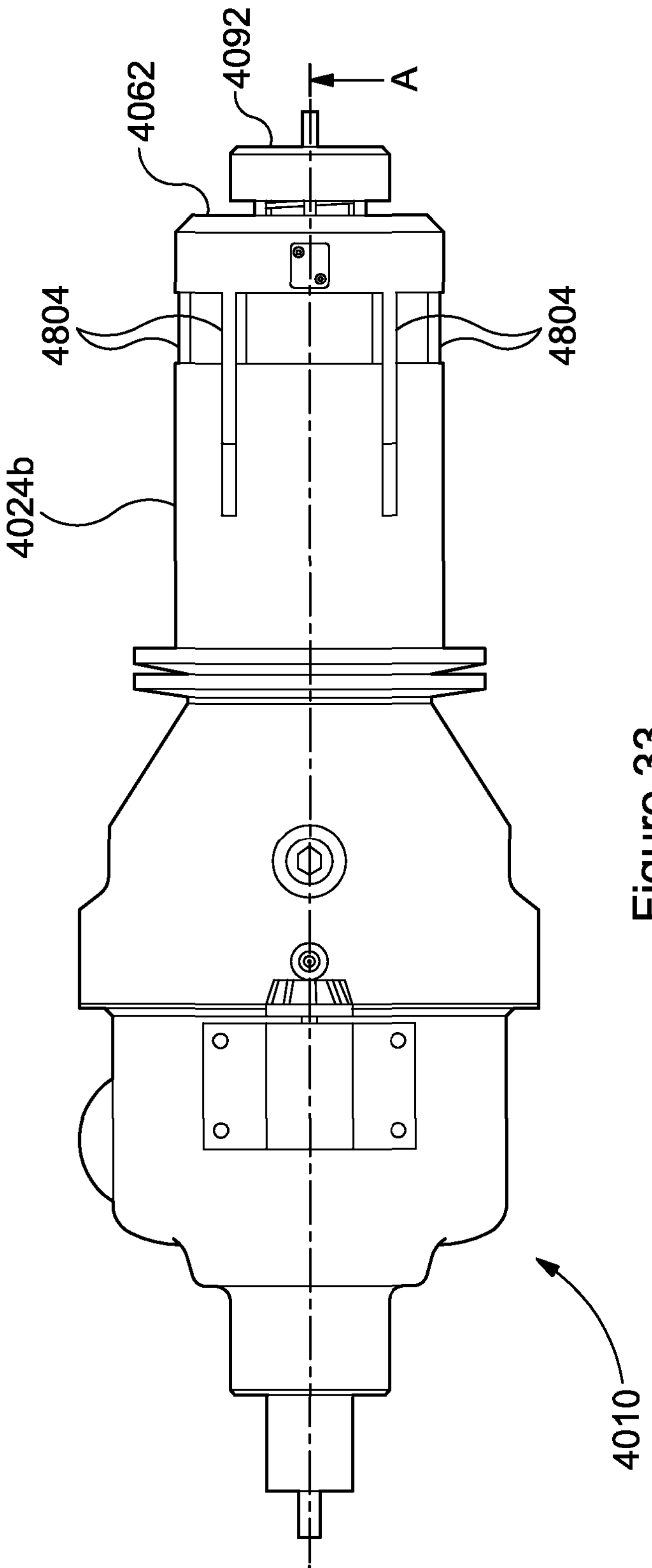

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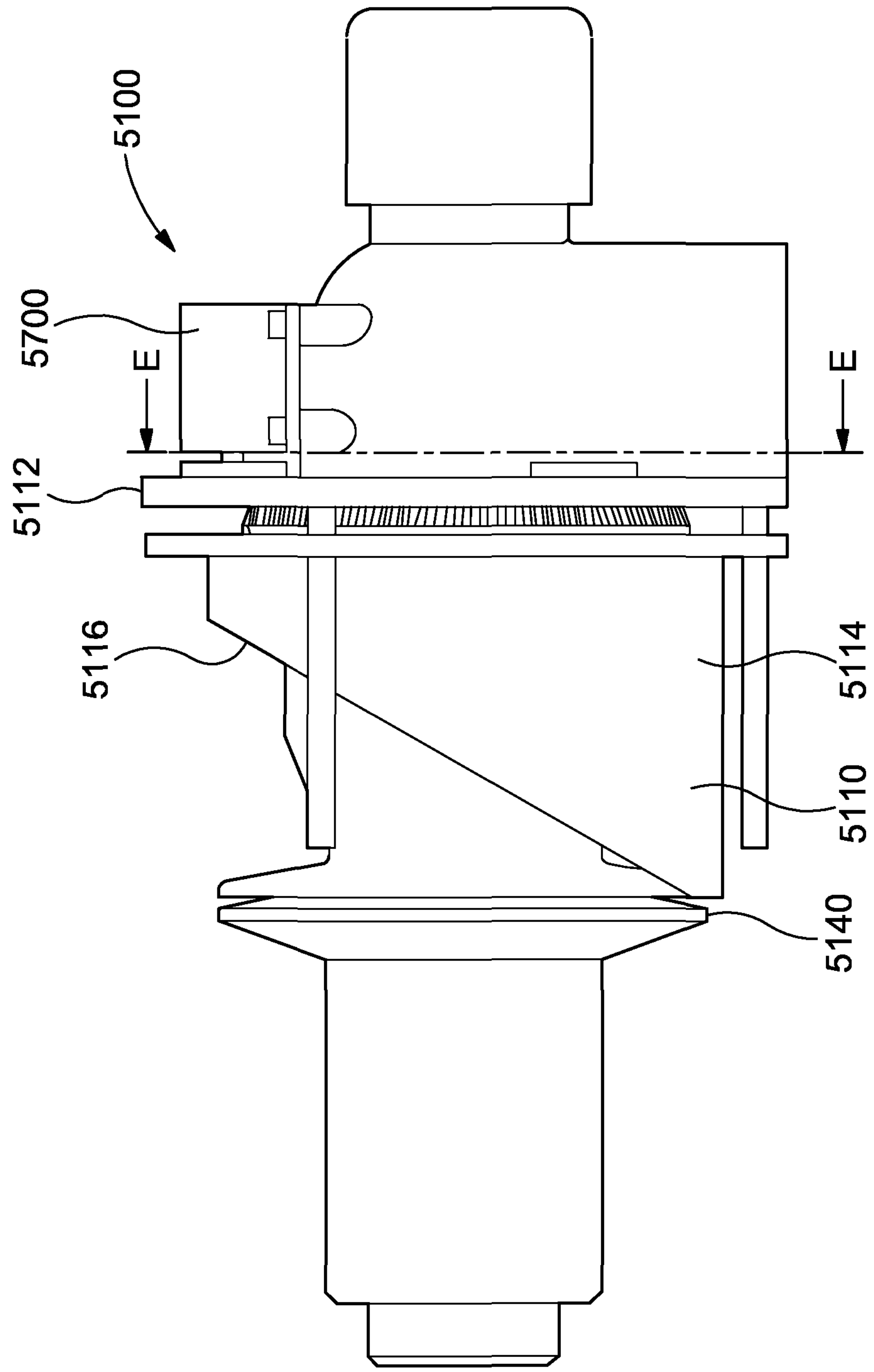

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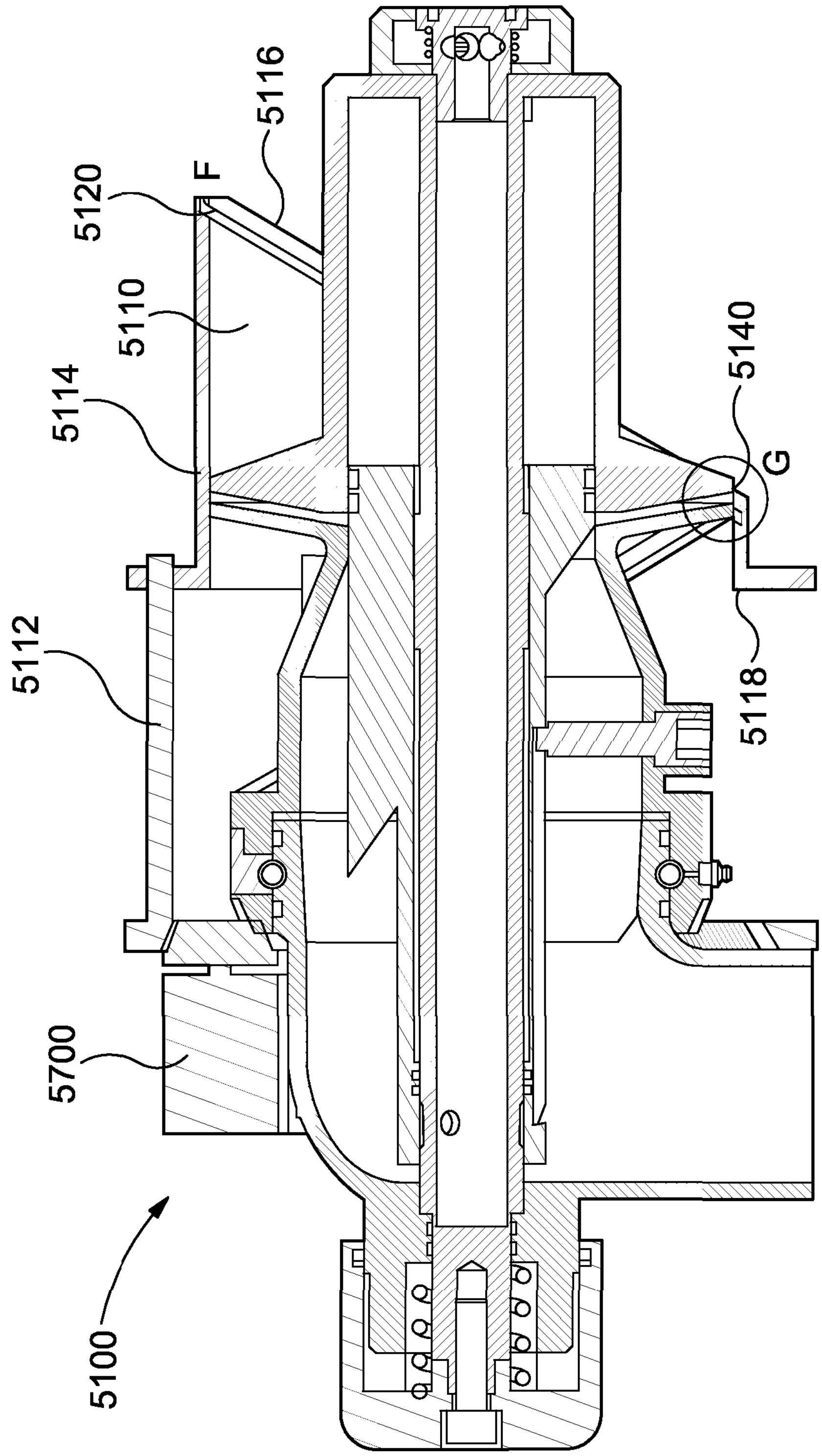

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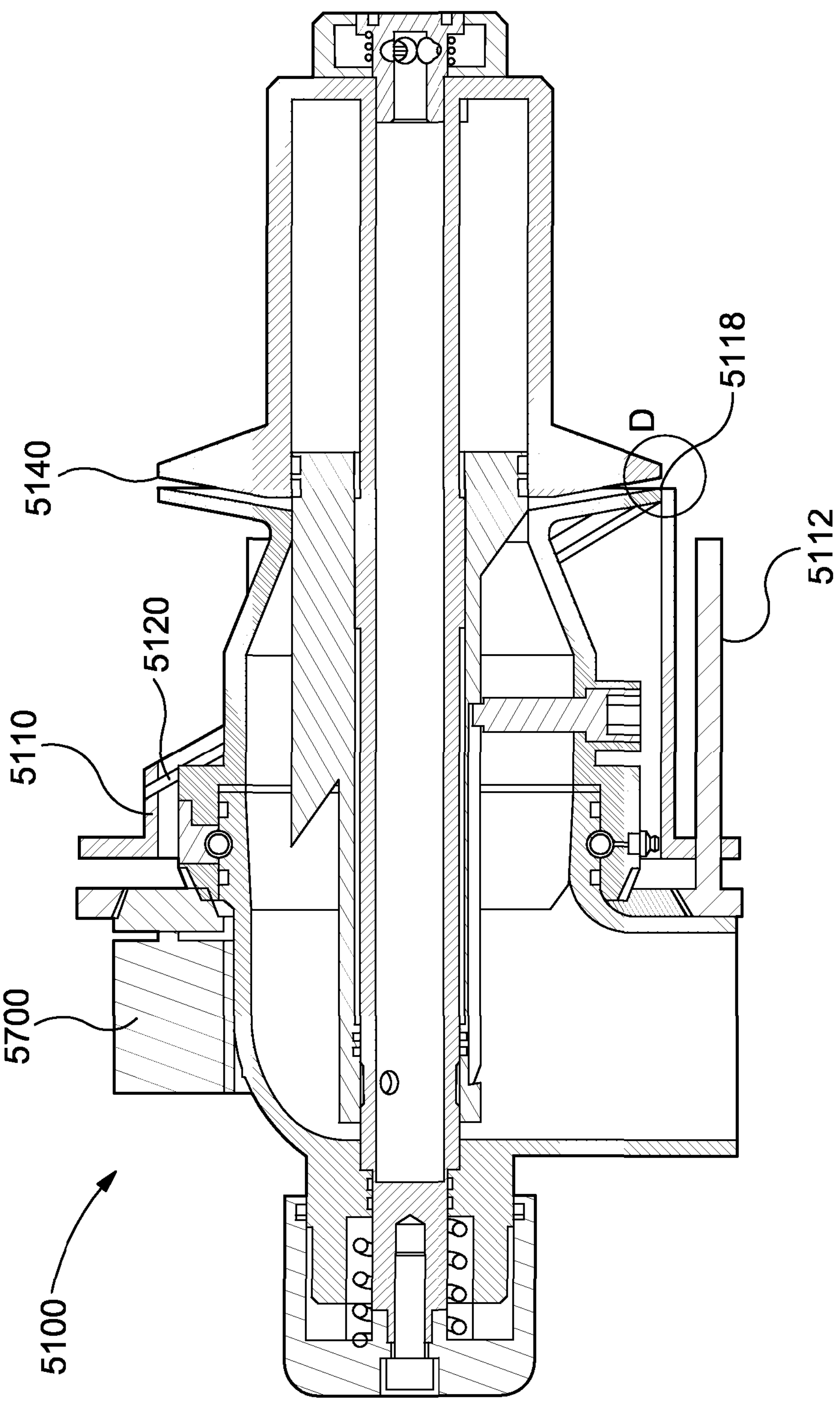

Figure 36

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2013/050582

A. CLASSIFICATION OF SUBJECT MATTER

INV. B05B1/30 B05B1/12 B05B1/04
ADD. B05B1/26 E21B41/00 F23G7/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B F23G B05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 622 947 B1 (RIVERA JOSEPH [US]) 23 September 2003 (2003-09-23) figures 1,8,9 -----	1-4,9, 10, 13-19, 21, 24-27, 30,56,57
X	GB 2 457 997 A (RIGCOOL LTD [GB] OPTIMA SOLUTIONS UK LTD [GB]) 9 September 2009 (2009-09-09) page 1; figures 1-14 -----	1-9,27, 30,32, 33,35, 37,38, 42,43, 45, 47-49, 51,54-60

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 July 2013	11/07/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Schork, Willi

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/084815 A2 (OPTIMA SOLUTIONS UK LTD [GB]; OAG JAMIE [GB]) 15 September 2005 (2005-09-15) figures 1-11	1-5, 8-10,12, 13,24, 25,27, 30,34, 35,38, 42-45, 47-49, 51,56-60
X	US 89456 A (ALLEN, ALBERT F.) 27 April 1869 (1869-04-27) figures 1,2	1-4,9, 10, 13-16, 19,21, 23-25, 30,56, 57,60
X	GB 721 037 A (STORK KONINKLIJKE MASCHF) 29 December 1954 (1954-12-29) figures 1,2	1-4, 9-11,13, 15,16, 19,21, 23,27, 28, 32-38, 41,42, 44,45, 47-49, 51,56,57
X	GB 1 028 004 A (FUR FIRESTONE PRODUKTE AG FAB) 4 May 1966 (1966-05-04) figure 1	1-6,9, 10,13, 24,25, 30,34
X	EP 0 927 562 A2 (VIGH ANDREAS [DE] VIGH ANDREAS [CH]) 7 July 1999 (1999-07-07) figures 1-5	1,2,56, 60

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2013/050582

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			NL	79125	C	02-07-2013
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